



Designation: ~~E1977-05~~ Designation: E1977 - 11

Standard Specification for Shelter, Tactical, Expandable, One-Side¹

This standard is issued under the fixed designation E1977; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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

1. Scope

1.1 This specification covers a rigid wall, one-side expandable shelter constructed of aluminum-faced, nonmetallic honeycomb sandwich panels, and meeting the International Organization for Standardization (ISO) Cargo Container specification in the transport mode. Nominal dimensions when closed (container mode) are: height 8 ft, width 8 ft, and length 20 ft (2.4 by 2.4 by 6.1 m). Approximate dimensions, when expanded (shelter mode) are: height 8 ft, width 15 ft, and length 20 ft (2.4 by 4.6 by 6.1 m).

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

1.3 The following precautionary statement pertains to the test method portion only. Section 7, 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 and health practices and determines the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

E864 Practice for Surface Preparation of Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels

E865 Specification for Structural Film Adhesives for Honeycomb Sandwich Panels

E866 Specification for Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels

E874 Practice for Adhesive Bonding of Aluminum Facings to Nonmetallic Honeycomb Core for Shelter Panels

E990 Specification for Core-Splice Adhesive for Honeycomb Sandwich Structural Panels

E1091 Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels

E1749 Terminology Relating to Rigid Wall Relocatable Shelters

E1773 Practice for Sealing Rigid Wall Tactical Shelters with Polysulfide Based Sealants

E1826 Specification for Low Volatile Organic Compound (VOC) Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded

E1925 Specification for Engineering and Design Criteria for Rigid Wall Relocatable Structures

2.2 ISO Standards:³

ISO 1161-1980 Series 1-Freight Containers-Corner Fittings, Specification

ISO 1496/I Series 1-Freight Containers-Specification and Testing Part I-General Cargo Containers

ISO 9001 Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, and Servicing

2.3 Military Standards:⁴

MIL-STD-129 Marking for Shipping and Storage

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

2.4 ANSI/ASQC Standard: ~~ANSI/ASQC Standards:~~⁵

ANSI/ASQC 21.4-1993 Sampling Procedures and Tables for Inspection by Attributes

¹ This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.53 on Materials and Processes for Durable Rigidwall Relocatable Structures.

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

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

⁵ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

2.5 Drawings:⁶

5-4-2828 ~~Shelter~~, Shelter, Assembly, One-Side Expandable-60 amp

~~5-4-3200 Shelter, Assembly, One-Side Expandable-100 amp~~⁶ 5-4-3200 Shelter, Assembly, One-Side Expandable-100 amp⁶

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<https://standards.itih.ai/catalog/standards/sist/043e17b0-1f05-48b2-af5d-b9c5eb3f7dc6/astm-e1977-11>

⁶ Copies of drawings are available from U.S. Army Natick Soldier Center, ATTN: AMSRD-NSC-CP-CS, Kansas Street, Natick, MA 01760-5018, <http://www.natick.army.mil>.

2.6 ~~SAE Standards~~ SAE Standards:⁷

SAE-AMS-STD-1595 Qualification of Aircraft, Missile, and Aerospace Fusion Welding
SAE-AMS-STD-2219 Fusion Welding for Aerospace Applications

3. General Requirements

3.1 *Alternate Components*—When this specification or the referenced drawings specify use of a specific component “or equal,” the contractor may substitute a component equal to the specified component provided that the contractor complies with the following requirements. Prior to manufacture of the first article, or if none is required, prior to commencing production, the contractor shall submit for the purchaser’s approval a list identifying each proposed “or equal” component together with proof that each listed component is functionally equal to the specified component and is compatible with the end item covered by this specification. The purchaser, at his option, may require a physical sample of any “or equal” component. Approval of the submitted listing and supporting data authorizes the commencement of fabrication of the first article or of production, as applicable, but does not relieve the contractor of the responsibility that the “or equal” components perform in accordance with specified requirements when incorporated into the end item.

