Designation: D7127 – 13

Standard Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces Using a Portable Stylus Instrument[1]

This standard is issued under the fixed designation D7127; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes a shop or field procedure for determination of roughness characteristics of surfaces prepared for painting by abrasive blasting. The procedure uses a portable skidded or non-skidded stylus profile tracing instrument. The measured characteristics are: *Rt* and *Rpc*. Additional measures of profile height (*Rmax* and/or *Rz*) may also be obtained as agreed upon by purchaser and seller. (The digitally-determined profile parameters *Rt*, *Rmax*, *Ry* and *Rzlmax* are extremely similar in definition.)

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 In general, this method should be limited to the measurement of surface roughness where *Rt* is in the range 10 to 150 µm (0.4 to 6 mil) and where the Peak Count, *Rpc* is less than 180 peaks/cm (450 peaks/in.).

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4417 Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ASME Standard:*

ASME B46.1-2002 Surface Texture, Surface Roughness Waviness and Lay[3]

2.3 *ISO Standards:*

ISO 4287: 1997 Geometrical Product Specifications (GPS)—Surface Texture: Profile Method—Terms, Definitions, and Surface Parameters[4]

3. Terminology

3.1 *Definitions*—The following definitions are provided as an aid to users of this document. Formal definitions of the surface roughness and instrument parameters below are contained in the referenced standards (Fig. 1).

3.1.1 *deadband, n*—that distance above and below the mean line that a continuous trace line must cross in both directions (up and down) to count as a single peak.

3.1.1.1 *Discussion*—Use of a deadband diminishes the effect of small, spurious peaks due to noise.

3.1.2 *evaluation length, n*—a sequence of five consecutive sampling lengths.

3.1.3 *Rpc, n*—the number of peak/valley pairs, per unit of length, extending outside a "deadband" centered on the mean line.

3.1.4 *Rt, n*—the vertical distance between the highest peak and lowest valley within any given evaluation length.

3.1.5 *Rmax, n*—the greatest vertical distance between highest peak and lowest valley for any of the five sampling lengths that comprise an evaluation length.

3.1.6 *Rz, n*—the vertical distance between the highest peak and lowest valley in a sampling length averaged over the five sampling lengths comprising the evaluation length.

3.1.7 *sampling length, n*—the nominal distance parallel to the surface being assessed within which a single value of a surface parameter is determined.

[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.46 on Industrial Protective Coatings.

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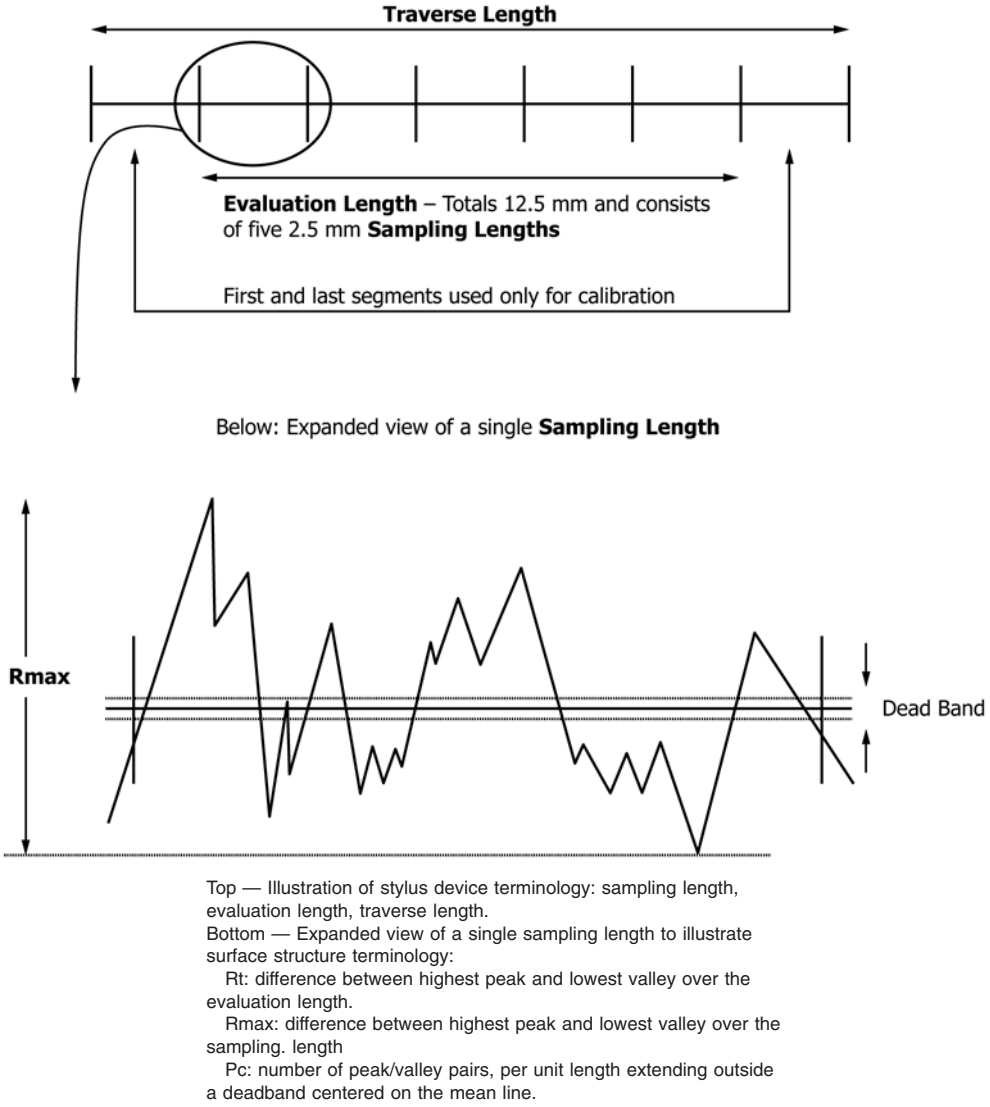
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.



