



# Standard Practice for Environmental Impact Analysis of Commercial Food Service Equipment<sup>1</sup>

This standard is issued under the fixed designation F2916; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice for analyzing the environmental impact of food service equipment is intended to document the performance of food service equipment using attributes that are indicators of the appliance's environmental impact. It includes, but is not limited to, cooking, warewashing, refrigeration, ventilation, and mechanical equipment that use energy or water in a typical commercial cooking application.

1.1.1 The method assigns points for each attribute and calculates a total score for the appliance. A specifier or purchaser of the appliance may use the individual results for certain attributes that are important in their analysis of the environmental impact of product. The results may also be used to compare the environmental impact of one model to another of the same type of equipment.

1.1.2 The total score is not intended to provide a positive or negative judgment of a certain appliance's environmental impact.

1.1.2.1 This analysis includes attributes that occur in the manufacturing, packaging, use, and disposal of a product.

1.2 *Units*—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard.

1.3 *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:<sup>2</sup>

F1275 Test Method for Performance of Griddles

F1361 Test Method for Performance of Open Deep Fat Fryers

F1484 Test Methods for Performance of Steam Cookers

F1496 Test Method for Performance of Convection Ovens

F1521 Test Methods for Performance of Range Tops

F1605 Test Method for Performance of Double-Sided Griddles

F1639 Test Method for Performance of Combination Ovens (Withdrawn 2012)<sup>3</sup>

F1695 Test Method for Performance of Underfired Broilers

F1696 Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines

F1704 Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems

F1784 Test Method for Performance of a Pasta Cooker

F1785 Test Method for Performance of Steam Kettles

F1786 Test Method for Performance of Braising Pans

F1787 Test Method for Performance of Rotisserie Ovens

F1817 Test Method for Performance of Conveyor Ovens

F1920 Test Method for Performance of Rack Conveyor, Commercial Dishwashing Machines

F1964 Test Method for Performance of Pressure Fryers

F1965 Test Method for Performance of Deck Ovens

F1991 Test Method for Performance of Chinese (Wok) Ranges

F2022 Test Method for Performance of Booster Heaters

F2093 Test Method for Performance of Rack Ovens

F2140 Test Method for Performance of Hot Food Holding Cabinets

F2141 Test Method for Performance of Self-Serve Hot Deli Cases

F2142 Test Method for Performance of Drawer Warmers

F2143 Test Method for Performance of Refrigerated Buffet and Preparation Tables

F2144 Test Method for Performance of Large Open Vat Fryers

F2237 Test Method for Performance of Upright Overfired Broilers

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.05 on Life Cycle Cost and Sustainability.

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

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

- F2238 Test Method for Performance of Rapid Cook Ovens
- F2239 Test Method for Performance of Conveyor Broilers
- F2324 Test Method for Pre-rinse Spray Valves
- F2379 Test Method for Energy Performance of Powered Open Warewashing Sinks
- F2380 Test Method for Performance of Conveyor Toasters
- F2472 Test Method for Performance of Staff-Serve Hot Deli Cases
- F2473 Test Method for Performance of Water-Bath Rethermalizers
- F2474 Test Method for Heat Gain to Space Performance of Commercial Kitchen Ventilation/Appliance Systems
- F2519 Test Method for Grease Particle Capture Efficiency of Commercial Kitchen Filters and Extractors

## 2.2 ASHRAE Standard:<sup>4</sup>

ASHRAE 72-2005 Method of Testing Commercial Refrigerators and Freezers

## 2.3 ARI Standard:<sup>5</sup>

ARI 810-2006 Performance Rating of Automatic Commercial Ice Machines

## 2.4 EU Standard:<sup>6</sup>

2002/95/EC Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

## 3. Terminology

### 3.1 Definitions:

3.1.1 *certified sustainable wood product, n*—wood product that uses new material that originates from a certified sustainable forest.

3.1.1.1 *Discussion*—Certifying organizations are the Sustainable Forestry Initiative (SFI), the Canadian Standards Association (CSA), the Forest Stewardship Council (FSC), and the American Tree Farm System (ATFS).

3.1.2 *easily recycled components, n*—parts made from recyclable materials in a product that can be separated for recycling either without any tools or with common hand tools.

3.1.2.1 *Discussion*—Materials shall be all one type with no coatings. Labels or small amounts of adhesives remaining on the materials are acceptable.

3.1.3 *ENERGY STAR certified, adv*—product is ENERGY STAR certified if it is included in the current U.S. Environmental Protection Agency (US EPA) list of certified equipment.

3.1.4 *global warming potential, GWP, n*—measure of how much a given mass of greenhouse gas is estimated to contribute to global warming.

