Designation: ~~F2795 – 15~~ F2795 – 18

An American National Standard

Standard Test Method for Performance of Self-Contained Soft Serve and Shake Freezers[1]

This standard is issued under the fixed designation F2795; 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 evaluates the energy consumption and performance of soft serve ice cream and shake freezers. The food service operator can use this test to evaluate and select an appropriate soft serve or shake freezer and understand its energy consumption and production capabilities.

1.2 This test method applies to the following types of soft serve and shake freezers: (any of which may or may not have a reservoir for liquid mix). Included in these test methods are conventional and heat-treatment freezers. The unit may include separate refrigeration systems for the frozen product and fresh mix and may be either air-cooled or water-cooled.

1.3 The soft serve/shake freezers will be tested for the following (where applicable):
1.3.1 Maximum power input, or maximum current draw,
1.3.2 Initial freeze-down energy consumption and duration,
1.3.3 Heavy-use energy consumption,
1.3.4 Production capacity,
1.3.5 Overrun,
1.3.6 Impact performance,
1.3.7 Idle energy rate, and
1.3.8 Heat treat cycle energy consumption (if applicable).

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
F1604 Specification for Freezers, Ice Cream, Soft Serve, Shake

2.2 *Code of Federal Regulations:*[3]
21 CFR 135.110 Ice cream and frozen custard

2.3 *NSF/ANSI Standard:*[4]
NSF/ANSI 6 Dispensing freezers

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[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.

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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.

[3] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

2.4 *ASHRAE Guideline:*[5]
ASHRAE Guideline 2 - 2005 (RA90) Engineering Analysis of Experimental Data

3. Terminology

3.1 *Definitions:*

3.1.1 *air cooled, n*—a freezer which uses air passing over a main condenser in the freezer cylinder refrigeration system.

3.1.2 *combination, n*—a freezer employing two main compressors and two main condensers with one or two condenser fan motors and two separate freezer doors (that is, one for soft serve and another for shake), designed to dispense shake and soft serve product in the same footprint.

3.1.3 *freeze-down energy, n*—amount of energy consumed (kWh) by the soft serve or shake freezer while cooling the product to a servable temperature.

3.1.4 *freeze-down time, n*—time required for the soft serve or shake freezer while cooling the product to a servable temperature.

3.1.5 *heat treat–cool phase, n*—portion of the heat treat cycle which involves cooling the product from ≥150°F (≥65°C) to ≤41°F (≤5°C) within a period of 120 min or less.

3.1.6 *heat treat–heat phase, n*—portion of the heat treat cycle which involves elevating product temperature from ≤41°F (5°C) to ≥150°F (66°C) within a period of 90 min.

3.1.7 *heat treat–hold phase, n*—portion of the heat treat cycle which involves holding the product above a ≥150°F (≥66°C) for a period of at least 30 min.

3.1.8 *heat-treatment freezers, n*—as defined in Specification F1604, operate as conventional freezers and heat all product to 150°F (66°C) minimum for at least 30 min daily to destroy undesirable microorganisms.

3.1.9 *ice cream or ice-cream (originally, iced cream), n*—a frozen dessert made from dairy products, such as milk and cream, combined with flavorings and sweeteners, such as sugar, and possible other ingredients. **(21 CFR 135.110)**

3.1.10 *idle energy rate, n*—the rate of energy consumed (kWh) by the soft serve or shake freezer while holding or maintaining the product in a ready-to-serve state without dispensing product.

3.1.11 *interval, n*—length of time for one operator to draw a portion of product from a soft serve or shake freezer.

3.1.12 *mix, n*—a fluid that contains 4 to 6 % butterfat and is a vanilla flavor.

3.1.13 *overrun, n*—the increase in volume due to incorporation of air while freezing soft serve and shake products under agitation, calculated by this formula:

$$\text{Overrun} = \frac{(\text{Weight of liquid mix} - \text{Weight of frozen product})}{\text{Weight of frozen product}} \quad (1)$$

3.1.14 *product, n*—mix that is frozen under agitation to specific temperature without syrup that is ready to serve.