Top — Illustration of stylus device terminology: sampling length, evaluation length, traverse length.
Bottom — Expanded view of a single sampling length to illustrate surface structure terminology:
Rt: difference between highest peak and lowest valley over the evaluation length.
Rmax: difference between highest peak and lowest valley over the sampling. length
Pc: number of peak/valley pairs, per unit length extending outside a deadband centered on the mean line.

FIG. 1 Illustration of Terminology

3.1.8 *surface preparation, n*—the cleaning and profiling of a metallic surface using an abrasive blast media or mechanical means to prepare that surface for coating.

3.1.9 *surface profile, n—for purposes of the standard*, the positive and negative vertical deviations (peaks and valleys) are measured from a mean line approximately the center of the profile being evaluated.

3.1.10 *surface roughness, n*—the combined characteristics of surface profile (height) and peak count (linear density) for a surface.

3.1.11 *traversing length, n*—seven sampling lengths comprising the evaluation length and the pre-travel and post-travel segments.

4. Summary of Test Method

4.1 This test method describes the proper use of a portable stylus surface roughness measuring device to evaluate specific surface parameters and evaluate their suitability for the application of the selected coating to the surface being prepared by abrasive blasting, or other mechanical means, prior to application.

4.2 The method describes considerations relevant to setup of stylus instruments for acquisition of required surface roughness parameters.

5. Significance and Use

5.1 This method may be useful in assuring conformance of a prepared surface to profile requirements specified by the manufacturer of a protective coating.

5.2 This method includes determination of the peak density (number of profile peaks in a specified distance). Some workers in the field believe that optimizing peak height and peak density can improve coating adhesion.

5.3 This method allows specifiers to objectively define surface texture after abrasive blast cleaning rather than using subjective terms such as "angular pattern" or "dense and uniform pattern."

5.4 Because implicit and explicit definitions of "roughness" may differ substantially, numerical characterizations of profile cannot be compared directly across different methods.

6. Apparatus

6.1 The apparatus consists of a portable skidded or non-skidded electronic surface roughness measurement instrument ("tester") capable of measuring *Rt* in compliance with ISO 4287 and *Rpc* in compliance with ASME B46.1. The apparatus should have a vertical range of at least 300 µm (12 mil) and permit a sampling length of 2.5 mm (0.1 in.) and an evaluation length of 12.5 mm (0.5 in.). (Laboratory experience suggests this vertical range is a practical requirement to meet the provisions of 6.2.) In 2009 there are believed to be at least three manufactures of such devices.[5]

6.2 The apparatus should include a stylus with a tip radius of 5 µm (0.2 mil), and permit recording of *Rt* in the range 10 to 150 mm (0.4 to 6 mil) and *Rpc* up to 180/cm (450/in.).

6.3 Surface deviations are sensed by the stylus and converted to electrical signals within the device. Internal processing converts these signals into standard surface characterization parameters, which are then displayed or printed.

7. Preparation of Apparatus

7.1 Set the apparatus to display, and, if so equipped, record the chosen parameters in accordance with the manufacturers' instructions.

7.2 The evaluation length should be set to 5 sampling lengths. The sampling length and evaluation length should be set to 2.5 mm (0.1 in.) and 12.5 mm (0.5 in.), respectively.

7.3 The traversing length of the apparatus should be set (or manufacturer preset) to include pre-travel and post-travel segments, usually equal to one sampling length at the beginning and one sampling length at the evaluation length. These portions of a traverse are, however, discarded by the instrument in its calculation of surface parameters.

