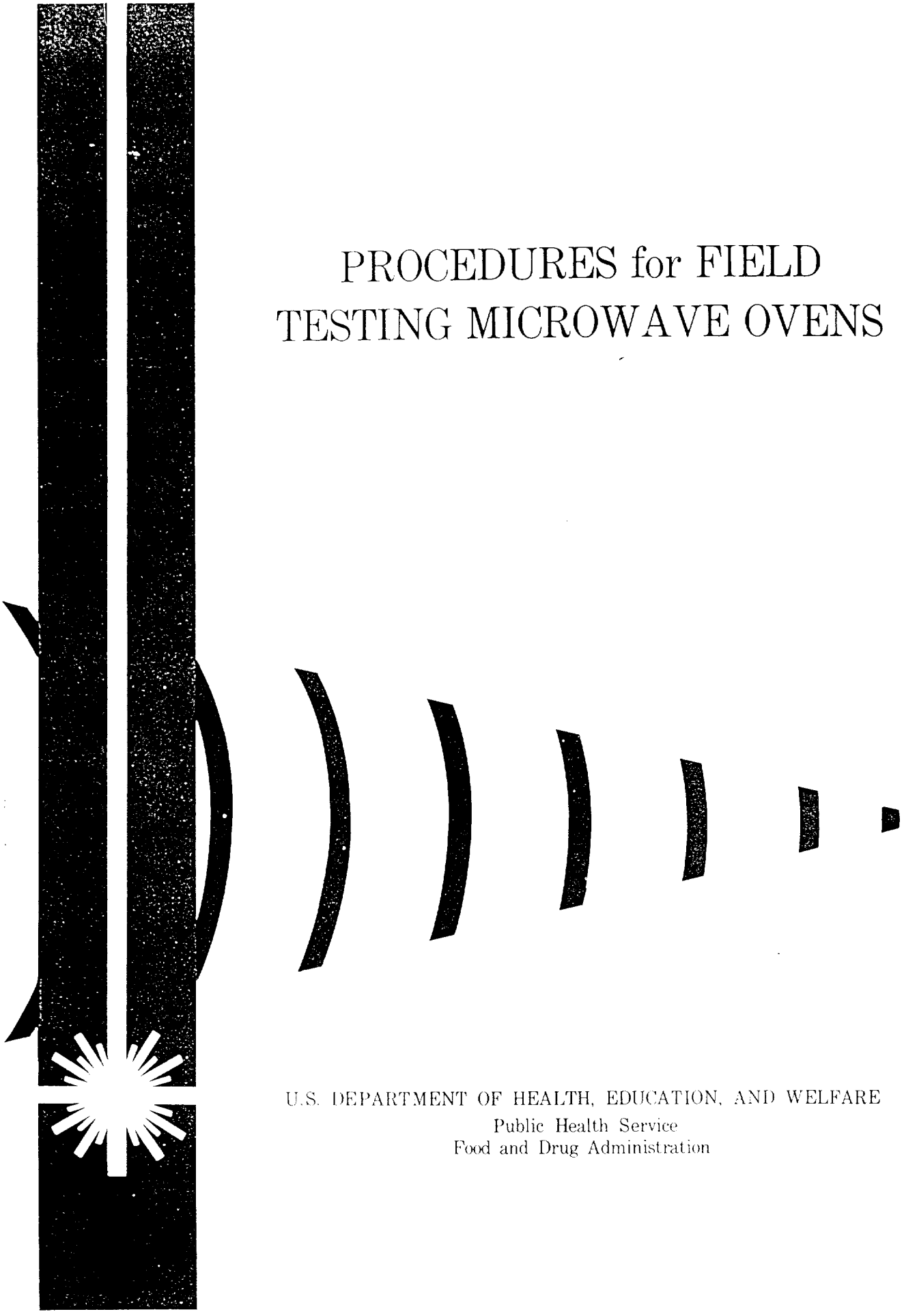
PROCEDURES for FIELD TESTING MICROWAVE OVENS



PROCEDURES for FIELD TESTING MICROWAVE OVENS

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Food and Drug Administration

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PROCEDURES for FIELD TESTING MICROWAVE OVENS

Division of Compliance

August 1977

WHO Collaborating Center for
Standardization of Protection
Against Nonionizing Radiations

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Food and Drug Administration
Bureau of Radiological Health
Rockville, Maryland 20857

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FOREWORD

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WHO Collaborating Center for Training and General Tasks in Radiation Medicine (Division of Training and Medical Applications)

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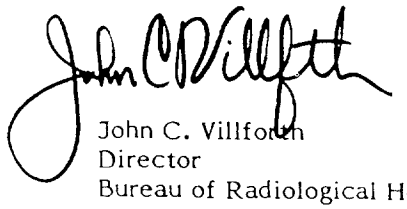

John C. Villforth
Director
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PREFACE

Testing programs for enforcement of the Food and Drug Administration's performance standard for microwave ovens, promulgated under the Radiation Control for Health and Safety Act, are performed by Agency field personnel as well as State and local radiation control personnel. These two groups test microwave ovens located in homes, food preparation establishments, and in dealer/distributor showrooms and warehouses for compliance with the microwave oven standard. This manual has been prepared in support of the field test programs to provide a detailed reference document covering the major aspects of field testing of microwave ovens. Substantial assistance was provided by the Bureau of Radiological Health's Division of Electronic Products regarding use of instruments and by personnel of the Executive Director of Regional Operations regarding the scope of the manual.

Robert G. Britain
Director, Division of Compliance
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ABSTRACT

This manual sets forth guidance and procedures for field testing microwave ovens for compliance with the microwave emission and safety interlock operation requirements of the Federal radiation safety performance standard. It presents background material and complete instructions for carrying out the necessary tests and also describes procedures for completing form FD 2536, "Microwave Oven Field Test Record," which is used to report the data to the Bureau of Radiological Health. It has been prepared to provide a detailed reference document that will be particularly useful to FDA, State, and local radiation control personnel responsible for the field testing of microwave ovens.

PROCEDURES FOR FIELD TESTING MICROWAVE OVENS

1.0 INTRODUCTION

This manual sets forth guidance and procedures for performing microwave oven compliance tests under FDA Compliance Program 7333.01, Field Compliance Testing of Microwave Ovens. The procedures will allow one to determine compliance with the two major safety aspects of the performance standard for microwave ovens: (1) microwave emission and (2) safety interlock operation. The remaining requirements of the standard, with one exception, are met by fixed design characteristics that are not subject to change after an oven is put into use. Compliance with these requirements is determined by the Bureau in its reports review program and by laboratory testing. The notable exception is the interlock monitor requirement. This is not amenable to field testing because it would, in most cases, require destructive testing, disassembly of the product, or both.

Data provided to FDA on microwave oven field tests through submission of completed form FD 2536 "Microwave Oven Field Test Record," is one of the essential elements in the continuing compliance program of the Bureau of Radiological Health. Testing in accordance with these procedures will provide the data necessary to complete form FD 2536. Such data are also necessary to the Bureau's continuing efforts to ensure that microwave ovens manufactured prior to the effective date of the standard (prestandard ovens) comply with the voluntary industry standard.

Although this manual contains complete instructions and background material, it is recommended that the tests described herein be performed by personnel who have been specifically trained in the proper methods for carrying out these tests. The manual is intended to supplement training courses that include demonstrations of proper test methods. These courses are normally presented by Regional Radiological Health Representatives of the Food and Drug Administration. Since the test procedures described in this manual include procedures to determine the radiation safety status of microwave ovens that have been exposed to worst-case conditions of use and misuse, it is essential that inspection personnel be well trained in proper inspection techniques in order that personnel exposure to microwave energy may be minimized or prevented.

2.0 MICROWAVE OVEN STANDARD

The performance standard for microwave ovens, 21 CFR 1030.10, was published as a final rule on October 6, 1970, and became applicable to all microwave ovens manufactured after October 6, 1971. The principal requirements of the standard are paraphrased as follows:

1. Microwave emission shall not exceed 1 milliwatt per square cent meter (mW/cm^2) at 5 cm or more from the external surface of the oven prior to acquisition by the purchaser and shall not exceed 5 mW/cm^2 at any time thereafter.

2. Microwave ovens shall have at least two safety interlocks, one of which must be concealed.

3. Failure of any single mechanical or electrical component shall not cause all safety interlocks to become inoperative.

4. Service adjustments or service procedures shall not cause safety interlocks to become inoperative or the microwave emission to exceed allowable limits.

5. Insertion of objects into the oven cavity shall not result in microwave emission in excess of the limits through reradiation.

A series of amendments to the standard has been promulgated bringing it to its present form. The principal amendments and their effective dates are as follows:

1. A means will be provided to monitor one or both required interlocks which shall cause the oven to become inoperable if the monitored interlock(s) fail in an unsafe condition. (Effective for all ovens manufacturered on or after August 7, 1974.)

2. One of the required interlocks (designated as primary) shall limit emission to 1 mW/cm^2 and another (designated as secondary) shall limit emission to 5 mW/cm^2 upon opening the oven door. (Effective for all ovens manufactured on or after August 7, 1974.)

3. User and service precaution labels and specific user and service safety instructions in manuals and cookbooks are required with all ovens manufactured on or after October 3, 1975.

4. Changes to clarify and strengthen requirements for interlock concealment and prevention of intrusion of objects are effective for all ovens manufactured on or after November 8, 1976.

5. An amendment to the regulations requires uncoded date of manufacture labels, i.e., a label with the month and year of manufacture, for all products for which there are standards, including microwave ovens manufactured on or after January 1, 1975.

The standard also requires that microwave emission be measured with a prescribed oven load through at least one stirrer cycle with the oven door closed and with the door fixed in any position which allows the oven to operate. Instruments for measuring microwave emission must meet certain response time, detector dimension, and accuracy specifications (see Appendix I, A-4).

Related regulations also require that each microwave oven produced after October 6, 1971, must bear a label certifying that it conforms to the standard applicable at the time of manufacture. It must also bear a label with name and address of the manufacturer (or the private label seller when sold under a brand other than the manufacturer's) and the place of manufacture (which may be coded).

3.0 MICROWAVE OVENS, DESCRIPTION AND OPERATION

The microwave oven is basically a metal cavity provided with a source of microwave energy and equipped with a door and door seal which, when closed, effectively prevents microwave energy from escaping from the cavity. The micro-

wave source is invariably a magnetron tube. The door is usually equipped with a viewing window that is covered by a metal screen which blocks microwave energy transmission through the window. The oven is equipped with interlocks that prevent generation of microwave energy when the door is opened. Most oven cavities are ventilated to remove moisture and hot air. Ventilation into the cavity is through perforations which are small enough to prevent the escape of microwave energy. Ventilation through the cabinet is through screens or louvers. On some ovens, some venting occurs through an air gap around the door seal.

Most ovens sold in the U.S. are intended for use in the home. Some, however, are intended for commercial use in restaurants, food vending establishments, fast food outlets, etc. The standard makes no distinction between those intended for either use. However, most commercial ovens are identifiable by their extensive use of stainless steel, simple controls (dial or pushbutton timers), heavy duty latches, and the lack of viewing screens. Most home ovens are in the 650-watt power range, whereas commercial ovens may range from 600 to 2400 watts or higher. Most commercial ovens will have commercial Underwriters Laboratories labels and National Sanitation Foundation labels. Note that ovens intended for household use will frequently be found in commercial use, particularly in small privately owned eating establishments.

3.1 OVEN CONTROLS

Microwave ovens have a variety of power and off/on controls that must be understood to ensure that emission tests are performed under the proper operating conditions. (Figs. 1 through 4.)

3.1.1 Power

While some ovens operate at constant power, others have provisions for setting microwave power in the form of (a) a power selector switch, (b) a step or continuously variable power control, or (c) cook/defrost selectors. Type (a) usually occurs in the higher power commercial ovens equipped with two magnetrons and may allow for selection of either magnetron or both. Types (b) and (c) usually control power by varying the magnetron duty cycle (ratio of off-time to on-time of a repetitive off-on cycle) with an electronic or electromechanical control. Off-on cycles may be as short as 1 second or as long as 1 minute. A few reduce power for defrosting or low power cooking by reducing the magnetron supply voltage and hence its output power.

3.1.2 Off/On Controls, Timers

All microwave ovens are equipped with a timer to stop microwave generation at the end of a predetermined period. These are usually rotary or linear dial timers or rotary, digital, pushbutton, or digital touchpad timers. Pushbutton timers are generally found only on commercial ovens and frequently are labeled by type of food rather than time. Some commercial ovens have both pushbutton and dial timers. Digital touchpad timers invariably use digital logic to control time and often provide programmability and digital power control.

