AEROSPACE STANDARD

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Superseding AS291E

Surface Texture, Roughness, Waviness and Lay

RATIONALE

This noncurrent standard has been stabilized.

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1. SCOPE:

This standard provides a method of applying surface roughness, waviness and lay control. The data included herein also covers the method of applying surface roughness symbols and related designations to drawings and specifications of parts when applicable. This standard is based on the Arithmetical Average (AA) method of instrumentation. Data compiled are based on current manufacturing practices. It also includes a summary of data published in the latest issue of the American Standards Association publication ASA B46.1.

2. SURFACE CHARACTERISTICS:

The following illustration depicts the terminology of the various elements involved in surface roughness control.

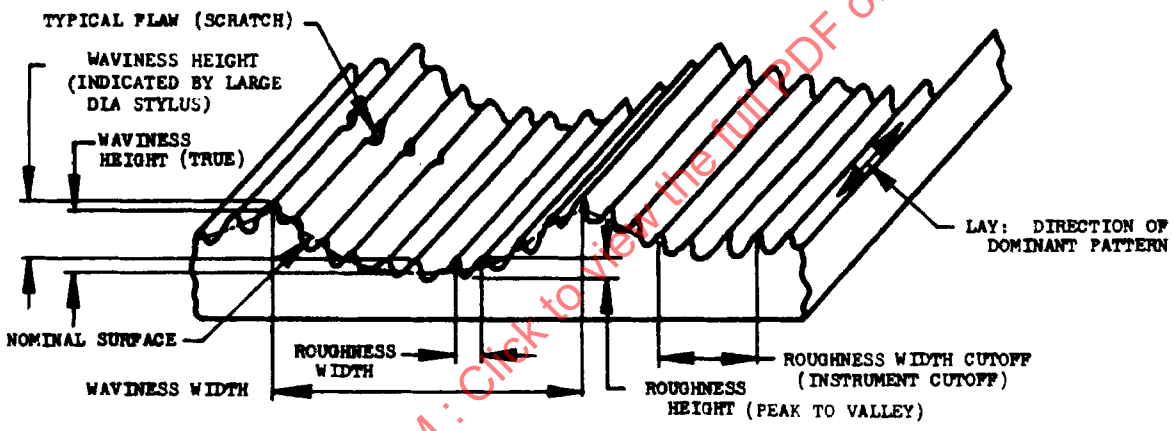


FIGURE 1

2.1 Definitions:

2.1.1 Surface: The individual surface of a part is that area which continues uninterrupted until it adjoins a fillet, corner, or another individual surface.

2.1.2 Nominal Surface: The imaginary true surface which would result if all surface irregularities (peaks, waves, ridges and hollows) were leveled off to zero value; or, non-existent. It is this nominal surface or "mean line" from which the surface irregularities deviate.

2.1.3 Surface Irregularities: Deviations from the nominal surface, as follows:

2.1.3.1 Roughness: Relatively finely spaced irregularities; the height, width, shape and direction of which, establish the predominant surface pattern.

2.1.3.2 Waviness: Irregularities of the nominal surface evidenced by recurrent forms of waves. Waviness may be caused by factors such as machining deflections, vibration, heat treatment, or warping strains (See Fig. 1)

2.1.3.3 Flaws: Irregularities of any sort which occur at only one place or at relatively infrequent and widely varying random intervals on a surface. A flaw may be a scratch, ridge, hole, peak, crack, check, etc. Unless otherwise specified, the effect of flaws shall not be included in the roughness height measurement.

2.1.4 Roughness Height Rating: Roughness height rating is a height rating of surface roughness over a length equal to the roughness width cutoff obtained by averaging the microinch deviations from the nominal surface. This method is described in paragraph 2.1.4.5.

2.1.4.1 Roughness Width: The distance in inches between successive ridges which constitute the predominant pattern of the surface roughness.

2.1.4.2 Roughness Width Cutoff (Instrument Cutoff): The unit length in inches over which the irregularities of the surface profile are to be averaged. The roughness width cutoff must always be greater than the roughness width in order to obtain a true roughness height rating.

2.1.4.3 Microinch (Mu in.): One millionth (0.000001) part of the U.S. Standard linear inch.

2.1.4.4 Contact Area: The designated surface required to contact a mating surface within the limits specified. The contact area shall be distributed uniformly over the surface.

