Testex
Press-O-Film Instructions

Testex Press-O-Film replica tape offers a simple way of obtaining an impression of a surface. The impression can then be measured in one of two ways. Either

1) an optical or other electronic profiling device can be used to produce maps of the replica's surface topography, or

2) a simple micrometric digital or dial thickness gage can be used to determine the average maximum peak-to-valley roughness, or "profile," of the replicated surface.

This second method is discussed in what follows.

What replica tape is:

Testex replica film consists of a layer of crushable plastic micro-foam coated onto an incompressible polyester substrate of highly uniform thickness. This film is mounted on a piece of adhesive-backed paper tape and is sold, as Press-O-Film replica tape, in a number of grades to accommodate measurements in different "profile" (peak-to-valley roughness) ranges.
The primary measurement range is 0.8 to 4.5 mils or 20 to 115 µm.
1 mil = 0.001 inch = 25 micrometers (µm)

How it works:

When compressed against a surface, the foam collapses to about 25% of its pre-collapse thickness. During compression, the foam acquires an impression of the surface against which it is burnished. The highest peaks on the original surface displace the fully compressed foam and come to rest against the polyester substrate. The deepest valleys on the original create the highest peaks on the replica. Consequently, the thickness of the compressed foam equals the average maximum peak-to-valley profile. The overall thickness of the compressed film is this profile plus the thickness of the incompressible polyester.
A spring-loaded micrometer gage is used to measure the thickness of the replica. Subtracting the substrate thickness from this gives the average maximum peak-to-valley roughness or "profile".

Characteristics of the spring micrometer gage:

All characterization of replica tape profile measurement has been performed with a gage having a measurement accuracy of 0.2 mil (5 µm), closing force of 4 ounces (1.5 N) and at least one anvil having a circular diameter of 0.25 inch (6.3 mm).

Suitable *inch and metric unit* gages are available from Testex and other companies but great care should be taken to assure that the gage is specifically designed to be used with replica tape.
Using the proper gage is essential to obtaining correct profiles.

(2010 "HT Averaging") Instructions for Using Press-O-Film With a Micrometric Thickness Gage:

Step 1: Locate a representative site for measurement.

Step 2: Select the appropriate grade of Press-O-Film replica tape based on your target profile:
For 0.8 to 2.5 mils (20 to 64 um) => Coarse grade
For 1.5 to 4.5 mils (38 to 115 um) => X-Coarse grade

Step 3: Prepare thickness gage: clean anvils and adjust zero point to read minus 2.0 mils (minus 50 µm). On a conventional Testex gage **this is equivalent to pre-setting to plus 8.0 mils (or, on a metric gage, plus 150 µm).**
Pre-setting the gage in this way automatically subtracts the thickness of the incompressible substrate from all further readings.

Step 4: Pull a single piece of adhesive-backed printed paper free of the release paper. The Press-O-Film is the 0.4 inch (1 cm) square white plastic film at the center of the adhesive-backed paper. A paper "bulls-eye" circle should remain behind on the release paper.

Step 5: Check the uncompressed film's thickness with gage. X-Coarse grade tape should have a (substrate corrected) thickness between about 5.0 and 6.0 mils (125 and 150 µm).

Step 6: Apply film to surface to be measured. Press the adhesive -backed paper to hold the film firmly in place.

Step 7: Firmly compress replica film with the smoothest surface on the round-end rubbing tool provided. (In a pinch, the rounded edge of the tape dispenser is also an acceptable tool.) Fully compress all parts of the film to produce a uniform pebblegrain appearance. Burnishing normally takes about 40 seconds.

Step 8: Remove the replica and place it between anvils of micrometer gage, making sure replica is centered between anvils.

Step 9 (Averaging):
A) If a measurement with either Coarse or X-Coarse grade is in the 1.5 to 2.5 mil (38 to 64 µm) **overlap window** (inclusive), take a 2nd reading with the OTHER grade.
If **both** readings are in the 1.5 to 2.5 mil (38 to 64 µm) window, record the **average** as the observed profile.
B) If the reading obtained with either grade is **outside this overlap window,** i.e., is between 0.8 and 1.4 mils (20 to 37 µm) or between 2.6 and 4.5 mils (65 and 115 µm) - it **should be used as is**, i.e., without averaging, as the profile.

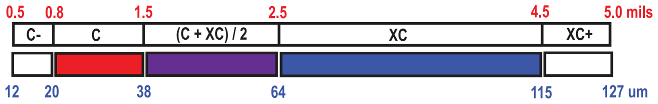
A video describing this procedure can be found at:

Averaging:

"Averaging", as described in Step 9A of the preceding instructions, means:
adding the profile obtained for a given surface using Coarse tape to the profile obtained for the same surface using X-Coarse tape and **dividing their sum by 2**.
This result, is—in the "overlap window"—the profile.