3.1.4.1 *Discussion*—It is a relative scale that compares the gas in question to that of the same mass of carbon dioxide (whose GWP is by convention equal to 1). A GWP is calculated over a specific time interval. For the purposes of this practice,

<sup>4</sup> Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329, <http://www.ashrae.org>.

<sup>5</sup> Available from Air-Conditioning and Refrigeration Institute, 4100 N. Fairfax Dr., Suite 200, Arlington, VA 22203.

<sup>6</sup> Available from <http://bookshop.europa.eu>.

use a 100-year time horizon for calculating GWP. Use GWP5 (1)<sup>7</sup> values from US EPA's tables (2).

3.1.5 *idle energy consumption rate, n*—average rate at which an appliance consumes energy while it is idling, holding, or ready to cook at a temperature specified in the applicable test method for the product.

3.1.6 *material utilization, n*—ratio of the total product weight to the total weight of raw materials used to make the product.

3.1.7 *ozone depletion potential, ODP, n*—ratio of the impact on ozone of a chemical compared to the impact of a similar mass of CFC-11.

3.1.7.1 *Discussion*—Thus, the ODP of CFC-11 is defined to be 1.0. For this practice, use values published by the US EPA (2).

3.1.8 *packaging ratio, n*—ratio of the product's packaging weight to the total product weight.

3.1.9 *packaging weight, n*—total weight of the product's packaging materials, which includes packaging for any accessories or options that are required to operate the product.

3.1.10 *rapidly renewable packaging content, n*—percentage of total package materials (by weight) that is from rapidly renewable resources.

3.1.10.1 *Discussion*—These are resources that can be harvested in less than ten years after planting. This includes bamboo and eucalyptus.

3.1.11 *recyclable materials, n*—materials that are commonly recycled, which includes steel, iron, brass, copper, aluminum, zinc, glass, plastics with a 1 to 6 recycling code, paper, solid wood, and plywood.

3.1.12 *recyclable packaging content, n*—percentage of total package materials (by weight) that is recyclable after reaching the product's destination.

3.1.12.1 *Discussion*—For this practice, recyclable materials include paper, cardboard, solid wood, plywood, and plastics labeled with recycling codes 1 to 6.

3.1.13 *recycled material, n*—any material that is recovered either as waste from a manufacturing process or a product after it is sold to the public that is remade into a new raw material.

3.1.14 *recycled packaging content, n*—percentage of total package materials (by weight) that is recycled material.

3.1.14.1 *Discussion*—The recycled material may be both pre- and post-consumer content.

3.1.15 *restorable product, n*—product that can be restored to its original performance after a normal lifetime of use by replacing less than 50 % by weight of the original materials.

3.1.16 *remanufactured part, n*—any part that is recovered from a product after it was sold to the public and then refurbished so that it meets its original specifications.

3.1.17 *significant components, n*—components that combine to equal at least 70 % of the total product weight.

<sup>7</sup> The boldface numbers in parentheses refer to the list of references at the end of this standard.

3.1.17.1 *Discussion*—Also, components that individually equal 5 % of the total product weight.

3.1.18 *total product weight, n*—weight of the product under evaluation that includes permanent fluids (refrigerants, lubricants, and so forth), and unattached or detachable parts that ship with every unit.

3.1.18.1 *Discussion*—Total product weight does not include options or accessories that are not required to ship with the product, packaging, and the user manual.

3.1.19 *use energy rate, n*—average rate of energy consumed by the appliance while it is fully loaded for cooking, holding, washing, or another primary function of the appliance.

#### 4. Summary of Practice

4.1 Detailed information is gathered on the sustainable factors for the product (see [Appendix X1](#)). This is information about the materials used in the product, the manufacturing process, packaging materials, and energy and water use of the product. The information is obtained by analysis of materials specified in the product's design, its manufacturing process, data gathered from component suppliers, and energy and water used during performance tests of the product.

4.2 The required information is entered in the associated worksheet. It is used to assign points for each factor. The worksheet then adds the points awarded for each factor and compares the sum to the total possible points for each product life-cycle phase (manufacturing, packaging, use, and disposal). The worksheet adjusts the total points for each phase so each phase represents one quarter or 25 points out of the total possible 100 points for products that consume water or energy. Each phase is assigned one third of the total possible points for products that do not consume water or energy (ignoring the use phase). The adjusted point total is then displayed for the phase and the total points are displayed.

4.3 If points are claimed for water or energy use testing, then the results of the tests are entered into the worksheet summary tab.

