

**Wrenches, Hand Twelve Point
High Strength, Thin Wall**

1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) covers high strength thin wall commercial sockets, universal sockets, box wrenches and torque adaptors which possess the strength, clearances, and internal wrenching design so configured that, when mated with 12-point fasteners conforming to the requirement of AS870, they shall transmit torque to the fastener without bearing on the outer 5% of the fastener's wrenching points.

Inclusion of dimensional data in this document is not intended to imply that all of the products described herein are stock production sizes. Consumers are requested to consult with manufacturers concerning lists of stock production sizes.

1.2 Classification:

Wrenches, sockets, and adaptors covered by this AS shall be of the following types, classes, and styles, as specified:

1.2.1 Type I Sockets

- a. Class 1 Sockets
 - (1) Style A - Regular
 - (2) Style B - Long
- b. Class 2 Universal Sockets (also known as flexible sockets)

1.2.2 Type II Wrenches, Box

- a. Class 1 Angled End
 - (1) Style A - Regular Length
 - (2) Style B - Long Length

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2004 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: <http://www.sae.org>

1.2.2 (Continued):

- b. Class 2 Modified Offset
 - (1) Style A - Regular Length
 - (2) Style B - Short Length
- c. Class 3 Deep Offset
 - (1) Style A - Regular Length
 - (2) Style B - Short Length
- d. Class 4 Combination
 - (1) Style A - Regular Length
 - (2) Style B - Short Length

1.2.3 Type III Torque Adaptors

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of all SAE Technical Reports shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS478 Identification Marking Methods

AS870 Wrenching Configuration, Double Hexagon (12-point) for Threaded Fasteners

2.2 American Society for Testing and Materials:

Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Standard Methods of Test For

ASTM B 487 Measurement of Metal and Oxide Coating Thickness Examination of a Cross Section

ASTM B 499 Measurement of Coating Thickness by the Magnetic Method, Standard Test Method for

ASTM B 504 Measurement of Thickness of Metallic Coatings by the Coulometric Method, Standard Test Method for

ASTM B 530 Measurement of Coating Thicknesses by the Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates, Standard Test Method for

ASTM B 568 Measurement of Coating Thickness by X-ray Spectrometry, Standard Test Method for

ASTM B 571 Adhesion of Metallic Coatings, Standard Test Methods for

ASTM B 748 Measurement of Thickness of Metallic Coatings by Measurement of Cross-Section with a Scanning Electron Microscope, Standard Test Method for

ASTM B 754 Coating Thickness by X-ray Fluorescence, Standard Test Method for

2.3 ANSI Publications:

Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B46.1	Surface Texture
ANSI B107.4	Driving and Spindle Ends for Portable, Hand, Air and Electric Tools
ANSI B107.6	Wrenches, Box, Open End, Combination and Flare Nut
ANSI B107.17M	Gages, Wrench Openings, Reference

3. REQUIREMENTS:

3.1 Illustrations:

The illustrations shown herein are descriptive, not restrictive, and are not intended to preclude sockets, universal sockets, box wrenches, and torque adaptors which are otherwise in accordance with this document.

3.2 Materials:

Unless otherwise specified hereinafter, the materials used in the manufacture of the sockets, universal sockets, box wrenches, and torque adaptors 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. Powdered metal or cast steel shall not be used.

3.3 Marking:

The sockets, universal sockets, box wrenches and torque adaptors shall be marked in a permanent manner with the country of origin and 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. Marking requirement shall be in accordance with AS478.

3.4 Square Drive Ends:

3.4.1 Drive End Dimensions: Female drive end dimensions shall conform to ANSI B107.4. Male drive tangs in accordance with ANSI B107.4 shall be used to judge the following requirements:

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

3.4.1.1.1 Detent: All four faces of the female drive opening shall be recessed so that one of the recesses engages the spring loaded steel ball on the corresponding male drive. For Type III, if the female drive end thickness is less than twice the dimension Df in Table 9 of ANSI B107.4, the recess shall be centered in the female drive opening within 0.010 in.

3.4.1.1.2 Cross-hole: One or more of the faces of the female drive opening shall be drilled with a cross-hole to engage the spring loaded steel ball or plunger on the corresponding male drive. For Type III, if the female drive end thickness is less than twice the dimension Df in Table 9 of ANSI B107.4, the cross-hole(s) shall be centered in the female drive opening within 0.010 in.

3.4.2 Tang Engagement and Disengagement: The detachable sockets, universal sockets and torque adaptors 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 the male 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, universal sockets, box wrenches and torque adaptors shall be hardened throughout to a Rockwell hardness of not less than 40 nor more than 54 on the "C" scale. Hardness definitions, nomenclature and procedures used herein can be found in ASTM E 18. When grinding is necessary to prepare the test surface, the amount removed must not exceed 0.007 in on the surface contacted by the indenter.

3.6 Finish:

Two types of protective finish are covered. Chromium plate will be furnished unless otherwise specified.

3.6.1 Chromium Plate: The plating shall be electroplated with a nickel (Ni) followed by a chromium (Cr) coating. There shall be no other undercoatings on the tools. Coating thickness requirements are as follows:

- a. Ni = 0.0002 in minimum
- b. Cr = 0.000007 in minimum

One measurement of the thickness of Ni and one measurement of the thickness of Cr shall be made in each of the areas indicated on Figure 1 using any of the following, as appropriate, methods:

- a. ASTM B 487
- b. ASTM B 499
- c. ASTM B 504
- d. ASTM B 530
- e. ASTM B 568
- f. ASTM B 748
- g. ASTM B 754

Visible contact marks resulting from electroplating operations shall be confined to the interior of the wrenching and drive openings. Electroplated surfaces of the tools shall be adherent, smooth, continuous, and free of visible defects such as blisters, pits, nodules, roughness, and cracks.

3.6.1 (Continued):

Plating adhesion shall be capable of withstanding the test specified in ASTM B 571 using one of the following methods:

- a. Grind - saw
- b. Push
- c. File
- d. Burnishing

3.6.1.1 Surface Finish Requirements of Chromium Plate: On all Type I sockets and universal sockets, the outer longitudinal surface or major diameter thereof shall be bright with 30 μ in maximum, except where knurled or grooved. The remaining exterior longitudinal socket surface shall be 150 μ in maximum. On all Type II box wrenches and Type III torque adaptors, a minimum of 180° of the outer periphery of the box ends (90° on each side of the longitudinal axis of the wrench) shall be 30 μ in maximum.

