



## Standard Test Method to Qualify Single-Use Foodservice Packaging for Use in Microwave Ovens

Method Revision: #1 – Feb/07

### 1. Scope

- 1.1 The intended use of this procedure is to provide uniform guidelines to manufacturers in order to qualify single-use foodservice packaging products for microwave heating applications.
- 1.2 This test method is applicable to packaging materials intended for use in consumer or institutional microwave ovens.
- 1.3 This test method does not determine regulatory compliance for use of a packaging material in food contact applications.

### 2. Referenced Documents

- 2.1 "TEST PROCEDURE GUIDELINES TO QUALIFY DISPOSABLES FOR USE IN MICROWAVE OVENS", Single Service Institute. (Available from FPI)
- 2.2 IEC 60705 "Household Microwave Ovens – Methods for Measuring Performance", Edition 3.1 (2004)
- 2.3 Gertrude Armbruster, "Development of Microwave Test Protocol – Final Report", Division of Nutritional Sciences, Cornell University (ca. 1981).

### 3. Summary of Test Method

Single-use foodservice packaging products are tested under typical real-use conditions using a variety of food types. Foods are heated in single-use packaging until uniformly cooked. Packaging is then assessed for structural integrity and the food is evaluated for any off-flavor or odor imparted by the packaging. Testing is conducted in the type of oven (consumer and/or institutional) consistent with the intended use of the package. It is recommended that packaging be tested using several different microwave ovens to account for variations between microwave oven models and manufacturers.

### 4. Equipment

- Microwave ovens, consumer, typically 1100-1300 watts
- Microwave ovens, institutional, typically 2000-3000 watts
  - Note: Use microwave ovens equipped with turntables or other dispersion devices (e.g. mode stirrers or convection fans) to reduce hot spots.
- Beakers, 2 L
- Stopwatch
- Digital temperature probe (readable to  $\pm 0.1^{\circ}\text{F}$ )
- Consumer food items (see Appendix 2)
- Foodservice packaging



## 5. Safety Precautions

Hazards associated with this test method include the potential for burns from handling hot foods and potential exposure to microwave radiation.

- Thermal gloves and safety glasses are recommended for handling containers with hot food or water.
- Follow the manufacturer's instruction manual for recommended operating procedures and safety precautions for the microwave oven.
- Do not operate a microwave oven if the door is bent, warped or otherwise damaged.

## 6. Test Procedure

6.1 Determine microwave oven power output.

- Power output of microwave ovens can vary significantly from their nominal rated value. Measurement of actual power output is useful for setting appropriate heating times for various foods. Calibrate microwave ovens according to IEC 60705, "Household Microwave Ovens – Methods for Measuring Performance". A summary of this calibration method is presented in Appendix 1.

6.2 Select foods from food categories.

- The full range of cooking from minor reheat to primary cooking is subdivided into seven levels. Examples of foods in each category are listed in Appendix 2. The various foods were placed into these levels according to the range of temperatures typically observed when heated, and their aggressive action (e.g. foods with high sugar or fat content.)
- Select two foods from each category, one from the light and heavy load within each category.

6.3 Prepare foods and containers for heating.

- Equilibrate food items in a refrigerator, freezer or at room temperature as indicated by starting temperatures listed in Appendix 2. Set refrigerator temperature no higher than 40°F (4°C) and freezer temperature no higher than 0°F (-18°C).
- Into separate foodservice package containers, place sufficient quantity of each food item to fill containers approximately  $\frac{3}{4}$  full, if appropriate for the type of food being tested. (Some foods such as pizza or muffins may require the use of individual portions.) Place an equivalent quantity of each food type selected into separate clean microwave-safe glass dishes. These samples will serve as control references. If called for, containers should be covered by the prescribed cover or loosely covered with a microwave-safe film.

6.4 Heat food

- Heat the control reference sample first, separately, and then heat the test container. Containers should be placed in the center of the microwave oven.
- Conduct heating test at high or full power setting, using appropriate time settings to achieve the desired temperature for each food category. Trial runs may be required to determine the appropriate heating time interval to achieve the desired minimum temperature.
- After heating, measure the temperature of the food item using a digital temperature probe at the center of mass, near the perimeter and approximately midway between the two locations. Each food temperature measurement shall be within the appropriate temperature range for that food category as listed in Appendix 2. If the food item is overcooked, repeat test with a shorter time interval.

6.5 Evaluate performance

- Given the subjective nature of taste and odor evaluations and the variation of sensory perception between individuals, it is recommended that a taste and odor panel be used for these evaluations.

