



Standard Specification for Ovens, Microwave, Electric¹

This standard is issued under the fixed designation F1360; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers commercial microwave ovens. These ovens use ultrahigh frequency electromagnetic radiation in the approved industrial, scientific, and medical bands to defrost, heat, and cook food.

1.2 *Limitations*—This specification does not include all types, sizes, groups, styles, and classes of the commodities indicated by the titles of the specification, or that are commercially available, but is intended to cover the types, sizes, groups, styles, and classes that are suitable for general requirements.

1.3 *Oven Selection And Application*—Prior to the use of the classifications given in 4.1, the user agency should ensure they are not restricted by some aspect of the microwave oven design such as a weight or external dimension limitation that would prevent the unrestricted use of the classifications given in 4.1.

1.4 *Microwave Oven Availability*—Although 4.1 lists a wide range of sizes, classes, groups, and styles for commercial types of ovens, not all combinations are available.

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

1.6 The following precautionary caveat pertains to the test method portion only, Section 11, of this specification: *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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.*

¹ This specification is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.02 on Cooking and Warming Equipment.

Current edition approved Jan. 1, 2023. Published February 2023. Originally approved in 1991. Last previous edition approved in 2017 as F1360 – 17. DOI: 10.1520/F1360-17R23.

2. Referenced Documents

2.1 ASTM Standards:²

A176 Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip (Withdrawn 2015)³

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

B108 Specification for Aluminum-Alloy Permanent Mold Castings

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) B0209_B0209M

D3951 Practice for Commercial Packaging

F760 Specification for Food Service Equipment Manuals

F1166 Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

2.2 ANSI Standards:⁴

B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)

C62.41 Guide for Surge Voltages in Low Voltage AC-Power Circuits⁴

WD-6 Wiring Devices—Dimensional Requirements⁴

Z1.4 Sampling Procedures and Tables for Inspection by Attributes⁴

2.3 *International Electrotechnical Commission Standard.*⁴
Standard No. 705 Methods for Measuring the Performance of Microwave Ovens for Household and Similar Purposes

2.4 *National Sanitation Foundation Standard.*⁵

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

2.5 *Underwriters Laboratories Standard.*⁶

ANSI/UL 923 for Microwave Cooking Appliances

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 The last approved version of this historical standard is referenced on www.astm.org.

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

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

⁶ Available from Underwriters Laboratories (UL) LLC, Corporate Progress, 333 Pfingsten Rd., Northbrook, IL 60062.

2.6 *Federal Standard*:⁷

FED-STD-123 Marking for Shipment (Civil Agencies)

2.7 *Military Standards*:⁷

MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment

MIL-STD-461 Requirements For the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

MIL-E-1399/300 Interface Standard for Shipboard Systems, Section 300A, Electric Power, Alternating Current

2.8 *Federal Regulations*:⁸

Title 21, Food and Drugs, Subchapter J—Radiological Health

Title 29, Labor, Chapter 17, Occupational Safety and Health Administration, Department of Labor

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

3.1.1 *cavity*—that portion of the microwave cooking appliance in which food may be heated, cooked, or defrosted.

3.1.2 *door*—the moveable barrier that permits access to the cavity for placement or removal of food, and whose function is to prevent emission of microwave energy from the passage or opening that provides access to the cavity.

3.1.3 *interlock*—a device or system, either electrical, mechanical, or electromechanical, that serves to prevent exposure to an electric shock, or physical injury, or excessive radiation emission when a door, cover, or access panel is opened or removed.

3.1.4 *magnetron*—a type of microwave energy generator usually used in microwave cooking appliances.

3.1.5 *microwave oven*—a device that uses ultrahigh frequency electromagnetic radiation in the bands of 915 ± 25 and 2450 ± 50 MHz to prepare food.

3.1.6 *microwave radiation emission*—the microwave energy to which persons might be exposed during operation or user servicing of a microwave cooking appliance.

3.1.7 *viewing screen*—that feature of a microwave appliance, usually part of the door assembly, that is opaque to microwave energy but visually transparent to provide for viewing the oven contents.

4. Classification

4.1 Microwave ovens covered by this specification are classified by types, sizes, groups, styles, and classes as follows:

4.1.1 *Type*:

4.1.1.1 *Type I*—Commercial microwave oven.

4.1.1.2 *Type II*—Combination commercial microwave and convection/radiant heat oven.