3.6.2 Black Oxide or Phosphate Treatment: 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 250 μ in.

3.6.3 Surface Roughness: All external surfaces shall be free from pits, nodules, forge flash, burrs, cracks, and other detrimental defects. The external forge flash shall blend smoothly with adjacent surfaces except that the forge flash shall be completely removed from the periphery of the heads of box wrenches and torque adaptors and from that portion of the handle which shall be essentially straight and uniform in section dimensions. Microinch measurements shall be made with a surface-measuring instrument using a 0.030 in roughness width cutoff. Definitions and nomenclature used herein can be found in ANSI B46.1.

3.7 Test Loads:

The items covered herein shall withstand the proof load specified in the applicable figures without injury or permanent deformation (set) which might affect durability or serviceability of the tools. Adequate safeguards for personnel and property shall be employed in conducting all tests. Approved eye protection shall be worn at all times and equipment safety shields in place when tests are in progress.

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 1. The fourth column of Table 1 does not apply when testing Type II, Wrenches and Type III, Torque Adaptors.

Mandrels shall be hardened to a Rockwell hardness of not less than 55 on the "C" scale and shall have smoothly finished wrench engagement surfaces.

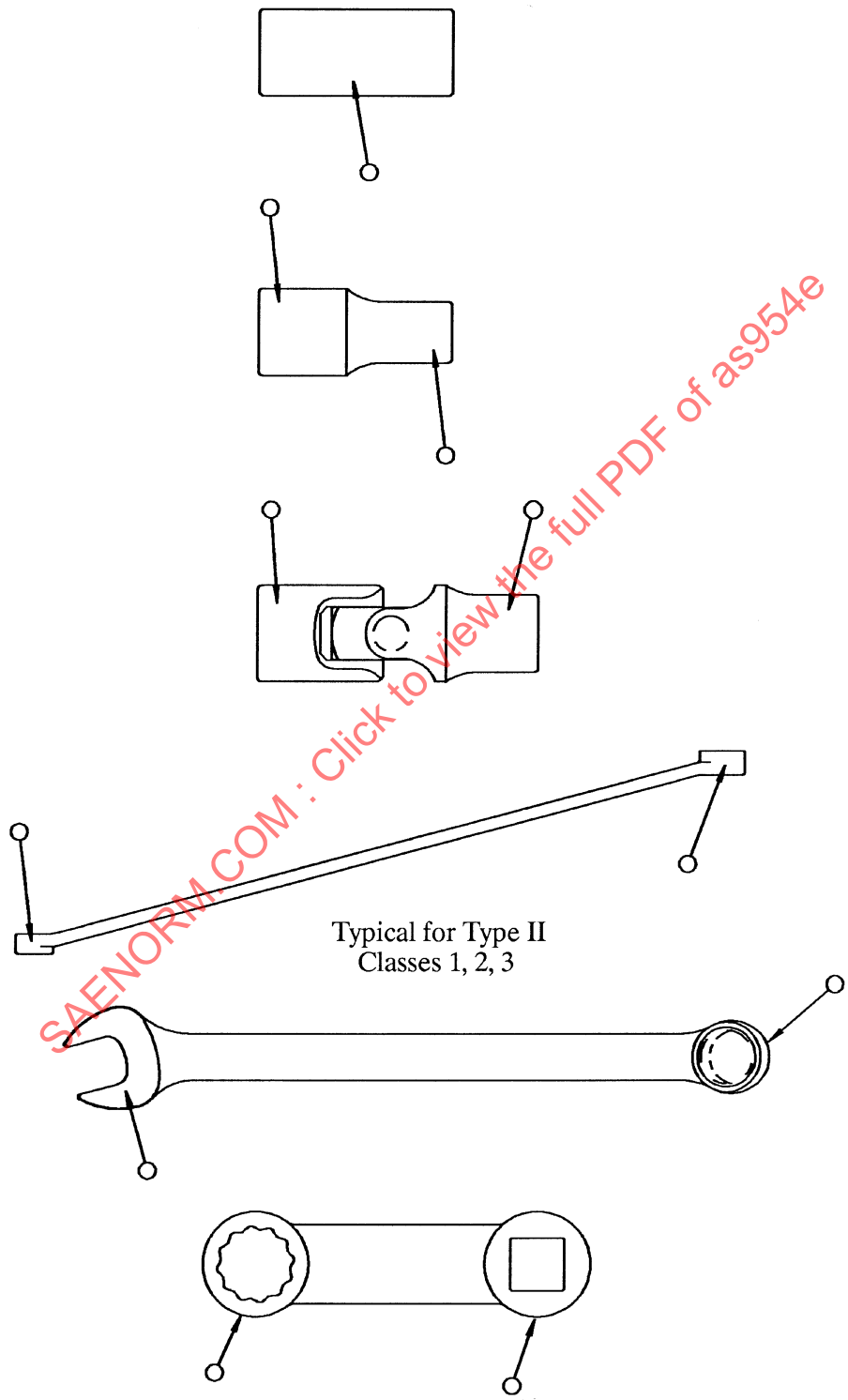


FIGURE 1 - Plating Thickness Test Areas

SAE AS954 Revision E

**TABLE 1 - Hexagon Mandrel Dimensions and Engagement Data
(Dimensions in Inches)**

For Wrench Sizes	Nominal Wrench Opening	Hexagonal Mandrel Across Flats Tolerances	Mandrel Engagement Maximum Depth of Insertion	No Bearing Area for Mandrel (Ref)
3/16	0.1875	+0.001 -0.002	0.094	0.0006
7/32	0.2188	+0.001 -0.002	0.109	0.0007
1/4	0.2500	+0.001 -0.002	0.125	0.0007
9/32	0.2812	+0.001 -0.002	0.141	0.0008
5/16	0.3125	+0.001 -0.002	0.141	0.0009
11/32	0.3438	+0.001 -0.002	0.156	0.0010
3/8	0.3750	+0.001 -0.002	0.156	0.0011
7/16	0.4375	+0.001 -0.002	0.218	0.0013
1/2	0.5000	+0.001 -0.003	0.265	0.0015
9/16	0.5625	+0.001 -0.003	0.328	0.0017
5/8	0.6250	+0.001 -0.003	0.375	0.0019
11/16	0.6875	+0.001 -0.003	0.375	0.0021
3/4	0.7500	+0.001 -0.003	0.437	0.0022
25/32	0.7812	+0.001 -0.003	0.453	0.0023
13/16	0.8125	+0.001 -0.003	0.453	0.0024
7/8	0.8750	+0.001 -0.003	0.500	0.0026
15/16	0.9375	+0.001 -0.003	0.546	0.0028
1	1.0000	+0.001 -0.003	0.546	0.0030
1-1/16	1.0625	+0.001 -0.003	0.625	0.0032
1-1/8	1.1250	+0.001 -0.003	0.656	0.0034
1-3/16	1.1875	+0.001 -0.003	0.656	0.0035
1-1/4	1.2500	+0.001 -0.003	0.750	0.0037
1-5/16	1.3125	+0.001 -0.003	0.765	0.0039
1-3/8	1.3750	+0.001 -0.003	0.781	0.0041
1-7/16	1.4375	+0.001 -0.003	0.875	0.0043
1-1/2	1.5000	+0.001 -0.003	0.875	0.0045
1-9/16	1.5625	+0.001 -0.007	0.875	0.0047
1-5/8	1.6250	+0.001 -0.007	1.000	0.0049
1-11/16	1.6875	+0.001 -0.007	1.000	0.0050
1-3/4	1.7500	+0.001 -0.007	1.093	0.0052

3.7.2 Test Plug:

