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METRIC
FED-STD-H28/21B
28 November 1984
SUPERSEDING
FED-STD-H28/21A
December 29, 1980

FEDERAL STANDARD

SCREW-THREAD STANDARDS FOR FEDERAL SERVICES

SECTION 21

METRIC SCREW-THREADS

This standard was approved by the Assistant Administrator, Office of Federal Supply and Services, General Services Administration, for the use of all Federal Agencies.

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All users of Federal Standards should keep them up to date by inserting revised or new pages as issued and removing superseded and canceled pages.

New and revised pages will be issued under Change Notices which will be numbered consecutively and will bear the date of issuance. Change Notices should be retained and filed in front of the Standard until such time as they are superseded by a reissue of the entire Standard.

FOREWARD

This section was developed to provide Metric Screw-Thread Standards for the Federal Services. It formalizes the Interim Federal Standard FED-STD-00H28/21(DLA-IS) dated 31 May 1977, which was prepared by the Interdepartmental Screw Thread Committee (ISTC) prior to its termination in November 1976. Responsibility for the standard was then transferred to the General Services Administration (GSA).

FED-STD-H28/21A was prepared by the Defense Industrial Supply Center (DLA-IS) and incorporated American National Standards on metric M & MJ profile screw-threads, ANSI B1.13M-1979 and ANSI B1.21M-1978, which are, in part, based upon the superseded Interim Federal Standard.

FED-STD-H28/21B is an updated version of FED-STD-H28/21A. In it, the requirements of ANSI/ASME B1.13M-1983 replace those of ANSI B1.13M-1979. Significant changes include the following: (1) inclusion of requirement for gages and gaging in accordance with FED-STD-H28/22; (2) addition of the new ISO "f" allowance; and (3) addition of lead and flank angle tolerances. Where practical, the contents of this standard are in accordance with International Organization for Standardization (ISO) practices.

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Section 21 - Metric Screw-Threads

1. Scope. The metric screw thread standards described herein constitute the basic standards to be used by the Federal Services. This document contains general standards for 60°, symmetrical threads - the M profile and the MJ profile.

1.1 Limitations. Screw threads covered in this section are only for sizes of 1.6 mm and larger. For smaller sizes, use miniature threads in accordance with FED-STD-H28/5.

1.2 Application.

1.2.1 M Profile Screw Threads. The M profile is intended for general purpose metric screw thread applications. With the standard tolerance class 6H/6g it is to be used for metric applications where inch class 2A/2B has been used.

1.2.2 MJ Profile Screw Threads. The MJ profile is to be used for metric applications where inch class 3A/3B and UNJ threads have been used. It is recommended for screw thread applications requiring the most efficient use of material (maximum loads with minimum material), fatigue life and stress levels commensurate with the physical size and weight of the product.

NOTE: The MJ profile provides a mandatory-controlled rounded root, for external thread, with an increased minor diameter. The rounded roots greatly reduce the concentration of stress, hence increase the fatigue life of the part. External threads produced by rolling after heat treatment and with rounded roots more than double part fatigue life. Its large core diameter improves the static tensile strength.

2. Referenced documents.

2.1 Government publications. The issues of the following documents in effect on the date of invitation for bids or request for proposal form a part of this standard to the extent specified herein.

Federal standards.

FED-STD-H28/1	Nomenclature, Definitions and Letter Symbols for Screw Threads
FED-STD-H28/20	Inspection Methods for Acceptability of UN, UNR, UNJ, M and MJ Screw-Threads
FED-STD-H28/22	Metric Screw-Thread Gages

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(Activities outside the Federal Government may obtain copies of Federal specifications and standards as stated in the Index of Federal Specifications, Standards and Commercial Item Descriptions. The Index, including cumulative supplements issued during the year, is sold on subscription by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402.

(Single copies of Federal specifications and standards required for bidding purposes are available from the General Services Administration Business Service Centers in Boston, MA; New York, NY; Atlanta, GA; Chicago, IL; Kansas City, MO; Fort Worth, TX; Denver, CO; San Francisco, CA; Los Angeles, CA; and Seattle, WA, or from the General Services Administration, Specifications Unit (WFSIS), 7th and D Streets, S.W., Washington, DC 20407.