#### 5. Significance and Use

5.1 The report provides an equipment specifier or buyer the information they need when submitting data about equipment in a project to sustainable certification programs such as, but not limited to, U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building program. The results of the analysis may also be used to compare to similar pieces of commercial food service equipment to determine which unit has a higher sustainability point total. Because a higher point total does not always indicate the product has a lower environmental impact, the user can review the report to determine how the points were awarded for each unit.

#### 6. Procedure

6.1 Obtain data and enter values for factors affecting the manufacturing of the product. These are entered on the manufacturing tab of the worksheet.

6.1.1 Determine environmental regulation compliance, Factor M1.

6.1.1.1 Determine if the product's manufacturing processes meet all local, state, and U.S. national regulations related to its manufacture. The manufacturer should review codes applicable to the production processes and confirm that it meets all requirements.

6.1.1.2 The manufacturer obtains statements confirming compliance to all relevant local, state, and national codes from suppliers of all purchased or sourced significant components such as, but not limited to, printed circuit boards.

6.1.1.3 If the review of manufacturing processes indicates compliance with all required environmental codes, then enter 5 points out of 5 possible for Factor M1.

6.1.2 Determine the recycled and remanufactured content of the product, Factor M2.

6.1.2.1 Analyze the product's components and determine the weight of each component that is recycled content. For common metals, use the following values: stainless steel—75 % (3), plain steel—33 % (4), aluminum—29 % (5), and copper (excluding wire)—72 % (6).

6.1.2.2 Sum the recycled content of all the components and determine the ratio of recycled material to the total product weight.

6.1.2.3 Enter the percent recycled material in the scoring comments column and assign points for Factor M2: 70 to 100 %—10 points, 60 to 69 %—8 points, 50 to 59 %—6 points, 40 to 49 %—4 points, 30 to 39 %—2 points, and less than 30 %—0 points.

6.1.3 Determine the product's material utilization, Factor M3.

6.1.3.1 Identify significant components to be used for the material utilization analysis. Group these parts by manufacturing process, for example, fabricated sheet metal, aluminum extrusion, copper tube, flat glass, and so forth.

6.1.3.2 Sum the weight of all significant components,  $w_{sc}$ .

6.1.3.3 Sum the weight of all components in each process group,  $w_{pg1}$ ,  $w_{pg2}$ , and so forth.

6.1.3.4 Determine the material utilization for each process,  $mu_1$ ,  $mu_2$ , and so forth.

6.1.3.5 Calculate the average material utilization for significant components,  $mu$ .

$$mu = (w_{pg1}/w_{sc}) * mu_1 + (w_{pg2}/w_{sc}) * mu_2 + \dots \quad (1)$$

6.1.3.6 Enter the average material utilization in the scoring comments column and assign points for Factor M3: 90 to 100 %—10 points, 80 to 89 %—8 points, 70 to 79 %—6 points, 60 to 69 %—4 points, 50 to 59 %—2 points, and less than 50 %—0 points.

6.1.4 Determine the GWP of refrigerants used in the product, Factor M4.

6.1.4.1 Identify the type of refrigerant used in the product if it used.

6.1.4.2 Identify the GWP for that type of refrigerant. Suppliers of refrigerant can provide this value.

6.1.4.3 Enter the type of refrigerant in the scoring comments column and assign points for Factor M4: GWP > 5000—0 points, GWP < 5000—1 point, GWP < 3000—2 points, GWP < 2000—3 points, GWP < 10 000—4 points, and GWP <



500—5 points. If the product does not use refrigerant, then enter NA. The worksheet will adjust the maximum points to 0 for this factor.

6.1.5 Determine the GWP of foam-blowing agents used in the product, Factor M5.

6.1.5.1 Identify the type of blowing agent used for foamed-in-place insulation used in the product.

6.1.5.2 Identify the GWP for that blowing agent. Suppliers of the material can provide this value.

6.1.5.3 Enter the type of blowing agent in the scoring comments column and assign points for Factor M4: GWP > 5000—0 points, GWP < 5000—1 point, GWP < 3000—2 points, GWP < 2000—3 points, GWP < 10 000—4 points, and GWP < 500—5 points. If the product does not use foamed-in-place insulation, then enter NA. The worksheet will adjust the maximum points to 0 for this factor.

6.1.6 Determine the ODP for refrigerants used in the product, Factor M6.

6.1.6.1 Determine the ODP for the refrigerant identified in Factor M4.

6.1.6.2 Assign points for Factor M6. If the ODP is 0—0 points. Assign –5 points if the ODP is greater than 0. Enter NA if the product does not use refrigerant.

6.2 Obtain data and enter values for factors affecting the packaging of the product. These are entered on the packaging tab of the worksheet.