3.1.15 *shake, n*—a sweet, cold beverage which is made from milk, ice cream, and flavorings or sweeteners such as fruit syrup or chocolate sauce.

~~3.1.16 *single spout freezer, n*—freezer employing a single spout with a single spout freezer door and dispense cylinder.~~

3.1.16 *spout adaptor, n*—a device which is attached to the freezer door spout to assist in the filling of sampling container.

3.1.17 *standby idle energy, n*—the rate of energy consumed (kWh) by the soft serve or shake freezer while holding or maintaining the product ≤41°F (≤5°C) without dispensing product. Also referred to as night mode in NSF/ANSI 6.

3.1.18 *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 test results.

3.1.19 *single spout freezer, n*—freezer employing a single spout with a single spout freezer door and dispense cylinder.

3.1.20 *twin single spout freezer, n*—a freezer employing either of the above configurations (Twin Twist freezer "A" or "B") but with two single spout doors which can only dispense from one Freezer Cylinder.

3.1.21 *twin twist freezer "A", n*—a freezer using two main compressors and two main condensers with one or two condenser fan motors and a freezer door (3 spout) which the center spout draws from both freezer cylinders.

3.1.22 *twin twist freezer "B", n*—a freezer with single main compressor, single main condenser fan motor, with a freezer door (3 spout) which the center spout draws product from both freezer cylinders.

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

[5] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

3.1.24 *water cooled, n*—a freezer which uses water passing through a twin tube condenser in the freezer cylinder refrigeration system.

4. Summary of Test Method

4.1 This test method is designed to address freezers which have self-contained refrigeration system(s) for the main freezing cylinder(s) and may or may not contain a mix storage system as part of the unit.

4.2 Power input is determined to confirm that the soft serve or shake freezer is operating below maximum nameplate power rating.

4.3 The mix storage and freezing cylinder are loaded with 36 ± 2°F (2.2 ± ~~1°C)~~0.5°C) mix. The time and energy required to freeze down the product to an acceptable serving condition is monitored (as defined in 10.2.2).

4.4 Minimum Dispensing Interval Determination (as defined in 10.4).

4.5 Heavy-Use Power Rating, Energy Consumption and Production Capacity Test (as defined in 10.5).

~~4.6 Impact Draw Test (as defined in 10.6).~~

4.6 Ready-to-Serve Idle Test (as defined in ~~10.7~~10.6).

4.7 Standby (Night Mode) Idle Test (as defined in ~~10.8~~10.7).

4.8 Heat Treat Cycle Energy Consumption Test (if applicable) (as defined in ~~10.9~~10.8).

5. Significance and Use

5.1 The freeze-down energy consumption and duration can be used to determine time and energy required for a freezer to be ready to serve when loaded with mix.

5.2 The minimum dispensing interval determination is used to determine the rate at which the product will be dispensed during the Heavy-Use Energy Consumption and Production Capacity Test (10.5). Measuring overrun during this test is critical to determining production capacity rating in gallons per hour.

5.3 Heavy-use energy consumption can be used by an operator to determine energy consumption during peak usage when selecting a soft-serve freezer. Measuring overrun during this test is critical to determining production capacity rating in gallons per hour.

5.4 Production capacity can be used by an operator in selecting a soft-serve or shake freezer that meets their production requirements. Measuring overrun during this test is critical to determining production capacity rating in gallons per hour.

5.5 Impact draw is used to determine the peak rate at which servable quality product (as defined in ~~10.2.2~~10.2.5) can be dispensed from a soft-serve or shake freezer.

5.6 Idle energy rate is a precise indicator of a soft serve ~~or shake~~ freezer's energy performance under a stabilized ready-to-serve operating condition. This information enables the food service operator to consider energy performance when selecting soft-serve or shake equipment.

