



AEROSPACE STANDARD

AS84**REV. D**

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Superseding AS84C

Splines, Involute (Full Fillet)

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature. This standard has been stabilized.

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1. SCOPE:

This SAE Aerospace Standard (AS) defines an involute with a 30° pressure angle and a full radius at the roots thus reducing the stress concentration in the area of the root.

2. REFERENCES:

2.1 SAE Publications:

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

ARP179 Involute Spline Gages (30° Pressure Angle)

3. FUNDAMENTAL PRINCIPLES:

- 3.1 This involute spline standard was adopted in 1942 for aircraft engine use, based on nearly 15 years of actual practice by one or more engine manufacturers.
- 3.2 It is a side bearing spline featuring a 30° pressure angle and a full radius at the roots of the teeth to decrease stress concentration at the root to a minimum. The primary object is to provide efficient, durable, and easily fabricated splines applicable to nearly all conditions where power transmitting splines are required in aircraft engines or similar high performance equipment.
- 3.3 This standard does not recommend specific classes or values of fits between internal and external splines, because these vary widely with the application and are usually selected according to the hardness of the materials, the loads to be transmitted, the assembly requirements, and other related factors.

4. PITCHES:

- 4.1 This standard incorporates a stubbed tooth form. The numerator or basic pitches are 14 in number, ranging from 2.5 to 48. The depth or denominator pitch being twice the basic pitch, ranges from 5 to 96. The table of basic tooth proportions covers from 8 to an indefinite number of teeth for pitches 2.5/5, 3/6, 4/8, 5/10, 6/12, 8/16, 10/20, 12/24, 16/32, 20/40, 24/48, 32/64, 40/80, and 48/96. The tables of dimensions cover from 8 to 50 teeth with pitch diameters from .1667 to 20.0000. To use a spline with less than 12 teeth, it is suggested that the tooth form be laid out to check for possible tooth interference or interferences with the mating member, and perhaps modifying the tooth to suit. For splines of more than 50 teeth, use the same tooth proportions as specified in the tables of dimensions, or as specified by formulas in Section 9 in conjunction with Table 1.

5. SPLINE TOOTH NOMENCLATURE:

- 5.1 Figure 1 shows a tooth diagram of splines in mesh. The various elements of the tooth are illustrated and defined.

6. METHOD OF DIMENSIONING SPLINES:

- 6.1 Figure 2 contains the required data to be incorporated on the engineering drawing with an illustration to clarify the dimensions. The dimensions and tolerances shall be taken from Tables 2 through 15 inclusive. The method of calculating the basic chordal space is indicated in Section 9.
- 6.2 The information given on the drawing will enable tool and production engineers to design tools, gages, and other equipment necessary for the manufacture of these splines.
- 6.3 Recommended cutter sizes for manufacturing splines are specified in Table 16. Involute spline gages are shown on ARP179.

7. BASIC TOOTH PROPORTIONS:

- 7.1 Table 1 specifies the basic tooth proportions. It is to be noted that the dedendum gives an amount of land clearance of the teeth which is considerably greater than on a gear of corresponding pitch. This is necessary in order to accommodate a full radius at the root of the teeth. The internal member does not require as much clearance as the external member; however, when the number of teeth of the internal becomes large enough to incorporate the same generating cutting tool as the external member, the depth of the internal tooth has been increased to equal that of the external, thereby eliminating one cutting tool. (See Note in Table 1.)
- 7.2 The true involute form diameter for the external spline is given as the maximum diameter and is the same as the basic (minimum) inside diameter of the internal spline. When an involute clearance is required, the true involute form diameter for the external spline must be decreased by twice the amount of the clearance. See Table 17 for this clearance.

- 7.3 The true involute form diameter for the internal spline is given as the minimum diameter and is the same as the basic (maximum) outside diameter of the external spline. When an involute clearance is required, the true involute form diameter for the internal spline must be increased by twice the amount of the clearance. See Table 17 for this clearance.
- 7.4 The fillet generated by a full radius tip tool is a curve related to a cycloid for both the internal and the external splines, but for practical purposes an approximate radius tangent to adjacent involutes and root diameter may be specified. The point of tangency must be on or inside the true involute form diameter on external splines, and on or outside the true involute form diameter on internal splines.