- 6.5.1 Odor Evaluation: After heating, smell the food in the control reference, then smell the food in the test container and determine if any off-odor is present. First, describe the experience as “equal to control” or “not equal to control”. If “not equal to control”, then describe the intensity of any off-odor as slight, medium or extreme. Record the type and intensity of off-odor on the evaluation form shown in Appendix 3.
- 6.5.2 Taste Evaluation: Taste a small sample of the food in the control container and then some from the test container. Determine if any off-flavor is present. Describe the intensity and type of off-flavor on the evaluation form.
- 6.5.3 Overall Taste and Odor Evaluation: Based on the taste and odor evaluations, rate the test sample as acceptable or not acceptable. Any off-odor or off-flavor rating of 2 or 3 renders the package not acceptable.
- 6.5.4 Structural integrity: Remove food and clean the container to allow observation of any structural changes such as discoloration, de-lamination, warping, cracking, distortion, etc. Record observations on a structure evaluation form shown in Appendix 4. Rate each container as acceptable or not acceptable. Any structural change rating of 3 renders the package not acceptable.

## **7. Suitability for Use**

- 7.1 Containers that are rated acceptable in both the organoleptic and structural integrity evaluations for foods from Categories 1 through 5 (Appendix 2) are considered suitable for microwave warming and heating applications, but not suitable for cooking.
- 7.2 Containers that are rated acceptable in both the organoleptic and structural integrity evaluations for foods from Categories 1 through 6 (Appendix 2) are considered suitable for all microwave applications including cooking.
- 7.3 Containers that are rated not acceptable in all foods categories are considered unsuitable for use in microwave ovens.

## **8. Definition of Terms**

A glossary of terms related to the testing of single-use foodservice packaging is included in Appendix 5.

## **9. Disclaimer**

This document, including the test methodology and procedures set forth herein and in the appendices hereto, is an account of work and research conducted by or on behalf of various member companies of the Foodservice & Packaging Institute, Inc. (“FPI”). The procedure set forth in this document is only intended to provide a guideline by which to evaluate single-use foodservice packaging products for microwave heating applications, and both the use of the methodology set forth herein and the evaluation of results obtained there from are matters within the discretion of the entity which elects to use such methodology.

Due to the subjectivity of taste and odor factors and due to variations between microwave oven models and manufacturers and possibly significant differences between the actual power output of some microwave ovens and their nominal rated value, the standard test methodology outlined in this document does not guarantee uniform or similar results for any given single-use product in all microwave ovens under all circumstances.

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## Appendix 1

### Determination of Microwave Power Output According to IEC 60705

The measurement is made with a water load in a glass beaker. The water temperature is initially below ambient temperature and is raised to approximately ambient temperature by heating in the microwave oven.

#### Procedure

1. Measure the weight of an empty 2-L beaker. Add 1,000 g  $\pm$  5 g of distilled water having an initial temperature of 10°C  $\pm$  1°C.
2. Measure the weight of the beaker to obtain the actual mass of water.
3. Measure the initial water temperature to the nearest 0.1°C.
4. Immediately place the beaker into the center of a microwave oven and operate the oven at full power until the water temperature is 20°C  $\pm$  2°C. Record the heating time to the nearest second, excluding the magnetron filament heat-up time.
5. Stir the water and measure the final water temperature to the nearest 0.1°C.  
NOTE: Stirring and temperature measuring devices are to have a low heat capacity
6. Calculate the microwave power output from the formula:

$$P = \frac{4.187 \cdot m_w (T_2 - T_1) + 0.55 \cdot m_c (T_2 - T_0)}{t}$$

Where:

- $P$  is the microwave power output, in watts;
- $m_w$  is the mass of the water, in grams;
- $m_c$  is the mass of the container, in grams;
- $T_0$  is the ambient temperature, in degrees Celsius;
- $T_1$  is the initial temperature of the water, in degrees Celsius;
- $T_2$  is the final temperature of the water, in degrees Celsius;
- $t$  is the heating time, in seconds, excluding the magnetron filament heating-up time.

The microwave power output is stated in watts, rounded off to the nearest 50 W.

Note: IEC60705 excludes magnetron filament heat-up time, however, for the purposes of this FPI Standard Test Method to Qualify Foodservice Packaging for Use in Microwave Ovens, the filament heat-up time is not considered significant.

