

**CASES OF ASME B89 DIMENSIONAL METROLOGY**

Approval Date: March 12, 2015

**Case: B89-002**

**B89.3.7-2013**

**Issues Regarding Granite Surface Plates**

**Inquiry 1:** For surface plates of the following sizes, is there an error in the thickness values stated in Nonmandatory Appendix B, Thickness, Tables B-2M and B-3M in this standard?

Width	Length	Diagonal	Area
1000 mm	2000 mm	2236 mm	2.000 m <sup>2</sup>
1500 mm	2000 mm	2500 mm	3.000 m <sup>2</sup>

*Response 1:* It is the opinion of the Committee that there are errors in the thickness values for the above two surface plate sizes in Tables B-2M and B-3M. It is recommended that the user of this standard replace these two tables with the corrected tables, B-2M (revised) and B-3M (revised), appended to this Report.

**Inquiry 2:** In table B-2, are the recommended thicknesses for AA Grade plates of size 12" x 12" and 24" x 48" correct?

*Response 2:* It is the opinion of the Committee that there are errors in the thickness values for these two surface plate sizes in Table B-2. It is recommended that the user of this standard replace this table with the corrected table, B-2 (revised), appended to this Report.

**Inquiry 3:** There appears to be an inconsistency between the values given in Table 1 – Common Sizes and Flatness Tolerance and the flatness tolerance and rounding rules given in Section 4.3.4. How should users resolve this inconsistency?

*Response 3:* It is the opinion of the Committee that values in Table 1 come from historical roots, mostly Federal Specification GGG-P-463, and that these values take precedence over values derived from Section 4.3.4. The guidelines given in Section 4.3.4 are intended to apply only when values are not found in Table 1.

**Inquiry 4:** There appear to be some errors in the calculations in the metric example in Appendix B. What should be the correct value in this Example?

*Response 4:* It is the opinion of the Committee that new text should be presented for the referenced Example, correcting minor numerical errors, and referencing sizes given in B-2M, rather than sizes not in that Table. The following Example should replace the one in the text of Appendix B in this Standard at the next revisions of the Standard, and is offered here to resolve the above question.

In Appendix B the Metric Example should be replaced by an example using a surface plate size from Table B2-M, rather than the 900 mm x 1200 mm size in the current example. The following example is more appropriate than the one in the current Appendix B:

**EXAMPLE (Metric):** A normally loaded Grade A surface plate 1000 mm x 1500 mm has an overall flatness tolerance of 13 µm (calculated from Section 4.3.4). From the table B-2M, assuming  $E = 38 \times 10^9 \text{ N/m}^2$ , the formula above gives

$$t^3 = (366 \text{ kg} \times 9.8 \text{ N/kg} \times (1.5\text{m})^2 \times 0.14 / 38 \times 10^9 \text{ N/m}^2 \times \frac{1}{2} \times 13 \times 10^{-6}\text{m})$$

$$t^3 = 1129.842/247 \times 10^3 \text{ m} = 4.574 \times 10^{-3} \text{ m}^3$$

$$t = 166 \text{ mm}$$

Table B-2M shows a value of 175 mm that is consistent with Note (2) in Appendix B.

**Inquiry 5:** There appear to be some error calculations in the examples in Appendix D. What should be the correct values in these Examples?

*Response 5:* It is the opinion of the Committee that new text should be presented for the referenced Examples, correcting minor numerical errors. In Section D-4 the metric example reduces the diagonal length by the width of the excluded section, rather than by its diagonal (see Table 3). Reducing the length of the working diagonal by 72 mm (the length of two diagonals of the excluded sections) yields a bow value of 5.4 µm, rather than the value of 5.6 µm given in the example in the standard.

The example in US Customary units has a similar shortcoming. In that example, after correcting for the proper length of the diagonal, the resulting bow should be 238 µin rather than the stated 249 µin.