4.1.2 *Size*:

4.1.2.1 *Size 600*—600 to 1199 W microwave power output.

4.1.2.2 *Size 1200*—1200 to 1799 W microwave power output.

4.1.2.3 *Size 1800*—1800 and greater watt microwave power output.

4.1.3 *Group*:

4.1.3.1 *Group 1*—0.5 to 0.8 ft³ (0.014 m³ to 0.0226 m³) cooking cavity (minimum cooking cavity dimensions of 7.5 shall be met).

4.1.3.2 *Group 2*—Over 0.8 to 1.2 ft³ (0.0226 m³ to 0.034 m³) cooking cavity.

4.1.3.3 *Group 3*—Over 1.2 to 1.5 ft³ (0.034 m³ to 0.042 m³) cooking cavity.

4.1.3.4 *Group 4*—Over 1.5 ft³ (0.042 m³) cooking cavity.

4.1.4 *Style*:

4.1.4.1 *Style 1*—Dial type timer(s).

4.1.4.2 *Style 2*—Digital timer and touchpad controls (computer controlled).

4.1.4.3 *Style 3*—Dial or pushbutton timer(s), or both.

4.1.5 *Class*:

4.1.5.1 *Class 1*—10 to 15 in. (254 to 381 mm) wide cooking cavity.

4.1.5.2 *Class 2*—Over 15 to 18 in. (381 to 457 mm) wide cooking cavity.

4.1.5.3 *Class 3*—Over 18 to 24 in. (457 to 610 mm) wide cooking cavity.

4.1.5.4 *Class 4*—Over 24 in. (610 mm) wide cooking cavity.

5. Ordering Information

5.1 *Ordering Data*—Purchasers shall select the preferred options permitted herein and include the following information in procurement documents:

5.1.1 Title, number, and date of this specification,

5.1.2 Type, size, group, class, and style of oven required (see 1.2 and 4.1),

5.1.3 When oven hardware, fittings, door, cooking cavity, and exterior materials are other than as specified (see 6.2, 6.4, 6.5, and 6.6),

5.1.4 When an automatic oven shutdown is required for vending operation use (see 7.3.2),

5.1.5 When surge voltage protection is required (see 7.4.2),

5.1.6 When an air intake filter is required (see 7.6),

5.1.7 When a heat control is to be provided (see 7.7),

5.1.8 When convection heating capability is to be provided (see 7.7),

5.1.9 When a temperature sensing probe is to be provided (see 7.7),

5.1.10 When an infrared temperature sensing device is to be provided (see 7.7),

5.1.11 When power level controls are to be other than specified, or when selection of microwave power in 10 % increments is offered (see 7.7.2),

5.1.12 Voltage and frequency (Hz) of input power, if other than specified (see 7.8.1),

5.1.13 When the power cord length is other than specified (see 7.8.2),

5.1.14 Treatment and painting, if other than specified (see 7.9),

⁷ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, or Acquisition Streamlining and Standardization Information System (ASSIST), which is the official source of all documents listed in the DoD Index of Specifications and Standards. The ASSIST can be located at <http://dsp.dla.mil>.

⁸ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

- 5.1.15 When windows are required in oven doors (see 7.12),
- 5.1.16 When a mounting is required for the oven (see 8.1).
- 5.1.17 When a cavity light for ovens without viewing screens is other than specified (see 8.2),
- 5.1.18 When the contractor is to have responsibility for, and use facilities other than specified for inspection requirements (see 10.3),
- 5.1.19 When a first article is required for inspection and approval (see 10.6),
- 5.1.20 When an oven light is required to be on (see 11.5.2),
- 5.1.21 Level of preservation and packing required if other than as stated in Practice D3951 (see 12.1),
- 5.1.22 When sides of shipping containers are to be marked other than as specified (see 12.2),
- 5.1.23 When Federal/Military procurements are required, review and implement the applicable supplemental requirements (see S1.1 thru S7.2.3),
- 5.1.24 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

6. Materials

6.1 *General*—Microwave ovens shall conform to the referenced documents listed in Section 2. Materials used shall be free from defects that would affect the performance or maintainability of individual components or of the overall assembly. Materials not specified herein shall be of the same quality used for the intended purpose in commercial practice. Unless otherwise specified herein, all equipment, material, and articles incorporated in the work covered by this specification are to be new and fabricated using materials produced from recovered materials to the maximum extent possible without jeopardizing the intended use. The term “recovered materials” means materials that have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products are allowed under this specification unless otherwise specified.