3.7.2.1 Type I, Class 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 the mandrel to a maximum depth in accordance with Table 1. A stop may be set at the outer end of the test plug to prevent slippage of the socket end-wise from the mandrel.

SAE AS954 Revision E

3.7.2.2 Type I, Class 2 Universal Sockets: A test plug as in 3.7.2.1 shall be used except that a means shall be provided to keep universal socket parts in the axis about which the load is applied.

3.7.3 Qualification Test:

3.7.3.1 All Type I Sockets, Type II Wrenches, Type III Torque Adaptors: As a design and process qualification test the manufacturer shall maintain a record of compliance with the cyclic load requirement of Figures 2, 3, 4, 5, 6, 7, 8, and 9 as applicable, of a sample tool. The test shall be required whenever the design or method of manufacture is significantly changed.

The cyclic load test shall consist of 2000 applications of the cyclic load torque applied in one direction at the rate of 15 to 240 cpm, maximum, using the mandrels of Table 1 as specified in 3.7.1. The tool shall be indexed 30° after 1000 load applications and shall withstand the torque proof load following the cyclic load test.

3.7.3.2 Fragmentation Test: One sample of each tool of Type I and Type III shall be loaded to failure. Failure shall not result in fragmentation into two or more pieces. The tool shall be considered to have passed the fragmentation test if it:

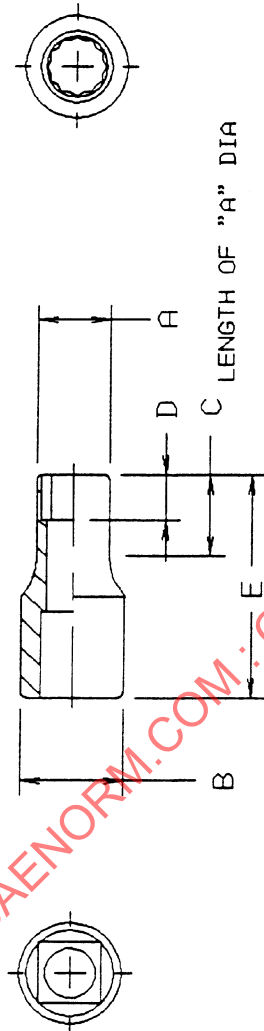
- a. Fails without fragmentation at any torque above the proof load
- b. Reaches the following maximum torque levels without failure
 - (1) 1/4 in square drive tools - 800 in-lb
 - (2) 3/8 in square drive tools - 3000 in-lb
 - (3) 1/2 in square drive tools - 7800 in-lb
 - (4) 3/4 in square drive tools - 21 600 in-lb

3.8 Wrench Opening:

3.8.1 Wrench Design: The internal wrench design of all Type I Sockets, Type II Wrenches, and Type III Torque Adaptors shall be so configured that, when mated with 12-point fasteners conforming to the requirements of AS870, they transmit torque to the fastener without bearing on the outer 5% of the fastener's wrenching points (see Figure 10).

3.8.2 Qualification Test Procedure for Wrench Design: Conformance of the wrench design to the requirements of 3.8.1 shall be demonstrated on a sample tool by the use of a mandrel or a template. The mandrel or template shall conform with the requirements of Figure 11.

3.8.2.1 The mandrel shall be of a nonferrous or ferrous material. When nonferrous material is used, torque shall be applied by the wrench to the mandrel to a level sufficient to cause an impression on the mandrel indicative of the loading pattern between the wrench and mandrel. When ferrous material is used, bluing shall be applied to the flats of the mandrel prior to the application of torque by the wrench to the mandrel to a level sufficient for the bluing to show the loading pattern. Care should be taken so that the true loading pattern can be discerned. The loading pattern shall not be on the corners of the mandrel.