(Federal Government activities may obtain copies of Federal specifications and standards from established distribution points in their agencies.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

American National Standards

ANSI/ASME B1.13M-1983 - Metric Screw Threads - M Profile
ANSI B1.21M-1978 - Metric Screw Threads - MJ Profile
ANSI B46.1 - Surface Texture - Surface Roughness, Waviness and Lay

(Application for copies should be addressed to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017 or the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

3. Definitions. Applicable definitions are included in FED-STD-H28/1 with specially tailored terms in accordance with ANSI/ASME B1.13M-1983, section 2.

4. General requirements.

4.1 Screw threads. M profile screw threads shall be in accordance with ANSI/ASME B1.13M-1983 and this Federal Standard. MJ profile screw threads shall be in accordance with ANSI B1.21M-1978 and this Federal Standard.

4.2 Acceptability. Screw thread inspection methods for acceptability shall be in accordance with FED-STD-H28/20. The required gaging system shall be specified in accordance with that standard.

4.3 Gages and gaging. Gages and gaging shall be in accordance with FED-STD-H28/22.

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4.4 Surface texture.

4.4.1 The threads shall have a smooth finish and be free from flaws and other defects, such as fins, nicks and burrs, that would make them unsuitable for the purpose intended.

4.4.2 Workmanship shall be consistent with the tolerances specified herein. Surface texture of threads produced to this standard shall not exceed 2.5 um arithmetical average roughness (R_a) for cut threads and 1.6um (R_a) for rolled and ground threads in accordance with ANSI B46.1.

NOTE: Coarse and fine pitch threads with rough surface texture are more likely to cross-thread. Threads with chamfered entering ends have the least tendency to cross-thread when assembled with power tools.

4.5 Chamfer. All entering ends of fasteners and threaded components shall have 45° chamfers (approximately) from minor diameter of external threads and major diameter of internal threads, unless otherwise specified.

4.6 Rolled threads.

4.6.1 Completely formed threads. A completely formed thread follows the thread profile, within the tolerance zone over an axial distance of one pitch. See figure 21.1.

4.6.2 Incomplete formed threads.

4.6.2.1 The lead-in thread is measured from the end of the product to the start of the first complete thread where the major diameter is equal to the minimum allowable major diameter and the thread root is equal to the maximum minor diameter. This should not exceed 2P. See figure 21.2.

4.6.2.2 The run-out thread is measured between the transition point of the product and the first thread root which is completely formed, where the minor diameter equals the maximum permissible minor diameter and the major diameter of the last fully formed thread equals the minimum permissibe major diameter. When root radius is specified, the last completely formed root at the minor diameter must meet the requirement. See figure 21.3 for full shank fastener, figure 21.4 for pitch diameter shank fastener, figure 21.5 for shoulder bolt, figure 21.6 for oversize diameter shank fastener and figures 21.7 and 21.8 for threaded to head fasteners.

5. Detailed requirements.

5.1 M profile screw threads.

5.1.1 Standard tolerance threads. Standard M profile screw threads shall be tolerance class 6g for external threads and 6H for internal threads. See 1.2.

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5.1.2 Size restrictions. Only the diameter/pitch combinations listed in tables 4 and 5 of ANSI/ASME B1.13M-1983 are applicable for the Federal Services unless prior approval has been granted by the procurement authority to deviate from them. Standard sizes listed in table 4 of ANSI/ASME B1.13M-1983 are preferred and should be the first choice as applicable.

5.1.3 Non-standard threads. Use of non-standard threads shall be approved by the procurement authority. Preferred special size threads shall be selected from table 6 of ANSI/ASME B1.13M-1983 and tolerance grade and position from sections 5.2 and 5.3 of ANSI/ASME B1.13M-1983. For special sizes and tolerance classes not included in detailed dimensional table, calculate using procedures stated in section 9 of ANSI/ASME B1.13M-1983.

The following examples illustrate the procedures necessary to calculate the limits of size of non-standard threads. All references to ANSI/ASME B1.13M-1983 are indicated by *.