8. DIMENSIONS FOR SPLINES:

- 8.1 Tables 2 through 15 inclusive show spline dimensions with tolerances, calculated from formulas given in Section 9 and in conjunction with Table 1. These tables of dimensions do not include involute clearances mentioned in 7.2 and 7.3.
- 8.2 Table 17 shows the recommended involute clearances which should be used in order to avoid any possible interference between the mating splines.

9. FORMULAS:

9.1 External and Internal Splines:

$$\text{Circular Pitch} = \frac{3.14159265}{\text{Diametral Pitch}^1}$$

$$\text{Addendum} = \frac{1}{\text{Diametral Pitch}^2}$$

$$\text{Dedendum} = \text{Addendum} + \text{Land Clearance}$$

$$\text{Land Clearance} = \text{Determined by layout}$$

$$\text{Working Depth} = 2 \times \text{Addendum}$$

$$\text{Whole Depth} = \text{Addendum} + \text{Dedendum}$$

$$\text{Involute Clearance and Full Radius is determined by layout}^3$$

$$N = \text{Number of Teeth}$$

¹ Use numerator of the diametral pitch.

² Use denominator of the diametral pitch.

³ For recommended involute clearance which can be used without requiring layout and special cutters, see Table 17.

9.1 (Continued):

$$\text{Basic Circular Space} = \frac{\text{Circular Pitch}}{2}$$

$$\text{Basic Chordal Space} = \text{Pitch Diameter} \times \frac{\sin 90^\circ}{N}$$

$$\text{Pitch Diameter} = \frac{\text{Number of Teeth}}{\text{Diametral Pitch}}^4$$

9.2 External Splines:

$$\text{Outside Diameter} = \text{Pitch Diameter} + (2 \times \text{Addendum})$$

$$\text{Root Diameter} = \text{Pitch Diameter} - (2 \times \text{Dedendum})$$

$$\text{True Involute Form Diameter} = \text{Inside Diameter of Internal Spline} - (2 \times \text{Involute Clearance, when required})$$

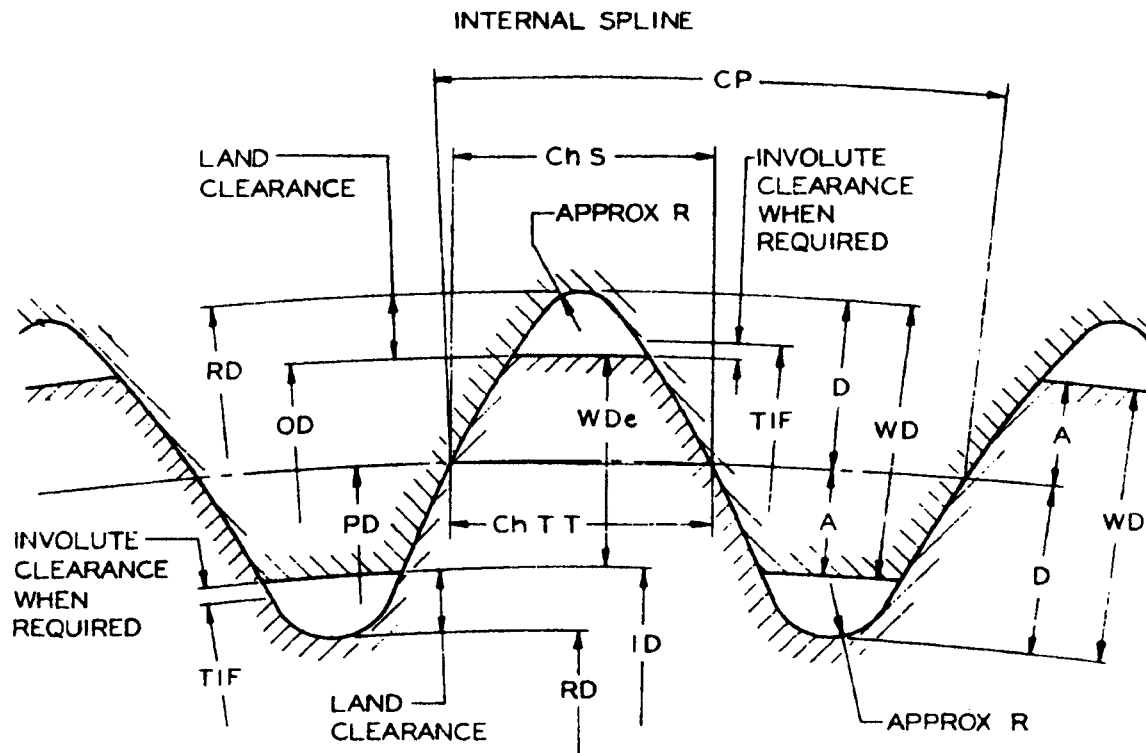
9.3 Internal Splines:

