Designation: F2473 – 12

An American National Standard

Standard Test Method for Performance of Water-Bath Rethermalizers[1]

This standard is issued under the fixed designation F2473; 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 covers the energy consumption and rethermalizing performance of floor-model and countertop water-bath rethermalizers. The food service operator can use this evaluation to select a water-bath rethermalizer and understand its energy consumption and production capacity.

1.2 This test method is applicable to floor and countertop model gas and electric units.

1.3 The water-bath rethermalizer can be evaluated with respect to the following (where applicable):

1.3.1 Energy input rate (10.2),

1.3.2 Preheat energy consumption, time, and rate (10.4),

1.3.3 Idle energy rate (10.5),

1.3.4 Pilot energy rate (10.6),

1.3.5 Retherm energy rate (10.8),

1.3.6 Production capacity (10.8), and

1.3.7 Retherm-energy efficiency (10.8).

1.4 This test method is not intended to answer all performance criteria in the evaluation and selection of a water-bath rethermalizer.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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]

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels

2.2 *ANSI Standard:*[3]

ANSI Z83.11 Gas Food Service Equipment

2.3 *ASHRAE Documents:*[4]

ASHRAE Handbook of Fundamentals Chapter 6, Table 2—Thermodynamic; Chapter 6, Table 2—Thermodynamic Properties of Water at Saturation

ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data

2.4 *NSF Standards:*[5]

NSF Listing-Food Equipment and Related, Components and Material

NSF/ANSI 4 Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transport Equipment

3. Terminology

3.1 *Definitions:*

3.1.1 *auto-fill, n*—water height sensor device that activates a fresh water fill solenoid when the water level in the rethermalizer drops below a predetermined height.

3.1.2 *energy input rate, n*—peak rate at which a water-bath rethermalizer consumes energy (Btu/h (kJ/h) or kW).

3.1.3 *idle energy rate, n*—average rate of energy consumed (Btu/h or kW) by the rethermalizer while holding or maintaining the water vat at the thermostat(s) set point.

3.1.4 *over-flow drain, n*—drain for eliminating the excess foam and starch created during the rethermalizing process.

3.1.5 *pilot energy rate, n*—average rate of energy consumption (Btu/h (kJ/h)) by a water-bath rethermalizer's continuous pilot (if applicable).

3.1.6 *preheat energy, n*—amount of energy consumed (Btu or kWh) by the rethermalizer while heating the water vat from ambient room temperature to the calibrated thermostat(s) set point.

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.06 on Productivity and Energy Protocol.

Current edition approved May 1, 2012. Published July 2012. Originally approved in 2005. Last previous edition approved in 2005 as F2473 – 05. DOI: 10.1520/F2473-12.

[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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[4] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

[5] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140.

3.1.7 *preheat rate, n*—average rate (°F/min) at which the water vat temperature is heated from ambient temperature to the rethermalizer's calibrated thermostat(s) set point.

3.1.8 *preheat time, n*—time required for the water vat to heat from ambient room temperature to the calibrated thermostat(s) set point.

3.1.9 *production capacity, n*—maximum rate (lb/h (kg/h)) at which water-bath rethermalizer can bring the refrigerated clam chowder to a specified rethermalized condition.

3.1.10 *retherm energy, n*—total energy consumed by the rethermalizer as it is used to reheat bags of refrigerated clam chowder.

3.1.11 *retherm-energy efficiency, n*—quantity of energy required to warm the specified food product (clam chowder soup), expressed as a percentage of the quantity of energy input to the water-bath rethermalizer during the reheating period.

3.1.12 *retherm energy rate, n*—average rate of energy consumed by the rethermalizer while reheating bags of refrigerated clam chowder.

3.1.13 *test method, n*—a definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test results.

3.1.14 *uncertainty, n*—measure of systematic and precision errors in specified instrumentation or measure of repeatability of a reported test result.

3.1.15 *water-bath rethermalizer, n*—appliance, including a rethermalizing vessel, in which water is placed to such a depth that the food is essentially supported by displacement of the water rather than by the bottom of the vessel, which is designed for the purpose of reheating pre-cooked food contained in vacuum-sealed, boilable bags.

4. Summary of Test Method

4.1 The water-bath rethermalizer under test is connected to the appropriate metered energy source. The measured energy input rate is determined and checked against the rated input before continuing with testing.

4.2 The water temperature in the rethermalizing zone of the water-bath rethermalizer is monitored at a location chosen to represent the average temperature of the water while the water-bath rethermalizer maintains a specified rethermalizing temperature.

4.3 Preheat energy, time, and rate are determined while the water-bath rethermalizer is operated with the thermostat(s) set to specified temperature.

4.4 The idle energy is determined while the water-bath rethermalizer is operated in a ready-to-use state with the thermostat(s) set to the calibrated temperature. The rate of pilot energy consumption also is determined when applicable to the water-bath rethermalizer under test.

4.5 Energy consumption and time are monitored while the water-bath rethermalizer is used to reheat three full loads of refrigerated, prepackaged clam chowder soup. Retherm-energy efficiency, retherm energy rate, and production capacity are determined from these tests.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the water-bath rethermalizer under test is operating in accordance with its nameplate rating.

5.2 The water-bath rethermalizer temperature calibration is used to ensure that the water-bath rethermalizer being tested is operating at the specified temperature. Temperature calibration also can be used to evaluate and calibrate the thermostat control dial(s).

5.3 Preheat energy and time can be useful to food service operators to manage energy demands, and to estimate the amount of time required for preheating a water-bath rethermalizer.

5.4 Idle energy rate and pilot energy rate can be used to estimate energy consumption during non-rethermalizing periods.

5.5 Production capacity is used by food service operators to choose a water-bath rethermalizer that matches their particular food output requirements.

5.6 Retherm-energy efficiency is a precise indicator of the water bath rethermalizer's energy performance under full-load condition. This information enables the operator to consider energy performance when selecting a water-bath rethermalizer.

6. Apparatus

6.1 *Analytical Balance Scale,* for measuring weights up to 15 lb (6.8 kg), with a resolution of 0.01 lb (0.004 kg) and an uncertainty of 0.01 lb (0.004 kg).

6.2 *Barometer,* for measuring absolute atmospheric pressure, to be used for adjustment of measured gas volume to standard conditions. Shall have a resolution of 0.2 in. Hg (670 Pa) and an uncertainty of 0.2 in. Hg (670 Pa).