2.1.4.5 Roughness Height (AA) Averaging Method: The method for determining the roughness height average is as follows:

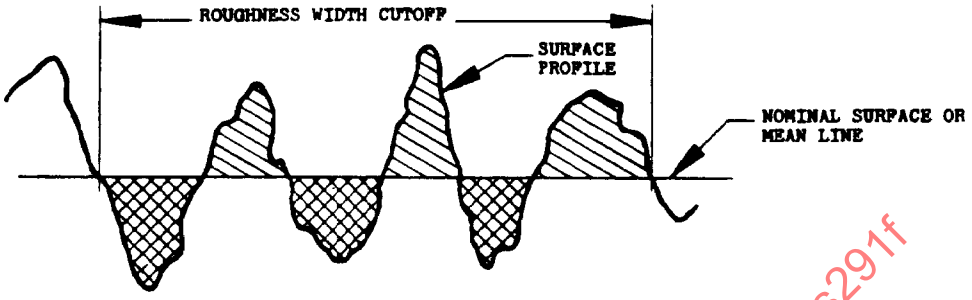


FIGURE 2

The mean line about which roughness is measured is a line parallel to the general direction of the profile throughout the roughness width cutoff length such that the sums of the areas contained between the mean line and those parts of the profile which lie on either side of it are equal.

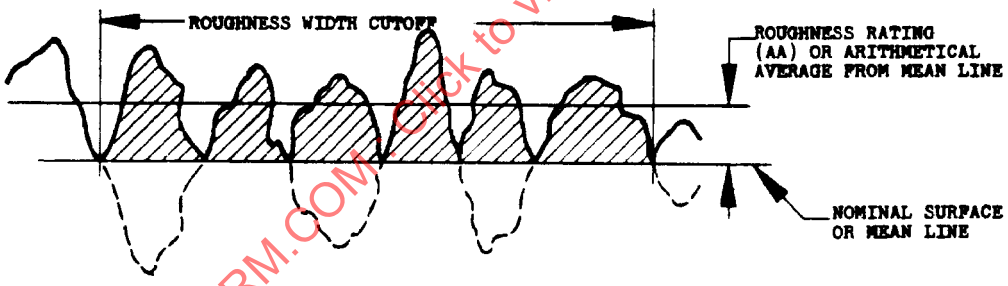


FIGURE 3

Fig. 3 shows deviation of the actual surface profile from the mean line plotted unilaterally. The arithmetic average deviation from the nominal surface, or the roughness rating is the height of a rectangle whose length is equal to the roughness width cutoff length such that the sum of the areas contained between the unilaterally plotted deviations and the nominal surface are equal to the area of the rectangle.

2.1.5 Waviness:

2.1.5.1 Waviness Height Value: A physical measurement in inches which represents the maximum height of the waves; from wave peak to wave valley.

2.1.5.2 Waviness Width Value: A physical measurement in inches which represents the width of the waves; from wave peak to wave peak.

2.1.6 Lay: The direction of the predominant surface pattern produced by tool marks.

3. SURFACE CONTROL APPLIED TO DRAWINGS:

3.1 General:

Surface roughness symbols and their applicable designations shall be placed on the drawing indicating the surfaces which are to be controlled. When desired, surface control may be specified in a general drawing note and exceptions to this note given by surface roughness symbols.

3.2 Surface Roughness Symbol:

The basic symbol is shown in Figure 4. The extension may be omitted when the roughness height rating and/or lay designation only is applied. See paragraphs 3.3.1 and 3.3.5.