On many ovens the timer is the only off/on control other than the safety interlocks. On these ovens, any time the door is closed and the timer is on, the oven will produce microwave energy. On such ovens the timer should always be turned off (i.e., set to zero) when closing the oven door except when microwave generation is desired. This will help avoid accidental operation of

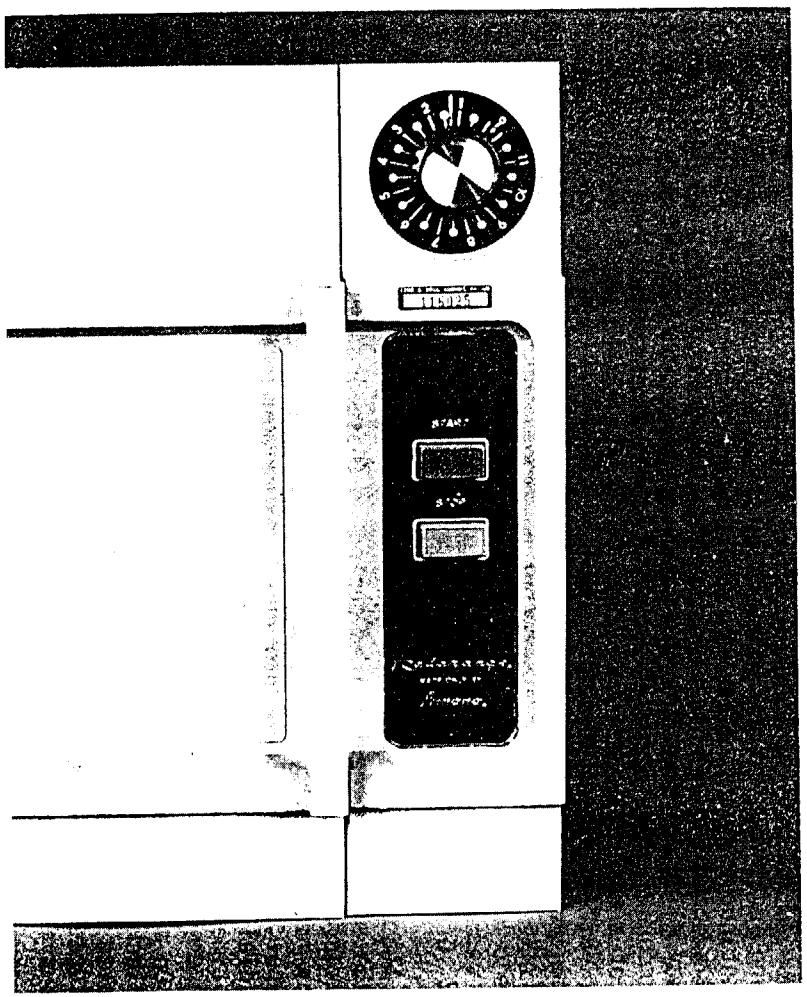


Figure 1

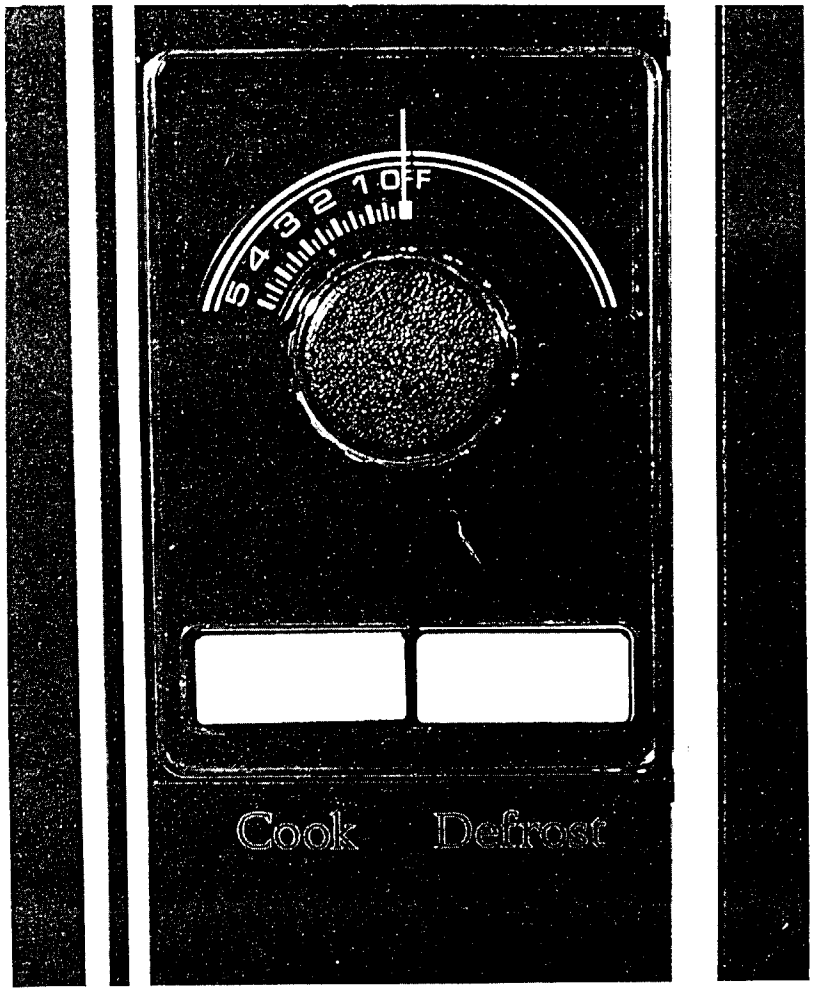


Figure 2

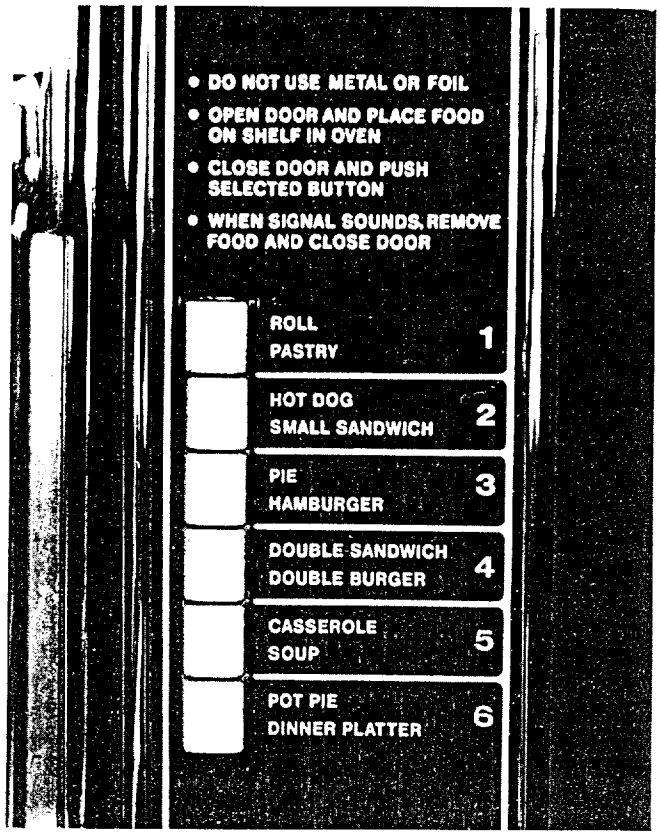


Figure 3

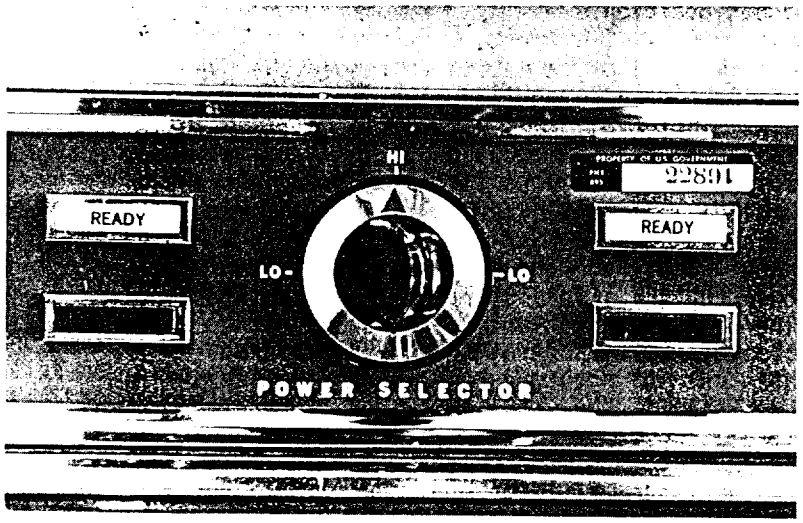


Figure 4

an oven without a load in place which might result in oven damage, e.g., due to overheating of the magnetron (which can in some cases lead to burnout of the magnetron).

In addition to a timer, some ovens are equipped with start/stop controls. Frequently the start controls will be labeled "cook." Such ovens require operation of the start control to turn on the magnetron; however, on some ovens with "cook/defrost" controls, the "cook" control is simply an operational mode selector and has no effect on starting the oven. On some ovens with "stop" controls it may not be possible to open the door until the "stop" button has been pressed or the timer turned off.

Because of these variations in operating procedures, it is necessary to familiarize oneself with the operating controls and their functions before attempting to test an oven.

3.2 INTERLOCKS AND MONITORS

Interlocks are normally actuated as a result of motion of a latching mechanism or motion of the door. Those operated by door motion are usually actuated either by a pin or other protrusion that enters a hole in the oven face when the door closes or by a fixed or pivoted arm attached to the door. The arm may also serve to limit door travel or control door closing.

Latch interlocks have the advantage of being able to terminate generation of microwave energy with little or no door motion. These types of interlocks can usually be identified by visual inspection. Absence of a latch, of course, precludes a latch interlock. Virtually all ovens with a latch will have one or more latch actuated interlocks. Latch release controls may be on the door or on the oven control panel.

In some ovens the latch (but not necessarily the interlock) is electrically actuated, preventing the door from being opened while microwave energy is being generated. On some of these the door may be pulled out slightly against the latch (typically 1 to 3 millimeters) while the oven is operating. On such ovens it is appropriate to perform the "door opening" test (see 4.2.2) with the door in the pulled out position.

The interlock monitor, a device to render the oven inoperable in the event of interlock failure(s), is required on all ovens produced on or after August 7, 1974. The interlock failure sensing element is usually a snap-action switch similar to the interlock switches, which is activated by door motion and is timed to close after the interlock(s) have opened and to open before the interlock(s) close. The oven is usually rendered inoperable by causing a fuse or similar device to open the main power circuit within the oven after interlock failure(s) have occurred and been detected. In some units the fuse may interrupt power to the solenoid of a relay, and in others a latching relay may be used. The relays in turn interrupt power to the magnetron. In all cases, repairs must be made before operation can be restored.

3.3 DOOR SEALS

A microwave oven must have a door to allow insertion and removal of food. This door must be designed to prevent the escape of the microwave energy with which the oven cooks. By making the door of microwave reflective metal, it can be made to contain the microwave energy with relative ease. The more difficult

job is in designing the door-to-oven seal to prevent the escape of microwave energy.

A number of mechanisms have been developed for this purpose, which we refer to generically as door seals. Some require a physically tight fit between oven and door so that the cavity and door effectively become a closed metallic box with no electrical discontinuity between door and oven cavity. On the other hand, sealing mechanisims have been developed which can function with no contact between door and oven and can, in fact, operate with an air gap between the two. The various types are described briefly below. They may be used singly or in a variety of combinations. It should be noted that the various door screens, which are provided to allow the user to view the inside of the cavity, do not allow microwave energy to pass through them but reflect it as though they were a solid surface. This phenomena is a function of the size of the holes in the screen and the wavelength of the microwave energy. The principal requirement is that the holes be a small fraction of a wavelength in size.

3.3.1 Metal-to-Metal Seals

The name of this seal is self descriptive. It requires an intimate electrical contact between the metal of the cavity and the metal of the door, and it effectively makes the door and oven cavity a closed metallic box. As long as an adequate metal-to-metal contact is provided, microwave energy will be contained within the cavity. However, due to the effects of wear and other use factors, it is difficult to maintain an effective metal-to-metal seal over the life of a product. Consequently, this is now the least used seal. Its most common form is that of a resilient metal mesh gasket attached to the oven door that makes conductive contact with the metal face of the cavity. In combination (microwave and thermal energy) ovens, a metal mesh gasket may be the primary seal or may be used with other types of seals and be present primarily to prevent heat transfer. In the latter instance it may contact an insulated rather than a conductive surface and form a secondary capacitive microwave seal. "Capacitive" seals are described below.

