Designation: C1607 – 06

# Standard Test Method for Determination of "Microwave Safe for Reheating" for Ceramicware[1]

This standard is issued under the fixed designation C1607; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method determines the suitability of ceramicware for use in microwave re-heating applications. Microwave ovens are mainly used for reheating and defrosting frozen foods. Severe thermal conditions can occur while reheating foods. Typical reheating of foods requires one to five min. in the microwave at the highest power settings. Longer periods than five minutes are considered cooking. Cooking test methods and standards are not addressed in this test method. Most ceramicware is minimally absorbing of the microwave energy and will not heat up significantly. Unfortunately there are some products that absorb microwave energy to a greater extent and can become very hot in the microwave and pose a serious hazard. Additionally, the nature of microwave heating introduces radiation in a non-uniform manner producing temperature differentials in the food being cooked as well as the ceramic container holding it. The differential may become great enough to thermal shock the ware and create dangerous conditions.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

C554 Test Method for Crazing Resistance of Fired Glazed Ceramic Whitewares by a Thermal Shock Method

## 3. Terminology

3.1 *Definition:*

3.1.1 *microwave safe for re-heating*—ceramic products that can be used in a microwave oven without any degradation, such as by deformation, fracturing, crazing, or heating up to excessive temperatures.

## 4. Summary of Test Method

4.1 This method can be used to determine if a product is safe to use for reheating foods in a microwave oven. The test emulates typical microwave use conditions. Temperature maximums and temperature differentials of products are determined after being subjected to microwave re-heating conditions.

## 5. Significance and Use

5.1 This test is for evaluating ceramic products that are intended for reheating in a Consumer based microwave oven. It is not intended for evaluating products that will be used in commercial type microwaves.

5.2 This test method is not intended to evaluate metallic or polymeric based products.

5.3 Ceramic products intended for microwave use must also be evaluated for thermal shock resistance and pass the 325°F criteria as described in Test Method C554, before being tested for microwave safety. This would include specific tests for dinnerware, cookware, drinkware and ancillary items intended for use with hot foods, such as gravy boats or any product intended for microwave use.

5.4 Dishes having a metallic glaze, decoration or paint should not be used in this test or microwave ovens unless it is specifically designed for and marked as microwave safe.

## 6. Interferences

6.1 Test samples must be free from any obvious physical defects.

## 7. Apparatus

7.1 The microwave oven chosen for testing is based on its power level and being close to a mid-sized consumer product. This is to provide a relatively high power density, which creates conditions that are slightly harsher than conditions found in the average microwave oven. The main difference between microwave ovens is the power of the magnetron, which generates the microwaves. Midsize and large ovens are

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

typically rated at 900 to 1300 watts and compact ovens have about 600 to 800 watts of output.

7.1.1 Greater wattage for a given space heats food more quickly. The microwave oven chosen for this method is based on having the greatest power output per volume. This provides worse case conditions for microwaves available in the midsize range while allowing for a greater range of sample sizes. Microwaves with greater power outputs of 1400 and 1600 watts that were once available are no longer in production.

7.1.2 *Microwave Oven*, (1350 Watts) with an internal oven cavity volume of approximately 0.045 $M^3$ (1.58 $ft^3$) dimensions of 228 by 418 by 470 mm (9 by 16 7/16 by 18 1/2 in.) and rotating glass platter.

7.2 *Fast Reading Contact Surface Thermocouple Probe*, or suitable surface temperature reading device.

7.3 *Scale*, capable of reading 1200 ± 0.5 g.

## 8. Reagents and Materials

8.1 *Tap Water*.

8.2 *Plastic Beakers*, 1 L, 500 mL; Graduate cylinder 250 mL.

8.3 *Eye Protection*.

8.4 *Insulated Gloves or Oven Mitts*, preferably waterproof.

8.5 *Permanent Marker*.

8.6 *Boiling Stones*.

## 9. Hazards

9.1 Thermal shock is possible during the testing of the product. Care should be taken while handling ware and be prepared for unexpected failure of the ware.

9.2 Whenever heating water in a microwave there is the possibility of super heating the water. Do not use distilled water, as it is more likely to superheat than tap water. If the water is super heated it is possible that it will spontaneously erupt splashing boiling hot water, which could potentially cause burns and injury. Always use boiling stones in the water container when boiling water.

9.3 People with Pacemakers or any other life sustaining devices should not perform this test and should also not be in the area when the test is performed.

9.4 While performing the test maintain a distance of at least 20 in. from the microwave oven when it is heating. This will reduce any possible leakage of radiation 100 times. The more distance from the microwave the greater the reduction in any exposure.

9.5 Do not operate an oven that is damaged or suspected of being physically damaged.

9.6 If there is any damage to the door, hinges or door seals have the oven repaired and tested for microwave leakage.

9.7 Look for holes created by electrical arcing inside the oven and on the door and door frame.

9.8 Wear oven mitts or insulated gloves when handling hot samples. Always test the piece before handling as there is the possibility that the product attained temperatures that will quickly burn through insulated oven mitts.

## 10. Sampling, Test Specimens, and Test Units

10.1 Representative sample(s) of the process generating the products should be used. Check ware before testing for any physical damage resulting from shipping or handling that would not represent the process.

## 11. Preparation of Apparatus

11.1 Only microwave models fulfilling the description in 7.1 of this method should be used for testing. It is critical to have the same power level of emitted microwaves in the same volume of space to achieve correlation between test sites.

## 12. Calibration and Standardization

12.1 Measure and log the available power for heating before performing tests. This should be performed one time at the beginning of tests to determine that the microwave unit is producing consistent power levels. It is important that the microwave does not have residual heat in it from previous testing so that this test starts from room temperature. The determination of power output is accomplished by measuring the temperature rise in 1 kg of water exposed to microwave radiation for a two-minute period of time. The analyst can relate power in watts to the power setting of the microwave.

12.1.1 Program the microwave for 2 minutes at maximum power and leave the door open.

12.1.2 Record the weight of the plastic beaker.

12.1.3 Add 1.0 kg (1000.0 ± 0.5 g) of tap water into a plastic beaker. Equilibrate the water to room temperature 23 ± 2°C (73 ± 4°F) measure to ± 0.1°C (0.2°F).

12.1.4 Place the beaker in the center of the glass platter close the door and press start on the microwave.

12.1.5 When the microwave finishes the 2-minute cycle, the beaker is removed and the water vigorously stirred with a plastic spoon for 10 seconds. Then immerse the temperature reading device into the water and slowly stir.

12.1.6 Record the maximum temperature within the first 10 seconds to ± 0.1°C (0.2°F). Use a new sample for each additional measurement. Do not reuse the water, even after cooling, as it may be more prone to create dangerous superheating conditions.

12.1.7 The absorbed power is determined by the following relationship:

$$P = \frac{(K\ Cp\ m\ \Delta T)}{t} \quad (1)$$

where:

$P$ = the apparent power absorbed by the sample in watts (W) (W = joule/s),

$K$ = the conversion factor for thermochemical calories/s to watts (= 4.184 joule/cal),

$Cp$ = the heat capacity, thermal capacity, or specific heat (cal/g °C) of water,

$m$ = the mass of the water sample in grams (g),

$\Delta T$ = the final temperature minus the initial temperature (°C), and

$t$ = the time in seconds (s).

12.1.8 Using 2 minutes and 1 kg of distilled water (heat capacity at 25°C is 0.99828 cal/g °C) the calibration equation simplifies to:

$$P = (\Delta T) \times (34.86) \quad (2)$$

12.1.9 Calculate and record the power absorption.