

PROGRESS IN THE REDUCTION OF MICROWAVE EXPOSURE FROM MICROWAVE
OVENS USED IN COMMERCIAL FOOD VENDING OPERATIONS 1/

by

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Abstract

During the past two years microwave ovens used in commercial food vending operations have been surveyed in cooperation with State participating Local Health Departments and Districts in Texas. These surveys have shown that there is a correlation between general sanitation and maintenance with leakage of microwave radiation. Additionally, since October 6, 1971, the effective date of the microwave oven manufacturing standard (developed under the Radiation Control for Health and Safety Act of 1968, PL 90-602), significant reduction in the percentages of leaking ovens has been noted for ovens manufactured after the effective date.

Introduction

The use of microwave ovens in the commercial food vending operations business over the past several years has been on a steady increase. Among the variables influencing this increase is the fact that extended storage time of refrigerated food is considerably greater than that of food stored hot, and the fact that microwave ovens can quickly heat cold food to serving temperatures.

The biological effects of microwave radiation are generally separated into two divisions, thermal and non-thermal. Present adopted standards relate to the thermal effects of microwave exposure. The ability of microwave ovens to heat food quickly can heat parts of the human body just as quickly. With the thermal sensors just under the skin and the maximum temperature from microwave heating occurring much deeper, the potential exists for significant damage prior to the sensation of pain.

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Federal regulations found in 21 CFR 278.212 require that all microwave ovens manufactured after October 6, 1971, have microwave radiation leakage of less than a power density of one milliwatt per square centimeter at any point five centimeters or more from the external surface of the oven prior to first sale and, thereafter, less than five milliwatts measured at the same distances.

The American Conference of Governmental Industrial Hygienists' "Threshold Limit Values of Physical Agents", recommends a time weighted microwave power density exposure not to exceed 10 milliwatts per square centimeter, with total exposure time limited to the 8-hour workday. However, this limit may be exceeded under the following conditions: for average power densities between 10 and 25 milliwatts per square centimeter, total exposure time shall be limited to no more than 10 minutes for any 60 minute period during the workday; and, for average power density levels in excess of 25 milliwatts per square centimeter, exposure is not allowed.

The U. S. Department of Labor, Occupational Safety and Health Administration, Occupational Safety and Health Standards are not quite so lenient. In 29 CFR 1910.97 they established a Radiation Protection Guide of 10 milliwatts per square centimeter averaged over any possible 0.1-hour period. This means the following: power density of 10 mW/cm² for periods of 0.1-hour or more; and, energy density of 1 mW-hr/cm² during any 0.1-hour period.

Beginning early in 1971, microwave ovens were surveyed to determine the rate of failure to meet the above standards. The ovens used in commercial food vending operations were selected for this study as it was felt that they would show the effects of extreme product use and abuse, since they are used by the general public without maintenance on its part. The typical vending installation consists of at least one cold food vending machine, one microwave oven and several drink and candy machines. The installations are generally serviced daily in the morning, with the route man cleaning the oven.

Survey Methods

Our surveys were done using a Narda 8100 Electromagnetic Radiation Monitor with a standard five centimeter spacer cone. The ovens were operated at their maximum output using a standard load of 7 Oz. of drinking water in a plastic drinking cup. This load is less than that used in 21 CFR 278.212; however, the results of the tests on defective ovens did not vary significantly with this reduced load, (206 vs 275 ml).

A total of 561 ovens was surveyed in commercial food vending operations with 104 of these being manufactured after the effective date of the manufacturing standard. The use of trained local health department personnel greatly aided the completion of this survey program as well as acquainting the local personnel with the hazards associated with microwave oven radiation emission.

Survey Results

Of the 561 microwave ovens used in commercial food vending operations surveyed, 452 or 81% were found to be emitting microwave radiation less than the present federal product standard of 5 mW/cm² as measured at 5 centimeters. Six percent of the ovens were in the 5-10 mW/cm² range, three percent were in the 10-15 mW/cm² range, and 11% were in excess of 15 mW/cm².

