



400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE
STANDARD

SAE AS 954C

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Superseding AS 954B

Submitted for recognition as an American National Standard

REVERSIBLE RATCHET HANDLES: AND 12-POINT, HIGH STRENGTH,
THIN WALL, HAND WRENCHES--SOCKETS, FLEXIBLE SOCKETS,
BOX WRENCHES AND TORQUE ADAPTERS

1. SCOPE AND CLASSIFICATION:

1.1 Scope: This Aerospace Standard (AS) covers reversible ratchet handles and high strength thin wall commercial sockets, flexible sockets, box wrenches and torque adapters designed for general usage which possess the strength, clearances, and internal wrenching design so configured that, when mated with 12-point fasteners conforming to the requirement of AS 870, they shall transmit torque to the fastener without bearing on the outer 5% of the fastener's wrenching points.

1.2 Classification: This AS covers only a limited number of sizes and combinations of sizes of the aforementioned items for which an aerospace engine need has been demonstrated and for which the commercial item manufacturers can meet all requirements of this AS. This document includes two types of protective finish. Type I will be furnished unless otherwise specified.

1.2.1 TYPE I: Type I protective finish is chromium and shall be in accordance with paragraph 3.6.2.

1.2.2 TYPE II: Type II protective finish is black oxide or manganese phosphate and shall be in accordance with paragraph 3.6.3.

2. APPLICABLE DOCUMENTS:

2.1 The following documents of the issue in effect on the date of invitations for bid or request for proposal, form a part of this AS to the extent specified herein.

2.1.1 Federal Standards: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

FED-STD-346 - Gauges, Wrench Openings

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- 2.2 Other Publications: The following documents form a part of this AS to the extent specified herein. Unless a specific issue is identified, the issue in effect on the date of invitation for bids or request for proposal shall apply:
- 2.2.1 American Society for Testing and Materials (ASTM) Standard: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.
- E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Standard Methods of Test For
- 2.2.2 American National Standards Institute (ANSI), Inc., Standards: Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
- B46.1 - Surface Texture
B107.4 - Driving and Spindle Ends for Portable, Hand, Air and Electric Tools
- 2.2.3 SAE Publications: Available from SAE, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.
- AS 478 - Identification - Marking Methods
AS 870 - Wrenching Configuration, Double Hexagon (12-point) for Threaded Fasteners

3. REQUIREMENTS:

- 3.1 Illustrations: The illustrations shown herein are descriptive and not restrictive and are included for the convenience of requisitioning and purchasing officers and manufacturers, and are not intended to preclude the purchase of sockets, flexible sockets, box wrenches, torque adapters and reversible ratchet handles which are otherwise in accordance with this standard.
- 3.2 Materials: Unless otherwise specified hereinafter, the materials used in the manufacture of the sockets, flexible sockets, box wrenches, torque adapters and reversible ratchet handles shall be steel, the chemical composition and heat treatment of which shall be such as to produce tools conforming to the physical requirements specified herein.
- 3.3 Marking: The sockets, flexible sockets, box wrenches, torque adapters and reversible ratchet handles shall be marked in a permanent manner with the manufacturer's name, or with a trademark of such known character that the source of manufacture may be readily determined. In addition, the tools shall be marked in a permanent manner with the nominal wrench opening (except for reversible ratchet handles). Marking requirement shall be in accordance with AS 478.

3.4 Manufacture and Design:

3.4.1 Drive End Dimensions: Male and female drive end dimensions shall conform to ANSI B107.4.

3.4.1.1 Male Drive Tangs: Male drive tangs shall be designed for square drive. The drive tangs shall have a smooth machined engaging surface. Each male drive tang shall be provided with a spring-loaded steel ball permanently staked in place and arranged to hold the mating sockets and attachments. Each male drive tang shall be shouldered at the flats to provide a positive stop for the tang.

3.4.1.2 Female Drive Opening: All female drive openings shall be broached or punched in a smooth and well defined manner. Tools having female drive openings shall be firmly attachable to corresponding size male drive tangs by the following methods:

3.4.1.2.1 On 3/8 In. and Larger Drive Openings: One or more faces of the female drive opening shall be drilled or recessed so that any recess or drilled hole shall engage the spring-loaded steel ball on the corresponding male drive. If only one or two faces of the female opening are recessed, the sockets shall be marked indicating the face of the opening which is recessed.

3.4.1.2.2 On 1/4 In. Drive Openings: One or more faces of the female drive opening may or may not be drilled or recessed, however, the minimum force required to remove tang as specified in ANSI B107.4 shall be met.