$$\text{Inside Diameter} = \text{Pitch Diameter} - (2 \times \text{Addendum})$$

$$\text{Root Diameter} = \text{Pitch Diameter} + (2 \times \text{Dedendum})$$

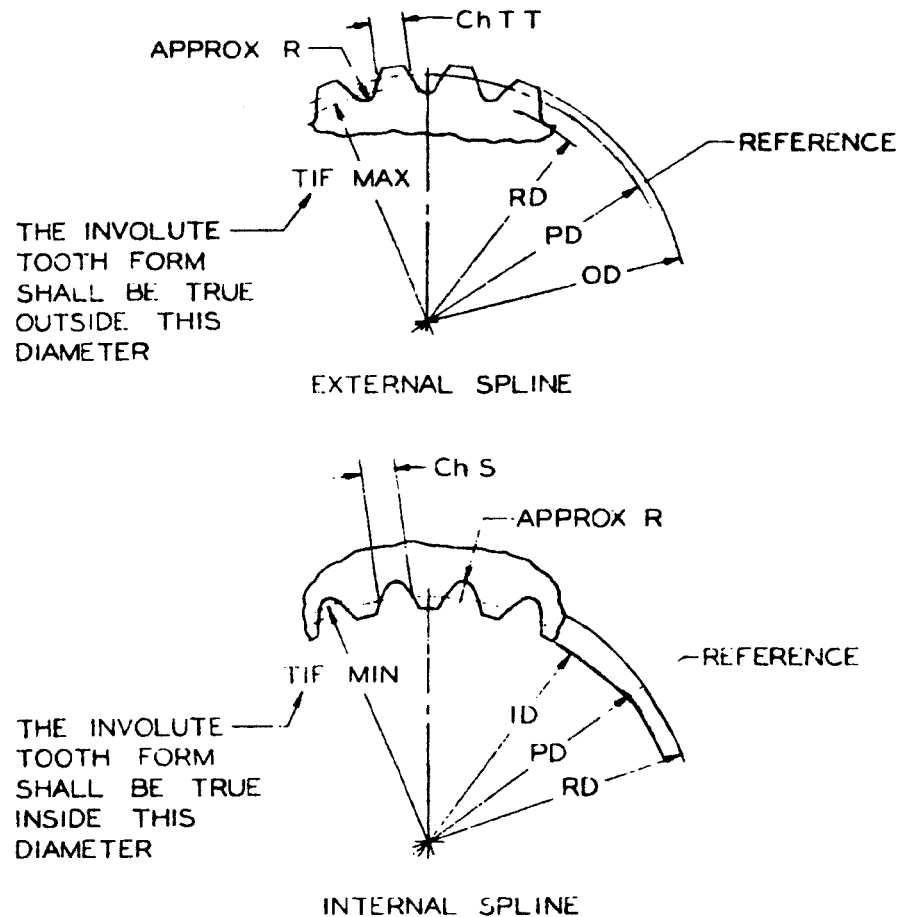
$$\text{True Involute Form Diameter} = \text{Outside Diameter of External Spline} + (2 \times \text{Involute Clearance, when required})$$

⁴ See Footnote 1.