6.2.1 Determine the total product weight, Factor P1A.

6.2.2 Determine the packaging weight, Factor P1B.

6.2.3 Determine the recycled packaging content, Factor P2A.

6.2.4 Determine the recyclable packaging content, Factor P2B.

6.2.5 Determine the rapidly renewable or sustainable packaging content, Factor P2C.

6.2.6 The worksheet calculates the packaging ratio, Factor P1.

6.2.6.1 The packaging ratio is calculated as packaging weight/total product weight.

6.2.6.2 The worksheet enters points based on the packaging ratio: 0 to 5 %—5 points, 6 to 10 %—4 points, 11 to 15 %—3 points, 16 to 20 %—2 points, and 21 to 25 %—1 point.

6.2.7 The worksheet calculates the points for packaging material content, Factor P2.

6.2.7.1 The packaging material content point value is calculated as the sum of Factors P2A, P2B, and P2C divided by 0.6. This creates a point range of 0 to 5 for the factor.

6.3 Obtain data and enter values for factors affecting the use of the product. These are entered on the use tab of the worksheet.

6.3.1 Determine if the product has been tested for energy consumption, Factor U1.

6.3.1.1 If the product consumes less than 25 W of energy during its use, enter NA for this factor.

6.3.1.2 Assign points for Factor U1. If the product has been tested for use and idle energy consumption, assign 2 points.

6.3.1.3 The tests procedure shall be (in order or preference):

(1) ASTM or ASHRAE—ASTM Test Methods **F1275, F1361, F1484, F1496, F1521, F1605, F1639, F1695, F1696,**

**F1704, F1784, F1785, F1786, F1787, F1817, F1920, F1964, F1965, F1991, F2022, F2093, F2140, F2141, F2142, F2143, F2144, F2237, F2238, F2239, F2324, F2379, F2380, F2472, F2473, F2474, and F2519** and ASHRAE 72-2005;

(2) International standard, for example, EN or CE;

(3) U.S. Department of Defense (DoD) standard;

(4) Obsolete standard;

(5) Test procedure used by multiple users or manufacturers; or

(6) Manufacturer's own test procedure.

6.3.1.4 The energy consumption test shall provide results for the idle and use energy consumption rate. Test reports should be available on request.

6.3.1.5 Enter information about the test results on the summary sheet. Record the test standard used, idle energy rate, and use energy rate. Add any comments needed to clarify the results such as the test conditions.

6.3.2 Determine if the product has been tested for water consumption, Factor U2.

6.3.2.1 If the product does not consume water or dispenses water for beverages or for another application, enter NA for this factor.

6.3.2.2 Assign points for Factor U2. If the product has been tested for water consumption, assign 2 points.

6.3.2.3 The tests procedure shall be (in order or preference):

(1) ASTM or ASHRAE (as listed in **6.3.1.3**);

(2) International standard, for example, EN or CE;

(3) U.S. Department of Defense (DoD) standard;

(4) Obsolete standard;

(5) Test procedure used by multiple users or manufacturers; or

(6) Manufacturer's own test procedure.

6.3.2.4 Test reports should be available on request.

6.3.2.5 Enter information about the test results on the summary sheet. Record the test standard used and water use rate. Add any comments needed to clarify the results such as the test conditions.

6.3.3 Determine if the product is Energy Star certified, Factor U3.

6.3.3.1 If the product is Energy Star certified, assign 2 points for this factor.

6.3.3.2 If there is no Energy Star category for the product, then enter NA for this factor on the worksheet.

6.3.4 Determine if the product has additional energy or water efficiency certification, Factor U4.

6.3.4.1 If the additional certification is for energy efficiency, the passing criteria shall be lower than the Energy Star level.

6.3.4.2 If the product is certified by an independent agency for energy or water efficiency, assign 1 point for this factor. Otherwise, enter NA and this factor does not contribute to the total possible points.

6.4 Obtain data and enter values for factors affecting the disposal of the product. These are entered on the disposal tab of the worksheet.

6.4.1 Determine if the product is restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) certified or if it meets the criteria for RoHS certification, Factor E1.

6.4.1.1 The product is RoHS certified if the manufacturer has a CE declaration of conformity for the product that includes the RoHS criteria.

6.4.1.2 The product meets the RoHS criteria if meets the requirements of European Union (EU) Directive 2002/95/EC. This directive restricts the amounts of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ether (PBDE) contained in a product.

6.4.1.3 *Assign Points for Factor E1*—Five points if the product meets RoHS criteria, 0 points if it does not.

