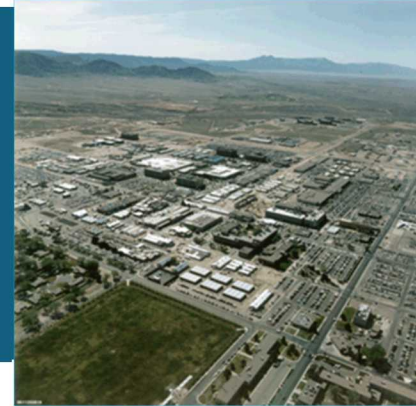


Form Matters / Gaging or Measuring Hole Size



PRESENTED BY

Margie Baca, Robert Jones & Tony Bryce



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How this Topic Came to Our Attention

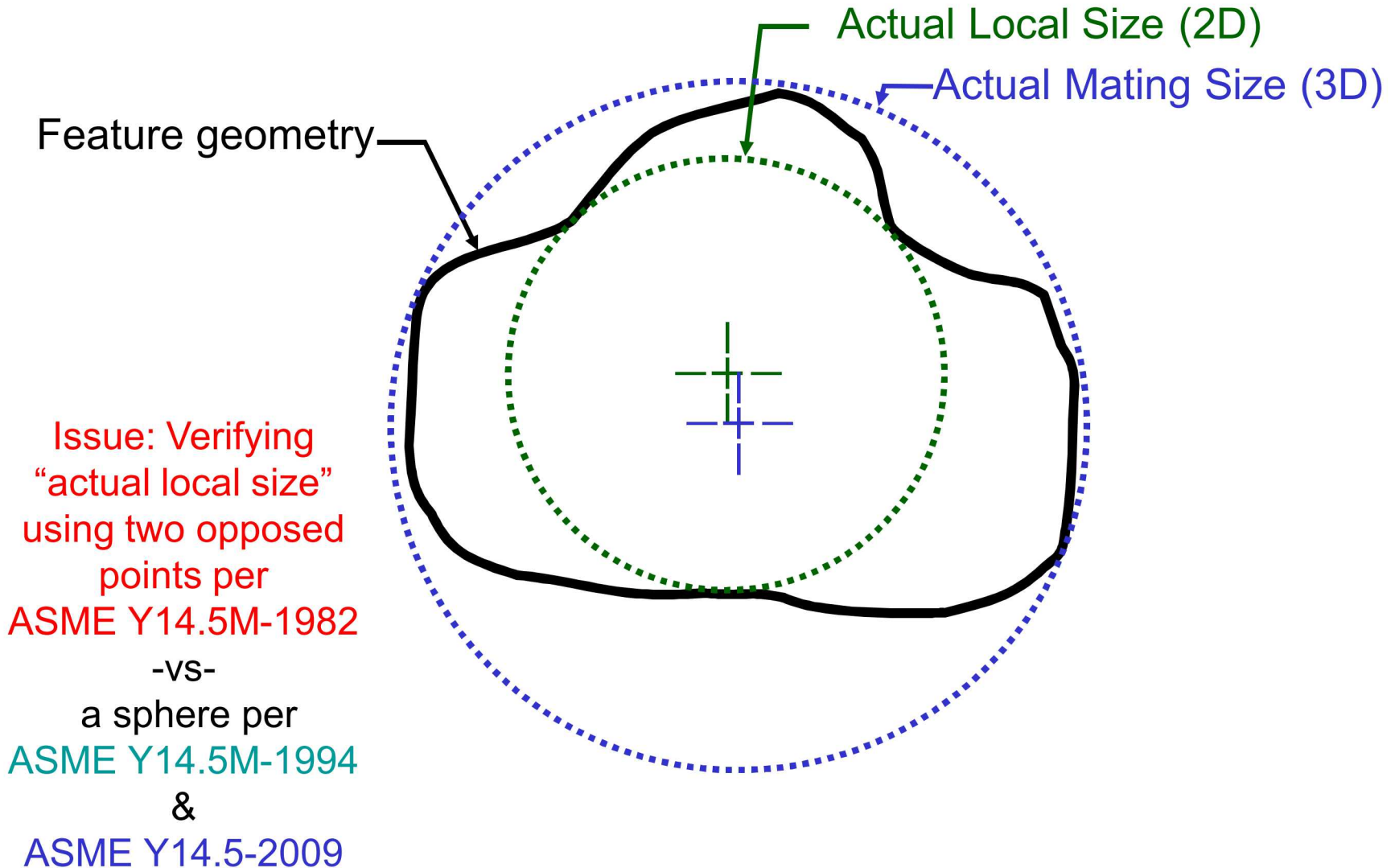
During routine measurement of an internal diameter (0.625” +0.0005/-0.0000”) using a CMM, the hole diameter (i.e. actual mating envelope) was found to be slightly under the lower limit, however when a gage pin was used the “go” size of 0.625” would pass through the hole.