Tape Range Illustration:

A graphic illustrating the ranges over which averaging should and should not be applied appears on each piece of tape and is reproduced below.



Accuracy and Reproducibility of Measurement:

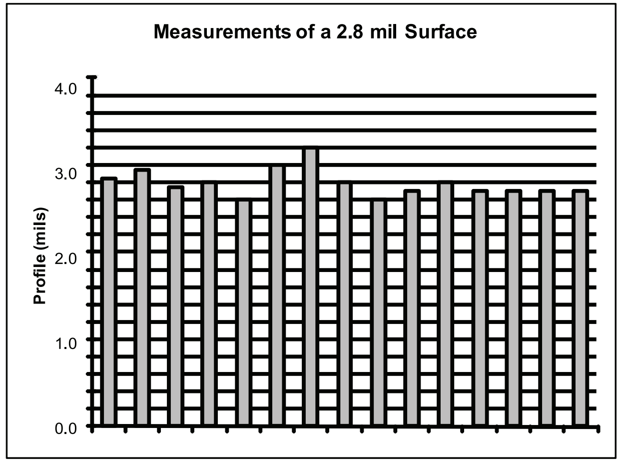
Different techniques for measuring surface roughness generally yield different numerical values because they implicitly or explicitly assume differing definitions of profile. Profiles obtained in different ways may not even be simply related. Different techniques may, for instance, be affected in divergent ways by choice of blast medium or by the presence or absence of waviness.

Replica tape measurements of profile are roughly similar in magnitude to the ISO-defined roughness parameter, Rt , "Total Height of the Profile", commonly called "peak-to-valley roughness".

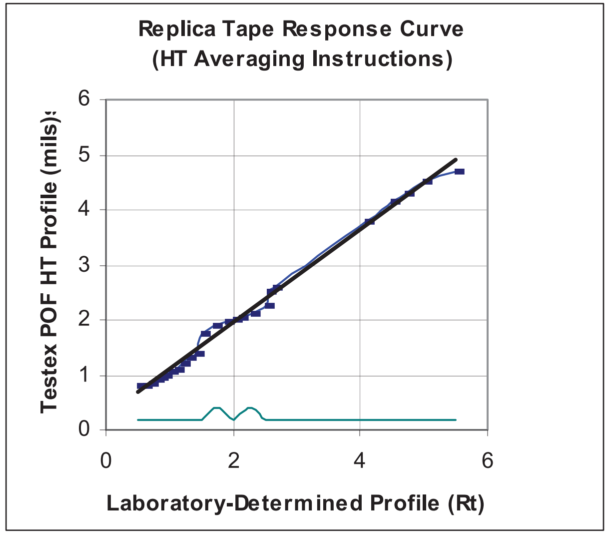
Over most of Press-O-Film's 0.8 to 4.5 mil (20 to 115 µm) primary range, measurements depart from linearity by less than about 0.3 mils (8 µm) and display a one-standard-deviation statistical error of under ±0.2 mils (±5 µm). Here, a profile "measurement" is defined to be the average of 2 replicas.

Above the high end of its range, replica tape tends to underestimate the profile height.
Below the low end of its range, replica tape tends to overestimate the profile height.
Upper end (**X-Coarse Plus**) and lower end (**Coarse Minus**) check grades of tape should be used to confirm that measurements are within the tape's primary range.

Graphical data in the adjacent panel is explained on the overleaf.



Typical Measurement Dispersion (Representative Surface)
Average profile = 2.8 mils (71 µm)
Standard deviation = 0.18 mil (5 µm)



Blue Curve = Replica Tape Profile
Black Line = Straight Line Fit
Green Curve (at bottom)
= Measurement Uncertainty = Standard Deviation

Replica Tape Response Curve:

The graph on the other side shows the generally linear response of replica tape to changes in surface profile. This curve also shows the beginnings of non-linear behavior at the upper and lower ends of the range and the slightly distorted response that occurs where **Coarse** and **X-Coarse** grades overlap (and where the averaging procedure is applied).

This distorted response—between 1.5 mils and 1.9 mils (38 and 48 µm) and between 2.1 mils and 2.5 mils (53 and 64 µm) - is a result of the fact that the low end of the **X-Coarse** range and high end of the **Coarse** range do not quite match up. The expected measurement uncertainty associated with these two regions is also anomalously large. Standard deviations are illustrated by the green curve at bottom of the graph.

In most cases, inspectors are interested in assuring that the measured profile is within a certain limits (“Pass/Fail”).