6.3 *Canopy Exhaust Hood,* 4 ft (1.2 m) in depth, wall-mounted with the lower edge of the hood 6 ft, 6 in. (1.98 m) from the floor and with the capacity to operate at a nominal net exhaust ventilation rate of 300 cfm per linear foot (460L/s per linear metre) of active hood length. This hood shall extend a minimum of 6 in. (152 mm) past both sides and the front of the rethermalizing appliance and shall not incorporate side curtains or partitions. Makeup air shall be delivered through face registers or from the space, or both.

6.4 *Data Acquisition System,* for measuring energy and temperatures, capable of multiple temperature displays updating at least every 2 s.

6.5 *Flow Meter,* for measuring total water consumption of the appliance. Shall have a resolution of 0.01 gal (0.04 L) and an uncertainty of 0.01 gal (0.04 L) at a flow rate as low as 0.2 gpm (0.8 lpm).

6.6 *Gas Meter,* for measuring the gas consumption of a water-bath rethermalizer, shall be a positive displacement type with a resolution of at least 0.01 ft^3 (0.0003 m^3) and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft^3 (0.06 m^3) per hour. If the meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution of at least 0.01 ft^3 (0.0003 m^3) and a maximum uncertainty no greater than 2 % of the measured value.

6.7 *Pressure Gage,* for monitoring gas pressure. Shall have a range of 0 to 15 in. H_2O (0 to 3.7 kPa), a resolution of 0.5 in. H_2O (125 kPa), and a maximum uncertainty of 1 % of the measured value.

6.8 *Stop Watch,* with a 1-s resolution.

6.9 *Thermocouple Probe(s),* industry standard type T or type K thermocouples capable of immersion, with a range of from 50 to 400°F (10 to 204°C) and an uncertainty of ±1°F (±0.5°C).

6.10 *Temperature Sensor,* for measuring natural gas temperature in the range of 50 to 100°F (10 to 38°C) with an uncertainty of ±1°F (±0.5°C).

6.11 *Watt-Hour Meter,* for measuring the electrical energy consumption of a water-bath rethermalizer, shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 1.5 % of the measured value for any demand greater than 100 W. For any demand less than 100 W, the meter shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 10 %.

7. Reagents and Materials

7.1 *Water* used shall have a maximum hardness of three grains per gallon. Distilled water may be used.

7.2 *New England Clam Chowder Soup,* refrigerated, ready to use, in nominal 1-gal (3.8-L) vacuum packed bags or "chubs," weighing 6.0 ± 0.2 lb (2.72 ± 0.09 kg) per bag. The clam chowder shall be stabilized in a refrigerator at 38 ± 2°F (3 ± 1°C).

NOTE 1—Generic brand New England Clam Chowder has been proven to be an acceptable product for testing by the Food Service Technology Center.

8. Sampling and Test Units

8.1 *Water-Bath Rethermalizer*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Measure the water-bath rethermalizer's vat's rethermalizing capacity. The water-bath rethermalizer's rethermalizing vat may be shaped in such a way that simple measurements do not yield the true rethermalizing capacity. In this case, fill the water-bath rethermalizer with water till the bottom edge of the rethermalizing capacity is reached. Then, measure the volume of water required to fill the rethermalizing capacity to the top.

9.2 Install the appliance according to the manufacturer's instructions under a 4-ft (1.2-m) deep canopy exhaust hood mounted against the wall, with the lower edge of the hood 6 ft, 6 in. (1.98 m) from the floor. Position the water-bath rethermalizer with the front edge of the water in the rethermalizing vat inset 6 in. (152 mm) from the front edge of the hood at the manufacturer's recommended working height. The length of the exhaust hood and active filter area shall extend a minimum of 6 in. (152 mm) past the vertical plane of both sides of the water-bath rethermalizer. In addition, both sides of the water-bath rethermalizer shall be a minimum of 3 ft (0.9 m) from any sidewall, side partition, or other operating appliance. The exhaust ventilation rate shall be 300 cfm per linear foot (460 L/s per linear metre) of hood length. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 73 ± 3°F (22 ± 2°C) within the testing environment when the exhaust ventilation system is operating.

9.3 The testing environment during energy tests shall be maintained in accordance with the section on performance for open top hot food holding equipment room specifications of NSF/ANSI 4. NSF/ANSI 4 test room conditions are ambient temperature of 73 ± 3°F (22 ± 2°C), no vertical temperature gradient exceeding 1.5°F/ft (2.5°C/m), and maximum air current velocity of 50 ft/min (0.25 m/s).

9.4 Connect the water-bath rethermalizer to a calibrated energy test meter. For gas installations, install a pressure regulator downstream from the meter to maintain a constant pressure of gas for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the water-bath rethermalizer and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, a voltage regulator may be required during tests if the voltage supply is not within ±2.5 % of the manufacturer's "nameplate" voltage.

9.5 For an electric water-bath rethermalizer, confirm (while the water-bath rethermalizer elements are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test.

NOTE 2—It is the intent of the testing procedure in this test method to evaluate the performance of a water-bath rethermalizer at its rated electric voltage. If the unit is rated dual voltage (that is, designed to operate at either 240 or 480 V with no change in components), the voltage selected by the manufacturer or tester, or both, shall be reported. If a water-bath rethermalizer is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, preheat time) may differ at the two voltages.

9.6 For a gas water-bath rethermalizer, adjust (during maximum energy input) the gas supply pressure downstream from the appliance's pressure regulator to within ±2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the water-bath rethermalizer following the manufacturer's recommendations for optimizing combustion. Proper combustion may be verified by measuring air-free CO in accordance with ANSI Z83.11.

9.7 Make the water-bath rethermalizer ready for use in accordance with the manufacturer's instructions. Clean the water-bath rethermalizer's vat by "boiling" with the manufacturer's recommended cleaner and water and then rinsing the inside of the rethermalizing-vat thoroughly before starting each test procedure.

9.8 To prepare the water-bath rethermalizer for temperature calibration, attach an immersion type thermocouple in the rethermalizing vat before beginning any test. The thermocouple used to calibrate the water-bath rethermalizer shall be located in the back of the rethermalizing vat, about ½ in. (13 mm) from the back edge of the rethermalizing vat, ½ in. (13 mm) above the heat transfer area or elements, or both, and located in the centered in relation to the sides of the rethermalizing vat.