BOLT CLEARANCE HOLE
PER FIGURE 12

Nominal Wrench Opening	A Dia. Max.	B Dia. Max.	D Depth Min.	Style A Regular Length C		Style B Long Length E		Torque Requirements	
				Min.	Max.	Min.	Max.	Cyclic Load (in-lb)	Proof Load (in-lb)
3/16	0.315	0.440	0.175	0.175	1.270	0.175	1.930	140	200
7/32	0.343	0.440	0.190	0.190	1.270	0.190	1.930	150	225
1/4	0.380	0.440	0.205	0.205	1.270	0.205	1.930	210	300
9/32	0.430	0.440	0.215	0.215	1.270	0.215	1.930	260	375
5/16	0.470	0.470	0.250	-----	1.270	-----	1.930	310	450
11/32	0.500	0.500	0.265	-----	1.270	-----	1.930	360	525
3/8	0.550	0.550	0.265	-----	1.270	-----	1.930	420	600
7/16	0.625	0.625	0.345	-----	1.270	-----	1.930	420	600
1/2	0.687	0.687	0.350	-----	1.270	-----	1.930	420	600
9/16	0.750	0.750	0.355	-----	1.270	-----	1.930	420	600

FIGURE 2 - Type I, Class 1 Socket Dimensions (Dimensions in Inches)
1/4 Square Drive

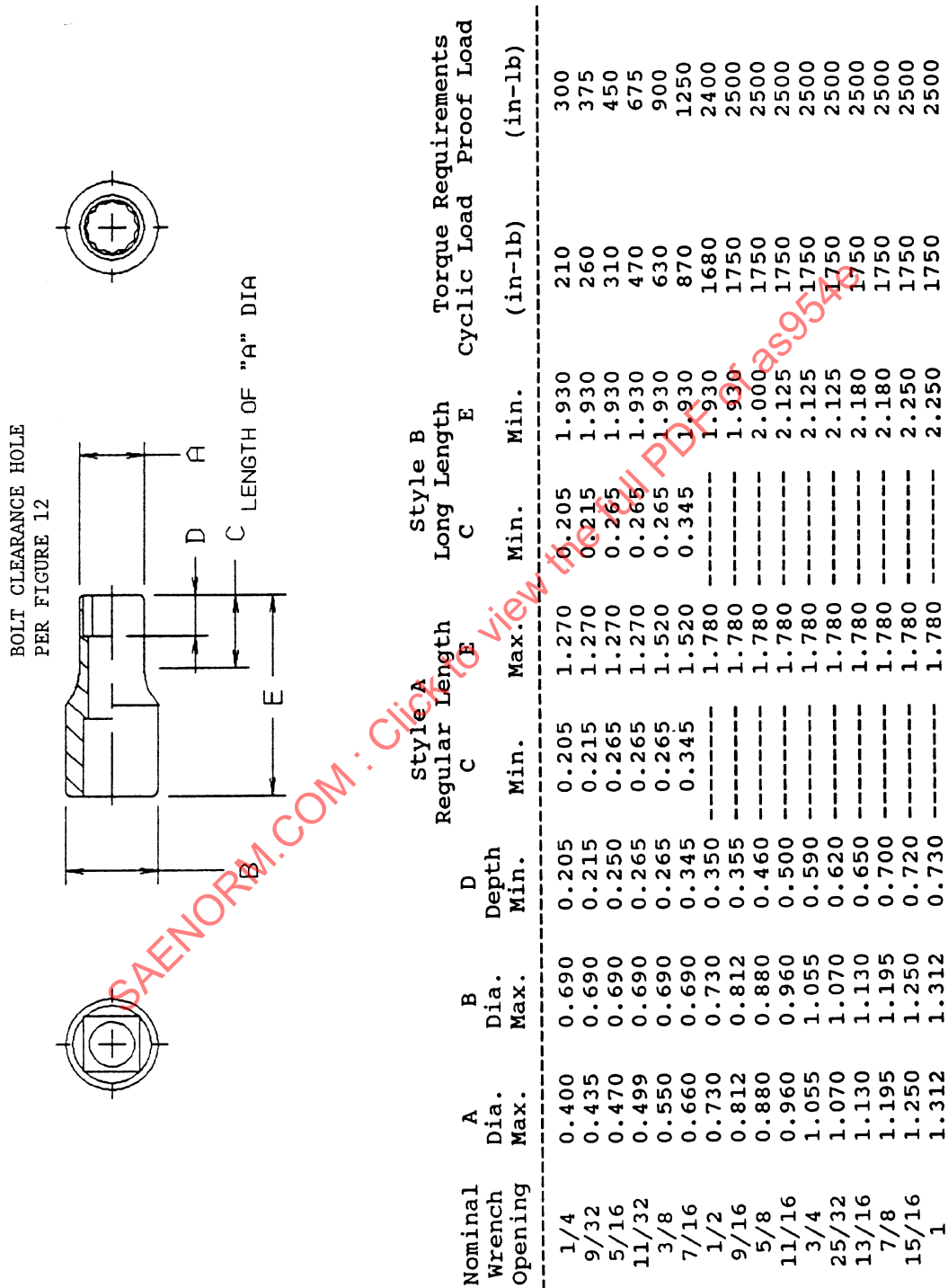
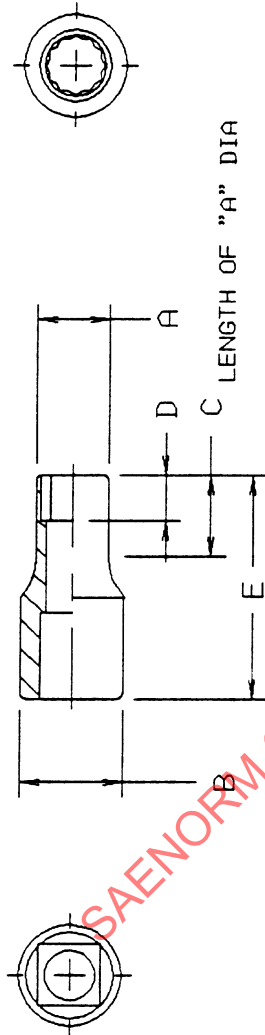
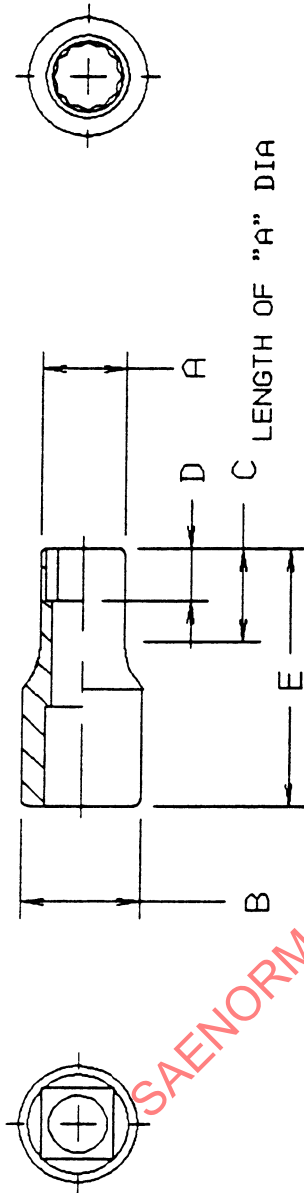