6.4.2 Determine if the product contains additional hazardous materials, Factor E2.

6.4.2.1 Review the materials used in the product to determine if they contain any of the following: PCBs, polychloronaphthalenes (CL > =3), radioactive substances, short-chain chlorinated paraffins, bis-tri-butyl tin oxide (TBTO), triphenyl tetrazolium (TPT), azoic dyes, lindane (wood treatment), pentachlorophenol (wood treatment), and formaldehyde.

6.4.2.2 If the product contains any of these materials, list them in the comments column. Assign –1 point for each material contained.

6.4.3 Determine the total product weight, Factor E3A.

6.4.4 Determine the weight of all easily recycled materials, Factor E3B.

6.4.5 Determine the weight of all other recyclable materials, Factor E3C.

6.4.6 The worksheet calculates the recyclable ratio, Factor E3D.

6.4.6.1 The recyclable ratio is calculated as  $(E3B + 0.5 * E3C)/E3A$ .

6.4.7 Assign points for the recyclable score, E3, based on the recyclable ratio: 0.8 to 1—5 points, 0.6 to 0.79—4 points,

0.4 to 0.59—3 points, 0.2 to 0.39—2 points, 0.1 to 0.19—1 point, and 0 to 0.09—0 points.

6.4.8 Determine if the product is restorable. Assign 5 points if the product meets the definition of a restorable product.

## 7. Calculation and Report

7.1 The summary tab of the worksheet calculates the total score. Enter general information about the evaluated product: manufacturer name, plant location, model number, model description, and date of evaluation.

7.1.1 For each phase (manufacturing, packaging, use, and disposal), the total awarded points and total possible points are summed.

7.1.2 Each phase is weighted equally at 25 % unless there is no energy and water use in the product. For products without energy and water use, all three phases except the use phase are weighted at 33 %.

7.1.3 The weighted phase score is calculated as:  $(\text{awarded points for phase}/\text{possible points for phase}) * \text{phase weight} * 100$ .

7.1.4 The weighted phase scores are summed to calculate the total score.

7.2 The total score is not intended to represent the sustainability of a certain model in an absolute sense. It is more useful when comparing similar models of the same type of equipment.

## 8. Keywords

8.1 commercial food service equipment; energy efficiency; environmental impact; sustainability

[ASTM F2916-11](https://standards.iteh.ai/catalog/standards/sist/bc4e3c1f-b003-4692-a0e0-e7ba96de4750/astm-f2916-11)

<https://standards.iteh.ai/catalog/standards/sist/bc4e3c1f-b003-4692-a0e0-e7ba96de4750/astm-f2916-11>

## APPENDIX

(Nonmandatory Information)

### X1. SAMPLE LIFE-CYCLE COST ANALYSIS

X1.1 **Figs. X1.1-X1.5** depict a sample sustainability analysis using the spreadsheet-based tool<sup>8</sup> provided by the North American Association of Food Equipment Manufacturers

(NAFEM).

<sup>8</sup>The tool is available to all users from North American Association of Foodservice Equipment Manufacturers (NAFEM), 161 N. Clark St., Suite 2020, Chicago, IL 60601.

ASTM F26.5 Committee on Foodservice Equipment Total Life Cycle Cost and Sustainability  
 NAFEM Technical Liaison Committee  
 Sustainability Calculator for Foodservice Equipment  
 Summary Sheet

Manufacturers enter information in light green cells.  
 Outputs and intermediate calculations are in light blue cell.

Manufacturer	Refrigerators Inc
Plant Location	USA
Model Number	RFG-1
Product Description	one door refrigerator
Date reviewed	1/19/2011

Life Cycle Phase	Points Awarded	Points Possible	Phase Weight	Phase Score
Manufacturing	25	35	25%	17.9
Packaging	5	10	25%	12.5
Use	4	6	25%	16.7
Disposal	9	15	25%	15.0
Total				62.0

This score is best used to compare equipment of the same type. It is not an absolute sustainable rating for the equipment.

**Energy Consumption Test Results (See Use Phase Tab)**

	Results	Units	Comments
Test Standard	ANSI/ASHRAE 72-2005	Not Applicable	
Idle Energy Rate	2.32	kwh/Day	
Use Energy Rate	2.32	kwh/Day	
Other:			

**Water Consumption Test Results (See Use Phase Tab)**

	Results	Units	Comments
Test Standard		Not Applicable	
Water Use Rate			

**FIG. X1.1 Sample Sustainability Calculator Summary Tab**

iTech Standards  
 (https://standards.itih.ai)  
 Document Preview

[ASTM F2916-11](#)

<https://standards.itih.ai/catalog/standards/sist/bc4ecbfe-f905-4692-a0e0-e7ba96de4750/astm-f2916-11>