Example 1: External thread, M27x1.5-4e6g
Basic sizes are listed in Appendix D*

Maximum major diameter = Basic size - es (table 8* for g allowance)
= 27.000 - 0.032
= 26.968

Minimum major diameter = Maximum major diameter - Td (table 11* for tolerance grade 6)
= 26.968 - 0.236
= 26.732

Maximum pitch diameter = Basic pitch diameter (Appendix D*) - es (table 8* for e allowance)
= 26.026 - 0.067
= 25.959

Minimum pitch diameter = Maximum pitch diameter - Td_2 (table 12* for tolerance grade 4)
= 25.959 - 0.095
= 25.864

Maximum flat form minor diameter = Basic minor diameter (Appendix D*) - es (table 8* for e allowance)
= 25.376 - 0.067
= 25.309

Example 2: Internal thread M27x1.5-6H
Basic sizes are listed in Appendix D*

Minimum major diameter = Basic size + EI (table 8* for H allowance)
= 27.000 + 0
= 27.000

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Minimum pitch diameter = Basic pitch diameter (Appendix D*) + EI (table 8* for H allowance)
= 26.026 + 0
= 26.026

Maximum pitch diameter = Minimum pitch diameter + TD_2 (table 13* for tolerance grade 6)
= 26.026 + 0.200
= 26.226

Minimum minor diameter = Basic minor diameter (Appendix D*) + EI (table 8* for H allowance)
= 25.376 + 0
= 25.376

Maximum minor diameter = Minimum minor diameter + TD_1 (table 10* for tolerance grade 6)
= 25.376 + 0.300
= 25.676

Example 3: External thread, M29x1.25-4g6h
Basic sizes are not listed in Appendix D*, so use formulas in section 9*.

Maximum major diameter = Basic size - es (table 8* for h allowance)
= 29.000 - 0
= 29.000

Minimum major diameter = Maximum major diameter - Td (table 11* for tolerance grade 6)
= 29.000 - 0.212
= 28.788

Maximum pitch diameter = Basic major diameter - 0.649519P (table 3*) -es (table 8* for g allowance)
= 29.000 - 0.81190 - 0.028
= 28.16010 which is rounded to 28.160

Minimum pitch diameter = Maximum pitch diameter - Td_2 (table 12* for tolerance grade 4)

NOTE: Since table 12* does not include P=1.25 for a 29 mm size, calculate in accordance with paragraph 6.6.1* as follows:

$$Td_2(4) = 0.63\ Td_2(6)$$

$$= 0.63 \times 0.09 P^{0.4} d_{bsc}^{0.1}$$

$$= 0.63 \times 0.09 \times 1.25^{0.4} \times 29^{0.1}$$

$$= 0.08681$$

So minimum pitch diameter is equal to 28.16010 - 0.08681 which is equal to 27,61883 and rounded to 27.619

ace (Include proposed rewrite, if possible. Attach extra sheets as needed.) 1. NATURE OF CHANGE (Identify paragraph number

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Maximum flat form minor diameter = maximum pitch diameter - 0.433013P (table 3*)
= 28.16010 - 0.54127
= 27.61883 which is rounded to 27.619

5.1.4 Designation. Designation of M Profile screw threads is in accordance with section 7 of ANSI/ASME B1.13M-1983.

5.2 MJ profile screw threads.

5.2.1 Standard tolerance threads. MJ profile screw threads shall be tolerance class 4h6h for external threads. Tolerance class for internal threads shall be 4H6H for sizes 1.6 through 5 mm and 4H5H for sizes 5.5 mm and larger. See 1.2.

5.2.2 Size restrictions. Only the diameter/pitch combinations listed in tables XXI.1 and XXI.2 are applicable for the Federal Services unless prior approval has been granted by the procurement authority to deviate from them. Standard sizes listed in table XXI.1 are preferred and should be the first choice as applicable.

5.2.3 Non-standard threads. Use of non-standard threads shall be approved by the procurement authority. Preferred special size threads shall be in accordance with tabulated data in ANSI B1.21M-1978. For other special sizes and tolerance classes, calculate using tables and formulas, as applicable, in ANSI B1.21M-1978 and ANSI/ASME B1.13M-1983. The following examples illustrate the procedures necessary to calculate limits of size of threads with non-standard diameter-pitch combinations. All references to ANSI B1.21M-1978 are indicated by +.