5.7 Stand-by (night mode) energy rate is a precise indicator of a soft-serve or shake freezer's energy performance under a simulated overnight operating condition. This information enables the food service operator to consider energy performance when selecting soft-serve or shake equipment, if applicable.

5.8 Heat Treat cycle energy consumption is a precise indicator of a soft serve or shake freezer's energy performance when operated in a heat treatment cycle. This information can be used by an operator to consider the energy requirement of using a heat treat cycle, if applicable.

6. Apparatus

6.1 *Analytical Balance Scale,* for measuring weights up to 25 lb (11.33 kg), with a resolution of 0.01 lb (0.004 kg) and an uncertainty of 0.01 lb (0.004 kg).

6.2 *Stop Watch,* with at least 1-s resolution.

6.3 *Thermocouple Probe,* calibrated industry standard type T thermocouples capable of immersion with a range of 0 to 212°F (–17.7 to 100°C) and an accuracy of ±1°F (±0.6°C). Thermocouples should be calibrated per ISO 17025 for the appropriate temperature range (19°F (–2.2°C) for soft serve, 26°F (–3.3°C) for shake).

6.4 *Thermocouple Wand*—A device used to hold four thermocouple probes such that the tips are within a 1-in. diameter circle without touching. Thermocouples used in the wand shall be wired together, to produce a single, averaged temperature reading.

6.5 *Watt-Hour Meter,* for measuring the electrical energy consumption, 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 %.

6.6 *Spout ~~Adapter,~~ Adapter (optional),* to facilitate measuring product temperature and filling container during the test which is made from an Acetal (POM) material and has a ID surface finish of ~~32√ .~~ 32√. Use the appropriate length to properly fill containers from the bottom. ~~A thermocouple should be installed in the geometric center of the spout adapter to measure dispensing temperature if a data acquisition system is used.~~ See Fig. 1.

6.7 *Small Container,* a small container shall be a cup design and shall be 8 ± 1.0 fl. oz (237 ± 15 mL) in capacity, with rigid sides. Thirty (30) cups will be required for tests which are listed in this standard.

6.8 *Medium Container,* a medium container shall be a cup design and shall be 16 ± 1.0 fl. oz (475 ± 15 mL) in capacity, with rigid sides. Thirty (30) cups will be required for tests which are listed in this standard.

6.9 *Large Container,* a large container shall be a cup design and shall be 32 ± 1.0 fl. oz (946 ± 15 mL) in capacity, with rigid sides. Thirty (30) cups will be required for tests which are listed in this standard.

6.10 Container volume should be measured by fully filling the container with room temperature water and measuring its weight excluding the container. Water density of 8.338 lb/gal should be used for 60°F water (1000 kg/m^3 @ 10°C) or 8.329 lb/gal for 70°F (998 kg/m^3 @ 20°C) water. Exact cup volume should be recorded in fl. oz based on a conversion of 128 fl. oz per gallon (1 m^3 = 1 000 000 mL).

~~NOTE 1—Container volume is usually labeled to hold that amount of volume without spilling; actual container volume filled to the rim will be greater than the label.~~

6.11 *Standard Straw,* for straw testing of shake, shall be length of X in. (minimum + 1 in. above shake product) by diameter of Y in.

NOTE 1—Container volume is usually labeled to hold that amount of volume without spilling; actual container volume filled to the rim will be greater than the label.

7. Reagents and Materials

7.1 *Soft Serve Mix,* liquid mix shall consist of 4 to 6 % butterfat and have a vanilla flavor only. Mix can be stored either in hermetically sealed bags or in cartons and shall be refrigerated to 36 ± 2°F (2.2 ± ~~1°C)~~0.5°C) prior to all tests.

7.2 *Small Container,* for testing soft serve freezers with less than 10 gal/h (37.8 L/h) capacity.

7.3 *Medium Container,* for testing soft serve freezers with greater than 10 gal/h (37.8 L/h) capacity and shake freezers rated ≤20 gal/h (≤75.7 L/h).

7.4 *Large Container,* for impact testing of shake freezers rated more than 20 gal/h (75.7 L/h).