3.4.2 Edges and Corners: All edges and corners, capable of causing injury, not otherwise covered herein, shall have sharp edges removed by rounding, chamfering, or other means. The inside edges of the wrench shall be chamfered.

3.4.3 Tang Engagement and Disengagement: The detachable sockets, flexible sockets, torque adapters and reversible ratchet handles shall be so designed that male tangs can be inserted into the corresponding female openings without undue force and shall be manually detachable without the use of any tools or keys, and meet the minimum force requirements to remove tang as specified in applicable tables of ANSI B107.4. Binding between surfaces and corners shall not be evident.

3.5 Hardness: Unless otherwise specified herein, sockets, flexible sockets, box wrenches, torque adapters and ratchet handles shall be hardened throughout to a Rockwell hardness of not less than 40 nor more than 54 on the "C" scale, except for ratchet drive tang which need not be hardened over more than the dimension "CM" as in Table X of ANSI B107.4. Hardness definitions, nomenclature and procedures used herein can be found in ASTM E18.

3.6 Finish:

3.6.1 Surface Roughness: All external surfaces shall be free from pits, nodules, forge flash, burrs, cracks, and other detrimental defects. The external forge flash shall be completely removed to blend smoothly with adjacent surface except that the forge flash shall be completely removed from the periphery of the heads of box wrenches and torque adapters and from that portion of the handle which shall be essentially straight and uniform in section dimensions. Maximum surface roughness values shall be determined in microinch values. Determination of microinch value shall be taken on a representative surface. Areas that are ground and buffed, or otherwise finished by an equivalent method, and provided with a Type I coating finish of chromium shall have a uniform bright finish with a maximum roughness in microinches using a 0.030 in. roughness width cutoff on the surface measuring instrument, conforming to Chart No. 1. Definitions and nomenclature used herein can be found in ANSI B46.1.

3.6.2 Chromium Plate (Type I): The plating shall be electrodeposited metals consisting of nickel, followed by chromium, the minimum thickness of which shall be 0.0002 in. for nickel or iron-nickel, and 0.00001 in. for chromium. The plating shall be adherent, smooth, continuous and free from pits, blisters, nodules, and any other defects which would interfere with their protective value and serviceability. The minimum thickness of the plating shall be as specified on all external visible surfaces which can be touched by a ball 0.750 in. in diameter.

3.6.3 Black Oxide or Manganese Phosphate Treatment (Type II): The tools shall be coated with a chemically produced oxide or phosphate coating followed with a coating of rust preventive oil. All external surfaces shall have a maximum roughness height value of 150 microinches.

3.7 Test Loads: The items covered herein shall withstand the test load specified in the applicable tables without injury or permanent deformation (set) which might affect the durability or serviceability of the tools.

3.7.1 Mandrels for Wrench Openings: Wrench openings shall be tested on hexagonal mandrels. The size of all mandrels shall conform to the dimensions and tolerances specified in Table V. The hexagonal mandrel shall be reduced by 0.05H at each corner as shown on Fig. 1 to ensure that wrench lobe does not transmit torque on mandrel points. Mandrels shall be hardened to show a Rockwell hardness of not less than 55 on the "C" scale and shall have smoothly finished wrench engagement surfaces.

3.7.2 Test Plug:

3.7.2.1 Sockets: A square test plug of suitable strength and complying with the minimum dimensional requirements of the male drive tang specified in ANSI B107.4 shall be employed. The test plug may be driven by any suitable manual or mechanical means. The socket shall then be engaged on the end of a mandrel to a maximum depth in accordance with Table V. A stop may be set at the outer end of the test plug to prevent slippage of the socket end-wise from the mandrel.

3.7.2.2 Flexible Sockets: A test plug as in 3.7.2.1 shall be used except that a means shall be provided to keep flexible socket parts in the axis about which the load is applied.

3.7.3 Qualification Test:

3.7.3.1 Sockets, Flexible Sockets, Box Wrenches, Torque Adapters: Each sample tool tested shall be capable of withstanding 2000 applications of the minimum torque endurance load specified in Tables I, IA or II, as applicable, and then the associated proof load when engaged per 3.7.1. After each 250 applications on the mandrel, the tool shall be indexed 30 degrees.