Example 1: External thread, MJS 6.5x1-4h6h
Use formulas in 6.8.1+

Maximum major diameter = Basic size
= 6.500

Minimum major diameter = Maximum major diameter - Td(6) (table 7+)
= 6.500 - 0.180
= 6.320

Maximum pitch diameter = Maximum major diameter - 0.649519P (table 1+)
= 6.500 - 0.64952
= 5.85048 which is rounded to 5.850

Minimum pitch diameter = Maximum pitch diameter - $Td_2(4)$ (table 9+)
= 5.85048 - 0.071
= 5.77948 which is rounded to 5.779

Maximum rounded form minor diameter = Maximum pitch diameter - 0.505181P (table 1+)
= 5.85048 - 0.50518
= 5.34530 which is rounded to 5.345

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Mi..imum rounded form minor diameter = Minimum pitch diameter - 0.565805P (table 1+)
= 5.77948 - 0.56581
= 5.21367 which is rounded to 5.214

ot radius = 0.18042P (table 4+)
= 0.180

oot radius = 0.15011P (table 4+)
= 0.150

Example 2: Internal thread, MJS6.5x1-4H5H
Use formulas in 6.8.2+

m major diameter = Basic size
= 6.500

Mi imum pitch diameter = Minimum major diameter - 0.649519P (table 1+)
= 6.500 - 0.64952
= 5.85048 which is rounded to 5.850

Maximum pitch diameter = Minimum pitch diameter + $TD_2(4)$ (table 9+)
= 5.85048 + 0.095
= 5.94548 which is rounded to 5.945

Minimum minor diameter = Minimum major diameter - 0.974279P (table 1+)
= 6.500 - 0.97428
= 5.52572 which is rounded to 5.526

Maximum minor diameter = Minimum minor diameter + $TD_1(5)$ (table 8+)
= 5.52572 + 0.190
= 5.71572 which is rounded to 5.716

5.2.4. Designation. Designation of MJ Profile screw threads is in accordance with section 7 of ANSI B1.21M-1978.

MILITARY INTERESTS:

Custodians
Army - AR
Navy - AS
Air Force - 11

Review Activities
Army - AT, AV, GL, ME, MI
Navy - SH, YD

User Activities
Navy - OS

CIVIL AGENCY COORDINATING ACTIVITIES:

Commerce - NBS
DOT - ACO, APM, FAA, FRA, NHT
GSA - FSS, PCD
HUD - HCC
Justice - FPI
NASA - JFK, LRC, MSF
USDA - AFS

PREPARING ACTIVITY:
DLA-IS

(DoD Project THDS-0048)

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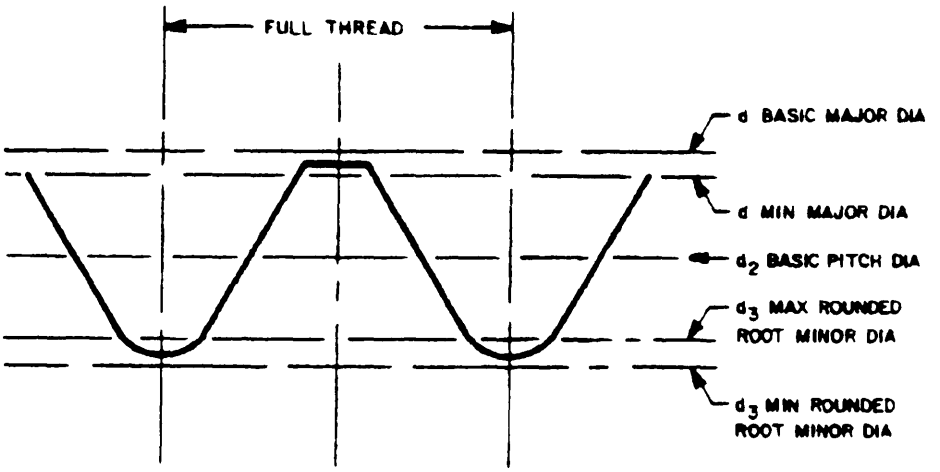