FIGURE 3 - Type I, Class 1 Socket Dimensions (Dimensions in Inches)
3/8 Square Drive

BOLT CLEARANCE HOLE
PER FIGURE 12

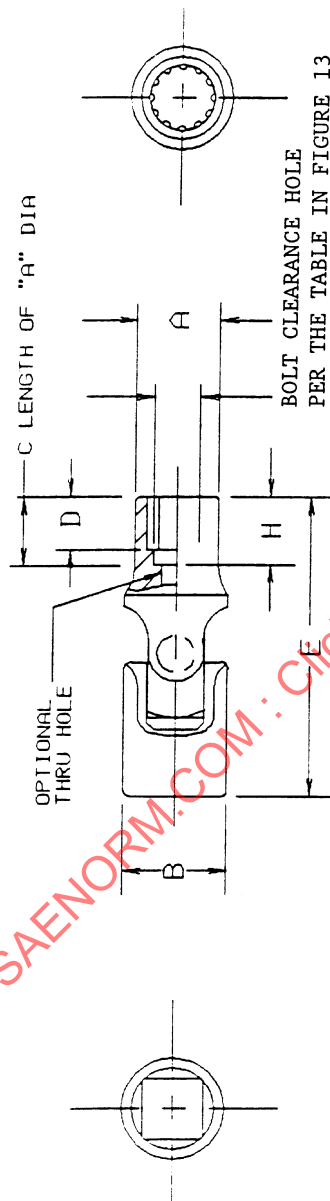
Nominal Wrench Opening	A Dia. Max.	B Dia. Max.	D Depth Min.	Style A		Style B		Torque Requirements	
				Regular Length C	Max. Length E	Long Length C	Min. Length E	Cyclic Load (in-lb)	Proof Load (in-lb)
3/8	0.580	0.880	0.265	0.265	1.780	0.265	2.930	840	1200
7/16	0.680	0.940	0.345	0.345	1.780	0.345	2.930	1190	1700
1/2	0.740	0.940	0.350	0.350	1.780	0.350	2.930	1680	2400
9/16	0.818	0.940	0.355	0.355	1.780	0.355	2.930	2520	3600
5/8	0.892	0.940	0.460	0.460	1.780	0.460	2.930	2800	4000
11/16	0.960	0.960	0.500	-----	1.780	-----	2.930	3850	5500
3/4	1.055	1.055	0.590	-----	1.780	-----	2.930	4200	6000
25/32	1.070	1.070	0.620	-----	1.780	-----	2.930	4200	6000
13/16	1.130	1.130	0.650	-----	1.780	-----	2.930	4200	6000
7/8	1.200	1.200	0.700	-----	1.780	-----	2.930	4200	6000
15/16	1.300	1.300	0.720	-----	1.850	-----	2.930	4200	6000
1	1.370	1.370	0.730	-----	1.900	-----	2.930	4200	6000
1-1/16	1.440	1.440	0.750	-----	1.950	-----	2.930	4200	6000
1-1/8	1.510	1.510	0.780	-----	2.000	-----	2.930	4200	6000
1-3/16	1.550	1.550	0.790	-----	2.030	-----	2.930	4200	6000
1-1/4	1.580	1.580	0.810	-----	2.050	-----	2.930	4200	6000
1-5/16	1.650	1.650	0.840	-----	2.070	-----	2.930	4200	6000

FIGURE 4 - Type I, Class 1 Socket Dimensions (Dimensions in Inches)
1/2 Square Drive

BOLT CLEARANCE HOLE
PER FIGURE 12

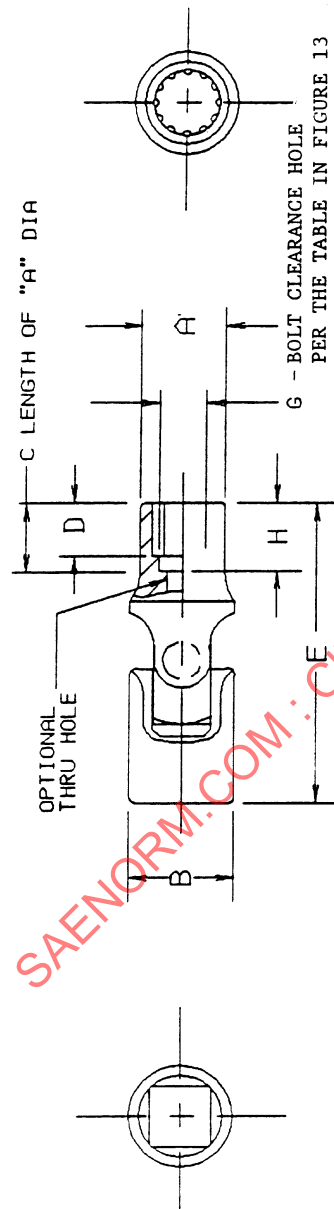
NOMINAL WRENCH OPENING	A		B		D		C		E		TORQUE REQUIREMENTS	
	DIA		DIA		DEPTH		REGULAR LENGTH		LENGTH OF "A" DIA		CYCLIC LOAD	PROOF LOAD
	MAX.	MIN.	MAX.	MIN.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	(IN. LB.)	(IN. LB.)
3/4	1.200	0.590	1.500	0.590	0.737	2.300	0.737	2.300			7350	10500
13/16	1.295	0.650	1.500	0.650	0.813	2.300	0.813	2.300			7700	11000
7/8	1.340	0.700	1.500	0.700	0.875	2.300	0.875	2.300			10500	15000
15/16	1.420	0.720	1.500	0.720	0.900	2.300	0.900	2.300			11900	17000
1	1.510	0.730	1.575	0.730	0.938	2.300	0.938	2.300			12600	18000
1-1/16	1.575	0.750	1.575	0.750	-----	2.300	-----	2.300			12600	18000
1-1/8	1.635	0.780	1.635	0.780	-----	2.300	-----	2.300			12600	18000
1-3/16	1.700	0.790	1.700	0.790	-----	2.300	-----	2.300			12600	18000
1-1/4	1.825	0.810	1.825	0.810	-----	2.300	-----	2.300			12600	18000
1-5/16	1.920	0.840	1.920	0.840	-----	2.700	-----	2.700			12600	18000
1-3/8	1.980	0.900	1.980	0.900	-----	2.700	-----	2.700			12600	18000
1-7/16	2.075	0.950	2.075	0.950	-----	2.700	-----	2.700			12600	18000
1-1/2	2.135	1.000	2.135	1.000	-----	2.700	-----	2.700			12600	18000
1-9/16	2.200	1.050	2.200	1.050	-----	2.700	-----	2.700			12600	18000
1-5/8	2.270	1.100	2.270	1.100	-----	2.700	-----	2.700			12600	18000
1-11/16	2.400	1.150	2.400	1.150	-----	3.200	-----	3.200			12600	18000
1-3/4	2.510	1.200	2.510	1.200	-----	3.200	-----	3.200			12600	18000