9.9 Fresh water supply to water-bath rethermalizer should be monitored to ensure that water temperature is 65 ± 5°F (18 ± 3°C).

9.10 Install flow meter to the water-bath rethermalizer water inlet such that total water flow to the appliance is measured.

9.11 *Food Racks,* for holding food packages upright during the test shall be used. If the manufacturer does not have food racks specifically designed for the water bath rethermalizer, then stainless steel wire racks conforming to the specifications in Fig. 1 may be used. Food racks must have clamps that will securely fasten the food and also have pins that will pierce food bags keeping them from floating.

9.12 Use the cooking racks to determine the maximum number of 6-lb clam chowder chubs to be placed inside each vat. Use one chub per rack and place it vertically inside the vat and place as many racks as possible until the vat is full. Record this value and use this amount for testing.

10. Procedure

10.1 *General:*

10.1.1 For gas appliances, record the following for each test run:

10.1.1.1 Higher heating value,

10.1.1.2 Standard gas pressure and temperature used to correct measured gas volume to standard conditions,

10.1.1.3 Measured gas temperature,

10.1.1.4 Measured gas pressure,

10.1.1.5 Barometric pressure, and

10.1.1.6 Energy input rate during or immediately prior to test.

NOTE 3—The preferred method for determining the heating value of the supplied to the water-bath rethermalizer under test is by using a calorimeter of gas chromatograph in accordance with accepted laboratory procedures. The use of "bottled" natural gas with a certified heating value within the specified 1025 ± 25 Btu/ft^3 (38 160 ± 930 kJ/m^3) range is an acceptable alternative.

10.1.2 For gas water-bath rethermalizers, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (10.2).

10.1.3 For electric water-bath rethermalizers, record the following for each run of each test run:

10.1.3.1 Voltage while elements are energized, and

10.1.3.2 Energy input rate during or immediately prior to test run.

10.1.4 For each test run, confirm that the peak input rate is within ±5 % of the rated nameplate input. If the difference is greater than 5 %, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the water-bath rethermalizer.

10.1.5 For all tests, record the altitude of the testing facility.

10.1.6 For all tests, maintain water level at the indication line. If the water-bath rethermalizer has no indication line, then maintain water level to the manufacturer's recommended capacity at all times.

10.2 *Measured Energy Input Rate:*

10.2.1 Load the water-bath rethermalizer to the indicated fill line with fresh water and turn the water-bath rethermalizer on with the temperature control(s) set to the maximum setting.

10.2.2 Let the water-bath rethermalizer run for a period of 15 min, then monitor the time required for the water-bath rethermalizer to consume 5 ft^3 (0.14 m^3) of gas. Adjustments to the appliance's input rate may be made by adjusting gas manifold pressure (gas water-bath rethermalizer).

10.2.3 For electric water-bath rethermalizers, monitor the energy consumption for 15 min with the controls set to achieve maximum input.

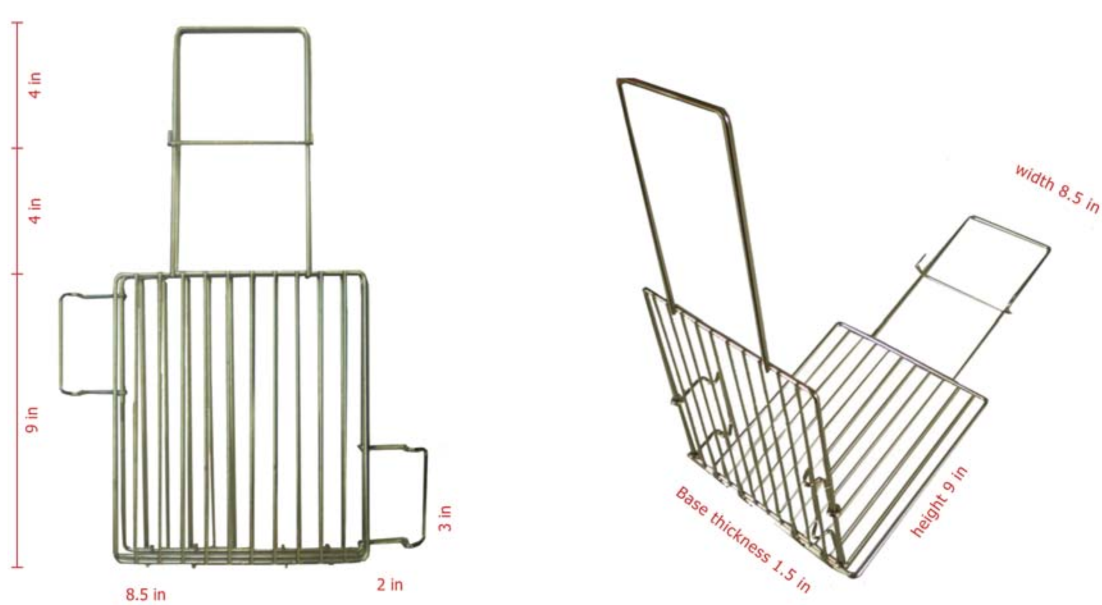

FIG. 1 Food Racks in Rethermalizer Used for Efficiency Tests

10.2.4 In accordance with 11.4, calculate the measured energy input rate for the water-bath rethermalizer under test. Report and compare the measured input to the "nameplate" energy input rate in Btu/h or kW. Confirm that the measured input rate is within ±5 % of rated "nameplate" energy input rate. If the difference is greater than ±5 %, testing shall be terminated and the manufacturer contacted. The manufacturer may make appropriate changes or adjustments to the water-bath rethermalizer. Also, the power supply may be changed, if necessary, to conform to manufacturer's specifications. It is the intent of the testing procedures in this test method to evaluate the performance of a water-bath rethermalizer at its rated energy input rate.

10.3 *Calibration:*

NOTE 4—The manufacturer may have a calibration procedure that may give some insight into their thermostatic control strategy. The manufacturer's calibration procedure may be used initially to help in the calibration of the rethermalizing temperature. After applying the manufacturer's calibration procedure, confirm calibration with 10.3.

10.3.1 Fresh water temperature supplied to the water-bath rethermalizer shall be 65 ± 5°F (18 ± 3°C).

NOTE 5—If the fresh water temperature is not within the specified temperature, mix the supply water with hot or cold sources to meet the desired temperature. The supply water can be tempered to obtain the proper supply water temperature.