7.4 The low frequency ("long wavelength" or "cutoff") filter should be set to "Gaussian" or "Gaussian 50 %." In general, the default setting will be compliant.

7.5 If the apparatus has a high frequency ("short wavelength" or "Ls") filter should be set to "off."

7.6 The apparatus should be adjusted (if necessary) to a deadband width (C1 = –C2) in the range 0.5 to 2.0 µm (20 to 80 µin.). The choice of deadband for profiles as large as those discussed in this standard will have little effect on the measurements. In general, the default setting will be compliant.

7.7 The accuracy of the apparatus should be checked regularly using a calibration block available from the equipment manufacturer using their written procedure and at their recommended interval.

8. Preparation of the Sample

8.1 Select an area of the surface to be tested that is visibly free from obvious defects such as scratches, deep marks, or other construction or corrosion defects.

8.2 Using a stiff nylon bristle brush, remove any dust or abrasive particles from the surface in the selected sample evaluation area. If not removed, such dust and micronic metallic particles may cause damage to the stylus and erroneous readings.

9. Calibration and Standardization

9.1 Precision reproductions of standard surface profiles such as those used by the manufacturer of the equipment, or described in their operational literature, may be used as calibration standards for the apparatus.

10. Procedure

10.1 Obtain an initial trace measurement (2 parameters), then four additional trace measurements taken in the compass directions from the original measurement and about 3 cm (1 in.) away for a total of 5 traces, avoiding obvious surface defects.

10.2 If the stylus is prevented from making a complete trace due to a physical interference, such as a deep scratch on the surface, move the apparatus to a close adjacent area away from the obvious defect and repeat the trace.

10.3 Record the 10 parameters resulting from these five traces (2 parameters per trace).

11. Calculation and Interpretation of Results

11.1 Calculate the five measurement average for each of the two parameters (*Rt* and *Rpc*).

12. Report

12.1 At a minimum, the report should contain the following items:

12.1.1 The sampling length and evaluation length,

12.1.2 Jobsite and location at which the measurement was made,

12.1.3 The values of the five trace measurements for each of the parameters measured (*Rt* and *Rpc at a minimum*) and their averages, and

12.1.4 Instrument used to obtain the measurements, including model number.

13. Precision and Bias

13.1 The precision of this test method is based on an intralaboratory study conducted in 2011. Eleven laboratories participated in this study, analyzing materials representing five different property types. Each "test result" reported represents an individual determination and the participating labs reported three replicate test results for each material type. Practice E691 was followed for the design and analysis of the data; the details

[5] Research Report to be developed with a listing of manufacturers.

TABLE 1 Test Method D7127 Profile Measurement Statistics

Coded Surface ID Number	Stylus Instrument Average Profile – Rt (mils)	Stylus Instrument Profile –Rt Reproducibility Standard Deviation (mils) S_r	Stylus Instrument Average Peak Count (mils)	Stylus Instrument Peak Count Reproducibility Standard Deviation (mils) S_r
102	1.18	0.076	174.8	8.4
114	2.50	0.210	140.2	7.8
124	2.91	0.286	159.3	12.9
121	4.06	0.345	92.1	6.7
119	4.52	0.356	51.3	3.5

TABLE 2 Comparison of Test Method D7127 Profile Measurements with Test Methods D4417 Replica Tape Measurements for Bias Estimation

Coded Surface ID Number	Test Methods D7127 Stylus Instrument Average Profile – Rt (mils)	Test Methods D7127 Stylus Instrument Profile – Rt Reproducibility Standard Deviation (mils)	Test Methods D4417 Average Replica Tape Profile (mils)	Test Methods D4417 Replica Tape Profile Reproducibility Standard Deviation (mils)
102	1.18	0.076	1.29	0.12
114	2.50	0.210	2.65	0.23
124	2.91	0.286	2.79	0.18
121	4.06	0.345	3.75	0.15
119	4.52	0.356	4.22	0.18

are given in ASTM Research Report RR:D01-1169.[6] Values in tables appearing in this section are taken from the foregoing report.

13.1.1 The Profile Reproducibility Standard Deviation (Profile S_R), documented in Table 1 for each of five levels of profile, is key to assessing whether a given measurement is statistically different from either an upper or lower profile limit established in advance by the interested parties.

13.1.2 The term "reproducibility standard deviation" is used as specified in Practice E177.

13.1.3 Similarly, the Peak Count Standard Deviation (PC S_R), also documented in Table 1, is key to assessing whether a given measurement is statistically different from either an upper or lower peak count limit established in advance by the interested parties.

13.1.4 A measured profile or peak count that is within either limit of a pre-specified range by an amount equal to S_R has a 68 % probability of satisfying specification. A profile within 1.5 S_R of a specified limit has an 86 % probability of satisfying specification and a profile within 2.0 S_R of a specified limit has a 95 % probability of satisfying the specification. Fig. 2 is a plot, using the data in Table 1, of peak count versus measured profile.