Pass/Fail determinations of profile around the values 1.5, 2.0 and 2.5 mils (38, 50 and 64 µm) will tend to be quite accurate. Pass/Fail assessments centered on other values in this 1.5 to 2.5 mil (38 to 64 µm) “overlap” part of the range will be less accurate. Testex recommends that specifiers and inspectors agree, before beginning a job, to limits on profile that take this circumstance into account.

Using the Averaging Instructions:

Testex began recommending the averaging procedure (“Step 9”) in 2010, when it introduced it’s High Temperature (HT) formulation. Testex recommends switching to the new (averaging) instructions but recognizes that, where consistency between old and new measurements requires it, contractors and inspectors always have the option of continuing to use the old, non-averaging, instructions.
Measurements made using the old instructions can be marked “non-HT”. Those using the new instructions can be marked “HT”. **Agreement on whether to use “HT” or “non-HT” instructions should be arrived at prior to starting a job.**

Number of Measurements:

Testex recommends that each replica be supplemented by a “check” replica obtained at the same surface location. If the two replicas differ by 0.2 mil (5 µm) or less, their average should be recorded as the profile.

If these two initial replicas differ by more than 0.2 mils (5 µm), a third replica is recommended. The average of these three should be recorded as the profile.

If the first replica value is inside the 1.5 to 2.5 mil (38 to 64 µm) overlap region, requiring a 2nd replica to meet the averaging requirement, only these 2 are required for a valid measurement.

Standards Governing Use of Replica Tape to Measure Profile:

ASTM (American Society for Testing and Materials) **D 4417** - ”Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel”

ISO (International Organization for Standardization) **ISO8503-5**

NACE International (National Association of Corrosion Engineers) **RP0287** - “Standard Recommended Practice: Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape”

SSPC - The Society for Protective Coatings
Standard Currently in Development: “Procedure for Determining Conformance to Steel Profile/Surface Roughness/ Peak Count Requirements”

In cases where standards compliance is required, the full original current standard should be consulted.

Sources of Error:

A human hair is about 2 mils (50 µm) thick and individual bacteria are 0.1 mil (2.5 µm) in size. Field profile measurements to accuracies in this range will be influenced by subtle effects.

The four major sources of error in determining the profile of a blasted surface using replica tape and a micrometer gage are:

1) Inherent variation in point-to-point profile over the surface being measured,

2) presence of particles of dirt on either the replica tape or gage,

3) gage accuracy (typically 0.2 mils or 5 µm),

4) rubbing technique, including incomplete compression of the foam.

Testex Training Surface:

The Training Surface is a 1.5 inch (38 mm) diameter disk of phenolic material. Its top surface carries the impression of a set of parallel ridges each of which has an inverted ‘V’ cross-section. The height of the highest ridge is the profile cited on the bottom of the training surface.

The training surface should not be used as a surface comparator or roughness standard. It can be useful, however, for familiarizing new users with replica tape.

Why Determination of Profile is Important:

Industrial steel in bridges, ships, railcars, etc., is almost always painted or otherwise coated to prevent corrosion. Before they can be painted, these metal surfaces must be cleaned and roughened to insure that the paint adheres. This is usually done by grit or shot blasting the surface. If the resulting surface is too smooth, the paint or coating will not stick. If the surface is too rough, the peaks poke through the coating and rusting occurs.

Grades of Replica Tape:

Testex Press-O-Film replica tape is available in several thicknesses to facilitate profile measurements in different ranges:

Grade	Foam Layer Thickness (mils)	(µm)	Range When Used With Gage (mils)	(µm)
Fine / Medium	0.4	10	***not applicable***	
Coarse Minus	1.2	30	**0.5 to 1.0**	**13 to 25**
Coarse	3.0+	75+	**0.8 to 2.5**	**20 to 64**
X-Coarse	5.2+	140+	**1.5 to 4.5**	**38 to 115**
X-Coarse Plus	6.4+	162+	**4.5 to 5.0**	**112 to 125**

Coarse and **X-Coarse** grades together cover replica tape’s primary measurement range.
The two grades shown in **green** are “check grades” at the upper and lower ends of this primary range.
(X-Coarse Plus may be used with caution, *and at users risk*, at profiles somewhat above the grade's nominal upper cut-off of 5.0 mils, or 125 um. Details at Testex website.)

Fine/Medium grade replica film is commonly used in applications in which the replica is analyzed using optical interferometric techniques. Fine/Medium grade is not suitable for use with a micrometric thickness gage.

Select grades can be provided with a thin Indium coating, to facilitate optical measurement. All grades are coated onto a tough polyester substrate 2.0 mils (50 µm) in thickness.

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