10.3.2 Ensure that the water-bath rethermalizer water is loaded to the indicated fill line or manufacturer's recommended water level. Preheat and allow the water-bath rethermalizer to stabilize for 30 min before beginning temperature calibration.

10.3.3 The water-bath rethermalizer water temperature shall be measured by attaching a calibrated immersion thermocouple type in the rear of the rethermalizing zone as detailed in 9.9. Adjust the water-bath rethermalizer temperature control(s) to maintain an average water vat temperature of 195 ± 5°F (91 ± 3°C). Record the water temperature over a 1-h period to verify temperature of the water at 195 ± 5°F (91 ± 3°C). The water temperature recorded over a 1-h period shall be considered as the average temperature for the water-bath rethermalizer.

10.4 *Preheat-Energy Consumption, Time, and Rate:*

10.4.1 Ensure that the water-bath rethermalizer is filled to the indicated fill line. If there is no indication line, then fill to the manufacturer's recommended water level. Record water temperature, barometric pressure, and ambient kitchen temperature at the start of the test (water temperature shall be 65 ± 5°F (21 ± 3°C) at the start of the test).

NOTE 6—The preheat test should be conducted prior to appliance operation on the day of the test. If another preheat is to conducted after the appliance has been preheated earlier, the water-bath rethermalizer mass temperature will need to be stabilized. Fill water-bath rethermalizer with fresh water and allow the water in the rethermalizing vat to stabilize at room temperature for at least 30 min. Drain the water from the water-bath rethermalizer and begin testing with 10.4.1.

10.4.2 Turn the water-bath rethermalizer on with the temperature controls set to attain the rethermalizing temperature calibrated in 10.3.

NOTE 7—It is the intent of this procedure to test the appliance at the rethermalizing temperature calibrated in 10.3. If the appliance is unable to achieve the rethermalizing temperature, then the manufacturer needs to be contacted. The manufacturer may make appropriate changes or adjustments to the water-bath rethermalizer.

10.4.3 Begin monitoring energy consumption and time as soon as the water-bath rethermalizer is turned on. The preheat period is measured from 75 to 195°F (24 to 91°C). Use the preheat energy consumption and time from 75 to 195°F (24 to 91°C) for preheat energy consumption and elapsed time.

10.5 *Idle Energy Rate:*

10.5.1 Ensure that the water-bath rethermalizer is filled to the indicated fill line or manufacturer's recommended water level. If the manufacturer provides a cover, then make sure that the cover is in place over the rethermalizer vat.

10.5.2 Allow the water-bath rethermalizer water to stabilize at calibrated idle temperature for at least 30 min after the last thermostat has commenced cycling about the thermostat set point.

10.5.3 Record the water-bath rethermalizer water temperature, barometric pressure, and ambient temperature at the start of the test.

10.5.4 Proceed to monitor the elapsed time and the energy consumption of the water-bath rethermalizer while it is operated under this idle condition for a minimum of 2 h.

10.6 *Pilot Energy Rate (Gas Model with Standing Pilots):*

10.6.1 Where applicable, set the gas valve controlling the gas supply to the appliance to the "pilot" position. Otherwise set the temperature controls to the "off" position.

10.6.2 Light and adjust pilots according to manufacturer's instructions.

10.6.3 Record gas reading, gas temperature, gas pressure, ambient temperature, barometric pressure, electric energy consumed, and time before and after a minimum of 8 h of pilot operation.

10.7 *Rethermalization Time Determination:*

10.7.1 Ensure that water-bath rethermalizer water is loaded to the indicated fill line. If there is no fill line, then fill to manufacturer's recommended water level.

10.7.2 Preheat the rethermalizer and allow the unit to stabilize for 30 min after being preheated.

10.7.3 Ensure that water-bath rethermalizer water is loaded to the indicated water-bath rethermalizer fill line. If there is no fill line, then fill to manufacturer's recommended water level. Confirm that the water-bath rethermalizer-water temperature is at its rethermalizing temperature as calibrated in 10.3.3.

10.7.4 Ensure that the soup chubs are 38 ± 2°F (3 ± 1°C).

10.7.5 Load the water-bath rethermalizer with the number of refrigerated soup chubs as determined in 9.12. Load time shall be no greater than 5 s per chub. If the manufacturer provides a cover, then make sure that the cover is in place over the rethermalizer vat. Begin monitoring rethermalization time and rethermalizer energy consumption.

10.7.6 Determine an approximate doneness of the soup (165 ± 5°F (74 ± 3°C)) by randomly selecting a chub and removing it from the water vat at predetermined time intervals. Shake the soup chub for 15 s to mix the soup, then fold the bag over a thermocouple probe. This will approximate the temperature of the chub.

10.7.7 If the average surface temperature of the soup chub is below 165 ± 5°F (74 ± 3°C), then put the soup chub back into the water vat and continue to rethermalize. Repeat this process, randomly selecting a different chub, until the approximate surface temperature of all the soup chubs reaches 165 ± 5°F (74 ± 3°C).

10.7.8 If the average internal temperature of all the soup chubs is greater than 170°F (77°C), the soup is overheated. Terminate the cook time determination test and repeat 10.7.1 – 10.7.7.

10.7.9 If the average temperature of all the soup chubs is 165 ± 5°F (74 ± 3°C), the soup is done. Record the rethermalization time.

10.8 *Retherm Energy Consumption and Production Capacity:*

10.8.1 The retherm energy consumption and production capacity test is to be conducted a minimum of three times. Additional test runs may be necessary to obtain the required precision for the reported test results (Annex A1). The reported values shall be the average of the replications (runs).

10.8.2 Ensure that water-bath rethermalizer water is loaded to the indicated fill line. If there is no fill line, then fill to manufacturer's recommended water level.

10.8.3 Preheat the rethermalizer and allow the unit to stabilize for 30 min after being preheated.

10.8.4 Prepare the required quantity of food for making up three replicates of the rethermalizing test as described in 9.12.

10.8.5 Ensure that the soup chubs are refrigerated to a temperature of 38 ± 5°F (3 ± 3°C).

10.8.6 Load the water-bath rethermalizer with the soup chubs and begin monitoring time and energy consumption. If the manufacturer provides a cover, then make sure that the cover is in place over the rethermalizer vat.