3.2 *Materials and Components*—Materials and components shall conform to the documents listed in Section 2 and as specified herein. Any change to the proposed materials or processes must be approved by the purchaser. It is encouraged that recycled material be used when practical as long as it meets the requirements of this specification.

3.3 *Workmanship*—The shelter, including all parts and accessories, shall be constructed and finished in a workmanlike manner with particular attention given to removal of burrs and sharp edges, accuracy of dimensions, thoroughness of soldering, welding, painting, alignment of parts of assemblies, and the tightness of screws, bolts, and so forth. Gaskets shall not be torn or split and shall be free of finish. Cloth components shall be clean and free of holes, cuts, or tears. All latches utilized for erection and closing of the shelter shall be properly adjusted before the shelter is prepared for delivery to the purchaser.

3.4 *Riveting*—Riveting joints shall be tight. The joined parts shall be undamaged, and the rivet heads shall be properly seated and tight against the bearing surfaces. All the rivets, except those used in panel bonding, shall be dipped in polysulfide sealant just prior to insertion, however, a dab of polysulfide sealant shall be applied to the head of each rivet.

3.5 *Cleaning*—After fabrication, parts shall be cleaned in accordance with the drawings.

3.6 *Welding*—Welded joints shall be such that grinding of the finished weld shall not be a requirement, except when specified on the drawing. Spot, stitch, and seam welds shall be as indicated on the drawings. All surfaces to be welded shall be cleaned and free from scale, paint, grease, and other foreign materials. Welds shall have thorough penetration, good fusion and shall be free from scabs, blisters, abnormal pock marks, cracks, voids, slag inclusions, and other harmful defects. Welded assemblies shall be cleaned to remove any scale, oxidation products, and excess flux. Any acid used in cleaning shall be completely neutralized and removed. Welders shall be certified in accordance with SAE-AMS-STD-1595. Welding equipment and procedures shall conform to SAE-AMS-STD-2219.

3.7 *Finish*—Coatings shall level out to an adherent, continuous and uniform film without runs, wrinkles, streaks, or areas of no film. Any coating damaged during assembly or examination shall be touched up. There shall be no areas of rust. Finish shall be free of blistering, peeling and chips.

3.7.1 *Adhesion of Paint*—The shelter shall be capable of withstanding, without degradation to the finish, the tests as specified in 7.37. After top coat application, the shelter in the deployed mode shall be stored for a minimum of 168 h at a minimum of 70°F (21°C) prior to performing this test.

3.7.2 *Color*—The color of the paint film shall be compared with an appropriate color chip for the paint specified.

3.7.3 *Thickness*—Thickness of the paint film shall be checked as specified in 7.39.

3.8 *Finish and Color*—Surfaces shall be of the color, treatment, and finish as shown on the drawings. Top coat painting shall be performed on the fully assembled shelter so as to prevent mismatch of color shading, unless other control techniques are approved by the purchaser. After top coat application, the shelter in the deployed mode (that is, expanded) shall be stored in a 70°F (21°C) minimum temperature indoor facility for a minimum of 36 h to ensure adequate coating(s) cure. During this storage period the shelter doors and vents shall be opened to permit air circulation within the shelter.

3.9 *Manuals*—Unless otherwise specified (see 13.2), technical manuals shall be provided with each shelter. Stowage provision for the manuals shall be located as shown on the applicable drawings.

3.10 Terminology related to this Specification is defined in Terminology E1749.

4. Design and Construction Requirements

4.1 *Design and Construction*—Design and construction of the expandable shelter shall conform to the requirements specified on the drawings, all subsidiary drawings and parts lists and hereinafter. The shelter shall be free of panel delaminations and shall meet all physical and environmental requirements specified herein.