3.3.2 "Capacitive" Seals

This is an improvement over the metal-to-metal contacting seal and evolved from a type of contacting seal. This seal used a large flexible metal plate which pressed against a wide border of metal around the front of the cavity, generally referred to as the oven face. Unfortunately, arcing frequently occurred between the seal plate on the door and the oven face wherever the seal plate was not in intimate contact with the oven face. To eliminate the arcing, the seal plate was covered with a thin layer of insulative coating. While this breaks the metal-to-metal contact, it prevents arcing and continues to seal the oven if the mating surfaces are wide enough and come into close enough contact. This type of seal is known as a "capacitive" seal because the two metallic surfaces with an insulator between them resemble a capacitor in construction. Actually, the interface created by the "capacitive" seal effectively creates a very low resistance path between the oven and the door for the microwave energy. Consequently, the microwave energy behaves as though a metal-to-metal contact exists between cavity and door.

While most manufacturers use the thin flexible metal seal plate, at least one manufacturer has succeeded in using a rigid plate on the door as well as on the cavity face. This type of seal is highly effective and overcomes many of the problems of the metal-to-metal seal. The better "capacitive" seals (or "capacitive" and choke seal combinations) can be expected to last the life of

the product with little or no degradation of performance. The "capacitive" seal plate on the door of many ovens is surrounded by a choke seal to block transmission of energy which escapes through the "capacitive" seal. Choke seals are described below. Some "capacitive" seals operate effectively with a small air gap between the door and cavity. Therefore, a test of tightness of fit is not necessarily a valid check for indication of leakage with this type of seal. The dielectric coatings may be formed by colorless anodizing of aluminum and may not be visually apparent.

3.3.3 Choke Seals

Choke seals do not require either a metallic contact or an intimate contact between insulated surfaces of the oven and door to function. The principle on which choke seals function involves electromagnetic resonance of mechanical structures whose dimensions are related to the wavelength of the microwave frequencies involved, in this case the 2450 MHz of the magnetron. Physically, the choke joint is made up of an air or plastic filled channel around the periphery of the cavity. The choke may be located in the oven face, the mating face of the door, or in a portion of the door which is inserted into the cavity. It may also be in the form of a channel in a shoulder around the periphery of the inner surface of the door, such that the choke, when the door is closed, will surround a mating shoulder built up around the cavity mouth.

The choke serves to reflect microwave energy, which attempts to pass between the oven and door, back into the oven cavity. Chokes vary in design somewhat, so that some are effective with substantial gaps between door and oven, while others require a tighter fit. The combination of a choke surrounding a "capacitive" seal is very effective and allows effective sealing with larger gaps between oven and door than can be tolerated in "capacitive" seals alone. The presence of a choke is not always apparent because all or part of the door surface, including the choke, may be covered by plastic. Variations of the choke make up the majority of the seals in use today. This type of seal is usually the least affected by wear and use of the product.

3.3.4 Absorbent Seals

There are two types of absorbent seals, resistive and magnetic; both are generally a plastic or synthetic rubber that is filled with carbon or a ferrous material. They are usually used to absorb harmonic energy that may not be blocked by capacitive or choke seals, but they may function equally well at the fundamental frequency. In some instances absorbent seals are designed to perform a secondary sealing function at the magnetron frequency to minimize leakage from a "capacitive" or choke seal. Some ovens use a "capacitive" seal, a choke seal, and an absorbent seal.

4.0 MICROWAVE OVEN TESTING

4.1 GENERAL TEST INSTRUCTIONS

4.1.1 Prestandard Versus Poststandard Ovens

The performance standard for microwave ovens became effective October 6, 1971, and applies to all ovens manufactured on or after that date, i.e., poststandard ovens. (This includes those manufactured before the effective date of the standard but voluntarily certified by their manufacturers.) Prestandard

ovens, those produced prior to the effective date and not certified, are not required to meet the standard. These are tested for proper interlock function and for compliance with the so called "voluntary industry standard" of 10 mW/cm^2 for microwave emission. The prestandard ovens also present certain special testing problems.

Most prestandard ovens were not equipped with latch-actuated interlocks, nor was any limit applied to the emission that may occur upon door opening prior to the point where the interlock turns off the magnetron. Many of these ovens emit a high burst of microwave energy every time the door is opened. The magnitude of the burst is limited only by the rapidity with which the door is opened. Consequently, special procedures and special care must be exercised when testing such ovens for interlock function.

Poststandard ovens must have two safety interlocks. At least one safety interlock must stop microwave generation upon door opening before the emission limits of the standard are exceeded. As with closed door leakage, this is 1 mW/cm^2 prior to purchase and 5 mW/cm^2 thereafter. Consequently, most poststandard ovens have one or two latch-actuated interlocks that actuate before door motion begins. In later poststandard ovens (produced on or after August 7, 1974), the second required interlock must also stop microwave generation before the 5 mW/cm^2 limit is exceeded. As a result, interlock function tests on poststandard ovens are simpler and inherently less hazardous to both personnel and instrumentation. Determination of prestandard or poststandard status of an oven can be made in several ways.

1. Presence or absence of certification label: Prestandard ovens will not have a label certifying compliance with the standard. All poststandard ovens are required to have a permanent label at the time of manufacture. However, a small percentage of these may have lost the certification label since being put into service.

2. Date of manufacture: This will appear in code either as part of the serial number or model number on some prestandard and on all poststandard ovens manufactured prior to January 1, 1975. The month and year of manufacture will be printed or written out in an uncoded form on all ovens produced after January 1, 1975. Decoding information is available through the Regional Radiological Health Representative (RRHR) in the FDA regional offices. (See Appendix II for addresses of FDA regional offices and the States that they cover.)

3. Date of purchase: The owner's statement of date of purchase, if prior to October 1971, will identify prestandard ovens as such. (A small number of ovens were certified prior to October 6, 1971. These will have certification labels and are considered to be poststandard ovens.)

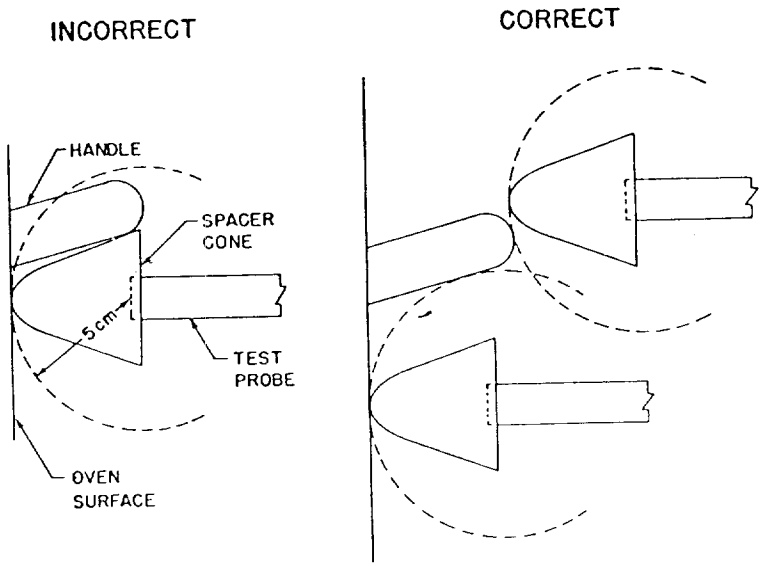
4. Oven Models: For most ovens it is possible to determine from the model number whether it is a prestandard or poststandard oven. Microwave oven model lists are available through the RRHR in the FDA regional offices.

If status cannot be determined, one should assume that the oven is prestandard and test it accordingly.

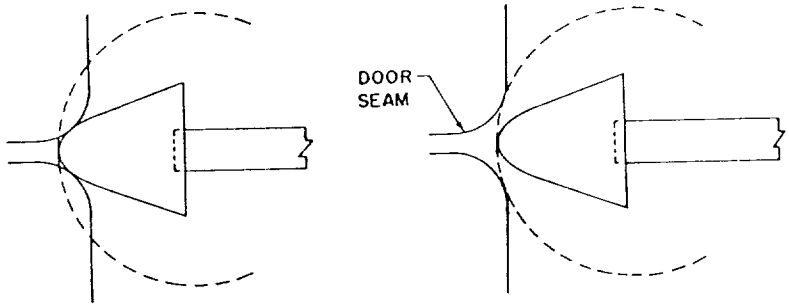
4.1.2 Position of Test Probe

The microwave oven standard requires that measurements be made at not less than 5 centimeters from the external surface of the oven. External surface, by definition, includes door handles, latches, and control knobs. Therefore, the

test probe should always be positioned so that the center of the detector in the probe is 5 cm from any external surface, i.e., as though the spacer cone were spherical in shape rather than conical. (Some newer instruments may be equipped with hemispherical or spherical spacers.) Examples of correct and incorrect location of the probe are shown in figure 5. The probe should normally be positioned so that it is perpendicular to the plane of the surface being surveyed, e.g., to the front, top, sides, or bottom as illustrated in figures 6 through 9. In some instances the source of a leak may be a door seam formed by surfaces which meet at an angle rather than in a plane, and the direction of leakage may be suspected to be in a direction other than perpendicular to the surface being scanned. In such cases the probe may be rotated around the corner in a plane which is perpendicular to the surfaces which form the corner. As shown in the photographs, the probe should always be held only by the handle when in use.