During validation of both the CMM program and gage pin sizes more questions than answers came up. Below are a few that came to mind.

- CMM related
 - How many points were taken?
 - Where and how were the points taken (i.e. scanning / single point and probing strategy)?
 - What diameter CMM probes were used that might influence mechanical filtering?
- Gage Pin related
 - What class pin do we have?
 - How is size (i.e. diameter) determined?
 - What is the form error?

Definition of the measured feature is never trivial

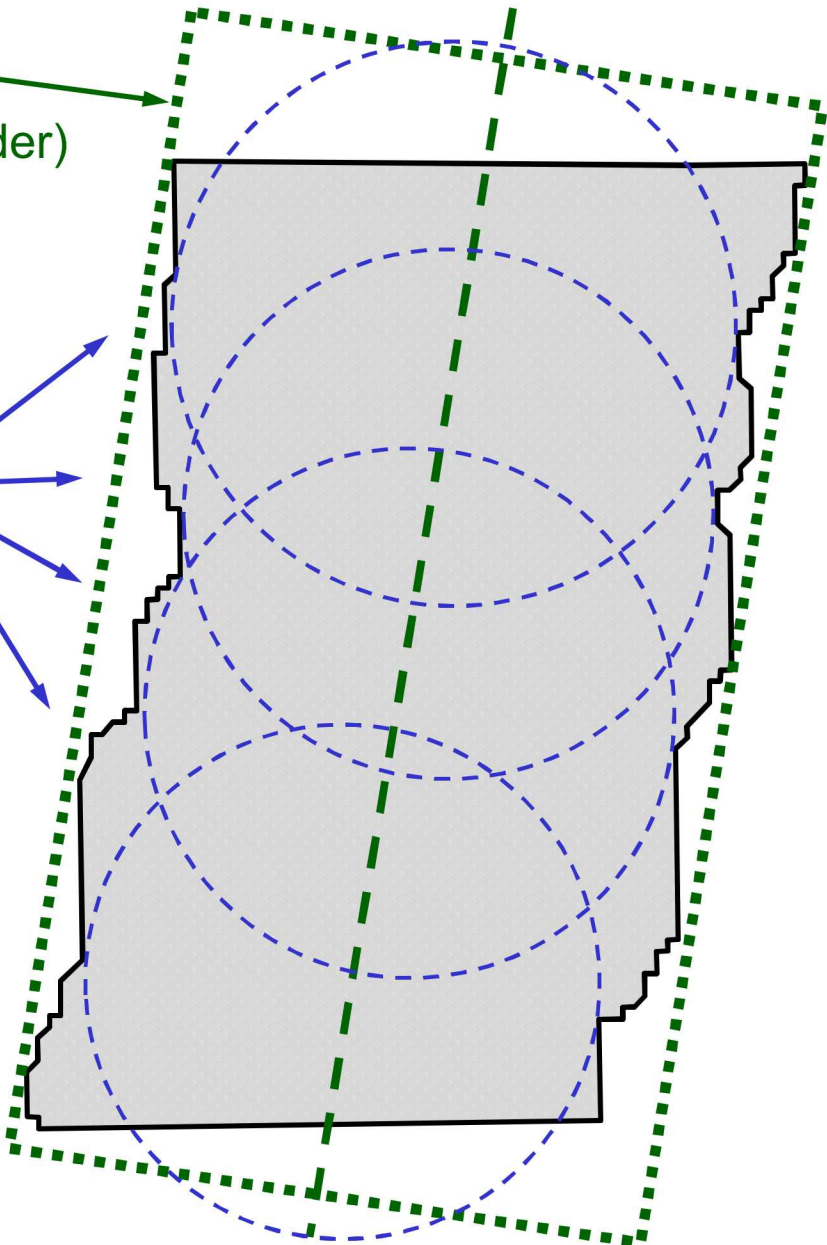
Example: Diameter of a cylindrical feature