FIGURE 5 - Type I, Class 1 Socket Dimensions (Dimensions in Inches)
3/4 Square Drive



Nominal Wrench Opening	Outer Diameter		Drive End		Min. C	Depth Opening		Bolt Clearance Length		Overall length		Cyclic Torque Load		Proof Torque Load	
	Max. A	Min. A	Max. B	Min. B		Min. D	Max. D	Min. H	Max. H	Max. E	Min. E	(in-lb.) Min.	(in-lb.) Min.	(in-lb.) Min.	(in-lb.) Min.
1/4	0.385	0.385	0.515	0.515	0.205	0.205	0.205	0.330	0.330	1.312	1.312	210	210	300	300
5/16	0.470	0.470	0.515	0.515	0.250	0.250	0.250	0.408	0.408	1.437	1.437	310	310	450	450
3/8	0.540	0.540	0.540	0.540	0.265	0.265	0.265	0.437	0.437	1.500	1.500	350	350	500	500
7/16	0.625	0.625	0.540	0.540	0.345	0.345	0.345	0.545	0.545	1.625	1.625	350	350	500	500
1/2	0.687	0.687	0.540	0.540	0.350	0.350	0.350	0.560	0.560	1.688	1.688	350	350	500	500

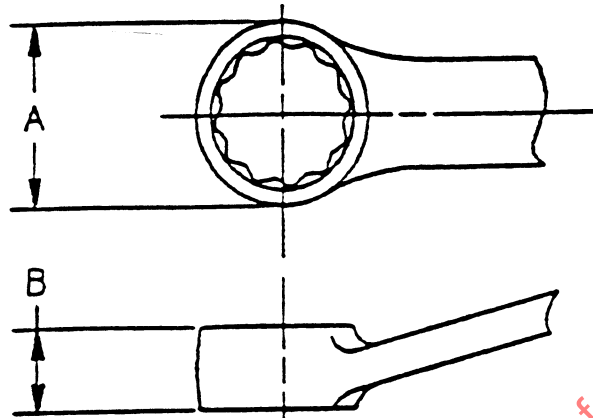
FIGURE 6 - Type I, Class 2 Universal Socket Dimensions (Dimensions in Inches)
1/4 Square Drive



Nominal Wrench Opening	Outer Diameter		Drive End		Min.		Depth		Bolt		Overall		Cyclic		Proof	
	Nut Max. A	End Max. B	Max. C	Min. D	Min. E	Min. F	Min. G	Min. H	Min. I	Min. J	Max. K	Min. L	Min. M	Min. N	Min. O	Min. P
3/8	0.550	0.750	0.265	0.265	0.265	0.265	0.265	0.465	2.000	630	900					
7/16	0.660	0.750	0.345	0.345	0.345	0.345	0.345	0.545	2.125	700	1000					
1/2	0.730	0.750	0.350	0.350	0.350	0.350	0.350	0.550	2.187	700	1000					
9/16	0.812	0.785	0.355	0.355	0.355	0.355	0.355	0.555	2.250	700	1000					
5/8	0.880	0.785	0.460	0.460	0.460	0.460	0.460	0.660	2.250	700	1000					
11/16	0.960	0.785	0.500	0.500	0.500	0.500	0.500	0.720	2.250	700	1000					
3/4	1.055	0.785	0.590	0.590	0.590	0.590	0.590	0.810	2.312	700	1000					

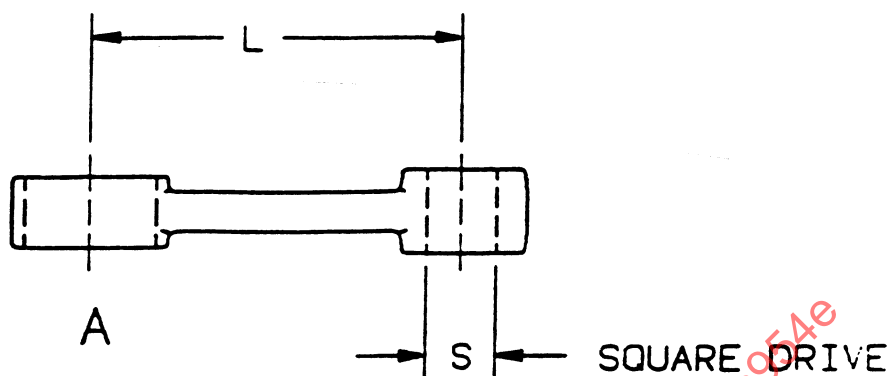
FIGURE 7 - Type I, Class 2 Universal Socket Dimensions (Dimensions in Inches)
3/8 Square Drive