TESTING IN CLOSE PROXIMITY TO HANDLE OR OTHER PROTRUSION



TESTING IN VICINITY OF SURFACE DISCONTINUITY

Figure 5

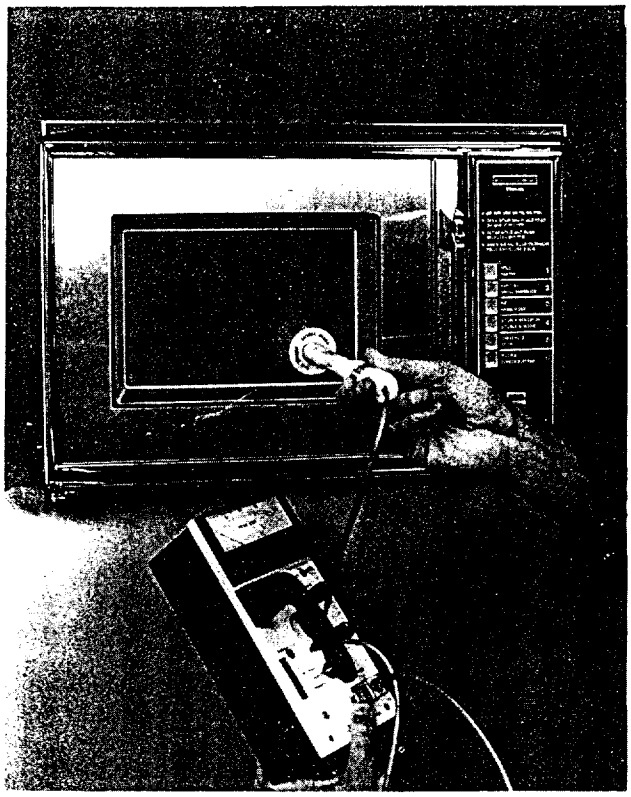


Figure 6

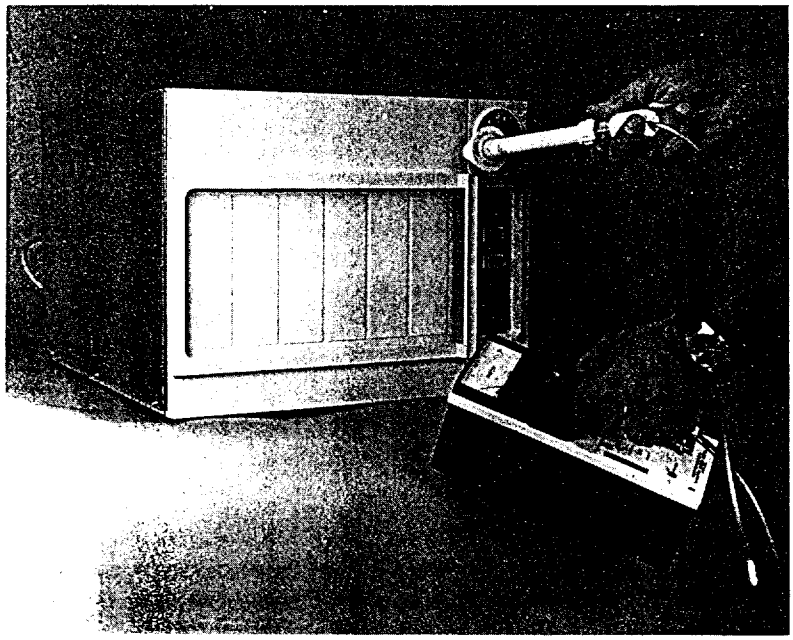


Figure 7

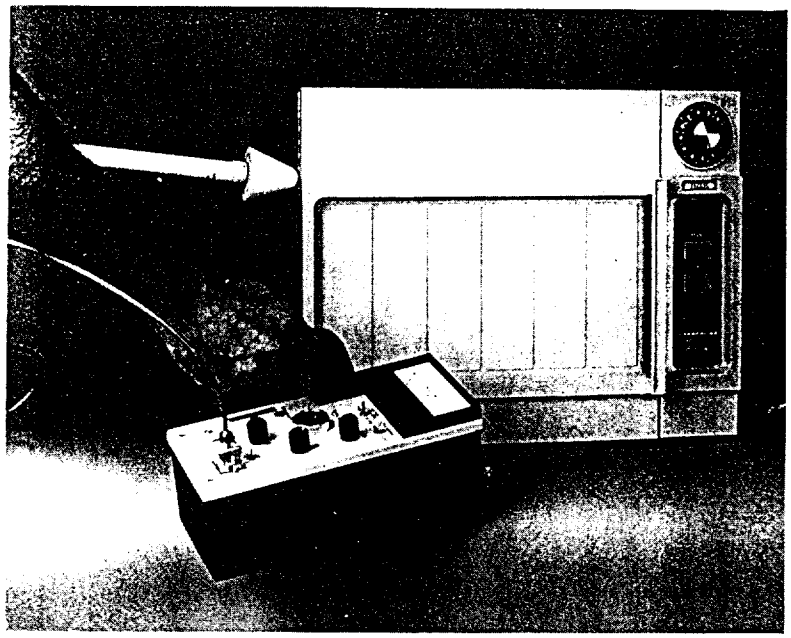


Figure 8

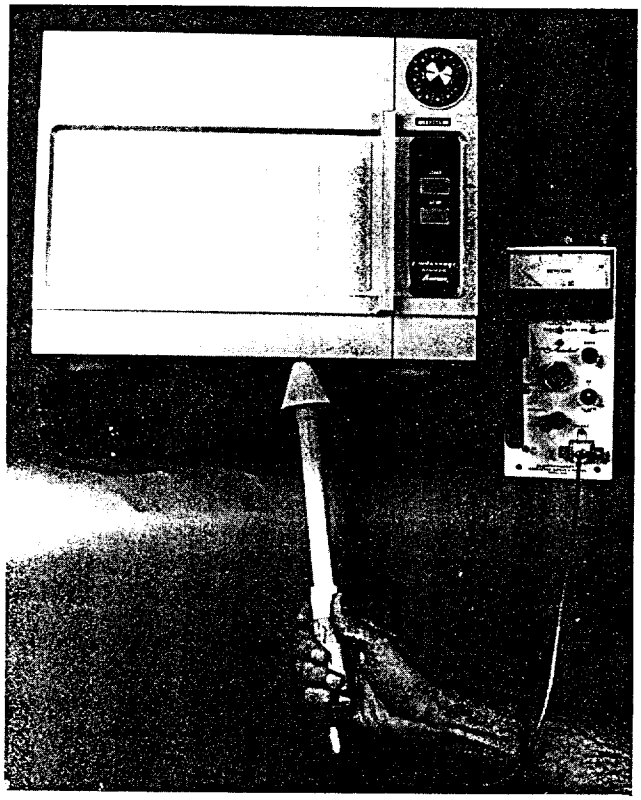


Figure 9

4.1.3 Oven Loads

In order to provide uniform test conditions, the standard requires that all emission tests be performed with a specific load. This is to be 275 ±15 milliliters of tap water, centered on the load carrying surface of the oven cavity. The water should have an initial temperature of 20 ±5 degrees Celsius. Its container should be of nonconductive material, e.g., glass or plastic, and have an inside diameter of approximately 8.5 centimeters, such as a low form beaker (Fig. 10). Such a load must be used for all compliance measurements of microwave emission from a microwave oven.

Figure 10

When testing for interlock function, particularly with prestandard ovens, it is best to use larger amounts of water initially to reduce leakage and thereby minimize the possibility of probe damage or personnel exposure. If larger amounts are used for this test, be sure to change the load to 275 milliliters for subsequent emission tests.

When testing ovens that have more than one vertically spaced position for the load bearing shelf, tests should be performed with the standard load centered on the shelf and with the shelf located in each position that will allow proper placement of the load. The shelf position that yields the highest leakage is the appropriate position for the test. The variable position shelf will generally only be found in so-called combination ovens, those designed to utilize microwave energy and conventional heat simultaneously, or ovens equipped with browning elements.

Ovens should never be operated without having a load in place. Some ovens, particularly older models, may be damaged if operated without a load. Damage may include magnetron burnout.

4.1.4 Power Settings

When performing emission tests, oven controls should be set to the highest available power setting in order to produce the maximum possible emission. For those ovens that provide defrost functions, reduced power, or variable power by cycling the magnetron off and on, care must be taken to assure that all emission tests are made with the controls in a continuous power mode in order to preclude testing while the magnetron is in an off cycle. On such ovens, cook/defrost controls should be set to cook and variable power controls should be set to full power. However, when testing for interlock function, power should be set at the lowest setting that provides continuous power (no off-on cycling of the magnetron) in order to minimize the possibility of probe damage or self-exposure to excessive levels of microwave energy. All prestandard ovens provide only continuous power, so they should always be set at the lowest power setting available during interlock testing.

4.2 SPECIFIC TEST PROCEDURES FOR MICROWAVE EMISSION (LEAKAGE) AND INTERLOCK FUNCTION

The specific tests to be performed on microwave ovens are closed-door leakage, door-opening leakage, and failed interlock. The closed-door leakage test is intended to determine the maximum leakage at any point 5 centimeters or more from the closest surface of the microwave oven. Areas that should be tested include the door seal, viewing window, control panels, ventilation and other openings in the oven's outer surface, and the line cord. The door-opening test is intended to determine the maximum leakage that will occur 5 centimeters from any surface at the door seal upon unlatching or opening the door. The failed-interlock test is intended to detect failure of an interlock or the interlock system. However it should be noted that failure of less than the entire interlock system will usually not be detectable without disassembly of the oven and detailed knowledge of the oven's circuitry.

On ovens without a latch interlock, the door-opening leakage levels will typically be higher than closed-door leakage. On ovens with one or more latch interlocks, closed-door leakage and door-opening leakage will usually be identical. However, if the maximum closed-door leakage occurs through the viewing screen or at a location other than the door seal area, closed-door leakage may be higher than the level recorded for door-opening leakage.

Prior to operating the oven, operational procedures should be discussed with the owner or user to ensure that the function of all controls are clearly understood by the surveyor and to ensure that no peculiar characteristics of the individual oven are overlooked that might affect its operation or safety.

IMPORTANT PRECAUTIONS

For prestandard ovens, it is important to establish whether or not excessive emission is present as soon as possible in order to prevent self-exposure. Consequently, the test procedures contain unique precautionary steps in appropriate places for use when testing prestandard ovens. There are two additional precautions that should always be taken to prevent exposure to excessive microwave emission.

1. CAUTION: Whenever emission exceeds 5 mW/cm^2, the probe must be held by its handle grip only and at arms length from the body. This will maintain the hand at a distance of 8 or more inches from the oven when the probe spacer is touching the oven. Consequently, the emission level at the hand

will be approximately 1/16 of the level measured by the survey meter. If at the same time the body is maintained at a distance of 20 inches or more from the oven by holding the probe at arms length, the emission level at the body will be approximately 1/100 of the level measured by the survey meter. CAUTION: If leakage exceeds 100 mW/cm^2, terminate the test.

2. When performing door opening tests, do not place any part of the hand across the door seam where leakage might occur. If it is necessary to place fingers or other parts of the hand near or across the door seam to properly control opening of the door, be certain that the oven does not leak in excess of 5 mW/cm^2 at the point where the hand will be placed.

4.2.1 Test Preparation

STEP 1. Examine the oven for evidence of damage to seals, latches and hinges or looseness of the door. CAUTION: If any damage or looseness is apparent, excercise the utmost care to avoid exposure to possible excess leakage. Damage and looseness are most likely to be found on prestandard ovens, particularly those in commercial use. Maximum leakage can be expected where damage or looseness exists, and leakage testing should begin at these points. Remember that a gap between the door and oven is normal with some door seals and is not always an indication of wear or damage. However, such seals were not used on any prestandard commercial ovens. A gap on such ovens should be considered to indicate possible excess leakage.

STEP 2. Examine the oven controls and determine the correct procedure for starting and stopping microwave generation.

STEP 3. Place a standard load, 275 ml of water, in the center of the load bearing surface. During the test, change the water as necessary to prevent boiling. CAUTION: Handle hot water carefully to avoid scalding from water or steam.

STEP 4. Prepare the test instrument for operation in accordance with the procedures in Appendix I. Set it for fast response (Narda 8100 or Holaday 1500) and use the 10 or 20 mW/cm2 range for poststandard ovens. When testing prestandard ovens with the Narda 8100 or 8200, use the red or yellow probe respectively on the 200 or 100 mW/cm2 range; if using a Holaday instrument, use the 100 mW/cm2 range. Place any unused probes as far from the oven as practical. Anytime the full-scale reading is reached, switch to the next highest full-scale range, rezeroing and changing probes if necessary.

STEP 5. With the oven door closed set the timer for approximately 1 minute of operation, or for uncalibrated pushbutton timers select one of the buttons providing a longer operating period. If required as a separate step, activate the microwave generator, e.g., press the cook or start button.

4.2.2 Closed Door Leakage Tests

STEP 6. Scan the door seal area at a rate of about 1 inch per second, looking for the point or points of maximum leakage. Whenever an upscale deflection of the meter indicates increasing leakage, reduce the scanning speed or stop the scan as necessary to determine the approximate magnitude of the emission. There will usually be some variation in leakage as a function of time. If this variation occurs at a very slow rate, it may be necessary to scan at a slower rate to ensure finding the point of maximum leakage. Scan the viewing screen when present, control panels, ventilation openings, line cord

(close to the oven), and any other openings in the outer wrap of the oven. Determine whether or not any emission exists at levels higher than that measured at the door seal area. If no measureable leakage was found during this procedure, determine whether or not the oven is operating by checking to see if the load is increasing in temperature. If the load is not heating, the oven is not operating and cannot be tested until repaired. Detection of microwave leakage and heating of the load are the only reliable indicators of microwave generation. Cook lights or similar indicators may operate whether or not microwaves are being generated and, therefore, are not reliable indicators of oven operation.

STEP 7a. Set the meter to slow response (unless it is a Narda 8200 or an unmodified Narda 8100, see Appendix I for details) and to the lowest full-scale range that is higher than the maximum emission already measured. Replace the water load with water of the proper temperature. Place the probe at the point where maximum emission was measured previously. Locate the precise point of maximum emission, and determine the maximum steady state leakage. Record this at item 30a on form FD 2536 unless Step 7b below is applicable. (See discussion of correction factor in Appendix I). CAUTION: If the maximum leakage exceeds 100 mW/cm^2, terminate the test, do not perform the door opening test, but go directly to the failed interlock test by performing step 9.

STEP 7b. For ovens for which leakage is less than 100 mW/cm2 and in which more than one vertical shelf position is provided, repeat steps 2 through 7 for each vertical location of the shelf on which the standard test load can be properly positioned. Note in item 40 (Remarks) the position of the shelf that resulted in the highest leakage and record the leakage from this shelf position at item 30a.

4.2.3 Door Opening Test

This test will normally be preceded by the closed-door leakage test described above. If for any reason this test must be performed first, perform steps 1 through 5 (4.2.1) above and then proceed with step 8 below. When following normal procedures, follow steps 6 and 7 above (4.2.2) with step 8 below.