3.7.3.2 Reversible Ratchet Handles: The ratchet mechanism shall withstand a cyclic test of 100,000 cycles using the cycle test torque, as specified in Table IV, without failure of the ratchet mechanism or loosening of screws or other parts of the ratchet handle. Following cyclic test, ratchet handle shall then be subjected to the proof load specified in Table IV and 3.12.2.

3.7.3.3 Integrity Test: One sample of each tool shall be loaded to failure. Failure shall not result in fragmentation.

3.8 Wrench Opening:

3.8.1 Wrenching Design: The internal wrench design of the socket, flexible socket, box wrench or torque adapter shall be so configured that, when mated with 12-point fasteners conforming to the requirements of AS 870, they shall transmit torque to the fastener without bearing on the outer 5% of the fastener's wrenching points. See Fig. 1.

3.8.2 Bolt and Nut End Opening Tolerance: Wrench opening tolerance shall be as specified in FED-STD-346.

3.9 Sockets: In addition to the requirements of 3.4, a bolt clearance hole shall be provided. The clearance hole length shall be from the base of the 12-point opening to the base of the square drive. The diameter of the bolt clearance hole shall conform to Table I.

- 3.10 Flexible Sockets: In addition to the requirements of 3.4, flexible sockets shall be provided with a friction type device which will hold the drive end and the socket end in any set position with a force adequate to hold the universal joint against gravity. Hinge pin shall be solid and not extended beyond the periphery of the universal joint. A bolt clearance hole shall be provided, the dimensions of which shall be as specified in Table IA. The universal joint shall be capable of rotation in a complete arc when the angular deviation of either end member from the common center line is 40 degrees.
- 3.11 Box Wrenches, Torque Adapters:
- 3.11.1 Box Wrenches: The 15-degree box wrenches shall be 12-point, double hexagon double-head design, shall possess the wrenching design of 3.8.1, and shall conform to Tables II and III.
- 3.11.2 Torque Adapters: Torque adapters shall be of the 12-point, double hexagon design with a 3/8 in. female square drive, shall possess the wrenching design of 3.8.1, and shall conform to Table II. One side of the square drive shall be within 3° of parallel to a line drawn from the center of the drive, through the center of the wrench opening.
- 3.12 Reversible Ratchet Handles: The shifting lever, knob, or button of the reversible ratchet handles shall be of sufficient strength to assure long life under hard usage and it shall be installed in such manner that it can only be removed by a deliberate prying action. If an opening is provided for lubricating the ratchet mechanism, it shall be constructed in such a manner that dirt will not enter.
- 3.12.1 Drop Test: The reversible ratchet handle shall be dropped on a concrete floor from a height of six feet, a minimum of twelve times in random positions. However, the ratchet (button) mechanism shall strike (first) on the concrete floor at least twice. During this test, all components shall remain properly assembled and the ratchet mechanism shall work satisfactorily after the last drop has been completed.
- 3.12.2 Proof Load Test: The ratchet handles shall withstand the test loads specified without permanent angular distortion or more than 5 degrees and shall show no indication of damage or adverse effect on the ratcheting mechanism or the handle after removal of the test load.
- 3.13 Workmanship: All details of workmanship shall be in accordance with high grade commercial practices. All items covered herein shall be free from rust, fins, burrs, external sharp or rough edges, corners or surfaces and other defects which may impair their serviceability of durability.

CHART NO. 1SPECIFIC AREAS OF FINISH

SOCKETS and FLEXIBLE SOCKETS	Outer longitudinal surface or major diameter thereof shall be bright with 30 microinches maximum, except where knurled or grooved. The remaining exterior longitudinal socket surface shall be 150 microinches maximum.
BOX WRENCHES and TORQUE ADAPTERS	A minimum of 180 degrees of the outer periphery of the box ends (90 degrees on each side of the longitudinal axis of the wrench) shall be 30 microinches maximum.
REVERSIBLE RATCHET HANDLES	At least 180 degrees of the periphery of the head shall be bright with 30 microinches maximum. The remaining surfaces, except where knurled or grooved, shall be 150 microinches maximum.