13.2 *Bias*—At the time of this study, there was no generally accepted reference method suitable for determining either profile or peak count bias for this test method, therefore no formal statement on bias is being made.

13.2.1 Nevertheless, testing in support of Test Methods D4417 relied on measurements of the same roughness test panels used to determine precision in Test Method D7127, the present standard. Comparison of data obtained using these two procedures gives a measure of relative method bias. Table 2 presents these data.

13.2.2 A plot (Fig. 3) of the Portable-Stylus-Instrument-determined parameter *Rt* against replica tape-determined profiles, shows good agreement within the error associated with each of the two methods. A least-square straight line fitted to profiles for the five surfaces measured using both methods has a slope of 1.1. Over the tested range, the straight line fit suggests that profiles measured with the two methods no where differ by more than about 0.3 mils (8 µm).

13.2.3 There is at present no alternative method for determining peak count, so no equivalent conclusions can be drawn about bias for this parameter.

13.3 This precision statement was determined through statistical examination of 160 test results, reported by eleven laboratories, on five surfaces of differing profile covering the approximate profile range 30 to 110 µm (1.2 to 4.4 mils). The five surfaces used in the study bore the control code numbers 102, 114, 124, 121, and 119.

14. Keywords

14.1 abrasive; abrasive blast cleaning; anchor pattern; peak count; surface profile; surface roughness

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1169. Contact ASTM Customer Service at service@astm.org.

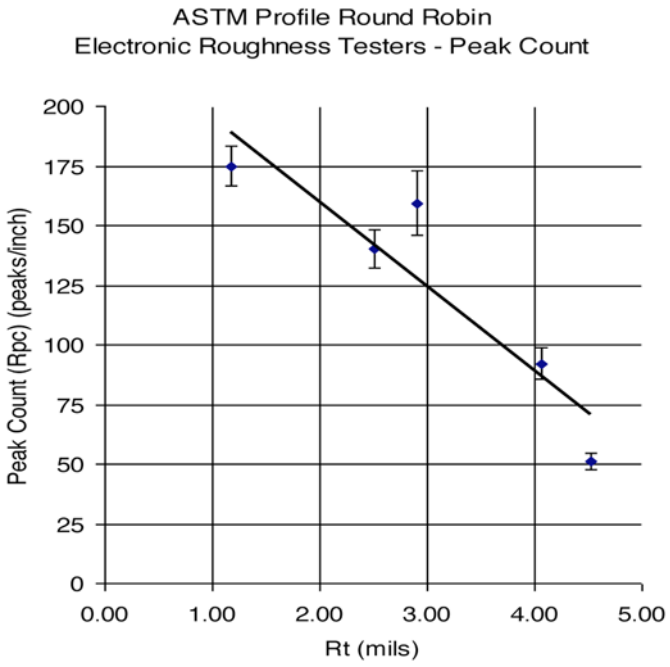


FIG. 2 Electronic Roughness Testers – Peak Count

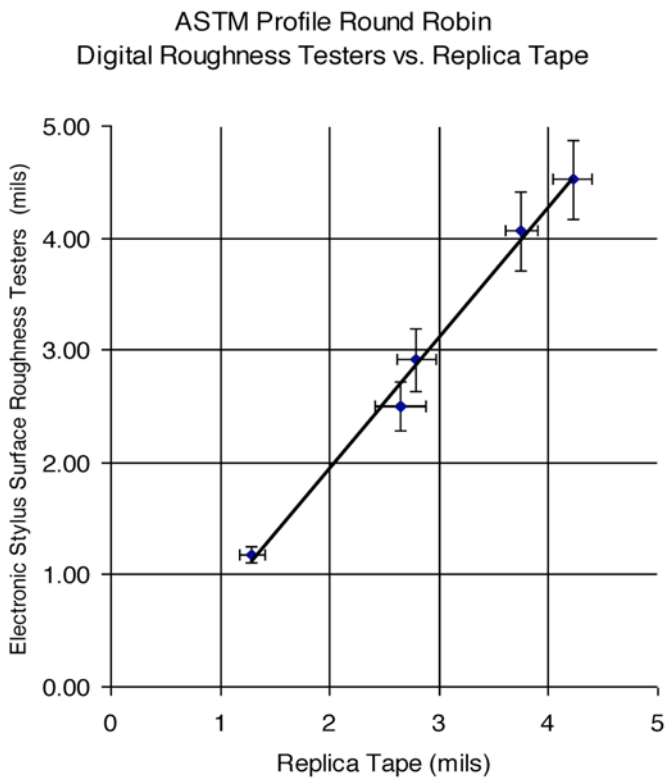


FIG. 3 Digital Roughness Testers vs. Replica Tape