In the example in Section D-5 in US Customary units the value of K is improperly shown as 3.8. A correct calculation yields 3.9. This correction changes the calculated soak out time from 14.2 hours to 14.6 hours.

**Inquiry 6:** In Nonmandatory Appendix F, Section F-2.1.1 and F-2.1.2 it appears that the formula for  $u(\text{acc})$  is incorrect on both pages 26 and 27, which if corrected would lead to slightly different values for the resulting Expanded uncertainty estimates.

*Response 6:* It is the opinion of the Committee that the resulting expanded uncertainty estimate is correct, but that there are some errors in the text which lead to some confusion. In order to resolve this confusion, the Committee recommends that users of this Standard delete the sentence which reads “To this is added in quadrature the standard uncertainty of the calibration.” which is the last sentence on page 25 and the last sentence on page 26. This makes the formulae at the top of pages 26 and 27 simply:

$$u(acc) = \{ (0.3\mu\text{m}/2)/[\sqrt{(3)}] \} = 0.09 \mu\text{m} \quad \text{on page 26}$$

and

$$u(acc) = \{ (12.0\mu\text{in.}/2)/[\sqrt{(3)}] \} = 3.5 \mu\text{in.} \quad \text{on page 27}$$

This opinion follows the recommendations given to the Project Team by the reviewer from B89.7- Measurement Uncertainty, who gave the opinion that it was improper to include both the half width of the distribution value and the uncertainty of that value in the evaluation of  $u(acc)$  as the uncertainty of the value is a second order correction.

**Summary:** It is the opinion of the Committee that the above issues should be incorporated into a revision of B89.3.7.

**Table B-2M (revised): Recommended Minimum Thickness for Normal Loading**

(240 kg/m<sup>2</sup> on Rectangular Granite Surface Plates on Three Supports)

Size (millimeters)			Area	Total Load	Granite Thickness (millimeters)*								
Width (w)	Length (L)	Diagonal	(m <sup>2</sup> )	(W in kg)	AA Grade			A Grade			B Grade		
					a	b	c	a	b	c	a	b	c
250	250	295	0.063	15	50	50	50	50	50	50	50	50	50
300	300	425	0.090	22	50	50	75	50	50	50	50	50	50
300	400	500	0.120	29	50	75	75	50	50	75	50	50	50
300	450	541	0.135	33	75	75	100	75	75	75	50	50	50
400	400	565	0.160	39	50	75	75	50	75	75	50	50	50
400	630	746	0.252	61	100	100	125	75	75	100	75	75	100
630	630	890	0.397	97	100	100	125	75	75	100	75	75	75
630	1000	1182	0.630	154	130	150	200	100	125	150	75	100	150
800	1200	1342	0.720	176	150	180	230	125	150	180	100	125	150
1000	1000	1414	1.000	244	130	150	200	100	125	175	75	100	150
1000	1500	1803	1.500	366	175	225	275	150	175	200	125	150	175
1000	2000	2236	2.000	488	250	275	330	180	225	275	150	175	225
1500	2000	2500	3.000	732	250	275	330	180	225	275	150	175	225
1500	3000	3354	4.500	1098	330	380	455	255	305	355	205	230	280
1500	3500	3808	5.250	1231	350	400	500	275	320	400	225	250	325
1500	4000	4272	6.000	1464	400	450	550	300	350	450	250	300	350

Column “a” is based on  $E = 62 \times 10^9 \text{ N/m}^2$

Column “b” is based on  $E = 38 \times 10^9 \text{ N/m}^2$

Column “c” is based on  $E = 21 \times 10^9 \text{ N/m}^2$

where E is Young’s Modulus of Elasticity

**Table B-2 (revised): Recommended Minimum Thickness for Normal Loading**

(50 lb/ft<sup>2</sup> on Rectangular Granite Surface Plates on Three Supports)