STEP 8. Check the water load and replace with cool water if necessary. Select a meter range of 10 or 20 mW/cm^2 or higher as shown to be necessary by the closed-door leakage reading made previously. Anytime the full-scale reading is reached, switch to the next highest range, rezeroing and changing probes if necessary. Locate the probe tip on the door seal at the point where maximum leakage was noted in the preceding test or, if a maximum could not be located, on the side of the door opposite the hinges.

a. Oven without latch interlocks: Activate the oven and slowly open the oven door until the oven turns off or until an emission level of 100 mW/cm^2 is observed, whichever occurs first. CAUTION: If leakage exceeds 100 mW/cm^2, terminate the test and proceed to step 9. If leakage is less than 100 mW/cm^2, set the meter to the lowest full-scale range that is higher than the maximum emission already measured. Open the door to a point just prior to interlock cutoff and scan the door seal area to find the point of maximum leakage. Switch to slow response time (except for the unmodified Narda 8100, see Appendix I) and hold the probe at the point of maximum leakage. Slowly open the door several times to determine the maximum leakage prior to interlock cutoff. Record this value at line 30b and record "2" (no) at line 29 on form FD 2536.

(It is unlikely, on an operating oven, that the door opening will reach a distance of 2 inches before cutoff due to interlock actuation or before leakage exceeds 100 mW/cm^2. If the door should open 2 inches before interlock cutoff or before leakage exceeds 100 mW/cm^2 in this step or step 8b, record "1" (yes) on form FD 2536 and omit step 9 below.)

b. Ovens with latch interlocks: Slowly move the latch or latch release to the released position (and, if necessary, slowly open the door) until the oven turns off or until an emission level of 100 mW/cm^2 is reached, whichever occurs first. Most ovens will turn off before the door begins to open; however, some detectable door motion (1 or 2 millimeters) may occur with some latch interlocks that are properly adjusted. CAUTION: If leakage exceeds 100 mW/cm2, terminate the test and proceed to step 9. If the oven shuts off before any perceptible door motion occurs or before any perceptible increase in leakage occurs, leakage upon door opening will be the same as the maximum closed-door leakage measured at the door seal area. If this has not been previously determined, repeat step 7 for the door seal area only. Record the leakage at line 30b and record "2" (no) at line 29 of form FD 2536. If there is a perceptible increase in leakage as the latch is released or as the door is opened, proceed as in step 8a to determine the maximum steady-state leakage. Record this at line 30b and record "2" (no) at line 29 of FD 2536.

c. Ovens with electrically controlled latches: (For description see 3.2.) With the oven operating determine (1) whether or not the oven must be turned off by the action of the timer or the stop button before the door can be opened and (2) whether or not the oven door can be pulled out to the limit allowed by the latch without shutting off. If the oven continues to operate after the latch has released the door, note in line 40 of FD 2536 (Remarks) that the latch interlock has failed and proceed to step 9. If the oven turns off normally, activate the oven and pull the door as far open as it will go without shutting off (i.e., to the limit allowed by the latch, or to the point just prior to interlock cutoff). Set the meter on the same range used to determine closed door leakage (unless this value was close to full scale, in which case go to the next higher range) and scan the door seal area to determine the point of maximum leakage. Switch the instrument to slow response (except for the Narda 8200 and the unmodified Narda 8100, see Appendix I) and the lowest full-scale range that is higher than the maximum emission already measured. Determine the maximum leakage at the door seal and record this value at line 30b and record "2" (no) at line 29 of form FD 2536.

4.2.4 Failed Interlock Test

CAUTION: This test is intended to detect complete failure of the interlock system. This condition is most likely to be found in prestandard ovens. Follow the instructions carefully. They are intended to minimize possible personal exposure to microwave leakage if the interlocks have failed. If in any of the preceding tests it is determined that the interlocks are functioning properly ("2" (no) has been recorded at line 29 of FD 2536), this test should be omitted.

STEP 9. Increase the load to the largest amount which is practical, i.e., fill the beaker with water or use a larger nonconductive container and fill it with water. If selectable, set power to the lowest available continuous power setting. Set the test instrument to the highest available range. If using the Narda 8100 or 8200, use the red or yellow probes if they are available. Place any unused probe as far from the oven as practical. Use the shortest available

timer setting that will allow the magnetron to reach full power. (Some ovens have a slight time delay between turn on and magnetron activation). With the oven off, open the door approximately 2 inches, blocking it open with a nonconductive object if necessary. Position yourself out of direct line of possible emission through the door gap, and as far from the oven as possible such that you are still able to reach the controls. Locate the probe in line with the door gap but 1 to 2 feet from the oven (Fig. 11). Position the test meter so that it can be read while activating the oven. Activate the oven. If the instrument meter starts to deflect up scale, indicating that the oven is generating microwave energy, turn the oven off immediately. If no up-scale deflection occurs, the probe should be moved closer to the door gap to verify that the oven is not operating.

CAUTION: If the oven generated microwave energy under the preceding test discontinue all further testing with power on. Record "1" (yes) on line 29 of FD 2536. Provide all pertinent details in the remarks section, item 40 of FD 2536.

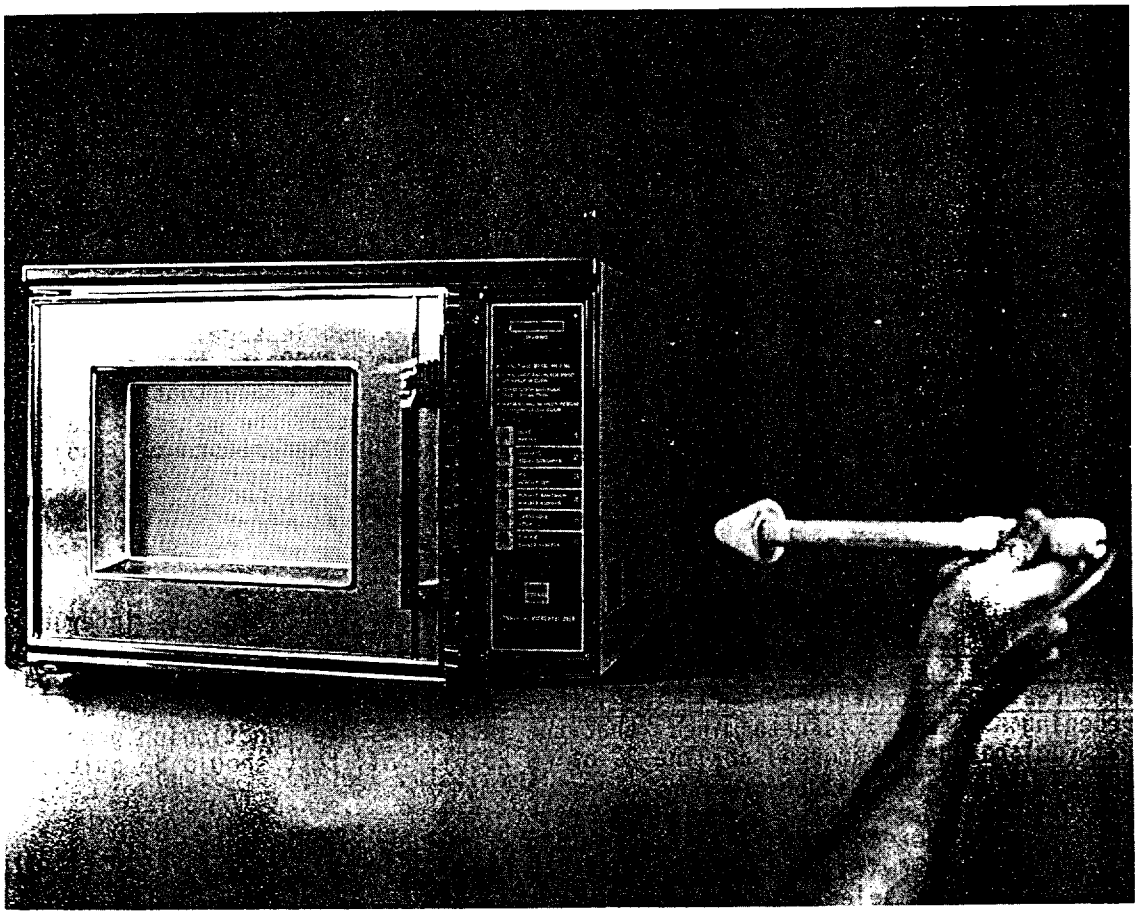


Figure 11

4.2.5 Procedure For Reporting Hazardous Microwave Ovens

If an oven is found to be leaking excessively (above 5 mW/cm^2 for certified, i.e., post standard ovens, or above 10 mW/cm^2 for prestandard ovens) or to have failed interlocks, the FDA or the BRH should be notified as soon as possible. FDA personnel should notify the BRH in accordance with procedures in FDA compliance program 7333.01. Non-FDA personnel should notify the RRHR in the FDA region covering their State. Regional coverage of States is shown in Appendix II.

5.0 COMPLETING THE FIELD TEST RECORD

The Microwave Oven Field Test Record (Form FD 2536) dated May 1974 (Fig. 12) is to be completed according to the following directions:

NOTE: 1) Do not write in shaded areas.

2) Enter one, and only one, character per box.

3) Unless otherwise specified, enter "X" when data is unknown or undetermined.

ITEM NUMBER

1 Enter established three-letter code for FDA district in which manufacturer or importer is located. Consult Regional Radiological Health Representative (RRHR) if the district code is not known.

2 For FDA personnel only: Enter home district established by FDA.

3 & 4 For FDA Regional Radiological Health Representative: Sign and date upon completion of review.

5, 6, 7 & 8 Enter the address as precisely as possible to enable followup surveys or notification if necessary.

9 Enter alphabetic postal abbreviation, e.g., [N][Y]

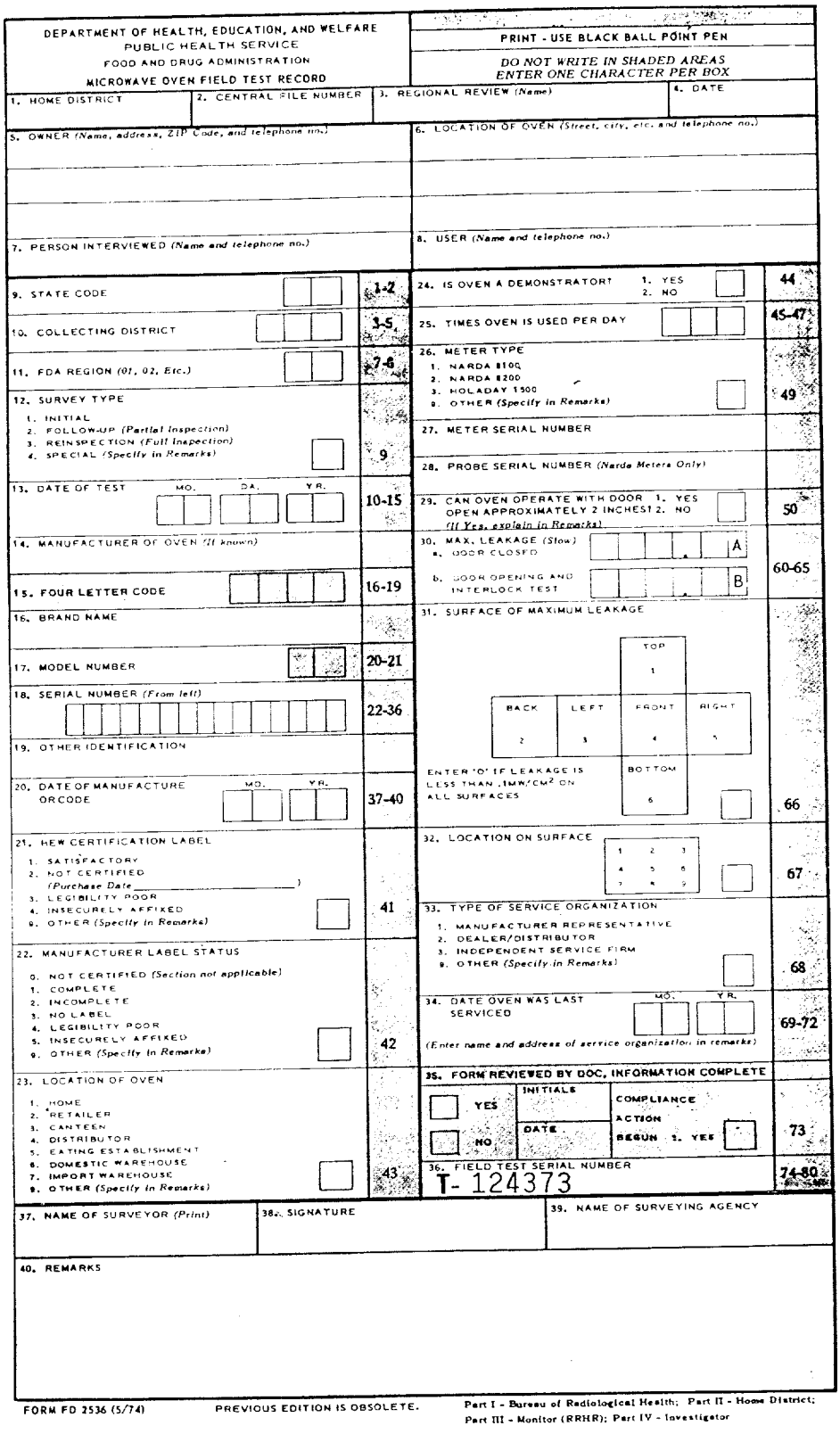
10 For FDA: Enter code of surveying district. For States: Enter FDA district code in which State is located.