8. Sampling, Test Units

8.1 *Soft Serve or Shake Freezer*—Select a representative production model for performance testing.

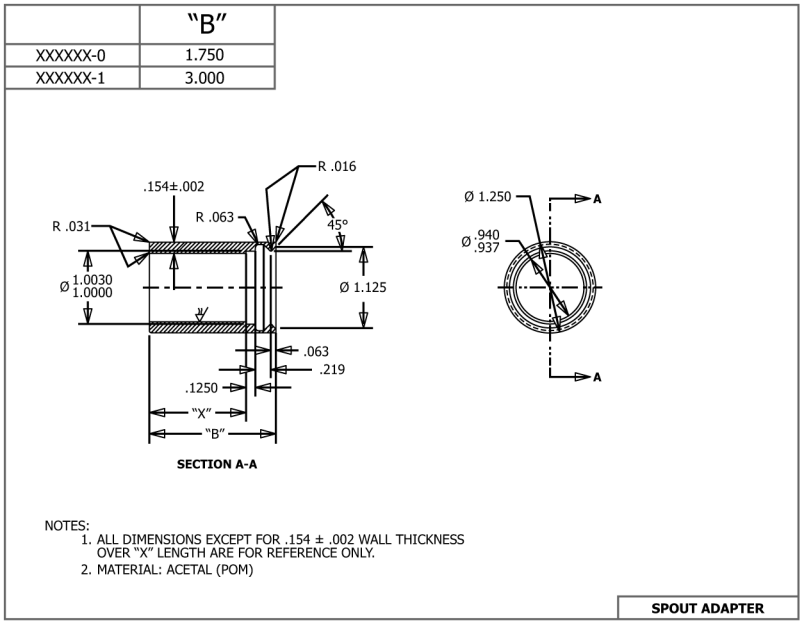

FIG. 1 Sample Spout Adapter Specification

9. Preparation of Apparatus

9.1 Install the soft serve or shake freezer so that there is ~~1 ft~~12 in. (30.48 cm) clearance maintained between a back wall and the back vertical plane of the soft serve ~~or shake~~ freezer. Both sides of the soft serve ~~or shake~~ freezer shall be a minimum of 1 ft (30.48 cm) from any side wall, side partition, or other operating soft serve freezer and a minimum of 3 ft (91.44 cm) clearance between the front vertical plane of the soft serve or shake freezer and any wall or side partition. (See Fig. 2.) Walls can be portable or suspended from ceiling. If manufacturer's instructions require additional clearance between soft serve or shake freezer and walls, then use manufacturer's clearance recommendations in place of clearances listed above. Record appliance placement relative to test room walls in results recording section. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 3°F (24 ± 2°C) during energy tests within the testing environment. Machine ambient temperature is measured 6 in. (15 cm) from air intake side of freezer, in line with the center of the condenser. Freezer to be installed in the temperature controlled room. Tests can start once all thermocouple temperatures are within the temperature specified for the ambient conditions of the room.

9.2 Connect the soft serve or shake freezer to a Watt-Hour meter. A voltage regulator may be required during tests if the voltage supply is not within ±2.5 % of the manufacturer's nameplate voltage.

9.3 Confirm (while the soft serve or shake freezer compressor(s) is 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—The purpose of the testing procedure is to evaluate the performance of a soft serve or shake freezer at its rated electric voltage. If a soft serve or shake freezer is rated dual voltage (that is, designed to operate at either 208 or 240 V with no change in components), the voltage selected by the manufacturer or tester, or both, shall be recorded. The performance of a dual voltage soft serve or shake freezer may differ at the two voltages.

9.4 To facilitate monitoring product temperature during testing, locate a thermocouple probe in the center of the mix storage container(s), 1 ± 0.1 in. (25 ± 2 mm) above the bottom surface of the storage container(s). For all draw tests, locate an additional thermocouple probe in the geometric center of the draw spout adapter(s). For all non-draw tests, locate an additional thermocouple probe in the product holding area of at least one of the dispenser heads (per NSF/ANSI 6).