10.8.7 Once the rethermalization time as determined in 10.7.8 has been reached, remove the soup chubs from the water-vat. Pour the contents into a container large enough to hold the contents of all the chubs, such as a stockpot. Thoroughly stir the soup for approximately 15 to 30 s in order to de-stratify the mixture.

10.8.8 Determine the final soup temperature by immediately placing a temperature probe tree into the soup utilizing 5 thermocouples distributed evenly throughout the pot starting 1 in. from the bottom and 1 in. from the soup surface. Record these temperatures for at least 2 min to calculate and determine the average cooked soup temperature.

10.8.9 If the average of the temperatures measured in 10.8.8 is above or below 165 ± 5°F (74 ± 3°C), the test is invalid and must be repeated. Adjust the rethermalization time as appropriate and repeat 10.8.2 – 10.8.8.

10.8.10 For units without auto-fill, replenish any lost water by filling the rethermalizer vat to the required fill line or to the manufacturer's recommended water level with fresh (65 ± 5°F (18 ± 3°C)) water right after removing the load from the rethermalizer, and allow the rethermalizer water temperature to return to 190°F (88°C).

10.8.11 Record the time and energy required to return the rethermalizer to 190°F (88°C).

10.8.12 Repeat 10.8.2 – 10.8.11 for replicates #2 and #3.

11. Calculation and Report

11.1 *Test Water-Bath Rethermalizer:*

11.1.1 Summarize the physical and operating characteristics of the water-bath rethermalizer. If needed, describe other design or operating characteristics (for example, cover, auto-fill, recirculation, and so forth) that may facilitate interpretation of the test results.

11.2 *Apparatus and Procedure:*

11.2.1 For electric water-bath rethermalizers, report the voltage for each test.

11.2.2 For gas water-bath rethermalizers, report the higher heating value of the gas supplied to the water-bath rethermalizer during each test.

11.3 *Gas Energy Calculations:*

11.3.1 For gas water-bath rethermalizers, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (11.4).

11.3.2 Calculate the energy consumed based on:

$$E_{gas} = V \times HV \tag{1}$$

where:

E_{gas} = energy consumed by the appliance,
HV = higher heating value,
= energy content of gas measured at standard conditions, Btu/ft^3 (kJ/m^3),
V = actual volume of gas corrected for temperature and pressure at standard conditions, ft^3 (m^3),

$$= V_{meas} \times T_{cf} \times P_{cf} \tag{2}$$

where:

V_{meas} = measured volume of gas, ft^3 (m^3),
T_{cf} = temperature correction factor,

$$= \frac{\text{absolute standard gas temperature } (°R)}{\text{absolute actual gas temperature } (°R)},$$

$$= \frac{\text{absolute standard gas temperature } (°R)}{[\text{gas temp } °F + 459.67] \ (°R)},$$

P_{cf} = pressure correction factor,

$$= \frac{\text{absolute actual gas pressure (psia)}}{\text{absolute standard pressure (psia)}}, \text{ and}$$

$$= \frac{\text{gas gage pressure (psig)} + \text{barometric pressure (psia)}}{\text{absolute standard pressure (psia)}}$$

NOTE 8—Absolute standard gas temperature and pressure used in this calculation should be the same values used for determining the higher heating value. Standard conditions using Practice D3588 are 519.67 °R and 14.73 psia.

11.4 *Energy Input Rate:*

11.4.1 Report the manufacturer's nameplate energy input rate in Btu/h for a gas water-bath rethermalizer and kW for an electric water-bath rethermalizer.

11.4.2 For gas or electric water-bath rethermalizer, calculate and report the measured energy input rate (Btu/h or kW) based on the energy consumed by the water-bath rethermalizer during the period of peak energy input according to the following relationship:

$$q_{input} = \frac{E \times 60}{t} \quad (3)$$

where:

q_{input} = measured peak energy input rate, Btu/h (kJ/h) or kW,
E = energy consumed during period of peak energy input, Btu (kJ) or kWh, and
t = period of peak energy input, min.

11.5 *Water-Bath Rethermalizer Temperature Calibration:*

11.5.1 Report the average bulk temperature for the water in the water-bath rethermalizer after calibration. Report any discrepancies between indicated on the control and the measured average water temperature. Report the altitude of the testing facility.

11.6 *Preheat Energy and Time:*

11.6.1 Report the preheat energy consumption (Btu (kJ) or kWh) and preheat time (min).

11.6.2 Calculate and report the average preheat rate (°F(°C)/min) based on the preheat period.

11.7 *Idle Energy Rate:*

11.7.1 Calculate and report the idle energy rate (Btu/h (kJ/h) or kW) based on:

$$q_{idle} = \frac{E \times 60}{t} \quad (4)$$

where:

q_{idle} = idle energy rate, Btu/h (kJ/h) or kW,
E = energy consumed during the test period, Btu (kJ) or kWh, and
t = test period, min.

11.7.2 Report the idle temperature setting and average temperature of the vat during the idle test.

11.8 *Pilot Energy Rate:*

11.8.1 Calculate and report the pilot energy rate (Btu/h (kJ/h)) based on:

$$q_{pilot} = \frac{E \times 60}{t} \quad (5)$$

where:

q_{pilot} = pilot energy rate, Btu/h (kJ/h),
E = energy consumed during the test period, Btu (kJ), and
t = test period, min.

11.9 *Retherm Energy Consumption and Production Capacity Test:*

11.9.1 Report the total energy consumed during the retherm energy consumption and production capacity test in Btu (kJ) or kWh. For gas units, separately report any electric energy consumption.

11.9.2 Calculate and report the retherm energy rate for three loads test based on:

$$q_{retherm} = \frac{E \times 60}{t} \quad (6)$$

where:

$q_{retherm}$ = retherm energy rate, Btu/h (kJ/h) or kW,
E = energy consumed during the test period, Btu (kJ) or kWh, and
t = test period, min.

11.9.2.1 For gas water-bath rethermalizers, report separately a gas retherm energy rate and an electric retherm energy rate.

11.9.3 Calculate production capacity (lb/h (kg/h)) based on:

$$PC = \frac{W \times 60}{t} \quad (7)$$

where:

PC = production capacity of the water-bath rethermalizer, lb/h (kg/h),
W = total weight of food cooked during three load production test, lb (kg), and
t = total time of three load rethermalizing test including recovery time, min.