4.2 *Container Mode*—The shelter in the closed or transport mode shall be referred to as a container, hereinafter, for the purpose of definition. The shelter, in the container mode, shall be an article of transport equipment meeting ISO freight container

⁷ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

⁷ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

requirements related to cargo containers. The shelter shall show no structural damage when tested as specified in 7.20, 7.22, 7.23, and 7.28-7.35 and shall show no leakage when tested as specified in 7.24, and 7.24.1-7.24.3. The contractor shall ensure that the shelter receives Coast Guard Certification for ISO Containers. The container overall dimensions shall be in accordance with ISO freight container designated IC and are as shown in Table 1.

4.3 *Panels*—The panels used as structural members in the container configuration shall meet structurally all transportation and environmental requirements specified herein. Each panel shall be fabricated as a net panel with aluminum extrusions bonded about the panel perimeter during panel bonding. The inner and outer skins on all joints shall be sealed to provide a water barrier against the entrance of moisture to the core material and to the interior of the shelter. The water barrier is to be maintained intact at all panel cross-sectional openings. All joints and edges shall be assembled and sealed in a manner to prevent collection and retention of moisture. Particular emphasis shall be placed on the sealing of all mitered corners.

All of the above sealing procedures shall be accomplished in accordance with Practice E1773.

Rivet shafts shall be coated with sealing compound before insertion. The sealer shall be as indicated on the drawings. The contractor shall have the appropriate equipment and facilities, use the correct procedures in accordance with Specifications E874 and E864, and use qualified panel components (that is, structural film and core splice adhesives, corrosion-inhibiting adhesive primer, structural nonmetallic honeycomb core, and as specified 5052-H34 or 6061-T6 aluminum skins, FRP barrier strips, 6061-T6 panel extrusions). Prior to use, all critical panel component materials must be qualified in accordance with Specifications E865, E866, E990, E1091, and E1826. There shall be no skin splices in the panels except where noted on the drawings. Unless otherwise specified (see X1.2), 13.2), prior to award of contract, the contractor shall submit to the purchaser a certified copy of a laboratory test report and a copy of their process specification covering fabrication of the metallic-faced, nonmetallic honeycomb core sandwich panels they propose to use in the construction of the end item. Using their process specification, the contractor shall fabricate qualification test sandwich panels and structural film adhesive floating roller peel test specimens, and shall perform tests in accordance with Specification E865 and Practice E874 (see 13.2).

4.3.1 *Panel Processing*—The shelter panels shall be processed and inspected as specified in Specifications E864, E865, E866, or E1826 depending upon which primer is being used, E874, E990, E1091, and Practice E1773. The shelter panels shall be inspected for dimensions and flatness in accordance with the “Dimensional and Flatness Inspection of Panel” Section of Practice E874 (see 10.2).

4.3.2 *Panel Watertightness*—Panel assemblies shall not permit the entry of water (see 10.3.1) when tested as specified in 7.18.

4.3.3 *Resistance to Thermal Shock*—Panels shall be resistant to thermal shock, when tested as specified in 7.6.

4.3.4 *Panel Interchangeability*—All panels and panel assemblies bearing same part numbers shall be functionally and dimensionally interchangeable without modification or rework. Individual assemblies shall not be hand picked for fit or performance, when tested as specified in 7.7.

4.3.5 *Delaminations*—Delaminations in shelter panels shall be tested as specified in 10.3.4.

4.3.6 *Panel Frame Area Tightness/Airtightness*—Welded panel frames shall be air tight when tested as specified in 7.407.41.

4.4 *Inserts*—When tested as specified in 7.8, the following sized inserts, where used, shall withstand the torque and pullout loads as specified in Table 2, without failure of the inserts, panel, or potting compound.

4.5 *Payload*—The unit is designed to carry a maximum payload of 9480 lb (4300 kg) during transport.

4.6 *Corner Fittings*—The container shall be equipped with corner fittings at the top and bottom corners in accordance with the dimensional requirements for corner fittings for series-1 freight containers as stipulated in ISO 1161 requirements for commercial containers. The upper faces of the top corner fittings shall protrude above the top of the rest of the container by a minimum of 1/4 in. (6 mm) The lower faces of bottom corner fittings shall protrude below the bottom of the container by a minimum of 7/16 in. (11 mm).