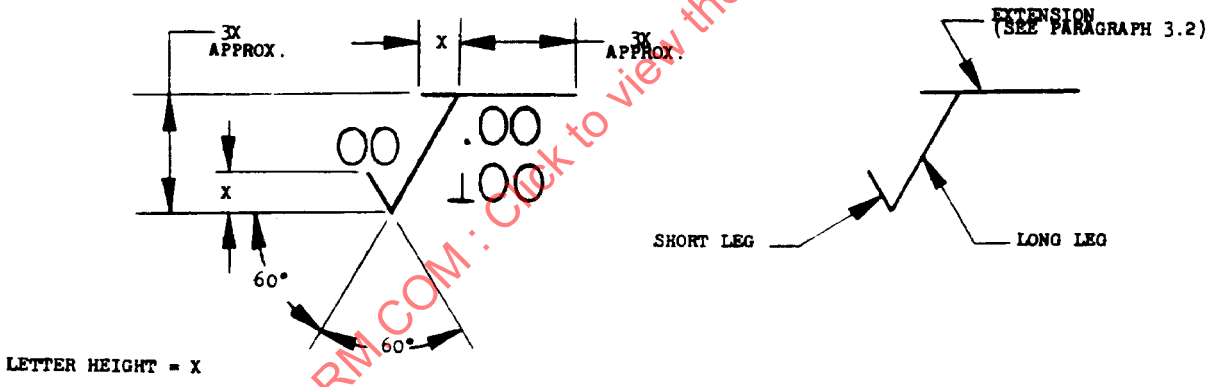


FIGURE 4

3.3 Relationship of Symbols to Surface Characteristics:

The following illustration symbolizes the surface characteristics shown in Figure 1, paragraph 2. It indicates the placement of the different designations and characters on the symbol as applied on the drawing.

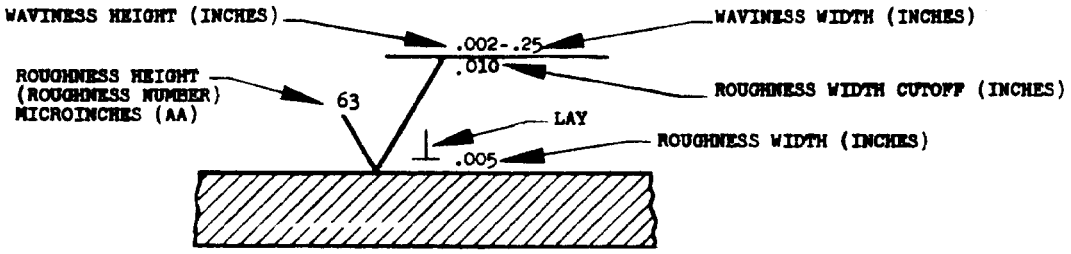
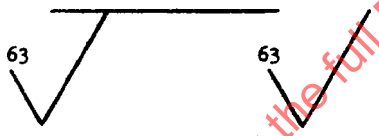
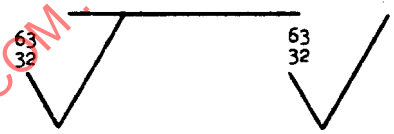


FIGURE 5

3.3.1 Roughness Height Rating: The roughness height rating shall be placed to the left and on the inside of the long leg as shown. The example indicates that the roughness height cannot exceed 63 AA.



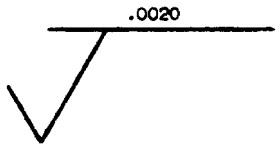
3.3.1.1 When the surface requires a specific range of roughness rating to be maintained, both limits shall be placed on the symbol as shown. The example indicates that the roughness height cannot be more than 63 AA, nor less than 32 AA.



3.3.1.2 Preferred Roughness Height Ratings: (Microinches):

1	2 4 8	16 32 63	125 250 500

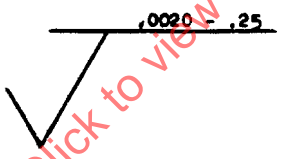
3.3.2 Waviness Height: The waviness height value, when used, shall be placed above the extension as shown. The example indicates that the wave height cannot exceed .002 inches.



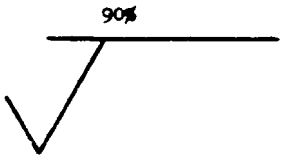
3.3.2.1 Preferred Waviness Height Value (Inches):

.00002 .00005	.0001 .0002	.0005 .0010	.0020 .0050	.0100

3.3.3 Waviness Width: The waviness width value, when required, shall be placed to the right of the waviness height value, preceded by a dash as shown. The example indicates that the wave width cannot exceed .25 inches. The word "min" may be added after the value when required. Standards have not been established for waviness width.



3.3.4 Contact Area: When a contact area control is required, the percentage of contact area required shall be placed above the extension as shown. The example indicates that there must be a minimum contact of 90% with the mating surface.



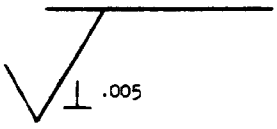
3.3.4.1 The preferred percentages are 90%, 75%, and 50%.

3.3.5 Lay: The lay designation, when used, shall be placed adjacent to and on the right of the long leg.

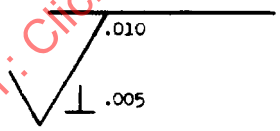
3.3.5.1 Lay Designations:

=	Parallel to the line of the surface indicated.
⊥	Perpendicular to the line of the surface indicated.
X	Angular in both directions to the line of the surface indicated.
M	Multi-directional.
C	Approximately circular-relative to the center of the surface indicated.
R	Approximately radial relative to the center of the surface indicated.