11.9.4 Report final retherm and recovery times in minutes and individual food load weight, lb (kg).

11.10 *Retherm-Energy Efficiency:*

11.10.1 Calculate and report the retherm-energy efficiency for the three loads tests based on:

$$\eta_{retherm} = \frac{E_{soup}}{E_{appliance}} \times 100 \quad (8)$$

where:

$\eta_{retherm}$ = retherm-energy efficiency,
E_{soup} = energy into clam chowder soup,
$E_{appliance}$ = energy into the appliance, Btu (kJ).

$$= W_i \times C_{p,\,soup} \times (T_f - T_i) \quad (9)$$

where:

W_i = initial weight of the refrigerated soup, lb (kg),
$C_{p,\,soup}$ = specific heat of New England clam chowder soup, Btu/lb, °F (kJ/kg, °C),
= 0.80,
T_f = final temperature of the reheated soup, °F (°C),
T_i = initial temperature of the refrigerated soup, °F (°C),

12. Precision and Bias

12.1 *Precision:*

12.1.1 *Repeatability (within laboratory, same operator and equipment):*

12.1.1.1 For the retherm-energy efficiency, retherm energy rate, and production capacity results, the percent uncertainty in each result has been specified to be no greater than ±10 % based on at least three test runs.

12.1.1.2 The repeatability of each reported parameter is being determined.

12.1.2 *Reproducibility (multiple laboratories)*—The interlaboratory precision of the procedure in this test method for measuring each reported parameter is being determined.

12.2 *Bias*—No statement can be made concerning the bias of the procedures in this test method because there are no accepted reference values for the parameters reported.

13. Keywords

13.1 efficiency; energy; performance; production capacity; retherm-energy efficiency; retherm, rethermalizer, appliance; test method; throughput

ANNEX

(Mandatory Information)

A1. PROCEDURE FOR DETERMINING THE UNCERTAINTY IN REPORTED TEST RESULTS

NOTE A1.1—This procedure is based on the ASHRAE method for determining the confidence interval for the average of several test results (ASHRAE Guideline 2-1986 (RA90)). It should only be applied to test results that have been obtained within the tolerances prescribed in this method (for example, thermocouples calibrated, appliance operating within 5 % of rated input during the test run).

A1.1 For the water-boil efficiency, retherm energy efficiency, retherm energy rate, and production capacity results, the uncertainty in the averages of at least three test runs is reported. For each test run, the uncertainty of the water-boil efficiency, retherm energy efficiency, rethermalizing energy rate and production capacity must be no greater than ±10 % before any of the parameters for that test run can be reported.

A1.2 The uncertainty in a reported result is a measure of its precision. If, for example, the production capacity for the water-bath rethermalizer is 30 lb/h (12.6 kg/h), the uncertainty must not be greater than ±3 lb/h (±1.4 kg/h) Thus, the true production capacity is between 27 and 33 lb/h (11.2 and 15 kg/h). This interval is determined at the 95 % confidence level, which means that there is only a 1 in 20 chance that the true production capacity could be outside of this interval.

A1.3 Calculating the uncertainty not only guarantees the maximum uncertainty in the reported results, but is also used to determine how many test runs are needed to satisfy this requirement. The uncertainty is calculated from the standard deviation of three or more test results and a factor from Table A1.1, which lists the number of test results used to calculate the average. The percent uncertainty is the ratio of the uncertainty to the average expressed as a percent.

A1.4 *Procedure*:

NOTE A1.2—Section A1.5 shows how to apply this procedure.

A1.4.1 *Step 1*—Calculate the average and the standard deviation for the test result (rethermalizing energy rate and production capacity) using the results of the first three test runs, as follows:

A1.4.1.1 The formula for the average (three test runs) is as follows:

$$Xa_3 = \left(\frac{1}{3}\right) \times (X_1 + X_2 + X_3) \quad (A1.1)$$

where:

Xa_3 = average of results for three test runs, and
X_1, X_2, X_3 = results for each test run.

A1.4.1.2 The formula for the sample standard deviation (three test runs) is as follows:

$$S_3 = \left(\frac{1}{\sqrt{2}}\right) \times \sqrt{(A_3 - B_3)} \quad (A1.2)$$

where:

S_3 = standard deviation of results for three test runs,
A_3 = $(X_1)^2 + (X_2)^2 + (X_3)^2$, and
B_3 = $(1/3) \times (X_1 + X_2 + X_3)^2$.

NOTE A1.3—The formulas may be used to calculate the average and sample standard deviation. However, a calculator with statistical function is recommended, in which case be sure to use the sample standard deviation function. The population standard deviation function will result in an error in the uncertainty.

NOTE A1.4—The "A" quantity is the sum of the squares of each test result, and the "B" quantity is the square of the sum of all test results multiplied by a constant (⅓ in this case).

A1.4.2 *Step 2*—Calculate the absolute uncertainty in the average for each parameter listed in Step 1. Multiply the standard deviation calculated in Step 1 by the Uncertainty Factor corresponding to three test results from Table A1.1.

A1.4.2.1 The formula for the absolute uncertainty (three test runs) is as follows:

$$U_3 = C_3 \times S_3 \quad (A1.3)$$

$$U_3 = 2.48 \times S_3$$

where:

U_3 = absolute uncertainty in average for three test runs, and
C_3 = uncertainty factor for three test runs (Table A1.1).

A1.4.3 *Step 3*—Calculate the percent uncertainty in each parameter average using the averages from Step 1 and the absolute uncertainties from Step 2.

A1.4.3.1 The formula for the percent uncertainty (three test runs) is as follows:

$$\%U_3 = \left(\frac{U_3}{Xa_3}\right) \times 100\,\% \quad (A1.4)$$

where:

$\%U_3$ = percent uncertainty in average for three test runs,
U_3 = absolute uncertainty in average for three test runs, and
Xa_3 = average of three test runs.

TABLE A1.1 Uncertainty Factors

Test Results, *n*	Uncertainty Factor, *Cn*
3	2.48
4	1.59
5	1.24
6	1.05
7	0.92
8	0.84
9	0.77
10	0.72

A1.4.4 *Step 4*—If the percent uncertainty, $\%U_3$, is not greater than ±10 % for rethermalizing energy rate and production capacity, report the average for these parameters along with their corresponding absolute uncertainty, U_3, in the following format:

$$Xa_3 \pm U_3$$

A1.4.4.1 If the percent uncertainty is greater than ±10 % for the rethermalizing energy rate and production capacity, proceed to Step 5.