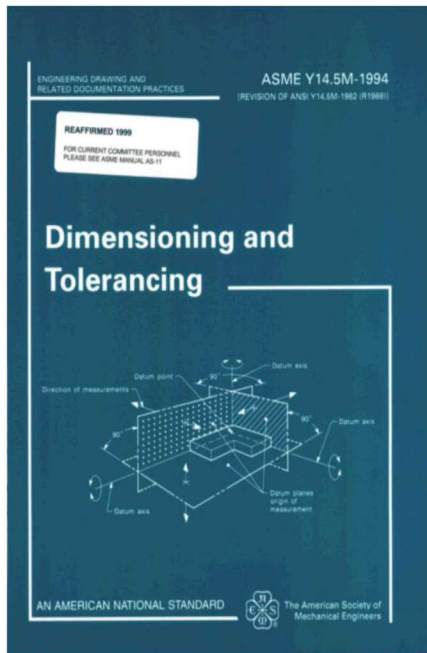


Actual Mating Size & Actual Local Size

3D Actual Mating Size
(Smallest Circumscribed Cylinder)

2D Actual Local Size
(Largest Inscribed Sphere)



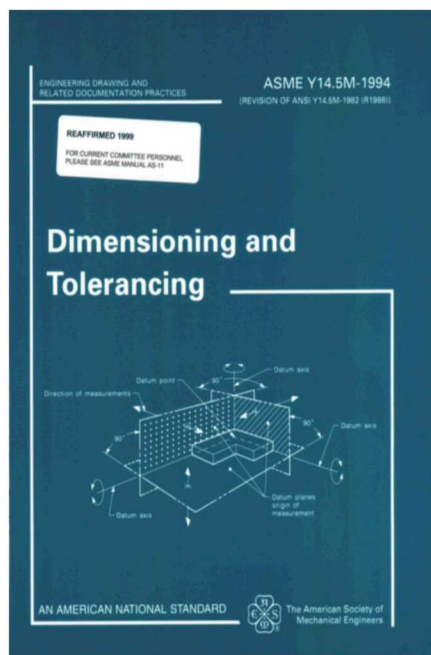


Actual mating envelope (1.3.11): “for an external feature, a similar perfect feature counterpart of smallest size that can be circumscribed about the feature so that it just contacts the surface at the highest points”

1.3.24 Size, Actual. The general term for the size of a produced feature. This term includes the actual mating size and the actual local sizes.

1.3.25 Size, Actual Local. The value of any individual distance at any cross section of a feature.

1.3.26 Size, Actual Mating. The dimensional value of the actual mating envelope.

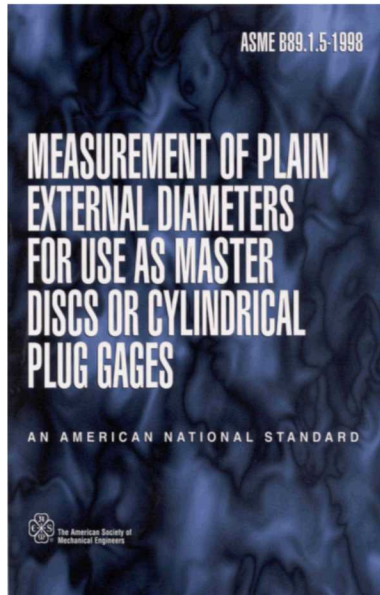


2.7.1.2 Variations of Form (Envelope Principle). The form of an individual feature is controlled by its limits of size to the extent prescribed in the following paragraphs and illustrated in Fig. 2-6.