PREPARED BY

SAE COMMITTEE EG-1, AEROSPACE PROPULSION SYSTEMS SUPPORT EQUIPMENT

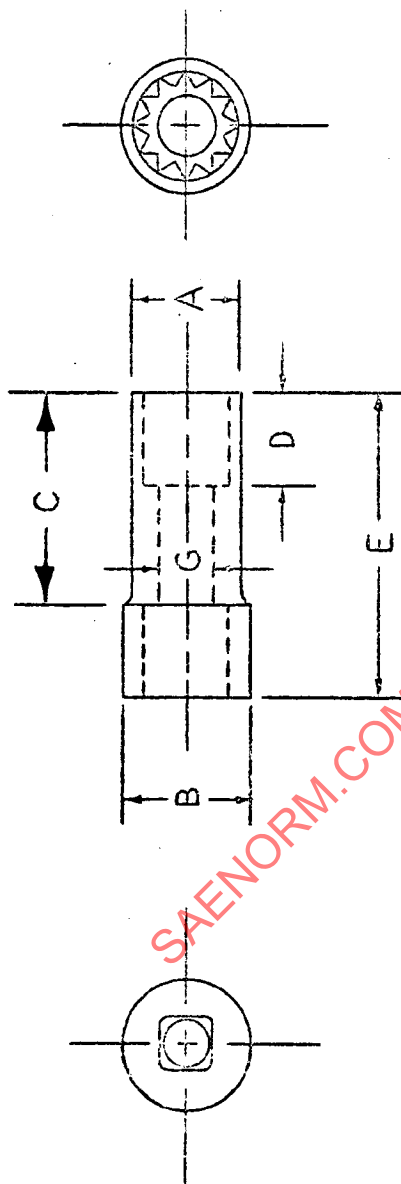


TABLE I - SOCKET DATA (DIMENSIONS IN INCHES)

Nominal Wrench Opening	A Max	B Max	C Min	D Min Depth	E Min	E Max	G Dia Min	Min Torque Endurance Load (in-lb)	Proof Torque Load (in-lb)	Nom Square Drive Size
7/32	0.343	0.440	0.390	0.190	.845	1.270	.195	75	225	0.250
1/4	.380	.440	.390	.205	.845	1.270	.203	100	300	.250
9/32	.430	.440	.390	.215	.845	1.270	.260	125	375	.250
5/16	.478	.460	.390	.265	.845	1.270	.265	150	450	.250
3/8	.550	.697	.420	.270	.900	1.520	.328	300	900	.375
7/16	.660	.697	.420	.360	.900	1.520	.390	400	1250	.375
1/2	.730	.697	.420	.370	.900	1.780	.453	800	2400	.375
9/16	.812	.810	.420	.380	.990	1.780	.515	840	2500	.375
5/8	.892	.940	.734	.460	1.470	1.780	.578	1650	5000	.500
11/16	.960	.960	.840	.500	1.470	1.780	.650	1850	5500	.500
3/4	1.055	1.055	.840	.590	1.470	1.780	.703	2000	6000	.500

OPTIONAL
THRU HOLE

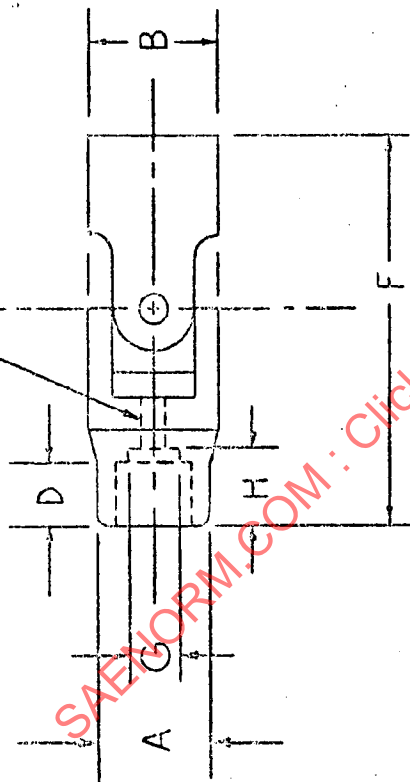


TABLE IA - FLEXIBLE SOCKET DATA
(DIMENSIONS IN INCHES)

NOMINAL OPENING	SQUARE DRIVE SIZE	OVERALL LENGTH MAX F	OUTER DIAMETER		NUT END		DRIVE END		DEPTH OPENING		BOLT CLEARANCE		TORQUE ENDURANCE		PROOF TORQUE	
			MAX A	MAX B	MAX C	MAX D	MAX E	MAX F	MIN G	MIN H	MIN I	MIN J	MIN K	MIN L	MIN M	MIN N
1/4	0.250	1.312	0.385	0.515	0.515	0.205	0.203	0.330	0.205	0.203	0.330	100	100	300	300	300
5/16	.250	1.437	.470	.515	.515	.265	.265	.408	.265	.265	.408	150	150	450	450	450
3/8	.250	1.500	.540	.515	.515	.270	.328	.437	.270	.328	.437	180	180	550	550	550
7/16	.375	2.000	.660	.750	.750	.360	.390	.568	.360	.390	.568	350	350	1000	1000	1000
1/2	.375	2.125	.740	.750	.750	.370	.453	.620	.370	.453	.620	350	350	1000	1000	1000
9/16	.375	2.187	.800	.750	.750	.380	.515	.630	.380	.515	.630	350	350	1000	1000	1000