6.2 *Hardware and Fittings*—Unless otherwise specified (see 5.1), all hardware and fittings shall be corrosion-resistant or suitably processed to resist corrosion in accordance with the manufacturer’s standard practice.

6.3 *Threaded Parts*—All threaded parts shall conform to ANSI B1.1.

6.4 *Cooking Cavity*—Unless otherwise specified (see 5.1), the cooking cavity shall be constructed of Types 302, 304, or 316 corrosion-resistant steel conforming to Specification A240/A240M, or aluminum alloy Type 3003-0 conforming to Specification B209. The cooking cavity shall be constructed and sealed to prevent spillage from draining into the oven chassis.

6.5 *Door*—Unless otherwise specified (see 5.1), the door shall be constructed of Types 302 or 304 corrosion-resistant steel conforming to Specification A240/A240M. Aluminum

alloy Types 356 or 319 conforming to Specification B108 or Type 6061 aluminum alloy conforming to Specification B209 may also be used alone or in combination with the corrosion-resisting steel described.

6.6 *Exterior*—Unless otherwise specified (see 5.1), material shall be Types 302, 304, 316 or 430 corrosion-resistant steel conforming to Specifications A240/A240M or A176 as applicable, and thickness shall be 20 gage min. (0.0375 in. (1 mm) U.S. revised standard gage).

7. Design, Construction, and Physical Requirements

7.1 *General*—Microwave ovens shall conform to the referenced documents listed in Section 2. The oven shall be delivered assembled with all components necessary to ensure a fully functional product.

7.2 *Microwave Energy Source*—Microwave energy shall be generated using one or more magnetron tubes or any other suitable generating source of microwave energy. Microwave energy shall be interrupted and the generating source shall be rendered inoperative (either turned off or switched to a standby mode) when the oven door is open or not securely latched in the closed position.

7.2.1 *Warning Label*—A warning marking shall be affixed to the outer case assembly or adjacent to each service access cover and adjacent to one of the fasteners that secures the outer case assembly to the oven chassis. A high voltage warning label shall also be placed near the high voltage components inside the outer case. The label shall include but is not limited to the following warnings:

7.2.1.1 A warning of high voltage,

7.2.1.2 Power supply must be disconnected before servicing,

7.2.1.3 Access covers must be in place during use, and

7.2.1.4 Servicing should be done only by authorized individuals.

7.2.2 *Microwave Radiation Distribution*—Means shall be provided to maintain uniform distribution of microwave radiation throughout the cooking cavity (see 11.6).

7.2.3 *Door Latch Mechanism*—The mechanical door latch mechanism shall be certified to be operable for no fewer than 10 000 cycles without any visible deformation or inoperation.

7.3 Magnetron Protection:

7.3.1 *Reflected Energy*—With the oven empty except for any required tray or sheet furnished by the manufacturer, the oven shall be capable of operation at maximum power output for 1 h or one maximum timer cycle, whichever is shorter, without damage to the magnetron or other oven components.

7.3.2 *Automatic Shutdown*—When specified (see 5.1), the ovens shall automatically shift to a standby condition after a nominal 60 s of nonoperation.

7.3.3 *Thermal Protection*—Means shall be provided to protect the magnetron from damage due to excessive heating. Protective devices shall be automatically resettable, or manually resettable without requiring any disassembly of the oven.

7.4 Circuit Protection:

7.4.1 *Excess Current Draw*—The power supply shall be protected against any damage that would occur as a result of an

overload (excess amperage) condition. Fuses or resettable circuit breakers shall be used for this purpose, and shall be accessible without disassembly of the oven.

7.4.2 Surge Voltage Protection—When specified (see 5.1), protection shall be provided for surge voltages experienced in low-voltage (120 and 240 vac) indoor alternating current power circuits as defined in ANSI C62.41, paragraphs 5.3 and 5.3.1. Protection shall be provided for oven semiconductor circuits from surge voltages origination from source defined in ANSI C62.41, Section 3, for the wave shape described in 5.3.1, Fig. 2 (0.5 μ s – 100 Hz ring wave (open circuit voltage)).