(a) The surface or surfaces of a feature shall not extend beyond a boundary (envelope) of perfect form at MMC. This boundary is the true geometric form represented by the drawing. No variation in form is permitted if the feature is produced at its MMC limit of size except as specified in para. 6.4.1.1.2.

(b) Where the actual local size of a feature has departed from MMC toward LMC, a variation in form is allowed equal to the amount of such departure.

(c) There is no requirement for a boundary of perfect form at LMC. Thus, a feature produced at its LMC limit of size is permitted to vary from true form to the maximum variation allowed by the boundary of perfect form at MMC.



4.5.1 General. The diameter will be measured per para. 6 of this Standard. Typical acceptance criteria for geometric requirements are diameter measurements spaced approximately 90 deg apart in each of three planes: the midsection, and each end, located 1.6 mm ($\frac{1}{16}$ in.) from inside the ends of corner radii or chamfers.

Two-point diameter measurements will not detect the effect that odd-numbered or irregular lobing has on size. Diameter measurements taken at multiple locations may not fully detect ovality, even-numbered lobing, or straightness deviation.

NOTE: ASME Y14.5M RULE #1 (para. 2.7.1) DOES NOT APPLY DUE TO THE LIMITATIONS OF PRECISION MEASURING EQUIPMENT AND THE INABILITY TO CORRELATE COMPOSITE FORM DEVIATIONS WITH ABSOLUTE SIZE. (Perfect form at maximum material condition is not required.)

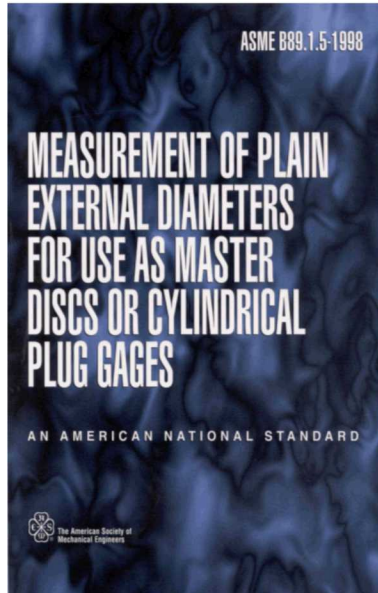


TABLE 3 DIAMETER TOLERANCES FOR CLASSES AND SIZES FOR MASTER DISCS AND PLUG GAGES

Diameter, in.		Tolerance Class, $\mu\text{in.}$					
Above	To and Including	XXX	XX	X	Y	Z	ZZ
0.010	0.825	10	20	40	70	100	200