4.7 *Shelter Mode*—The shelter in the erected mode shall be referred to as a shelter herein for the purpose of definition. Hinged shelter panels shall be attached in a manner to ensure compliance with the environmental test requirements as specified in 7.6, 7.13-7.17, 7.24, and 7.26.

4.8 *Exterior Lighting*—One area lighting fixture, as shown on the drawings, shall be provided with each shelter.

4.9 *Shelter Electrical System:*

4.9.1 *General*—The system shall have all equipment, cabling and other hardware necessary to receive three phase 120/208 V, 60 Hz power from the base electrical distribution systems, and distribute it to lighting fixtures and receptacles as indicated on the drawings. The 60 A shelters shall be in accordance with Drawing 5-4-2828 and all subsidiary drawings and parts lists. The 100 A shelters shall be in accordance with Drawing 5-4-3200 and all subsidiary drawings and parts lists. All parts of the electrical system shall operate when tested for electrical continuity as specified in 7.40.

4.9.2 *Operating Temperature*—The wiring system and all individual hardware items shall be capable of operating at their required capacity within an ambient temperature range of -60 to 125°F (-51 to 52°C), except that the fluorescent lights shall

TABLE 1 Container Overall Dimensions

Type	Height				Width				Length			
	ft	in.	Tol.	in.	ft	in.	Tol.	in.	ft	in.	Tol.	in.
IC	8	0	+0	-0.1875	8	0	+0	-0.1875	19	10.5	+0	-0.25
	(2.438 m)		+0	(-5 mm)	(2.438 m)		+0	(-5 mm)	(6.058 m)		+0	(-6 mm)

TABLE 2 Insert Strength (Proof Loads)

Insert (Diameter Thread Size)	Pull-out, lb (kN)	Torque, ft-lb (N·m)
10-32	1000 (4.5)	10 (13.6)
1/4-28	1000 (4.5)	20 (27.2)
5/16-24	2000 (9.0)	20 (27.2)
3/8-24	2000 (9.0)	40 (54.2)

operate from 0 to 125°F (–18 to 52°C), when tested as specified in 7.14 and 7.15.

4.9.3 *Current Rating*—All conductors and appropriate hardware shall be rated for current carrying in accordance with the applicable industry standards as specified on the drawings. Derating of components may be necessary for an operating ambient temperature of 125°F (52°C).

4.9.4 *Finish*—Panel boards and all other exposed metallic items shall have finishes as indicated on the drawings (see 3.7).

4.9.5 *Panel Board*—The panel board used shall be as indicated on the drawings. It shall be of dead front construction and have a solid neutral bus, a ground bus, and a 60 A or 100 A three phase main breaker as specified (see 13.2). The panel will have a NEMA-1 enclosure with conduit hubs as necessary and at least 18 breaker spaces excluding the main breaker. The panel board bus feed shall be by rigid conduit and conductors; the conductors having a current carrying capacity of at least 100 A at 125°F (52°C) ambient temperature. The bus feed cables shall terminate in a connector mounted on the exterior of the shelter. Conductors running from panel board circuits to fixtures or receptacles shall be enclosed in rigid conduit or shall be specified flexible cable for the expandable portion of the shelter. The current carrying capacity of the conductors shall be 20 A minimum, based upon an ambient temperature of 125°F (52°C) and NEC rating procedures. All circuit breakers used in the system shall be bolt-on type and have a minimum interrupting capacity of 10 000 A RMS symmetrical.

4.9.6 *Cabling*—Flexible cables shall be used to feed all relocatable lighting fixtures and receptacles. These cables shall be as indicated on the drawings.

4.9.7 *Switches*—Switches used shall be as indicated on the drawings.