11 Enter FDA region in which the test was conducted. Enter as two digits, e.g., [0][4] .

12 Enter Survey Type. Enter 1, 2, 3, or 4 depending on the type of survey being performed as defined below.

1. Initial - An "initial" survey is the first survey recorded on an FD 2536 test record by a public health representative. Prior surveys performed by the manufacturer or service firms are not considered to be an initial survey.

2. Followup - A "followup" survey is a partial survey performed on an oven which had been previously tested. This would typically occur when an oven is found to be faulty (e.g., emitting excessive leakage) and is



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
MICROWAVE OVEN FIELD TEST RECORD

PRINT - USE BLACK BALL POINT PEN
DO NOT WRITE IN SHADED AREAS
ENTER ONE CHARACTER PER BOX

1. HOME DISTRICT
2. CENTRAL FILE NUMBER
3. REGIONAL REVIEW (Name)
4. DATE
5. OWNER (Name, address, ZIP Code, and telephone no.)
6. LOCATION OF OVEN (Street, city, etc. and telephone no.)
7. PERSON INTERVIEWED (Name and telephone no.)
8. USER (Name and telephone no.)
9. STATE CODE 1-2
10. COLLECTING DISTRICT 3-5
11. FDA REGION (01, 02, Etc.) 7-6
12. SURVEY TYPE
1. INITIAL
2. FOLLOW-UP (Partial Inspection)
3. REINSPECTION (Full Inspection)
4. SPECIAL (Specify in Remarks) 9
13. DATE OF TEST MO. DA. YR. 10-15
14. MANUFACTURER OF OVEN (If known)
15. FOUR LETTER CODE 16-19
16. BRAND NAME
17. MODEL NUMBER 20-21
18. SERIAL NUMBER (From left) 22-36
19. OTHER IDENTIFICATION
20. DATE OF MANUFACTURE OR CODE MO. YR. 37-40
21. NEW CERTIFICATION LABEL
1. SATISFACTORY
2. NOT CERTIFIED
(Purchase Date _____)
3. LEGIBILITY POOR
4. INSECURELY AFFIXED
9. OTHER (Specify in Remarks) 41
22. MANUFACTURER LABEL STATUS
0. NOT CERTIFIED (Section not applicable)
1. COMPLETE
2. INCOMPLETE
3. NO LABEL
4. LEGIBILITY POOR
5. INSECURELY AFFIXED
9. OTHER (Specify in Remarks) 42
23. LOCATION OF OVEN
1. HOME
2. RETAILER
3. CANTEEN
4. DISTRIBUTOR
5. EATING ESTABLISHMENT
6. DOMESTIC WAREHOUSE
7. IMPORT WAREHOUSE
9. OTHER (Specify in Remarks) 43
24. IS OVEN A DEMONSTRATORT 1. YES 2. NO 44
25. TIMES OVEN IS USED PER DAY 45-47
26. METER TYPE
1. NARDA 8100
2. NARDA 8200
3. HOLADAY 1500
9. OTHER (Specify in Remarks) 49
27. METER SERIAL NUMBER
28. PROBE SERIAL NUMBER (Narda Meters Only)
29. CAN OVEN OPERATE WITH DOOR OPEN APPROXIMATELY 2 INCHES? 1. YES 2. NO 50
(If Yes, explain in Remarks)
30. MAX. LEAKAGE (Slow)
a. DOOR CLOSED A
b. DOOR OPENING AND INTERLOCK TEST B 60-65
31. SURFACE OF MAXIMUM LEAKAGE
TOP 1
BACK 2 | LEFT 3 | FRONT 4 | RIGHT 5
BOTTOM 6
ENTER '0' IF LEAKAGE IS LESS THAN .1MW/CM² ON ALL SURFACES 66
32. LOCATION ON SURFACE
1 2 3
4 5 6
7 8 9 67
33. TYPE OF SERVICE ORGANIZATION
1. MANUFACTURER REPRESENTATIVE
2. DEALER/DISTRIBUTOR
3. INDEPENDENT SERVICE FIRM
9. OTHER (Specify in Remarks) 68
34. DATE OVEN WAS LAST SERVICED MO. YR. 69-72
(Enter name and address of service organization in remarks)
35. FORM REVIEWED BY DOC, INFORMATION COMPLETE
YES NO INITIALS DATE
COMPLIANCE ACTION BEGUN 1. YES 73
36. FIELD TEST SERIAL NUMBER T-124373 74-80
37. NAME OF SURVEYOR (Print)
38. SIGNATURE
39. NAME OF SURVEYING AGENCY
40. REMARKS

FORM FD 2536 (5/74) PREVIOUS EDITION IS OBSOLETE. Part I - Bureau of Radiological Health; Part II - Home District; Part III - Monitor (RRHR); Part IV - Investigator

Figure 12

resurveyed following repairs. An oven that was inoperative on the first visit will not be recorded until it is operative. Then it will be recorded as an initial survey, not as a followup survey.

3. Reinspection - A "reinspection" is a complete survey of an oven that was previously surveyed and for which the data was recorded on an FD 2536 test record.

4. Special - A "special" survey is a survey initiated by special instructions from FDA headquarters, which instructions specify "special."

13 Enter date of test. Use two digits each for month, day and year, e.g.,

MO.	DA.	YR.
0 4	1 6	7 5

(April 16, 1975).

14 Enter the name of the manufacturer if known. The name of the actual manufacturer may not be explicitly stated on the oven, especially for so-called "private label" brands. If name is coded or not clearly given, consult the Regional Radiological Health Representative for correct information.

15 No entry; do not write in shaded areas.

16 Enter brand name. This is not always as straight forward as one might hope. For example, the name "Amana Radarange" includes both the manufacturer's name and trademark. Amana is both manufacturer and brand name. However, "Wards Signature" may appear together or separately. Either or both may be recorded as the brand name. The same is true for "Sears Kenmore." In both cases the manufacturer's name is coded in the model number. If there is any doubt, too much information is preferable to not enough. Consult Regional Radiological Health Representative for list of manufacturers and models.

17 Enter the model number. The model number is usually identified and will consist of a series of numbers or letters. The information supplying the date or year of manufacture is sometimes encoded in the model number (Figs. 13 through 16). Write the model number to the left of the boxes; leave shaded area boxes blank.

18 Enter the serial number. The serial number is usually a longer series of numbers or letters. It too may have encoded within it the date of manufacture (Figs. 13 through 16). If not present or visible, explain in "Remarks." When entering serial number, start in left-most box. Do not write in the remaining boxes to the right of the serial number. For example:

18. Serial Number	1	0	3	8	2	B	A

19 Sometimes there are other identifying numbers or letters (such as a vendor's number) on an oven which do not appear to pertain to either a serial number or a model number. These extra numbers should be written in the space called "other identification."

20 Enter date of manufacture using two digits each for month and year, e.g.,

MO.	YR.
0 4	7 6

.

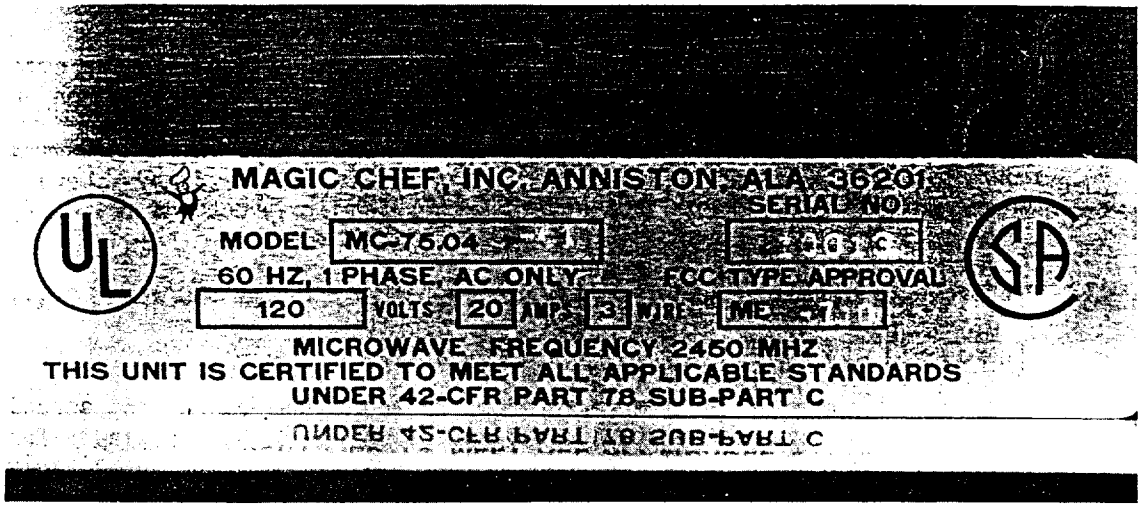


Figure 13

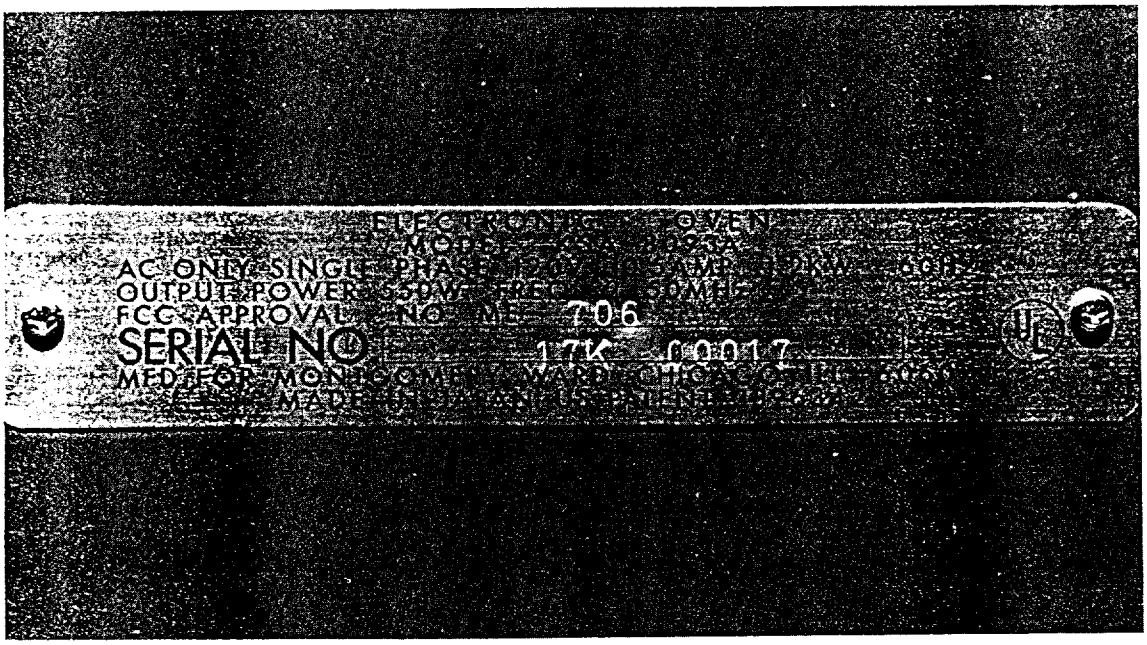


Figure 14

Panasonic MICROWAVE OVEN (HOUSEHOLD)

MODEL NO. NE-6420 SERIAL NO.

MANUFACTURED 1975

INPUT 120V, 12.0A, SINGLE PHASE, 3-WIRES, 60Hz, AC

OUTPUT 600W, 2450MHz

COMPLIES WITH D.H.E.W. RADIATION PERFORMANCE STANDARDS, 21CFR SUBCHAPTER

MANUFACTURED BY:

MATSUSHITA ELECTRIC INDUSTRIAL CO.,LTD.