9.5 For water cooled soft serve or shake freezers, the supplied water for the main condensing system must be 70 ± 2°F (21 ± ~~1°C).~~1.1°C).

10. Procedure

10.1 *General:*

10.1.1 The following shall be obtained and recorded for each run of every test.

10.1.1.1 Voltage.

10.1.1.2 Average air temperature over the complete test period.

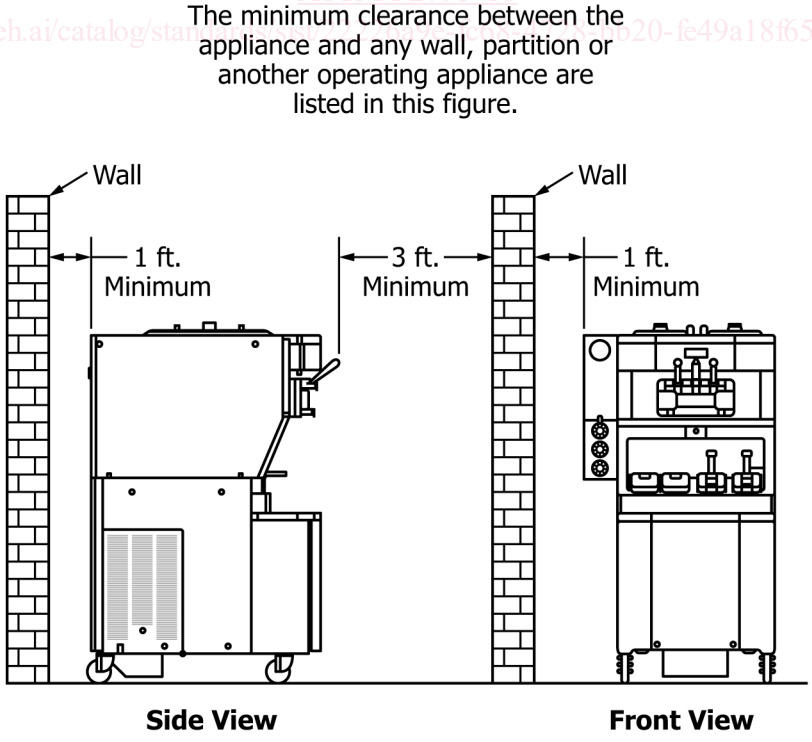

FIG. 2 Example of Appliance Placement

10.1.1.3 Average relative humidity over the complete test period.

10.1.1.4 Water consumed (where applicable for water cooled freezers).

10.1.1.5 Average incoming water temperature over the complete test period (where applicable for water cooled freezers).

10.1.1.6 Average exit water temperature over the complete test period (where applicable for water cooled freezers).

10.1.1.7 Temperature of mix.

10.1.1.8 Temperature of dispensed product.

10.1.1.9 Weight of frozen product in the cup, when applicable.

10.1.2 For each test run, confirm that the maximum 10-s continuous amperage draw rate is not >110 % of the rated nameplate amperage. After 10 s, if the measured amperage is >110 % of the rated nameplate maximum amperage, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the soft serve or shake freezer.

10.2 *Freeze-Down Energy Consumption and Duration:*

NOTE 3—The freeze-down test should be conducted prior to ~~soft serve or shake freezer operation on the day of the test.~~ all tests. It is the intent of this procedure to determine the energy and time it takes the soft serve or shake freezer to freeze mix to a servable product.

10.2.1 Before every freeze-down, the soft serve hopper and barrels must be filled with water (75 ± 3°F) and allowed to stabilize for 15 min.

NOTE 4—The purpose of the step described in 10.2.1 is to ensure that the internal components of the soft serve freezer are all stabilized at a consistent temperature in order to enhance repeatability in freeze-down data.