A1.4.5 *Step 5*—Run a fourth test for each loading scenario whose percent uncertainty was greater than ±10 %.

A1.4.6 *Step 6*—When a fourth test is run for a given loading scenario, calculate the average and standard deviation for test results using a calculator or the following formulas:

A1.4.6.1 The formula for the average (four test runs) is as follows:

$$Xa_4 = \left(\frac{1}{4}\right) \times (X_1 + X_2 + X_3 + X_4) \quad \text{(A1.5)}$$

where:

Xa_4 = average of results for four test runs, and
X_1, X_2, X_3, X_4 = results for each test run.

A1.4.6.2 The formula for the standard deviation (four test runs) is as follows:

$$S_4 = \left(\frac{1}{\sqrt{3}}\right) \times \sqrt{(A_4 - B_4)} \quad \text{(A1.6)}$$

where:

S_4 = standard deviation of results for four test runs,
A_4 = $(X_1)^2 + (X_2)^2 + (X_3)^2 + (X_4)^2$, and
B_4 = $(1/4) \times (X_1 + X_2 + X_3 + X_4)^2$.

A1.4.7 *Step 7*—Calculate the absolute uncertainty in the average for each parameter listed in Step 1. Multiply the standard deviation calculated in Step 6 by the Uncertainty Factor for four test results from Table A1.1.

A1.4.7.1 The formula for the absolute uncertainty (four test runs) is as follows:

$$U_4 = C_4 \times S_4 \quad \text{(A1.7)}$$

$$U_4 = 1.59 \times S_4$$

where:

U_4 = absolute uncertainty in average for four test runs, and
C_4 = the uncertainty factor for four test runs (Table A1.1).

A1.4.8 *Step 8*—Calculate the percent uncertainty in the parameter averages using the averages from Step 6 and the absolute uncertainties from Step 7.

A1.4.8.1 The formula for the percent uncertainty (four test runs) is as follows:

$$\%U_4 = \left(\frac{U_4}{Xa_4}\right) \times 100\,\% \quad \text{(A1.8)}$$

where:

$\%U_4$ = percent uncertainty in average for four test runs,
U_4 = absolute uncertainty in average for four test runs, and
Xa_4 = average of four test runs.

A1.4.9 *Step 9*—If the percent uncertainty, $\%U_4$, is not greater than ±10 % for rethermalizing energy rate and production capacity, report the average for these parameters along with their corresponding absolute uncertainty, U_4, in the following format:

$$Xa_4 \pm U_4$$

A1.4.9.1 If the percent uncertainty is greater than ±10 % for the rethermalizing energy rate and production capacity, proceed to Step 10.

A1.4.10 *Step 10*—The steps required for five or more test runs are the same as those described above. More general formulas are listed below for calculating the average, standard deviation, absolute uncertainty, and percent uncertainty.

A1.4.10.1 The formula for the average (*n* test runs) is as follows:

$$Xa_n = \left(\frac{1}{n}\right) \times (X_1 + X_2 + X_3 + X_4 + \ldots + X_n) \quad \text{(A1.9)}$$

where:

n = number of test runs,
Xa_n = average of results *n* test runs, and
$X_1, X_2, X_3, X_4, \ldots X_n$ = results for each test run.

A1.4.10.2 The formula for the standard deviation (*n* test runs) is as follows:

$$S_n = \left(\frac{1}{\sqrt{(n-1)}}\right) \times \left(\sqrt{(A_n - B_n)}\right) \quad \text{(A1.10)}$$

where:

S_n = standard deviation of results for *n* test runs,
A_n = $(X_1)^2 + (X_2)^2 + (X_3)^2 + (X_4)^2 + \ldots + (X_n)^2$, and
B_n = $(1/n) \times (X_1 + X_2 + X_3 + X_4 + \ldots + X_n)^2$.

A1.4.10.3 The formula for the absolute uncertainty (*n* test runs) is as follows:

$$U_n = C_n \times S_n \quad \text{(A1.11)}$$

where:

U_n = absolute uncertainty in average for *n* test runs, and
C_n = uncertainty factor for *n* test runs (Table A1.1).

A1.4.10.4 The formula for the percent uncertainty (*n* test runs) is as follows:

$$\%U_n = \left(\frac{U_n}{Xa_n}\right) \times 100\,\% \quad \text{(A1.12)}$$

where:

$\%U_n$ = percent uncertainty in average for *n* test runs,
U_n = absolute uncertainty in average for *n* test runs, and
Xa_n = average of *n* test runs.

A1.4.10.5 When the percent uncertainty, $\%U_n$, is less than or equal to ±10 % for the rethermalizing energy rate and production capacity, report the average for these parameters along with their corresponding absolute uncertainty, U_n, in the following format:

$$Xa_n \pm U_n$$

NOTE A1.5—The researcher may compute a test result that deviates significantly from the other test results. Such a result should be discarded only if there is some physical evidence that the test run was not performed according to the conditions specified in this method. For example, a thermocouple was out of calibration, the appliance's input capacity was not within 5 % of the rated input, or the pasta basket was not within specification. To assure that all results are obtained under approximately the same conditions, it is good practice to monitor those test conditions specified in this method.

A1.5 *Example of Determining Uncertainty in Average Test Result*:

A1.5.1 Three test runs for the rethermalizing energy performance yielded the following Production Capacity (PC) results:

Test	PC
Run #1	33.8 lb/h
Run #2	34.1 lb/h
Run #3	31.0 lb/h

A1.5.2 *Step 1*—Calculate the average and standard deviation of the three test results for the PC.