7.5 Cooking Cavity—The cooking cavity shall be rectangular in shape with no dimension less than that specified. The cavity construction shall meet NSF/ANSI 4 requirements as applicable for food contact zones. (Minimum cubic capacity must conform to 4.1.3):

Minimum Cooking Cavity Dimensions

Height (in.)/(mm)	Width (in.)/(mm)	Depth (in.)/(mm)
7.5/(191)	10/(254)	11.5/(292)

7.6 Ventilation System—A forced air circulation system shall be provided that will exhaust water vapor and cooking vapors from the cooking cavity. When specified (see 5.1), the ovens shall be furnished with an air intake filter that shall be removable and readily accessible for cleaning or replacement.

7.7 Controls—All required oven controls shall be installed on the front of the oven. A main power switch device may be located in a position accessible from the front of the oven. When specified (see 5.1), the following option(s) shall be provided: a heat control function that varies the power level output in the cooking cavity, convection heating capability, an infrared sensing device that automatically senses food temperatures and terminates the cooking cycle when the desired food temperature has been reached, and a temperature sensing probe.

7.7.1 Timers—Oven timers shall provide minimum control functions of OFF, timed cooking cycles, and automatic termination of the oven operation after completion of the timing cycle. An audible signal shall sound at the end of the timing cycle or at the end of a cooking cycle. Maximum control graduations shall not exceed 1 s intervals for models with touch pad controls. For models having dial-type timers, maximum control graduations shall not exceed 12 s intervals per graduation marking on the timer control dial. Touch pad timers shall be accurate to ± 1 s of selected time. Dial type timers shall be accurate to ± 5 s of selected time.

7.7.1.1 Dial Type Timers—Dial type timers shall employ either an electric timing motor as the timing element, or solid-state, electronic timing circuitry for the timing element. When a single dial type timer is provided, the minimum time setting shall be not more than 15 s, and the maximum time setting shall be not less than 5 min.

7.7.1.2 Digital timer And Touchpad Controls—Touchpad controls shall utilize electronic solid-state components that process user instructions input by means of data entries to control the starting, stopping, timing, and heat-control power-level functions of the oven. A lighted digital read-out panel

shall display each data segment when entered accompanied by an audible tone or beep, countdown time remaining to end of current cooking cycle, and indicate completion of cooking cycle prior to opening oven door after the cooking cycle is finished.

7.7.2 Power Level Control—Unless otherwise specified, all ovens shall have microwave power level controls that provide for selection of microwave power with a minimum designated defrost/low, medium, and full power settings. In addition to these settings, Type II ovens shall be equipped with a thermostatic control to regulate oven temperature and a control to allow selection of the convection heating elements selectively, upper element only (broil/brown), lower element only (bake), and both upper and lower elements (preheat/bake). When offered and specified, the power level controls shall have selection of microwave power in 10 % increments from 10 % of maximum rated output to 100 % of rated output with a designated “defrost” power setting (see 5.1).

7.7.3 Indicating Light—A light shall be installed on the front of the oven that indicates when the oven is operating. When digital display is offered, it functions as a Power-On indicator.

7.8 Electrical Requirements:

7.8.1 Input Power—Unless otherwise specified (see 5.1), the ovens shall be designed to operate on 120 V, or nominal 220 to 240 V, 60 Hz, single-phase, alternating current (ac).

7.8.2 Power Cord and Connector—Unless otherwise specified (see 5.1), the power cord length shall be in accordance with ANSI/UL 923, and shall contain conductors and connecting plugs conforming to ANSI WD-6 for the type, size and category of equipment ordered.

7.8.3 Electric Motors—All electric motors shall have bearings that require no additional lubrication for the life of the motor.

7.8.4 Bleeder Resistor—A bleeder resistor or other suitable power dissipating device shall be provided to bleed the charge from the magnetron power supply capacitor when the oven is turned off. The voltage across the capacitor shall be less than 50 V within 30 s after the power supply is turned off.

7.9 Treatment and Painting—Unless otherwise specified (see 5.1), treated and painted components used on the microwave ovens shall comply with the applicable requirements of NSF/ANSI 4.

7.10 Steel Fabrication—The steel used in fabrication shall be free from kinks, sharp bends, and other conditions that would be deleterious to the finished product. Manufacturing processes shall not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes shall be done neatly and accurately. All bends shall be made by controlled means to ensure uniformity of size and shape.

7.11 Lubrication—All bearings (unless lifetime lubricated), gears and sliding parts shall have provision and instructions for lubrication. There shall be no bearings or parts requiring lubrication internal to the oven cavity.