10.2.2 Follow the manufacturer's recommended instructions for priming the soft serve or shake freezer prior to the freeze down test. Subsequent testing and results are not valid if the manufacturer's operating instructions are not completed. Start with the unit in a room at 75 ± 3°F ~~(24~~(23.9 ± 2°C), fill the mix storage and freezing cylinder with refrigerated mix (36 ± 2°F (2.2 ± ~~1°C))~~1.1°C)) to the manufacturer's recommended level. During all tests, refill mix if the "Mix Low" indicator appears.

10.2.3 Record the temperature of the mix in the center of the mix storage container, 1 in. (25 mm) above the bottom surface of the mix storage container. Start the initial freezing process.

10.2.4 Freeze-down per manufacturer's instructions, in absence of specific instruction, is judged complete when the main compressor(s) or beater drive motor(s), or both, for freezing cylinder(s) have cycled off.

10.2.5 Confirm that the freezer is ready to serve by dispensing one 8 fl. oz (236.6 mL) portion of product. Record the ~~coldest~~stabilized temperature in the ~~spout adapter while dispensing or in the~~ geometric center of the receiving ~~container. If not using thermocouple in spout adapter, temperature measurement is acceptable within 30 s from the end of the draw.~~ container within 30 s from the end of the draw using the thermocouple wand. The wand shall be used to vigorously stir the dispensed product before the measurement is taken. For soft serve, the temperature of the dispensed product shall be ~~19~~18 ± ~~2°F (–7 ± 1°C); for~~ 3°F (–7.5 ± 1.5°C). For soft serve, invert the cup for 5 s before taking temperature. If the soft serve remains in the cup, the serving is acceptable if also within temperature. For shakes, the temperature of the dispensed product shall be 26 ± 2°F (–3 ± 1°C). ~~If the~~ For shakes, place a straw near the center of the cup and submerge to the bottom of the filled cup. If the straw remains in place for 5 s, the serving is acceptable if also within temperature. If the product temperature is above the threshold criteria, repeat 10.2.1 – ~~10.2.5~~10.2.4, adding an additional main compressor cycle (on then off again). If the temperature of the product is outside the specified limits stated above adjust the temperature or equipment settings and repeat 10.2.1 – ~~10.2.5~~10.2.4. Note in test record that another compressor cycle or adjustments were part of this test.

10.2.6 Record energy consumption, elapsed time, and final mix storage container temperature when the motor(s) and main compressor(s) for freezing cylinder(s) has cycled off and verified that product is in the appropriate serving temperature range.

10.3 *Draw Rate:*

10.3.1 If the freezer door has an adjustable draw handle, set the draw rate to the manufacturer's recommended setting and record the draw rate. In the absence of the manufacturer's recommendation, start with the draw handle set to the maximum draw rate. If the draw rate is not adjustable, record the draw rate. In the event of barrel starvation, refer to 10.3.5 through 10.3.9 before continuing.

NOTE 5—Some soft serve freezers will suffer from a phenomenon known as barrel starvation, which is caused by an air-to-mix ratio that is too high, causing the draw rate to significantly drop. In this event, extra steps must be taken in order to properly adjust the draw handle for this and all subsequent tests.

10.3.2 Tare the selected container on the scale. Dispense product continuously for 10 s into the selected container.

10.3.3 Divide the weight of the dispensed product by 10 and record this as the draw rate (weight oz/s or g/s). Wait for the compressor to cycle off.

10.3.4 Repeat ~~steps~~10.3.1 ~~10.3.1~~ and ~~10.3.2~~10.3.2 ~~two~~five more times and record the draw rate each ~~time.~~ time for a total of six draw events. Take the sum of the last three ~~tests~~events and divide by three. Record this number as the average draw rate.

10.3.5 Record the minimum temperature of the product in the ~~third container~~ sixth container as described in 10.2.6 to make sure it is at ~~19~~18 ± ~~2°F (–7~~3°F (–7.5 ± ~~1°C~~1.5°C) for soft serve product and 26 ± 2°F (–3 ± 1°C) for shake freezers (without syrup) product.