- A = ADDENDUM
- D = DEDENDUM
- WDe = WORKING DEPTH
- WD = WHOLE DEPTH
- R = FILLET RADIUS
- CP = CIRCULAR PITCH
- Ch T T = CHORDAL TOOTH THICKNESS (EXTERNAL)
- Ch S = CHORDAL SPACE (INTERNAL)
- PD = PITCH DIAMETER
- OD = OUTSIDE DIAMETER
- RD = ROOT DIAMETER
- ID = INSIDE DIAMETER
- TIF = TRUE INVOLUTE FORM DIAMETER

FIGURE 1 - Tooth Nomenclature



NOTES:

1. THE CHORDAL SPACE OF THE INTERNAL SPLINE (SEE TABLES) IS BASIC WITH A POSITIVE TOLERANCE.
2. THE CHORDAL TOOTH THICKNESS AND TOLERANCE OF THE EXTERNAL SPLINE SHOULD BE SELECTED TO OBTAIN THE DESIRED FIT.
3. SPLINE DATA:
30° STUB TOOTH FORM
XX TEETH XX/XX PITCH

FIGURE 2 - Method of Dimensioning

TABLE 1 - Basic Tooth Proportions

Dia Pitch	Circular Pitch	Type	Number of Teeth	Addendum	Dedendum	Working Depth	Whole Depth	Approximate Fillet Radius
2.5/5	1.2566	External	8 to Rack	.2000	.3500	.4000	.5500	.180
		Internal	8 to 24	.2000	.3300	.4000	.5300	.190
			25 to Rack	.2000	.3500	.4000	.5500	.180
3/6	1.0472	External	8 to Rack	.1667	.2917	.3333	.4584	.150
		Internal	8 to 24	.1667	.2750	.3333	.4417	.160
			25 to Rack	.1667	.2917	.3333	.4584	.150
4/8	.7854	External	8 to Rack	.1250	.2188	.2500	.3438	.110
		Internal	8 to 24	.1250	.2063	.2500	.3313	.120
			25 to Rack	.1250	.2188	.2500	.3438	.110
5/10	.6283	External	8 to Rack	.1000	.1750	.2000	.2750	.090
		Internal	8 to 24	.1000	.1650	.2000	.2650	.100
			25 to Rack	.1000	.1750	.2000	.2750	.090
6/12	.5236	External	8 to Rack	.0833	.1506	.1667	.2339	.080
		Internal	8 to 29	.0833	.1370	.1667	.2203	.080
			30 to Rack	.0833	.1506	.1667	.2339	.070
8/16	.3927	External	8 to Rack	.0625	.1127	.1250	.1752	.060
		Internal	8 to 36	.0625	.1050	.1250	.1675	.060
			37 to Rack	.0625	.1127	.1250	.1752	.055
10/20	.3142	External	8 to 19	.0500	.0901	.1000	.1401	.050
			20 to Rack	.0500	.0901	.1000	.1401	.045
		Internal	8 to 41	.0500	.0850	.1000	.1350	.045
			42 to Rack	.0500	.0901	.1000	.1401	.040
12/24	.2618	External	8 to 20	.0417	.0749	.0833	.1166	.040
			21 to Rack	.0417	.0749	.0833	.1166	.035
		Internal	8 to 47	.0417	.0725	.0833	.1142	.035
			48 to Rack	.0417	.0749	.0833	.1166	.030
16/32	.1963	External	8 to Rack	.0312	.0625	.0625	.0937	.020
		Internal	8 to 59	.0312	.0555	.0625	.0867	.020
			60 to Rack	.0312	.0625	.0625	.0937	.015
20/40	.1571	External	8 to Rack	.0250	.0500	.0500	.0750	.018
		Internal	8 to 71	.0250	.0425	.0500	.0675	.018
			72 to Rack	.0250	.0500	.0500	.0750	.018
24/48	.1309	External	8 to Rack	.0208	.0417	.0417	.0625	.015
		Internal	8 to 83	.0208	.0355	.0417	.0563	.015
			84 to Rack	.0208	.0417	.0417	.0625	.010
32/64	.0982	External	8 to Rack	.0156	.0312	.0312	.0468	.010
		Internal	8 to 111	.0156	.0275	.0312	.0431	.010
			112 to Rack	.0156	.0312	.0312	.0468	.010
40/80	.0785	External	8 to Rack	.0125	.0225	.0250	.0350	.009
		Internal	8 to Rack	.0125	.0225	.0250	.0350	.009
48/96	.0654	External	8 to Rack	.0104	.0184	.0208	.0288	.008
		Internal	8 to Rack	.0104	.0184	.0208	.0288	.008

NOTE: The shallow depth given for the smaller internal splines may be used for the full range of the number of teeth, depending on the size of the cutter.