4.9.8 *Grounding*—All noncurrent carrying metal components shall be solidly grounded using the green ground wire within the wiring system, as indicated on the drawings.

4.9.9 *Receptacles*:

4.9.9.1 *Electrical Power Service Entrance*—The electrical power service entrance shall be as shown on the drawings.

4.9.9.2 *Convenience Outlets*—The shelter shall contain duplex convenience outlets as indicated on the drawings. All outlets shall be electrically grounded.

4.9.9.3 *Air Conditioning*—Power for heating and cooling equipment shall be provided from the distribution panel in the shelter to an electrical connector mounted in the service entrance recessed pan on the outside of the shelter as indicated on the drawings.

4.9.9.4 *External Outlets*—Power distribution shall be provided from the distribution panel box in the shelter to outlets mounted in the service entrance recessed pan on the outside of the shelter as indicated on the drawings.

4.9.10 *Communications*—The shelter shall have four (two pairs) circuits through the wall telephone and intercom utility connections terminating in four protected terminals inside and outside the shelter, as indicated on the drawings.

4.9.11 *Tools*—Tools provided with the shelter shall be readily accessible to personnel when the shelter is in both the container and shelter configuration.

4.10 *Nameplates and Product Marking*—All markings shall conform to the drawings. Each shelter shall be serially numbered and provided with a nameplate in accordance with applicable drawings (see X1.2)–13.2).

4.10.1 *Interior Markings*—Interior markings shall be as shown and in the locations shown on the applicable drawings.

4.10.2 *Exterior Markings*—The shelter shall be provided with specific exterior markings as shown on the applicable drawings.

5. Performance Requirements

5.1 *Floor Loads*—The shelter floor shall be capable of supporting a uniform load of 65 lb/ft² (320 kg/m²). The shelter floor shall be capable of supporting a concentrated load of 2000 lb (910 kg) over a 4 ft² (0.4 m²) area at the center of the floor. The floor shall also be capable of supporting a point load of 125 lb/in.² (9 kg/cm²). Loads shall not cause any permanent deformation of the floors or cause any deflection that interferes with proper shelter operation, when tested as specified in 7.9.

5.2 *Roof Loads*—The roof assembly of the shelter shall withstand a snow load of 40 lb/ft² (200 kg/m²) and a personnel load of 660 lb (300 kg) static over 2 ft² (0.2 m²) when tested as specified in 7.10.

5.3 *Door Loads*—Container doors shall be tested to withstand the following loads without deformation or impairment of function:

5.3.1 *Static Door (Hinge) Load*—The doors, frames, and hardware shall be capable of supporting 200 lb (90 kg) applied to the door at the edge opposite the hinge pivot line with the door open to approximately 90 when tested as specified 7.11.

5.3.2 *Wind Gust Door (Stop) Load*—The doors, frames, and hardware shall withstand a wind gust of 60 mph (100 km/h) in any direction when the door is secured in its open position by its door stop device when tested as specified in 7.11.

5.4 *Step Assembly*—The completely mounted step assembly shall withstand a vertical load of 500 lb (225 kg) applied to the outer section without deformation of the assembly of supporting structure when tested as specified in 7.12.

5.5 *Airtightness*—The shelter shall not permit air leakage beyond specified limits in either container or shelter configuration when tested as specified in 7.13.

5.6 *Temperature Range:*

5.6.1 *Non-operating Temperature*—The container mode configuration shall withstand exposure to a temperature range of –60°F to 160°F (–51 to 71°C).

5.6.2 *Operational Temperature*—The shelter shall be dependable and operable in an ambient temperature range of –60°F to 125°F (–51 to 52°C) plus a solar load such that the outer skin reaches a temperature of 200°F (93°C), when tested as specified in 7.14, 7.15, and 7.26.

5.7 *Humidity and Temperature Aging (Components)*—The shelter components shall be capable of withstanding the conditions of a minimum 95 % relative humidity at 200°F (93°C). There shall be no evidence of delamination, cracking, corrosion, or deterioration when tested as specified in 7.16.