FIGURE 21.1 COMPLETELY FORMED EXTERNAL THREAD

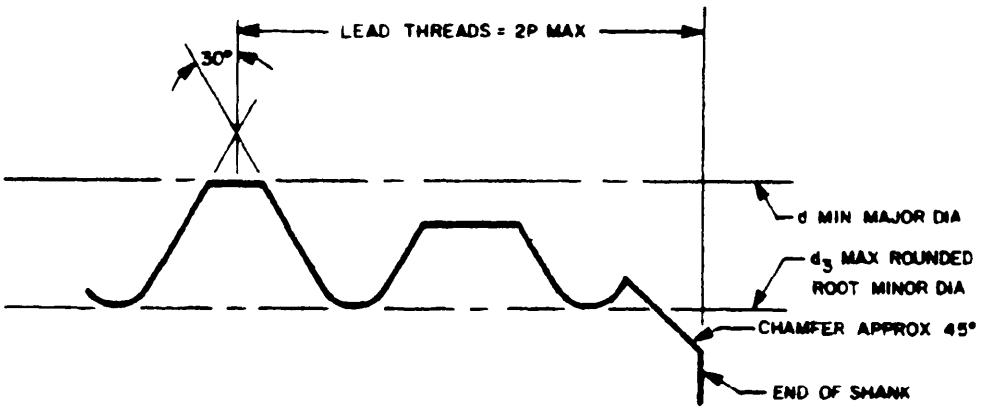

FIGURE 21.2 INCOMPLETE FORMED EXTERNAL THREADS, LEAD-IN THREADS

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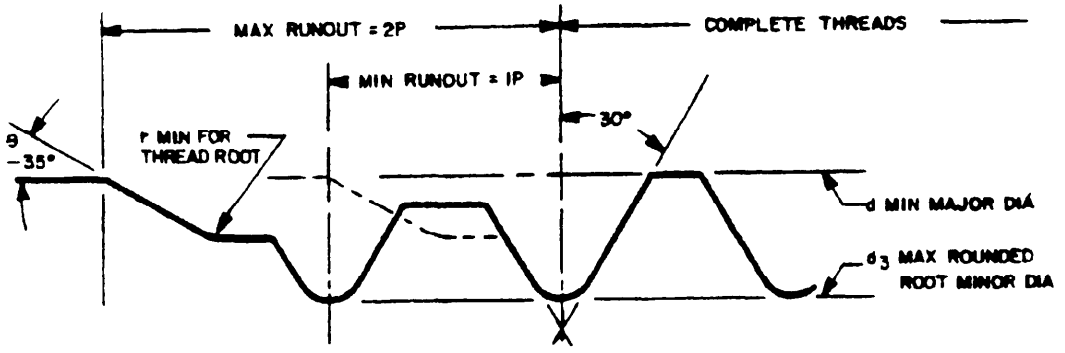