The eleven percent in excess of 15 mW/cm² were ordered removed from service until corrections could be accomplished by the vending company. This action level was determined as a maximum allowable level to continue operation of the ovens. Ovens in the 10-15 mW/cm² range were allowed to operate; however,

the vending company was notified of the defect and requested to repair the oven within 24 hours. The 15 mW/cm² level was determined from OSHA regulations using a minimum exposure time of 1 minutes. It is felt that exposure times under one minute are difficult to determine. Under normal use conditions found during the survey, one minute was found to be a typical user exposure/use time.

If we use the ACGIH exposure ceiling value of 25 mW/cm², we find that six percent of the ovens exceeded that value. Also, four percent of the ovens were found to be in excess of 50 mW/cm².

TABLE I

<u>Power Density</u>	<u>% of ovens less than or equal to the power density</u>	<u>% of ovens manufactured prior to October 6, 1971 less than or equal to power density</u>	<u>% of ovens manufactured after October 6, 1971 less than or equal to power density</u>
5 mW/cm ²	81%	77%	98%
10 mW/cm ²	87%	84%	100%
15 mW/cm ²	91%	88%	100%
50 mW/cm ²	96%	95%	100%

Table I shows the results and distribution of the various surveys broken down into ovens manufactured prior to or after the October 6, 1971, manufacturing standard date. It is of significance to note that only two new ovens out of 104 surveyed failed to meet the new standard. Their emission levels were found to be 6 and 10 mW/cm².

TABLE II

Ovens Manufactured prior to October 6, 1971: Total of 167 in group

<u>Power Density P (mW/cm²)</u>	<u># of ovens in Power Density range found dirty</u>	<u># of ovens in Power Density range found clean</u>	<u>% of ovens found dirty in each range</u>
P<5	50	79	39%
5<P<10	5	6	45%
10<P<15	7	3	70%
15<P<50	11	4	73%
50<P	4	2	67%

Ovens Manufactured after October 6, 1971: Total of 72 in group

P<5	22	48	31%
5<P<10	1	1	50%
10<P	0	0	--

The data in Table II would seem to indicate that the new ovens are being maintained in the same condition and under the same sanitary standard as the older units. However, one should note that in older units there is a correlation between the dirty units and those showing excessive leakage, thereby, showing the importance of proper maintenance.

Swabs were taken on several microwave units to determine whether biological growth could be supported inside the ovens. In the test, swabs soaked in growth media were wiped over an eight square inch area inside the oven. The swabs were stored in a sterile vial and refrigerated until returned

to the Texas State Department of Health laboratory for growth under standard conditions. Colony counts in excess of 10,000 were found; however, this is not a true indication of the total condition of the ovens. More data is still needed to give the true picture of the ovens in operation, since the areas wiped were not food contact surfaces.

If we accept the five milliwatt per square centimeter standard, then one may analyze our results on a vendor basis to determine both microwave emission and sanitary conditions and perhaps determine if the vendor is doing his job. Table III presents our data in this matter. Vending companies doing business under the same name in several different cities have been lumped together.

TABLE III

Vendor Symbol (10 or more ovens)	% less than 5 mW/cm ²	% of all ovens found dirty when surveyed "U" means undetermined
A (20)	85%	20%
B (22)	100%	U
C (28)	64%	36%
D (113)	74%	27%
E (15)	87%	U
F (85)	87%	33%
G (20)	60%	47%
H (12)	92%	33%
I (51)	84%	36%
J (47)	79%	15%
K (13)	69%	U
<u>L (68)</u>	<u>81%</u>	<u>U</u>
494 ovens	81%	30%

The last figures in the column are presented for statistical purposes only.

The data in Table III when taken together with the data in Tables I and II allows one to analyze a given vendor's maintenance program.

Conclusions

The microwave ovens manufactured after the effective date of the federal product standard, October 6, 1971, have microwave emissions much less than those manufactured prior to the standard date. This lower emission is maintained even though they receive the same maintenance as the older ovens.

The general sanitary condition of microwave ovens in the commercial food vending business leaves much to be desired.