DISTRIBUTED BY:

MATSUSHITA ELECTRIC CORP. OF AMERICA

1 PANASONIC WAY, SECAUCUS, NEW JERSEY 07094

U.S.P. 3,304,401 MADE IN JAPAN

F.C.C. TYPE APPROVAL NO. ME-941

LISTED UL 831B ISO

Figure 15

THIS MICROWAVE OVEN HAS BEEN DESIGNED AND TESTED FOR COMPLIANCE TO THE U.S GOVERNMENT DEPARTMENT OF HEALTH. EDUCATION AND WELFARE FEDERAL REGULATION 21 CFR SUBCHAPTER J PERFORMANCE STANDARD FOR MICROWAVE OVENS.

HOUSE HOLD UL LISTED 2913H

MADE IN JAPAN FOR

SEARS, ROEBUCK AND CO., U.S.A.

HOUSEHOLD MICROWAVE OVEN

MODEL NO. 564.9917610

SERIAL NO. 5K 400238

AC ONLY SINGLE PHASE 120V 60Hz

MICROWAVE FREQUENCY 2450 MHz

POWER CONSUMPTION 1.3 KW

U.S. PATENT 3396342

Figure 16

If in code, use decoding information and enter actual date. If manufacturer's date code decoding information is unavailable, leave the blocks blank. For ovens manufactured after January 1, 1975, the month and year of manufacture must be written out. It may appear on the identification, certification or other label.

21 Enter the status of the HEW Certification Label. Ovens manufactured after October 6, 1971, are required to bear a certification label stating that the oven complies with Federal performance standards under DHEW rules. Current models may cite 21 CFR 1030.10, 21 CFR Subchapter J, or the Radiation Control for Health and Safety Act of 1968, but older models may cite 42 CFR 78 or 21 CFR 278. This certification statement may be on a separate label or it may be part of the oven identification label. Do not confuse this certification label with an FCC approval label which is also required on microwave ovens. (Fig. 13 through 16). If it can be determined, include the purchase date if "2" (Not Certified) is checked.

22 Each oven must be labeled with the manufacturer's name and address and date of manufacture (date may be encoded only if oven was manufactured before January 1, 1975). (Figs. 13 through 16.) It is also required that these labels be legible and securely attached to the oven. Any exceptions should be noted under "Remarks."

23 Enter the location of oven at time of survey. Oven locations are defined as follows:

1. Home: A private residence.

2. Retailer: A merchant who sells microwave ovens to the public.

3. Canteen: A commercial or vending machine location such as a food store, snack bar, or self service cafeteria where the microwave oven is intended for use by the vending machine customer.

4. Distributor: A distributor-owned warehouse or similar facility from which ovens are normally sold to retailers rather than directly to consumers.

5. Eating Establishment: An establishment, such as a restaurant, hospital, or nursing home where the oven is intended for use by the establishment staff.

6. Domestic Warehouse: A private or public storage warehouse.

7. Import Warehouse: A bonded warehouse or the bonded area of a warehouse where imported products are held while in import status.

9. Other: If oven does not fall into one of the above categories, enter "9" and explain in remarks.

24 A demonstrator is an oven displayed and used to demonstrate its performance to the customer and intended to be sold as used. If the dealer represents oven as a demonstrator but the investigator sees no evidence of its being a demonstrator (i.e., it is still packed in a box, appears to be unused, is displayed in an area with no electrical outlet, or is intended to be sold as a new oven by the dealer), code as "2" (no) but explain in "Remarks."

25 Enter user's best estimates of the average number of uses per day. Use three digits; enter "000" if never used or enter "XXX" if number of uses is unknown or undetermined. Note that some ovens may be used for conventional as well as microwave cooking. In this event enter microwave uses here and total uses under "Remarks."

26 Enter survey meter type.

27 Enter survey meter serial number.

28 Enter probe serial numbers for Nardas and any other meters with a detachable probe.

29 & 30 Fill in in accordance with procedures contained in Section 4.0 (Microwave Oven Testing). Record details under "Remarks." Completely fill in boxes, e.g.,

0	0	1	.	5	A

.

Record uncorrected meter readings here and note instrument correction factor in "Remarks."

31 & 32 a. Show surface and location of maximum "door closed" leakage by circling numbers of appropriate surface and location respectively.

b. Show surface and location of maximum "door open" leakage by placing an "X" over numbers of appropriate surface and location respectively.

c. Enter number for code of surface and location corresponding to highest reading (either door closed or open).

d. Enter "0" in each box if there is no measurable leakage.

EXAMPLE: If maximum leakage occurs during "door closed" tests and is found to be at the lower left area on the right side of oven surface, number 5 should be circled and a "5" recorded in the box for item 31. For item 32, location number 7 should be circled and a "7" entered in the box.

NOTE: If oven door is flush with sides of oven so that the oven seal is visible from the side of the oven, the seal is considered to be a part of the side rather than the front.

33 & 34 Enter all "0"s if never serviced. Enter "X"s if unknown.

35 & 36 No entry; do not write in shaded areas.

37 Enter first name, middle initial, and last name of surveyor (and employee number, if FDA).

38 Enter usual signature.

39 For FDA: enter five-letter field or district code or spell out resident post locations; e.g., BOS-FO, BOS-DO, Hartford RP. For State or local government: Enter the name of surveying agency.

40 Enter remarks, comments, and any information necessary to supplement other portions of the test record. For additional remarks use Form FD 2782, "Field Test Record Continuation Sheet," copies of which are

distributed with the FD 2536. Enter Field Test Serial Number from item 36 of FD 2536 onto appropriate space on FD 2782.

Incomplete or incorrect survey forms may be returned to be completed or corrected.

APPENDIX I

FIELD TEST INSTRUMENTS

A. General Considerations

1. Instrument error: The best instruments presently available have an overall accuracy of about ±1 dB. This is approximately equal to +25 percent and -20 percent. That is to say that any given reading may be in error by as much as +25 percent or -20 percent. Emission readings of 1 and 5 mW/cm^2 could result from emissions as low as 0.8 and 4 mW/cm^2 respectively, or from emissions as high as 1.25 and 6.25 mW/cm^2 respectively. This error must be taken into account when making a determination of noncompliance. To minimize the possibility that a compliant oven is erroneously found to be noncompliant, only ovens measured to be leaking greater than 1.25 mW/cm^2 and 6.25 mW/cm^2 will, in general, be considered noncompliant with the respective 1 mW/cm^2 and 5 mW/cm^2 limits of the standard.

2. Correction Factor: All microwave survey instruments that are calibrated by the FDA are provided with a correction factor in order to correct all readings to the calibration point of the field that is used by the Bureau to calibrate the instruments. The correction factor will typically fall between 0.85 and 1.15. To convert the meter reading to a corrected reading, the meter reading must be multiplied by the correction factor of the instrument. When recording leakage levels on Form FD 2536, always record the uncorrected instrument reading at item 30 a and b and record the instrument correction factor under item 40, "Remarks."

3. Measurement Frequency: The frequency at which the instrument operates or is set to operate must be the same as the operating frequency of the oven or gross errors of measurement will occur. Virtually all microwave ovens operate at 2450 MHz. The only known exceptions are the combination ranges manufactured by the General Electric Co. under the General Electric and Hotpoint brand names. They are commonly known as Versatronic or Cook Center ranges, operate at 915 MHz and use both conventional electric heat and microwave energy simultaneously in the same oven. Note that all General Electric and Hotpoint brand countertop microwave ovens operate at 2450 MHz.

4. Instrument Acceptability: The Federal performance standard for microwave ovens requires that compliance with the power density limits be determined by measurements made with an instrument system which reaches 90 percent of its steady-state reading in 3 seconds when subjected to a stepped input signal and which has a radiation detector with an effective aperture of 25 square centimeters (as measured in a plane wave) with no dimension exceeding 10 centimeters. (The aperture is determined at the fundamental frequency of the oven being tested for compliance.) The instrument system shall be capable of measuring the power density limits of the standard with an accuracy plus or minus 1 decibel.

Of the several instruments manufactured to measure microwave power density, only a few are satisfactory for determining compliance with the microwave oven standard. The proper procedures for use of three of these are described below. A fourth, the Holaday 1700, is satisfactory but its use is not described because it is not commonly used as a portable or field instrument. A fifth instrument, the Simpson 380 (Series M), has been evaluated and found to be satisfactory for compliance measurements. However, the evaluation was not completed in time to incorporate an operation procedure in this manual. Refer to the manufacturer's instructions for proper operational procedures. Additional instruments are being evaluated by the Bureau. If any are found to be adequate for making compliance measurements, appropriate announcement of the fact will be

made. It is anticipated that procedures for their use will be similar to those for the instruments described below. Instruments not known to have been evaluated and found to comply with the requirements of the standard by the Bureau, should not be used for compliance measurements.

5. Instrument Calibration: Instruments used for compliance measurements should be recalibrated periodically. Information pertaining to periodicity of calibration and procedure for having instruments calibrated is available from: Chief, Electromagnetics Branch, Bureau of Radiological Health, 5600 Fishers Lane, Rockville, MD 20857.

6. Care of Probes and Spacers: Instrument probes may be damaged by exposure to excessive radiation even though the instrument is turned off, or in the case of removable probes, when the probe is not connnected to the meter. Before preparing the instrument for use, make sure that any microwave ovens in the immediate vicinity are turned off. If this is not possible, e.g., in a restaurant with ovens that are in use continuously, prepare the instrument for use at a point several feet distant from the operating ovens. When not in use, the instrument should always be turned off.

Probes are provided with spacer cones, hemispheres, or spheres to maintain the detector elements at a uniform 5-cm distance from the external surface of the oven. These should be maintained in a clean and undamaged condition to ensure proper measurement distance. Worn, damaged, or excessively dirty spacers should be replaced.

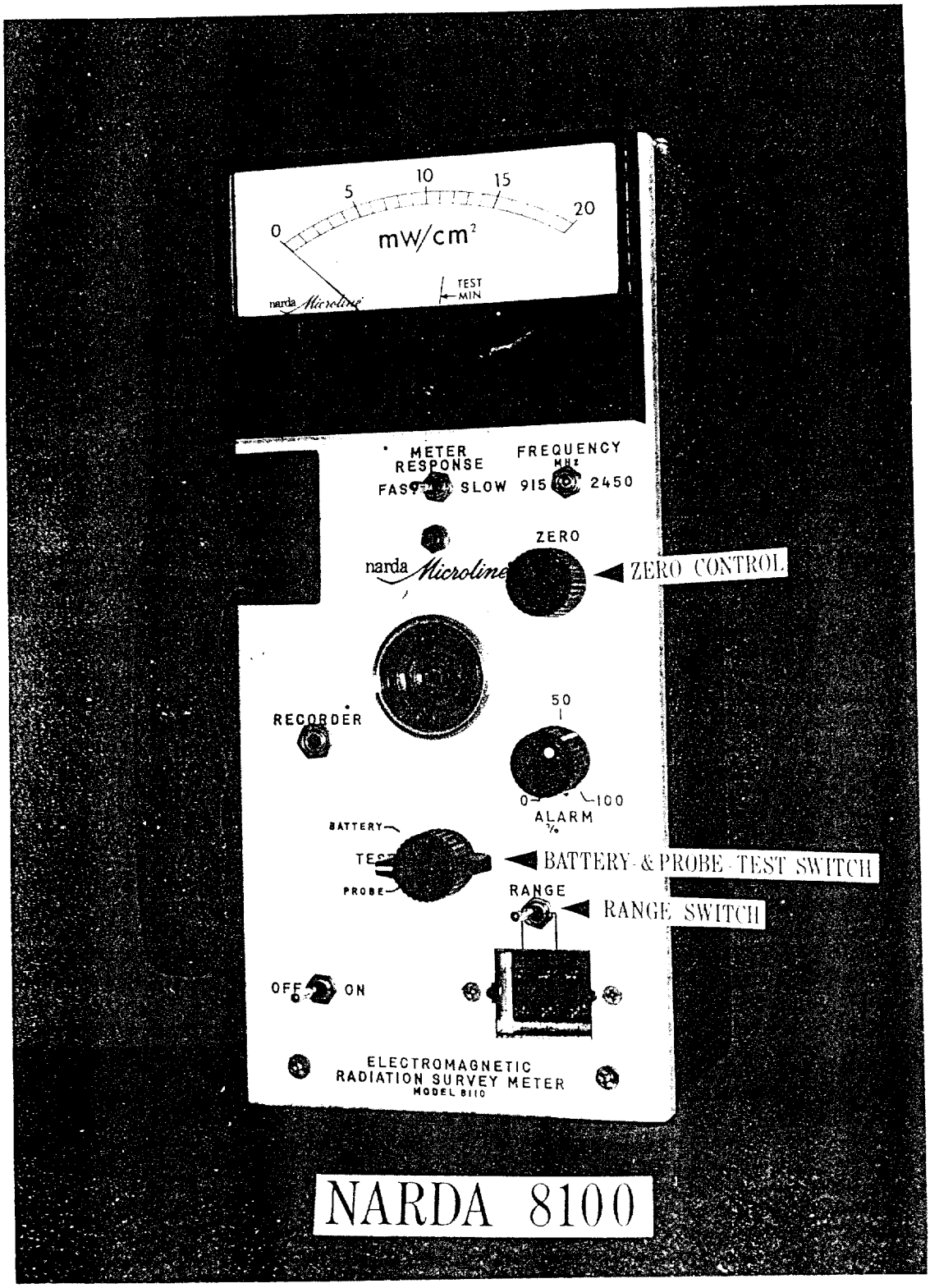
B. Narda 8100 Systems (Fig. 17)