3.3.6 Roughness Width: The roughness width value, when required, shall be placed to the right of the lay designation. The example indicates that the roughness width cannot exceed .005 inch. Standards have not been established for roughness width.



3.3.7 Roughness Width Cutoff: When the roughness width cutoff is required to be other than the standard .030 inch (which is not specified on the symbol), the width must be specified on the symbol and placed below the extension line, and above the lay and roughness width designations. The example indicates the roughness width cutoff shall be .010.



3.3.7.1 Roughness Width Cutoff Values (Inches):

.003	.010	.030*	.100	.300	1.000

* .030 is the standard value generally used.

3.3.8 Placement of Symbols: The point of the symbol, shall be either on the line depicting the surface; on a witness line; or on a leader line with an arrow pointing to the surface as shown in Figure 6. The symbol shall be drawn erect, (the long leg and extension to the right), so that it can be read when the drawing is viewed from the bottom edge.

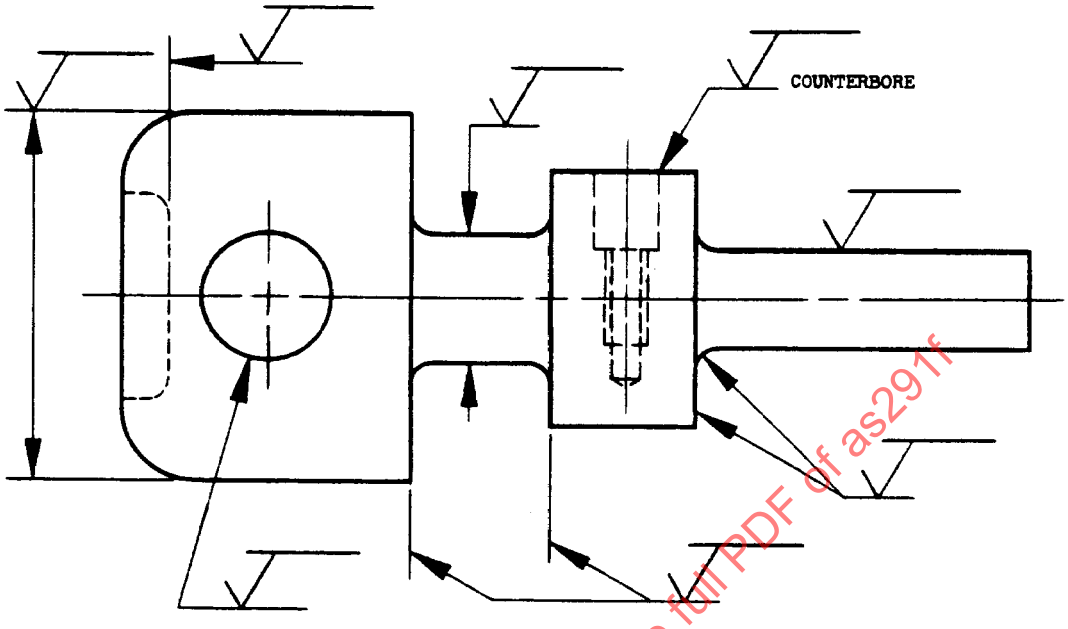


FIGURE 6

4. INSPECTION REQUIREMENTS:

4.1 General:

4.1.1 Surface roughness symbols are not required for surfaces for which no specific surface roughness control is necessary. Such surfaces are acceptable to the surface roughness normally produced by manufacturing methods (casting, forging, drilling, reaming, etc.) required to meet the dimensional limitations of the part see Appendix.

4.1.2 Where the surface roughness symbol is used with a dimension it affects all surfaces defined by the dimension. Areas of transition, such as chamfers and fillets, shall conform with the roughest adjacent finished area, unless otherwise indicated.

4.1.3 Roughness height, roughness width, waviness width and lay indicated on plated, coated or processed surfaces apply to the base metal unless otherwise stated by a note on the drawing or when otherwise stated in the specification. Waviness height on these surfaces however, applies to both base metal and after plating, coating or processing, since waviness and flatness are coincidental and affect the ultimate design of the part.

4.1.3.1 The contact area control on plated or processed surfaces applies after plating or processing.