5.8 *Blackout*—There shall be no internal light visible from outside of the unit in the shelter mode when tested as specified in 7.17.

5.9 *Insert Strength*—When tested as specified in 7.19, the inserts indicated in Table 2 shall withstand loads equal to 80 % of the applicable strengths shown in Table 2 without failure and as indicated in Table 3.

5.10 *Rail Transportability*—The shelter when tested as specified (see 7.20) shall be capable of withstanding, without damage, the shocks normally induced by rail transport.

5.11 *Impact Resistance*—The shelter panel shall be impact resistant when tested as specified in 7.21.

5.12 *Drop Test*—The shelter when tested as specified in 7.22 shall show no evidence of damage as a result of the drop test.

5.13 *Towing*—The shelter shall show no evidence of damage when tested as specified in 7.23.

5.14 *Water Leakage*—The shelter shall show no evidence of leakage when tested as specified in 7.24.

5.15 *Fluorescent Light Temperature* —Shelter fluorescent light assemblies shall show no failure when tested as specified in 7.25.

5.16 *Solar Load*—The shelter shall withstand a solar load test when tested as specified in 7.26.

5.17 *Operational Fitness*—The shelter shall prove functional when tested as specified in 7.27.

5.18 *Heat Transfer*—The overall coefficient of heat transfer of the shelter shall not exceed 0.35 BTU per hour per square foot per degree Fahrenheit (2.0 watts per square metre per degree Kelvin) (see 7.36).

6. Other Requirements

6.1 Requirements and testing for lifting, six-high stacking, longitudinal restraint, racking, lashing, endwall strength, sidewall strength, and lifting from fork lift pockets shall conform to ISO 1496-1 when tested as specified in 7.28-7.35.

6.2 *First Article*—When specified, a sample shall be subjected to first article inspection (see 8.1, 13.1, and 13.3).

6.3 *Inspection Comparison Testing Sample*—When specified (see 13.2), the contractor shall furnish a sample for comparison inspection and approval (see 8.1 and 13.4).

6.4 *Manuals*—Unless otherwise specified (see 13.2), technical manuals shall be provided with each shelter. Stowage provisions for the manuals shall be located as shown on the applicable drawings.

7. Test Methods

7.1 *Electrical Continuity Testing*—Test every end item as specified in 7.40. Any test failure shall be cause for rejection of the end item.

7.2 *Water Leakage and Operational Testing*—Test the first ten production units as specified in 7.24, 7.24.1 and 7.24.3. If no failures are experienced, five of the next ten production units shall be tested. If no failures are experienced on the 50 % sample, one of each 25 production units shall be tested thereafter. Any failure on sampled units shall be cause for rejection of the lot and return to 1008 testing; repeat the above procedure (starting with the units of that lot).

7.2.1 *Water Leakage (Fully Loaded)*—Test one out of every 50 production units as specified in 7.24.2 and 7.24.3. Notify the purchaser of any test failure within 72 h. Prepare a failure analysis report with corrective action defined, and test one out of the next ten production units followed by one out of the next fifty if no failures occur.

7.3 *Performance Testing*—Test one end item from each inspection lot as specified in 7.13 (shelter mode only) and 7.26. After successful completion of these tests, test the end item sample as specified in 7.17. The size of the inspection lot shall not exceed 25 shelters. Any test failure shall be cause for rejection of the lot.

7.4 *Paint Adhesion Testing*—Test one of every forty production units as specified in 7.37. Test this unit in the deployed mode

TABLE 3 Insert Strength (Working Loads)

Insert (Diameter Thread Size)	Pull-out, lb (Kg)	Torque, ft-lb (J)
10-32	800 (360)	8 (11)
1/4-28	800 (360)	16 (22)
5/16-24	1600 (725)	16 (22)
3/8-24	1600 (725)	32 (43)