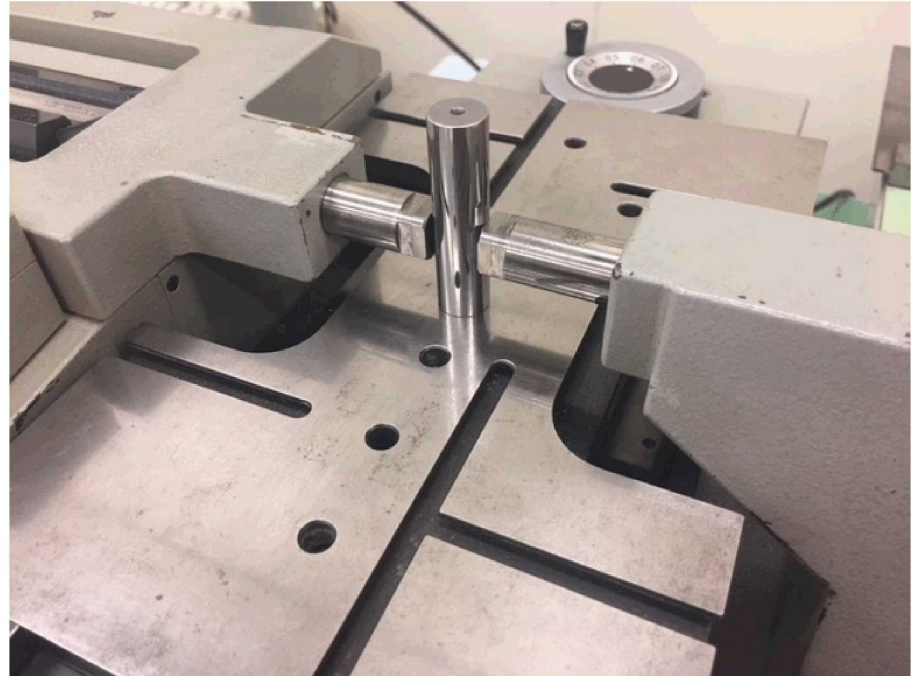
Form is expressed as roundness and taper.
Cylindricity not used.

Gage Pin – Size Measured

Pin measured using 1D
Universal Length
Measuring System
(SIP305M shown)

ASME specification for
size on class XXX plug
gages is 10 micro-
inches

Measuring accuracy
for system shown
between +/- 15 to 40
micro-inches



Conclusions

Diameter (i.e. actual mating envelope per ASME Y14.5) not easily achieved using plain pin gages with size determined per ASME B89.1.5

Possible to approximate actual mating size by adding form (roundness and taper) to ASME B89.1.5. size

Issues with ability to measure XXX plain cylindrical gages to ASME specifications for form

More evaluation needs to be done to determine best practice for future certifications



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September 26, 2018

Mr. E. A "Tony" Bryce
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Albuquerque, NM 87185

Subject: Copyrighted Material

Dear Mr. Bryce:

In response to your e-mail dated September 23, 2018, ASME will grant you permission to reproduce excerpts from the standard listed below:

ASME B89.1.5-1998

Section 4.5.1
Table 3

ASME Y14.5-1994

Section 1.3.24
Section 1.3.25
Section 1.3.26
Section 2.7.1.2

as requested to be used in a presentation to be given on October 16-17, 2018 at the IMOG Measurement Technology Subgroup meeting, provided that you agree to fully acknowledged ASME and the source document. **"Reprinted from ASME B89.1.5-1998 and ASME Y14.5-1994, by permission of The American Society of Mechanical Engineers. All rights reserved." Permission is for these editions only. No further copies can be made or distribute without written permission.**

If you have any questions, do not hesitate to contact me.

Sincerely,

Ivette Estevez
Manager, Standards IPR
estevezi@asme.org
(212) 591-8482

/IE

Appendix – A / Permissions for Use of Materials

IIGD&T Permission Letter

Good morning Tony,

Yes, your more than welcome to us any or all of the slides in the presentation.

Let me know if I can be of further help in your efforts by providing any additional slides I may have.

Have a wonderful day!

Greg

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From: Bryce, Tony [<mailto:eabryce@sandia.gov>]

Sent: Sunday, September 23, 2018 5:27 PM

To: Greg Hetland - IIGDT <greg-hetland@iigdt.com>

Cc: Baca, Margaret C <mcbaca@sandia.gov>; Jones, Robert Edward <rjones3@sandia.gov>

Subject: RE Permission Request

Greg,

I would like Margje and Robert to present information to our IMOG Group next month and would like to ask if you would be open to allowing us to use some of the slides in the attached file you provided. I can make the presentation Official Use Only restricting the distribution to within the group if needed.

Please advise and thank you!

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