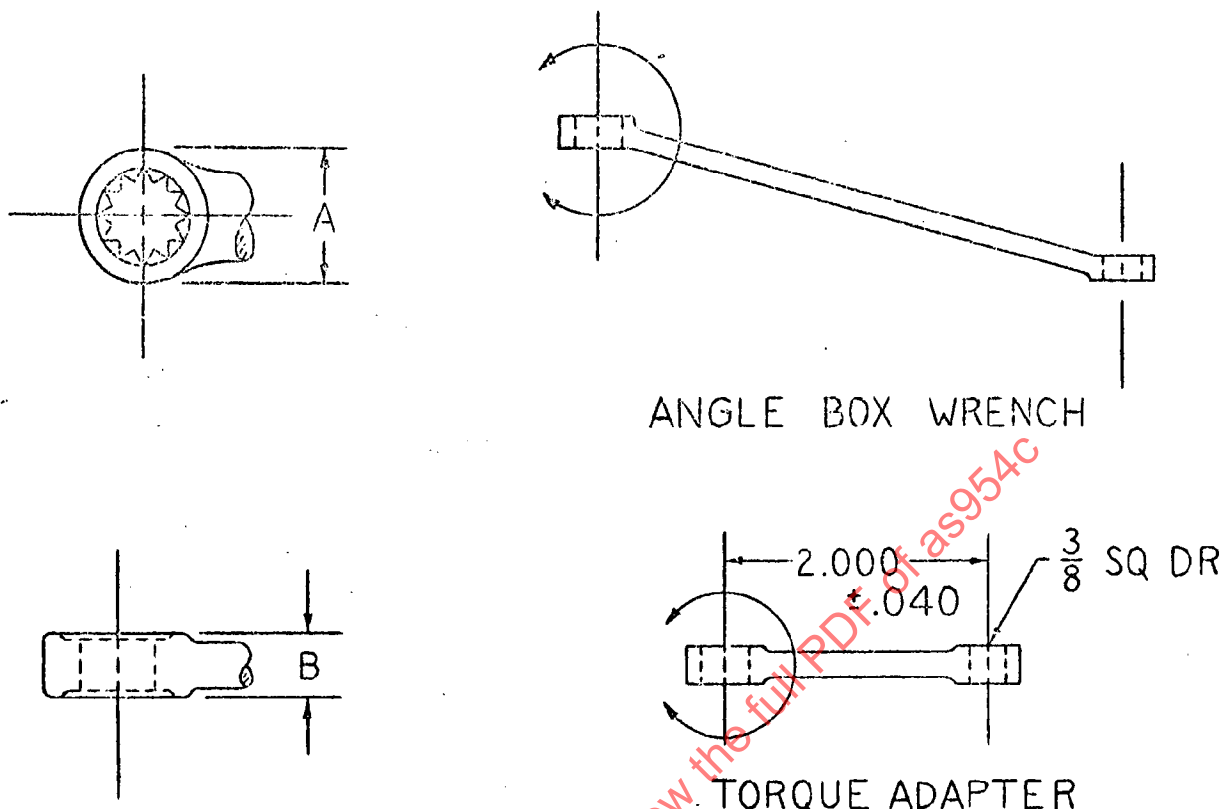


TABLE II - BOX WRENCH AND TORQUE ADAPTER DATA
(DIMENSIONS IN INCHES)

Nominal Wrench Opening	A Max	B Max	Min Torque Endurance Load (in-lb)	Proof Torque Load (in-lb)
7/32	0.375	0.250	60	180
1/4	.425	.250	70	220
9/32	.445	.250	85	250
5/16	.480	.266	90	275
3/8	.578	.327	200	605
7/16	.660	.349	250	750
1/2	.750	.359	400	1200
9/16	.830	.406	550	1650
5/8	.920	.468	750	2200
11/16	1.010	.490	880	2640
3/4	1.090	.531	1000	3000

NOTE: 5/8, 11/16, 3/4 data apply to box wrenches only