Size (inches)			Area	Total Load	Granite Thickness (inches)*								
Width (w)	Length (L)	Diagonal	(ft <sup>2</sup> )	(W in lb.)	AA Grade			A Grade			B Grade		
					a	b	c	a	b	c	a	b	c
12	12	17.0	1	50	3	3	3	2	2	2	2	2	2
12	18	21.6	1.5	75	3	3	4	3	3	3	2	2	2
18	18	25.5	2.25	112	3	4	4	3	3	3	2	2	2
18	24	30.0	3	150	4	4	5	3	3	4	2	3	3
24	24	33.9	4	200	4	4	5	3	3	4	3	3	4
24	36	43.3	6	300	5	6	7	4	6	6	3	4	5
24	48	53.7	8	400	6	8	9	5	6	7	4	5	6
36	36	50.9	9	450	5	6	7	4	5	6	3	4	4
36	48	60.0	12	600	6	7	9	5	6	7	4	5	6
36	60	70.0	15	750	7	9	11	6	7	8	5	6	7
36	72	80.5	18	900	9	10	13	7	8	10	6	7	8
48	48	67.9	16	800	7	8	9	5	6	8	4	5	6
48	60	76.9	20	1000	7	9	10	6	7	8	5	5	7
48	72	86.5	24	1200	8	10	12	7	8	10	5	6	8
48	96	107.3	32	1600	11	13	15	9	10	12	7	8	9
48	120	129.2	40	2000	13	15	18	10	12	14	8	9	11
60	120	134.2	50	2500	13	15	18	10	12	14	8	9	11
72	96	120.0	48	2400	10	12	15	8	10	12	6	7	9
72	144	161.0	72	3600	14	17	20	11	13	16	9	10	12

Column "a" is based on  $E = 9.0 \times 10^6$  psi.

Column "b" is based on  $E = 5.5 \times 10^6$  psi.

Column "c" is based on  $E = 3.0 \times 10^6$  psi.

where E is Young's Modulus of Elasticity

**Table B-3M (revised): Recommended Minimum Thickness for Heavy Loading**

(480 kg/m<sup>2</sup> on Rectangular Granite Surface Plates on Three Supports)

Size (millimeters)			Area	Total Load	Granite Thickness (millimeters)*								
Width (w)	Length (L)	Diagonal	(m <sup>2</sup> )	(W in kg)	AA Grade			A Grade			B Grade		
					a	b	c	a	b	c	a	b	c
250	250	295	0.063	30	75	75	75	75	75	75	75	75	75
300	300	425	0.090	44	75	75	100	75	75	75	75	75	75
300	400	500	0.120	58	75	100	100	75	75	100	75	75	75
300	450	541	0.135	66	100	100	125	100	100	100	75	75	75
400	400	565	0.160	78	75	100	100	75	100	100	75	75	75
400	630	746	0.252	122	125	125	150	100	100	125	100	100	125
630	630	890	0.397	194	125	125	150	100	100	125	100	100	100
630	1000	1182	0.630	308	175	200	250	125	150	225	125	150	200
800	1200	1342	0.720	352	200	225	300	150	200	225	125	150	200
1000	1000	1414	1.000	488	175	200	250	125	150	225	100	125	200
1000	1500	1803	1.500	732	225	275	350	200	225	250	150	200	225
1000	2000	2236	2.000	976	300	350	425	230	280	330	200	225	275
1500	2000	2500	3.000	1464	300	350	425	230	280	330	200	225	275
1500	3000	3354	4.500	2196	415	475	575	320	385	450	260	290	350
1500	3500	3808	5.250	2462	440	510	625	350	400	500	285	315	410
1500	4000	4272	6.000	2928	500	565	700	375	440	565	315	375	440

Column "a" is based on  $E = 62.05 \times 10^9 \text{ N/m}^2$

Column "b" is based on  $E = 37.92 \times 10^9 \text{ N/m}^2$

Column "c" is based on  $E = 20.68 \times 10^9 \text{ N/m}^2$

where E is Young's Modulus of Elasticity