SAE AS954 Revision E



Nominal Wrench Opening	Type II Class 1, 2, 3 Type III		Type II Class 4		Torque Requirements		Torque Requirements	
	A	B	A	B	Type II, Classes 1 and 4	Type II, Classes 2 and 3	Type II, Classes 2 and 3	Type II, Classes 2 and 3
	Max.	Max.	Max.	Max.	Cyclic Load (in lb)	Proof Load (in lb)	Cyclic Load (in lb)	Proof Load (in lb)
3/16	0.345	0.230	0.345	0.230	110	165	110	165
7/32	0.375	0.250	0.375	0.250	120	180	110	165
1/4	0.425	0.250	0.435	0.250	150	220	150	220
9/32	0.445	0.250	0.460	0.250	170	250	170	248
5/16	0.495	0.287	0.560	0.287	190	275	190	275
11/32	0.535	0.300	0.590	0.300	210	300	190	275
3/8	0.578	0.327	0.615	0.327	420	605	420	605
7/16	0.660	0.349	0.710	0.349	520	750	500	715
1/2	0.750	0.386	0.802	0.386	840	1200	710	1020
9/16	0.830	0.428	0.895	0.406	1150	1650	1050	1500
5/8	0.920	0.478	0.986	0.478	1540	2200	1540	2200
11/16	1.010	0.498	1.060	0.498	1840	2640	1840	2640
3/4	1.090	0.538	1.130	0.538	2100	3000	2000	2860
25/32	1.135	0.550	1.180	0.550	2200	3150	2160	3080
13/16	1.180	0.562	1.230	0.562	2310	3300	2310	3300
7/8	1.270	0.594	1.340	0.594	2590	3700	2540	3630
15/16	1.360	0.615	1.420	0.615	3220	4600	3160	4510
1	1.450	0.630	1.530	0.640	3850	5500	3770	5390
1-1/16	1.530	0.660	1.640	0.720	4200	6000	4160	5940
1-1/8	1.610	0.690	1.720	0.780	4620	6600	4540	6490
1-3/16	1.690	0.720	1.790	0.800	5110	7300	4540	6490
1-1/4	1.780	0.750	1.900	0.840	5600	8000	-----	-----
1-5/16	1.860	0.780	-----	-----	6300	9000	-----	-----
1-3/8	1.940	0.810	-----	-----	6650	9500	-----	-----
1-7/16	2.020	0.840	-----	-----	6820	9750	-----	-----
1-1/2	2.110	0.870	-----	-----	8400	12000	-----	-----

FIGURE 8 - Type II Box Wrench and Type III Torque Adaptor Data
(Dimensions in Inches)



NOMINAL WRENCH OPENING A	NOMINAL SQUARE DRIVE S	CENTER LENGTH $L \pm .040$	TORQUE REQUIREMENTS CYCLIC LOAD (IN-LB)	PROOF LOAD (IN-LB)
7/32	3/8	2.000	110	165
1/4	3/8	2.000	150	220
9/32	3/8	2.000	170	248
5/16	3/8	2.000	190	275
3/8	3/8	2.000	420	605
7/16	3/8	2.000	500	715
1/2	3/8	2.000	710	1020
9/16	3/8	2.000	1050	1500
5/8	3/8	2.000	1400	2000
11/16	3/8	2.000	1400	2000
3/4	3/8	2.000	1400	2000
9/16	1/2	3.000	1050	1500
5/8	1/2	3.000	1540	2200
11/16	1/2	3.000	1840	2640
3/4	1/2	3.000	2000	2860
13/16	1/2	3.000	2310	3300
7/8	1/2	3.000	2540	3630

FIGURE 9 - Type III, Torque Adaptor (Dimensions in Inches)

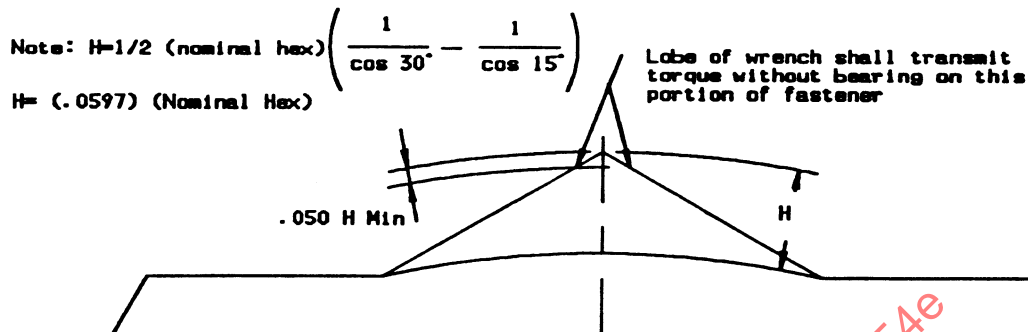


FIGURE 10 - Internal Wrench Engagement

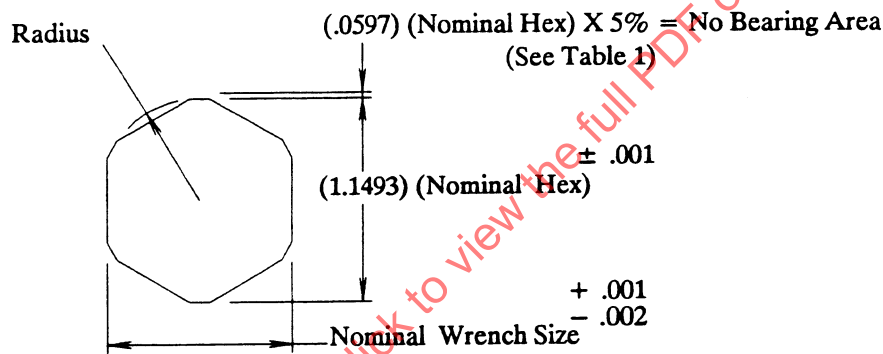


FIGURE 11 - Mandrel for Wrench Design Test Procedure

3.8.2.2 The template shall be used in conjunction with an optical comparator. The centerline of the wrench configuration shall be placed on the centerline of the template and rotated until a point of contact between the wrench configuration and the template is established. The point of contact shall not be on the corners of the template.

3.8.3 Bolt and Nut End Opening Tolerance: Wrench opening tolerance shall be as specified in ANSI B107.17M. The bolt clearance hole shall not infringe on the internal wrench design or alter its shape for the minimum depth of the wrench opening "D" in the appropriate figure.