## Appendix 2

### Food Categories

Category	Temperature Range <sup>1</sup>	Type	Food Item	Starting Temperature <sup>2</sup>
1	120 – 150°F	Light product	Crackers	Room Temp.
			Bread	Room Temp.
		Heavy Product	Sandwich	Room Temp.
			Muffins or cake	Room Temp.
2	130 – 180°F	Light product	Waffles	Frozen ≤0°F (-18°C)
			Pancakes	Frozen ≤0°F (-18°C)
		Heavy Product	Broccoli	Frozen ≤0°F (-18°C)
			Cauliflower	Frozen ≤0°F (-18°C)
3	160 – 205°F	Light product	Cinnamon rolls	Frozen ≤0°F (-18°C)
			Melting Cheese	Refrigerated ≤40°F (-4°C)
		Heavy Product	Pizza	Frozen ≤0°F (-18°C)
			Pre-cooked hamburger patties	Frozen ≤0°F (-18°C)
4	170 – 220°F	Light product	Pre-cooked pork sausage	Frozen ≤0°F (-18°C)
			Melting butter or margarine	Refrigerated ≤40°F (-4°C)
		Heavy Product	Lasagna	Frozen ≤0°F (-18°C)
			Macaroni and cheese	Frozen ≤0°F (-18°C)
5	170 – 250°F	Light product	Melting chocolate squares	Room Temp.
		Heavy Product	Vegetables with cheese sauce	Frozen ≤0°F (-18°C)
6	170 - >250°F	Light product	Melting caramels	Room Temp.
		Heavy Product	Sliced Bacon	Refrigerated ≤40°F (-4°C)

<sup>1</sup> Temperature range that food items typically achieve during warming, heating and/or cooking according to Reference 2.3: Gertrude Armbruster, "Development of Microwave Test Protocol – Final Report", Division of Nutritional Sciences, Cornell University (ca. 1981).

<sup>2</sup> Storage temperatures recommended by the U.S. Food and Drug Administration Center for Food Safety and Applied Nutrition. Refrigerator temperature should be set no higher than 40°F (4°C) and freezer temperature set no higher than 0°F (-18°C).

**Appendix 3**

**Taste and Odor Evaluation Form**

**Date:**

**Container Description:**

**Food Item:**

**Cooking time:**

**Describe the intensity of any off-flavor or off-odor using the following scale:**

- 0 = Equal to control**
- 1 = Slight off-flavor or odor**
- 2 = Moderate off-flavor or odor**
- 3 = Extreme off-flavor or odor**

Sample ID:					
Off-odor Description:					
Burned					
Chemical					
Plastic					
Paper or cardboard					
Other (describe):					

Off-flavor Description:					
Overcooked					
Burner					
Chemical					
Plastic					
Paper or Cardboard					
Other (describe):					

Overall Evaluation:					
Acceptable					
Not Acceptable					

Appendix 4

Structural Integrity Evaluation Form

Date:

Container Description:

Food Item:

Cooking time:

Describe any observed structural changes using the following scale:

- 1 = No change
- 2 = Slight Change
- 3 = Severe Change

Sample ID:					
Observations:					
Blisters, bumps, wrinkles or pitting					
Cracking or crazing					
Dimensional change					
Distortion or buckling					
Rupture, holes or penetration					
Melting					
Undesired or undesigned discoloration					
Other (describe):					

Overall Evaluation:					
Acceptable					
Not Acceptable					

## Appendix 5

### Glossary Of Terms Relating To Testing Of Single-Use Foodservice Packaging For Use In Microwave Ovens

Term	Definition
Char	To scorch or burn slightly, usually accompanied by a color change.
Container	A dish, vessel or enclosure used to hold food.
Cooking	The act of preparing food for consumption. Cooking usually involves applying heat in order to kill microorganisms and chemically transform a food, thus changing its flavor, texture or appearance.
Crack	A break or fissure penetrating the entire container thickness.
Craze	Small surface cracks that do not penetrate through the entire container thickness.
Dimensional Change	A change of the width, length or height of a container.
Discolor	To change color from an original state, e.g. fade or stain.
Distortion	To twist or deform from an original state.
Failure	Container after testing shows evidence that it is unusable as a cooking container.
Heat / Reheat	To increase the temperature of food by application of microwave energy.
Melt	To liquefy by heating.
Microwave Oven	An oven that uses microwave radiation to heat food.
Penetration	Transfer of food or food component such as grease into or through packaging material.
Rupture or Hole	Evidence of a crack, break or opening through the container allowing leakage.