Description: This instrument covers the two frequency bands used for microwave cooking, 915 and 2450 MHz. It utilizes interchangeable probes to provide four full-scale measurement ranges. The blue probe, model 8120A, covers 0.2 mW/cm^2 and 2.0 mW/cm^2, the white probe, model 8121A, covers 2 mW/cm^2 and 20 mW/cm^2, and the red probe, model 8122A, covers 20 mW/cm^2 and 200 mW/cm^2. The blue probe is not normally used for microwave oven field testing and is very susceptible to burnout from exposure to stray electromagnetic radiation. It should always be carefully shielded by wrapping in metal foil, and kept away from microwave ovens whose leakage levels are unknown. Prepare the instrument for use as follows:

1. Probe: Select the correct probe in accordance with the instructions in the test procedure. Place the correct spacer cone or sphere, if available, on the end of the probe and plug the probe into the receptacle in the lower right corner of the instrument. (See item 4 below on the 915-2450 switch for information on selecting the spacer).

2. Alarm Control: Set the alarm control to 100 percent. This control presets the percentage of full scale at which an audible alarm will sound. Use of the alarm is not a necessary part of the test procedure so it may be set at 100 percent at all times or at a lower level at the user's discretion. The alarm will sound if the meter is turned on without a probe properly connected.

3. Fast-slow switch: Set this switch to fast prior to turning the instrument on. It sets the response time of the instrument. As supplied by the manufacturer, the slow response is slower than allowed by the microwave oven standard. All measurements with such instruments must be made with this switch in the "Fast" position.


0
5
10
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mW/cm²
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2450
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ZERO
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RECORDER
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ALARM
%
BATTERY
TEST
PROBE
BATTERY & PROBE TEST SWITCH
RANGE
RANGE SWITCH
OFF
ON
ELECTROMAGNETIC
RADIATION SURVEY METER
MODEL 8110
NARDA 8100

Figure 17

The 8100 may be modified to change the response time in the "Slow" position to the 3 seconds allowed by the standard. Most FDA-owned 8100's have been so modified. These can be identified by the presence of an adjusting screw just below the "Fast Slow" switch. This screw is normally sealed with "Glyptol" and its adjustment should not be changed. When testing with modified instruments, follow the instructions in the test procedure for use of fast or slow response. Changing response should not affect the zero setting but the zero control can be inadvertantly moved when switching response, and care should be exercised to prevent such accidental zero shift.

4. 915-2450 Switch: Set this switch to the operating frequency of the oven to be tested and select the correct spacer for the test probe. The spacers are labeled as to frequency. In addition, the 915-MHz spacers can be identified by the presence of crossed antenna dipoles in its base. Unless testing an oven known to operate at 915 MHz, this frequency selector switch should always be set to 2450 and the probe should always be fitted with a 2450-MHz spacer.

5. Range Switch: This switch selects one of the two ranges provided by each probe. The range switch should be set to the higher range when preparing the instrument for use. Subsequently, it should be set in accordance with the instructions in the test procedure. Changing ranges or probes may alter the zero point. Be sure to check and, if required, reset the instrument to zero while keeping the probe well away from any microwave fields each time the range is changed.

6. Off-On Switch: Switch the instrument to on.

7. Zero: Set the meter pointer to zero by adjusting the zero control. The zero control has a wide adjustment range on the lower ranges and misadjustment can easily cause the pointer to go off scale in either direction. If the meter is off scale in the up-scale direction and cannot be brought on scale by adjusting the "zero" control, check that the probe plug is seated properly. If it still remains off scale, the probe may be defective. This can be checked by fitting the instrument with a second probe and determining if it can be zeroed properly. When checking or setting the meter to zero, always be sure that it is in an area that is free of microwave energy. If possible, turn off all ovens in the vicinity where the test is being performed.

8. Test Switch: Turn to the "Battery" position. If the batteries are adequately charged, the meter needle will deflect up scale above the line marked "Test Min." If the meter reads below the "Test Min" line, the batteries must be recharged in accordance with the instructions at the end of this procedure. Turn the test switch to the "Probe" position. If the probe is good, the needle will deflect up scale above the "Test Min" line. If it fails to do so, the probe is defective and must not be used for testing until repaired. Probes which have been exposed to excessively high microwave fields or roughly handled may sustain damage that will cause significant measurement errors, but may still indicate above the "Test Min" line, i.e., bad probes may under some conditions test "good." If there is any doubt about a probe's condition, it should be checked by comparing it against a known good probe or by returning it to the manufacturer or repair facility. Probes which are FDA property should be returned to the Bureau of Radiological Health if their condition is suspect. If the battery is charged and the probe is determined to be good, the instrument is ready to use.

9. Battery Charging: The battery may be recharged by removing the cover labeled "A.C. Charge" and connecting the a.c. meter plug to a 110 VAC power line. The battery should be charged approximately one-half hour for each hour of meter operation, or 10 hours if fully discharged. Batteries should be maintained at the fully charged condition whenever possible. If necessary, the meter can be operated from the a.c. power line. The charging rate will be reduced by a factor of about 2. However, such use should be avoided because electromagnetic pickup by the power line can introduce errors in the instruments readings. The "A.C. Charge" cover should be fastened securely in place whenever the instrument is in use to prevent error due to electromagnetic interference.

C. NARDA 8200 (Fig. 18)

This is a single frequency instrument usually covering the 2450-MHz band. However, some 8200's have been produced that cover 915 MHz rather than 2450 MHz. Be sure to determine that the instrument's operating frequency is the same as that of the oven to be tested. Two probes are available with the 8200: The white probe, model 8221, covers 2 and 20 mW/cm^2 full scale and the yellow probe, model 8223, covers 10 and 100 mW/cm^2 full scale. Prepare the instrument for use as follows:

1. Probe: Select the correct probe in accordance with the instructions in the test procedure and firmly fasten it to the connector at the top of the instrument, screwing the securing collar down firmly. Make sure that the styrofoam spacer is in place on the probe.

2. Range Multiplier Switch: This switch selects the operating range of the probe being used. The meter should be read directly in the X1 position, and its reading must be multiplied by 10 in the X10 position. The scales of the meter are color coded to correspond to the color of the probe being used. The range multiplier should be set to X10 when preparing the instrument for use. Subsequently, it should be set in accordance with the instructions in the test procedure.

3. Bat Test, Off, On Switch: Place the switch in the BAT TEST position. If the battery is in good condition, the meter needle will deflect to the right of the "Test Min" mark. If it does not, the battery is weak and must be replaced before using the instrument. If the battery is good, place the switch in the "On" position.

4. Zero: Set the pointer to zero by turning the zero control. The zero control has a wide adjustment range on the lower ranges, and misadjustment can easily cause the pointer to go off scale in either direction. If the meter is off scale in the up-scale direction and cannot be brought on scale by adjusting the "Zero" control, check that the probe connector plug is secured properly. If it still remains off scale, the probe may be defective. This can be checked by fitting the instrument with a second probe and determining if it can be zeroed properly. When checking or setting the meter to zero, always be sure that the probe is in an area that is free of microwave energy. If possible, turn off all ovens in the vicinity where the test is being performed.

D. Holaday HI 1500 (Fig. 19)

The HI 1500 is a single frequency instrument operating at 2450 MHz. It has a single, permanently attached probe operating at three switch selectable ranges: 2, 10, and 100 mW/cm^2 full scale. It has two switch selectable

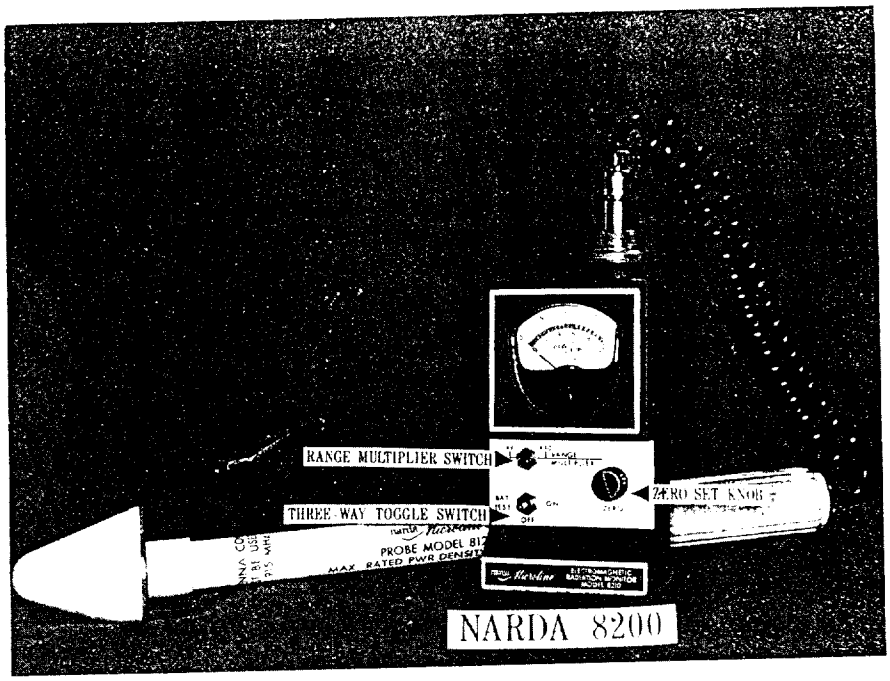

Figure 18

Figure 19

response times. In the SLOW position, the response time is just under 3 seconds, the maximum allowed by the standard. All other functions are controlled by a single rotary selector switch. On this instrument the styrofoam spacer cone is "permanently" affixed to the probe. No attempt should be made to remove it unless it is necessary to replace it with a new one. For all instruments that are periodically calibrated by the Bureau of Radiological Health, a spacer cone inspection is performed at the time of calibration. If the cones are in need of replacement, they will be replaced at this time. Prepare the instrument for use as follows:

1. Slow-Fast Response Switch: Set this switch to the fast response position when preparing the instrument for use. It will be used in this mode except when the test procedure calls for using slow response.

2. Selector Switch:

a. Turn the Selector Switch to the "Battery Test" position. The needle should move above the "Battery OK" line on the meter. If the needle does not reach this mark, the two 9-volt batteries must be replaced before attempting to use the instrument.

b. Turn the selector switch to the "Probe Test" position. Set the zero adjust control to the center, or "twelve o'clock" position. If the probe is good, the needle will come to rest between the green lines in the "Probe Test OK" area. If it does not, the probe is defective and the instrument must not be used for oven testing.

c. Set the selector switch to the range specified in the test procedures. Note that the range indications on the selector switch are the full-scale values for each range; they are not range multipliers. The 2-mW range uses the 2 scale and the 10 mW- and 100 mW-ranges use the 10 scale. The reading must be multiplied by 10 when using the 100 mW/cm2-range.

3. Zero Adj.: Set the pointer to zero by turning the zero control. When checking or setting the meter to zero, always be sure that the probe is in an area that is free of microwave energy. If possible, turn off all ovens in the vicinity where the test is being performed. NOTE: The zero setting of some Holaday 1500's exhibits a substantial positive temperature coefficient. This will not affect measurement accuracy if properly zeroed. Whenever possible, allow time for the instrument's temperature to stabilize at the ambient temperature of the area where the testing is to be performed. If this cannot be done, be sure to rezero the instrument as necessary and always before taking a final reading for record purposes.