A1.5.2.1 The average of the three test results is as follows:

$$Xa_3 = \left(\frac{1}{3}\right) \times (X_1 + X_2 + X_3) \quad (A1.13)$$

$$Xa_3 = \left(\frac{1}{3}\right) \times (33.8 + 34.1 + 31.0)$$

$$Xa_3 = 33.0 \text{ lb/h}$$

A1.5.2.2 The standard deviation of the three test results is as follows. First calculate "A_3" and "B_3":

$$A_3 = (X_1)^2 + (X_2)^2 + (X_3)^2 \quad (A1.14)$$

$$A_3 = (33.8)^2 + (34.1)^2 + (31.0)^2$$

$$A_3 = 3266$$

$$B_3 = \left(\frac{1}{3}\right) \times [(X_1 + X_2 + X_3)^2]$$

$$B_3 = \left(\frac{1}{3}\right) \times [(33.8 + 34.1 + 31.0)^2]$$

$$B_3 = 3260$$

A1.5.2.3 The new standard deviation for the PC is as follows:

$$S_3 = \left(\frac{1}{\sqrt{2}}\right) \times \sqrt{(3266 - 3260)} \quad (A1.15)$$

$$S_3 = 1.71 \text{ lb/h}$$

A1.5.3 *Step 2*—Calculate the uncertainty in average.

$$U_3 = 2.48 \times S_3 \quad (A1.16)$$

$$U_3 = 2.48 \times 1.71$$

$$U_3 = 4.24 \text{ lb/h}$$

A1.5.4 *Step 3*—Calculate percent uncertainty.

$$\%U_3 = \left(\frac{U_3}{Xa_3}\right) \times 100\,\% \quad (A1.17)$$

$$\%U_3 = \left(\frac{4.24}{33.0}\right) \times 100\,\%$$

$$\%U_3 = 11.9\,\%$$

A1.5.5 *Step 4*—Run a fourth test. Since the percent uncertainty for the production capacity is greater than ±10 %, the precision requirement has not been satisfied. An additional test is run in an attempt to reduce the uncertainty. The PC from the fourth test run was 32.5 lb/h.

A1.5.6 *Step 5*—Recalculate the average and standard deviation for the PC using the fourth test result.

A1.5.6.1 The new average PC is as follows:

$$Xa_4 = \left(\frac{1}{4}\right) \times (X_1 + X_2 + X_3 + X_4) \quad (A1.18)$$

$$Xa_4 = \left(\frac{1}{4}\right) \times (33.8 + 34.1 + 31.0 + 32.5)$$

$$Xa_4 = 32.9 \text{ lb/h}$$

A1.5.6.2 The new standard deviation is. First calculate "A_4" and "B_4":

$$A_4 = (X_1)^2 + (X_2)^2 + (X_3)^2 + (X_4)^2 \quad (A1.19)$$

$$A_4 = (33.8)^2 + (34.1)^2 + (31.0)^2 + (32.5)^2$$

$$A_4 = 4323$$

$$B_4 = \left(\frac{1}{4}\right) \times [(X_1 + X_2 + X_3 + X_4)^2]$$

$$B_4 = \left(\frac{1}{4}\right) \times [(33.8 + 34.1 + 31.0 + 32.5)^2]$$

$$B_4 = 4316$$

A1.5.6.3 The new standard deviation for the PC is as follows:

$$S_4 = \left(\frac{1}{\sqrt{3}}\right) \times \sqrt{(4323 - 4316)} \quad (A1.20)$$

$$S_4 = 1.42 \text{ lb/h}$$

A1.5.7 *Step 6*—Recalculate the absolute uncertainty using the new standard deviation and uncertainty factor.

$$U_4 = 1.59 \times S_4 \quad (A1.21)$$

$$U_4 = 1.59 \times 1.42$$

$$U_4 = 2.25 \text{ lb/h}$$

A1.5.8 *Step 7*—Recalculate the percent uncertainty using the new average.

$$\%U_4 = \left(\frac{U_4}{Xa_4}\right) \times 100\,\% \quad (A1.22)$$

$$\%U_4 = \left(\frac{2.25}{32.9}\right) \times 100\,\%$$

$$\%U_4 = 6.8\,\%$$

A1.5.9 *Step 8*—Since the percent uncertainty, $\%U_4$, is less than ±10 %; the average for the production capacity is reported along with its corresponding absolute uncertainty, U_4, as follows:

$$\text{PC}: 32.9 \pm 2.25 \text{ lb/h} \quad (A1.23)$$

A1.5.9.1 The production capacity can be reported assuming the ±10 % precision requirement has been met for the corresponding rethermalizing energy rate. The production capacity and its absolute uncertainty can be calculated following the same steps.

APPENDIX

(Nonmandatory Information)

X1. RESULTS REPORTING SHEETS

Manufacturer ______________________________
Model ____________________________________
Date _____________________________________
Test Reference Number (optional) ______________

X1.1 Water-Bath Rethermalizer Description

Description of operational characteristics: ____
____
____
____
____
____
____
____

Water-Bath Rethermalizer Manufacturer's Nameplate Information:
Rated Input _______ (Btu/h, kW)
Voltage _______
Phase _______

X1.2 Apparatus

_______ Check if testing apparatus conformed to specifications in Section 6.

Deviations: ____
____
____
____
____
____

X1.3 Maximum Energy Input Rate

Test Voltage (V) _______
Gas Heating Value (Btu/ft^3 (kJ/m^3)) _______
Measured (Btu/h (kJ/h) or kW) _______
Rated (Btu/h (kJ/h) or kW) _______
Percent Difference between Measured and Rated, % _______

X1.4 Temperature Calibration

Measured boiling temperature, °F _______
Altitude of testing facility, ft _______

X1.5 Preheat Energy and Time

Test Voltage (V) _______
Gas Heating Value (Btu/ft^3 (kJ/m^3)) _______
Energy Consumption (Btu (kJ) or kWh) _______
Time from ___ °F (°C) to boiling temperature ___ °F (°C) (min) _______
Preheat Rate (°F/min (°C/min)) _______

X1.6 Idle Energy Rate

Test Voltage (V)	_______	
Gas Heating Value (Btu/ft^3 (kJ/m^3))	_______	
Idle Energy Rate (Btu/h (kJ/h) or kW)		_______
Electric Energy Rate (kW, gas water-bath rethermalizer only)		_______

X1.7 Pilot Energy Rate (if applicable)

Gas Heating Value (Btu/ft^3 (kJ/m^3))	_______	
Pilot Energy Rate (Btu/h (kJ/h) or kW)		_______

X1.8 Retherm Energy Consumption and Production Capacity Test

Test Voltage (V)	_______	
Gas Heating Value (Btu/ft^3 (kJ/m^3))	_______	
Retherm Time (min)		_______
Recovery Time (min)		_______
Production Capacity (lb/h (kJ/h))		_______
Retherm Energy Consumption (Btu (kJ) or kWh)		_______
Retherm Energy Rate (Btu/h (kJ/h) or kW)		_______
Electric Energy Rate (kW, gas water-bath rethermalizer only)		_______
Retherm Energy Efficiency (%)		_______