7.12 Viewing Screen—Unless otherwise specified (see 5.1), viewing screens are not required on the ovens.

7.13 *Codes and Standards*—The oven(s) shall conform to the requirements of Title 21 Code of Federal Regulations, Subchapter J: Title 29 CFR, Part 18; ANSI/UL 923; and NSF/ANSI 4 as applicable unless otherwise specified herein. Acceptable evidence of meeting the requirements of ANSI/UL 923 and NSF/ANSI 4 shall be the UL or NSF certification symbol or label affixed to the oven, listing of the equipment by model number and name of manufacturer in the UL or NSF directory of approved equipment respectively, or a certified test report from a recognized independent testing laboratory, acceptable to the user agency, indicating the oven has been tested and conforms to ANSI/UL 923 and NSF/ANSI 4.

8. Performance Requirements

8.1 *Oven*—The cooking surface shall be capable of supporting a load of a 10-psf (0.48 kPa) without permanent deformation of the oven cavity (see 11.1). The ovens shall be suitable for mounting on a counter, wall, or in-wall when installed with adequate ventilation as specified by the manufacturer. When specified (see 5.1), ovens shall be provided with a suitable mounting to install the oven in the intended manner.

8.2 *Cooking Cavity Light*—Ovens with viewing screens shall have the cooking cavity illuminated. The light shall automatically activate when the door is opened. It shall also remain lighted while a cooking cycle is in progress. Unless otherwise specified (see 5.1), ovens without viewing screens shall be equipped with an oven cavity light that automatically illuminates when the oven door is opened.

8.3 *Interchangeability*—All units of the same classification furnished with similar options under a specific contract shall be identical to the extent necessary to ensure interchangeability of component parts, assemblies, accessories, and spare parts.

8.4 *Microwave Rated Power Output*—When tested in accordance with 11.2, the oven microwave power output shall be within $\pm 10\%$ of the rated output power as stated by the manufacturer.

8.5 *Operation*—When tested in accordance with 11.3 the ovens shall be capable of not less than 20 h of operation without failure of the major oven functional components including the magnetron, power supply and timer.

9. Workmanship, Finish, and Appearance

9.1 *Bolted Connections*—Bolt holes shall be accurately punched or drilled and shall have the burrs removed in accordance with good commercial practice. Washers or lock washers shall be provided in accordance with good commercial practice, and all bolts, nuts, and screws shall be tight.

9.2 *Riveted Connections*—Rivet holes shall be accurately punched or drilled and shall have the burrs removed in accordance with good commercial practice. Rivets shall be driven with pressure tools and shall completely fill the holes. Rivet heads, when not countersunk or flattened, shall be of approved shape and of uniform size for the same diameter of rivet. Rivet heads shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

9.3 *Welding*—Welding procedures shall be in accordance with a nationally recognized welding code. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds shall transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

9.4 *Castings*—All castings shall be sound and free from patching, misplaced coring, warping, or any other defect that reduces the castings ability to perform its intended function.

9.5 *Machine Work*—Tolerances for contact and bearing surfaces shall conform to standards prevailing among manufacturers normally producing ovens.

10. Sampling and Inspection

10.1 *Sampling*—Sampling and inspection procedures shall be in accordance with ANSI Z1.4. The unit of product shall be one microwave oven. All ovens of the same classification offered for delivery at one time shall be considered a lot for the purpose of inspection. The inspection level shall be Level II and the Acceptable Quality Level (AQL) shall be 2.5 % defective. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for a complete reinspection. Resubmitted lots shall be reinspected using tightened inspection. If the rejected lot was screened, reinspection shall be limited to the defect causing rejection. If the lot was reprocessed, a reinspection shall be performed for all defects. Rejected lots shall be separated from new lots, and shall be clearly identified as reinspected lots.

10.2 *Examination*—Each oven selected shall be examined for compliance with the requirements specified in Section 7. Any redesign or modification of the contractor's standard product to comply with specified requirements, or any necessary redesign or modification following failure to meet specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirement shall constitute one defect.

10.3 *Responsibility For Inspection*— Unless otherwise specified in the contract or purchase order (see 5.1), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order (see 5.1), the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the purchaser. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

10.4 *Responsibility For Compliance*—All items must meet all requirements of Sections 6 – 12. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. Sampling in quality