FIGURE 21.3 INCOMPLETE FORMED THREADS, FULL SHANK FASTENER-STANDARD DIAMETER

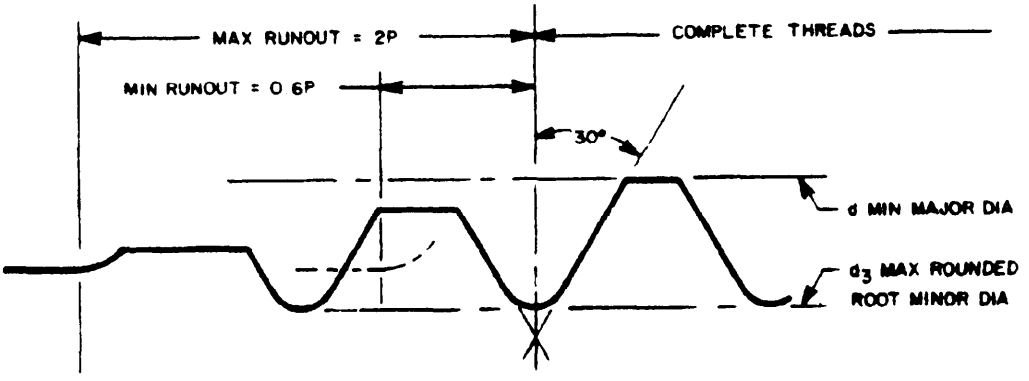

FIGURE 21.4 INCOMPLETE FORMED THREADS, PITCH DIAMETER SHANK FASTENER

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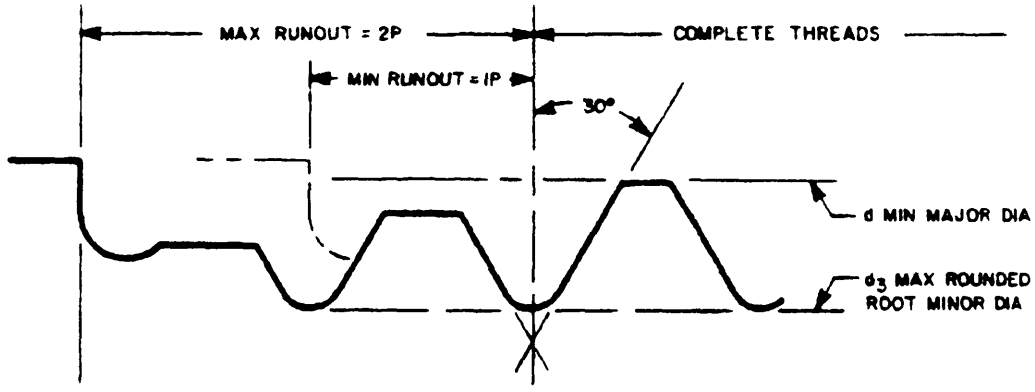

FIGURE 21.5 FULL SHANK FASTENER - STANDARD DIAMETER, OPTIONAL CONFIGURATION (SHOULDER BOLT)

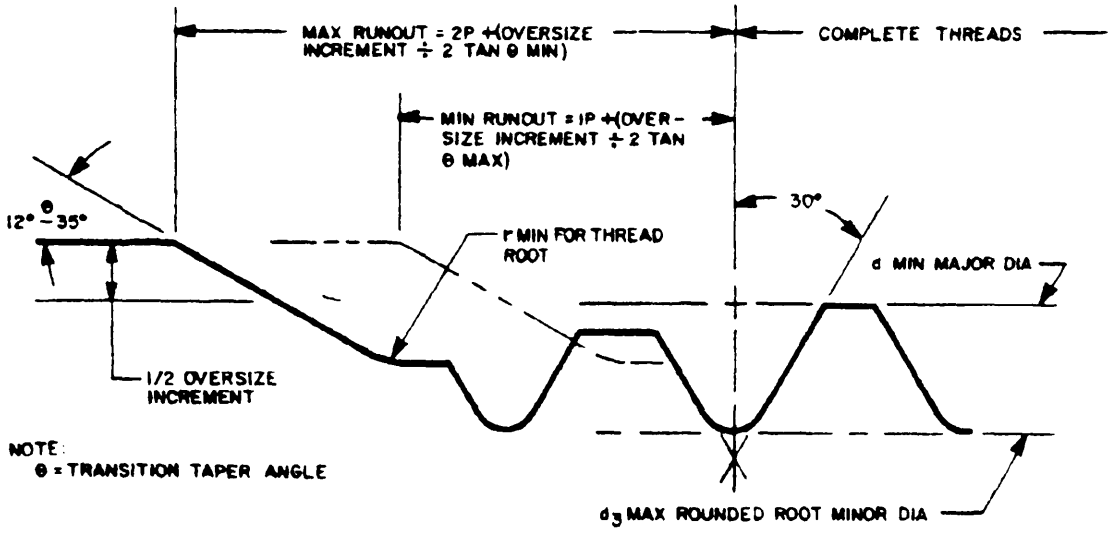

FIGURE 21.6 FULL SHANK FASTENER - OVERSIZE DIAMETER

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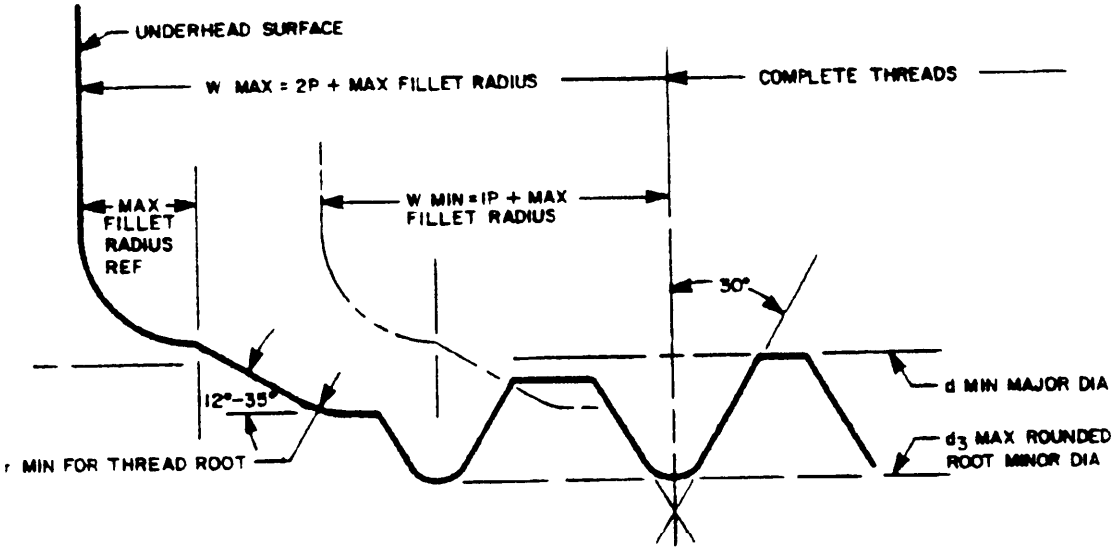