3.9 Type I, Class 1 Sockets:

The sockets shall conform to the requirements of 3.4, Figures 2, 3, 4, and 5, and the following:

3.9.1 Clearance Holes:

3.9.1.1 Through Hole Clearance: A through clearance hole with a minimum diameter of 1/2 the nominal square drive size, or equal to the bolt clearance diameter, shall extend completely through each socket.

- 3.9.1.2 Bolt Clearance Hole: The bolt clearance hole shall be in accordance with the diameter, length and location defined in Figures 12 and 13. The bolt clearance hole shall be measured using the gage in Figure 14. A "web" within the bolt clearance hole is acceptable provided all dimensional requirements are met.

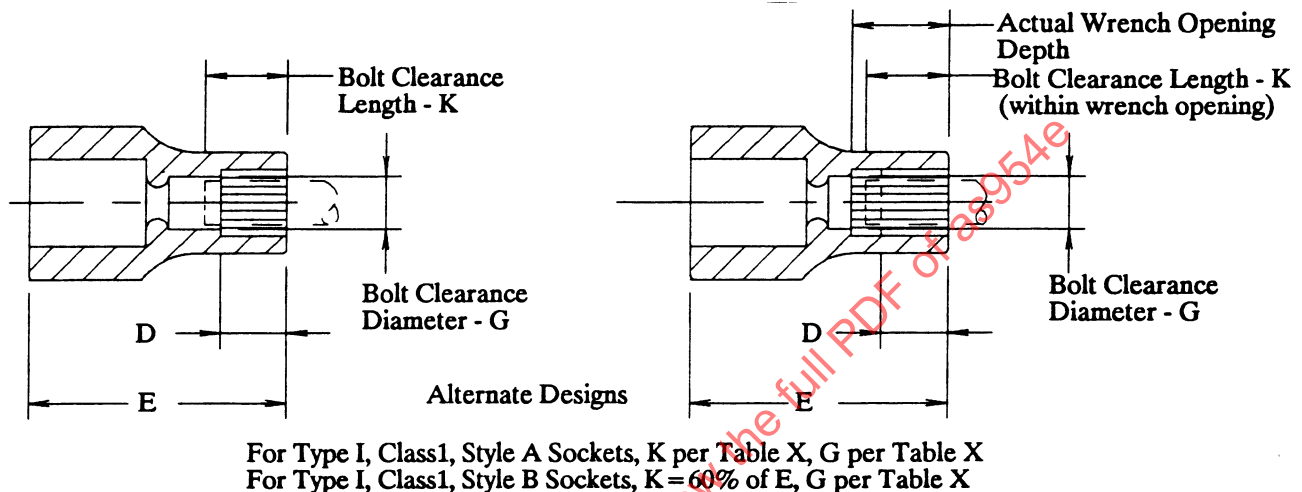


FIGURE 12 Bolt Clearance Hole

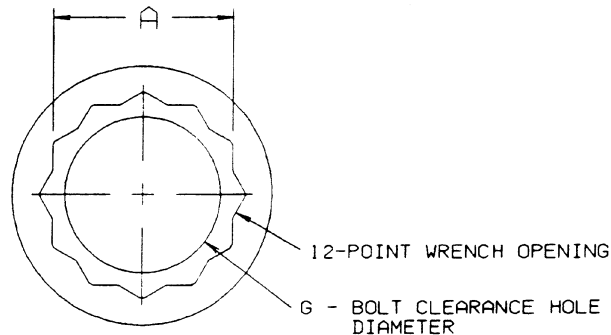
3.10 Type I, Class 2, Universal Sockets:

In addition to the requirements of 3.4, universal 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. The hinge pin shall be solid and not extend beyond the periphery of the universal joint. The universal joint shall be capable of rotation in a complete arc when the angular deviation of either end member from the common centerline is 40°. A bolt clearance hole and other universal socket dimensions shall conform to Figures 6 and 7. A "web" within the bolt clearance hole is acceptable provided all dimensional requirements are met.

3.11 Type II Wrenches, Type III Torque Adaptors:

- 3.11.1 Type II, Class 1 Box Wrench, Angled End: The angled end box wrenches shall be 12-point, double hexagon double-head design, shall possess the wrenching design of 3.8.1 and shall conform to Figures 8 and 15.
- 3.11.2 Type II, Class 2, Style A & B Box Wrench, Modified Offset: The modified offset box wrenches shall be 12-point, double hexagon double-head design, shall possess the wrenching design of 3.8.1 and shall conform to Figures 8 and 16.

SAE AS954 Revision E



NOMINAL WRENCH OPENING	A	G BOLT CLEARANCE DIAMETER MIN.	K BOLT CLEARANCE LENGTH MIN.
3/16	0.1875	0.157	0.342
7/32	0.2188	0.190	0.357
1/4	0.2500	0.190	0.393
9/32	0.2812	0.250	0.429
5/16	0.3125	0.250	0.464
11/32	0.3438	0.313	0.515
3/8	0.3750	0.313	0.515
7/16	0.4375	0.375	0.595
1/2	0.5000	0.438	0.650
9/16	0.5625	0.500	0.655
5/8	0.6250	0.563	0.760
11/16	0.6875	0.625	0.833
3/4	0.7500	0.688	0.965
25/32	0.7813	0.688	0.995
13/16	0.8125	0.688	1.025
7/8	0.8750	0.750	1.129
15/16	0.9375	0.813	1.179
1	1.0000	0.875	1.230
1-1/16	1.0625	0.938	1.250
1-1/8	1.1250	1.000	1.280
1-3/16	1.1875	1.063	1.290
1-1/4	1.2500	1.063	1.310
1-5/16	1.3125	1.125	1.340
1-3/8	1.3750	1.188	1.400
1-7/16	1.4375	1.250	1.450
1-1/2	1.5000	1.313	1.500
1-9/16	1.5625	1.375	1.550
1-5/8	1.6250	1.438	1.600
1-11/16	1.6875	1.500	1.650
1-3/4	1.7500	1.563	1.700

FIGURE 13 - Bolt Clearance Hole Requirements Per Figure 12
(Dimensions in Inches)