FIGURE 21.7 FULL SHANK FASTENER - THREADED TO HEAD

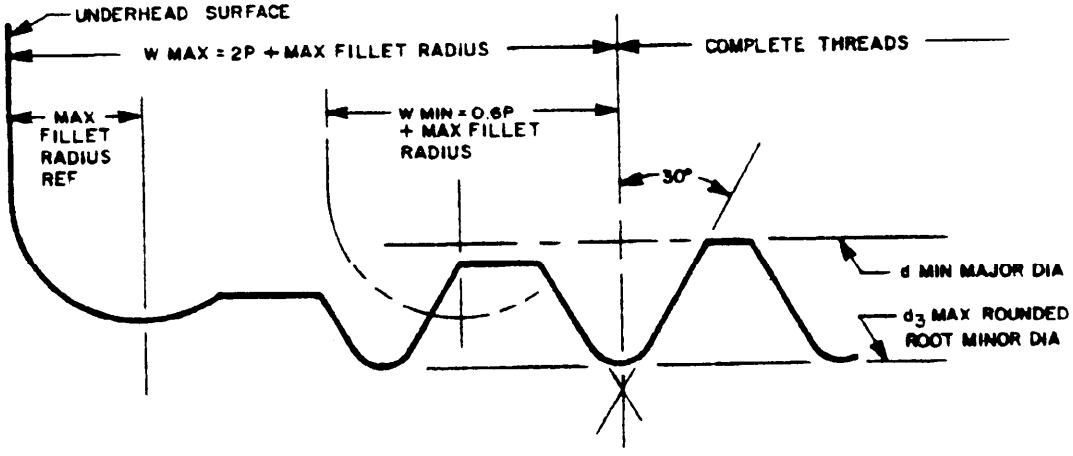

FIGURE 21.8 PITCH DIAMETER SHANK FASTENER - THREADED TO HEAD

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TABLE XXI.1 Standard MJ Profile Fastener Threads.

NOMINAL SIZE (mm)	PITCH (mm) COARSE	PITCH (mm) FINE	NOMINAL SIZE (mm)	PITCH (mm) COARSE	PITCH (mm) FINE
1.6	0.35		20	2.5	1.5
2	0.4		22		1.5
2.5	0.45		24	3	2
3	0.5		27		2
3.5	0.6		30	3.5	2
4	0.7		33		2
5	0.8		36	4	2
6	1		39		2
7	1(a)		42	4.5	2
8	1.25	1	48	5	2
10	1.5	1.25	56	5.5	2
12	1.75	1.25	64	6	2
14	2	1.5	72	6	2
16	2	1.5	80	6	2
18		1.5	90	6	2
			100	6	2

(a) For special Aerospace Applications only.

TABLE XXI.2 Standard MJ Profile Screw Threads.

NOMINAL SIZE (mm)	PITCH (mm) FINE	NOMINAL SIZE (mm)	PITCH (mm) FINE
10	0.75	70	1.5
11	1.25 (a)	75	1.5
12	1	80	1.5
15	1	85	2
17	1	95	2
20	1	105	2
25	1.5	110	2
30	1.5	120	2
35	1.5	130	2
40	1.5	140	2
45	1.5	150	2
50	1.5	160	3
55	1.5	170	3
60	1.5	180	3
65	1.5	190	3
		200	3

(a) Only for aircraft control cable fittings.