GGG-P-463c
September 10, 1973
SUPERSEDING
Fed. Spec. GGG-P-463b
September 12, 1973

FEDERAL SPECIFICATION

PLATE, SURFACE, (GRANITE)

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers igneous rock (granite) surface plates for use in precision locating, layout, and inspection work. It encompasses new certification, recertification in the field, and recertification after resurfacing.

1.1.1 Federal specification coverage. Federal specifications do not include all styles, grades, and sizes of the commodity indicated by the titles of the specifications, but are intended to cover only those generally used by the Federal Government.

1.2 Classification.

1.2.1 Styles and grades. Surface p ates shall be of the following styles and grades.

Style (Shape):

Style 1 - Rectangular, no lip (see fig. 1).
Style 2 - Rectangular, 2 lip, either direction (see fig. 2).
Style 3 - Rectangular, 4 lip (see fig. 3).
Style 4 - Round, no lip (see fig. 4).

Grades:

Grade AA
Grade A
Grade B

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issues in effect on date of invitation for bids, or request for proposal, form a part of this specification to the extent specified herein:

Federal Specifications:

TT-V-121 - Varnish, Spar, Water-Resisting.
PPP-B-1055 - Barrier Material, Waterproofed, Flexible
PPP-B-601 - Boxes, Wood, Cleated-Plywood.
PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636 - Box, Fiberboard.
PPP-B-665 - Boxes, Paperboard, Metal-Stayed (Including Stayed Material).
PPP-B-676 - Boxes, Set-Up, Paperboard.
PPP-C-650 - Crates, Wood, Open and Covered.

Federal Standards:

Fed. Std. No. 123 - Marking for Domestic Shipment (Civil Agencies).

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards, and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Denver, San Francisco, Los Angeles, Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards, from established distribution points in their agencies.)

Military Specifications:

MIL-P-116 - Preservation, Methods of.
MIL-I-45177 - Instruments, Tracer, Surface Roughness.

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking and Waterproofing, with Appropriate Test Methods.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

American National Standards Institute, Inc., Standards:

B46.1 - Surface Texture-Surface Roughness, Waviness and Lay.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

American Society for Testing and Materials (ASTM) Standards:

C119-71, 1972, Vol. 12 - Standard Definitions of Terms Relating to Natural Building Stones.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

Uniform Classification Committee, Agent:

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

National Motor Freight Traffic Association, Incorporated, Agent:

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Association, Inc., Tariff Order Section, 1616 P St., N. W., Washington, DC 20036.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Material. Surface plates covered by this specification shall be made from fine or medium grained igneous rock such as biotite granite, biotite hornblende, diabase, hypersthene gabbro, muscovite-biotite, and muscovite biotite/granite-gneiss, etc. The material shall be free of seams, or other defects which may affect the serviceability of the surface plate. Other granites are acceptable provided they meet the requirements of this specification (see 4.5) and are in accordance with ASTM granite definition (see 6.3a).

3.2 Design and construction. The design and construction shall be such that the surface plate be free from any defects which may render it unserviceable.

3.2.1 Style. Surface plates covered by this specification shall be of the four styles illustrated in figures 1, 2, 3 and 4, respectively.

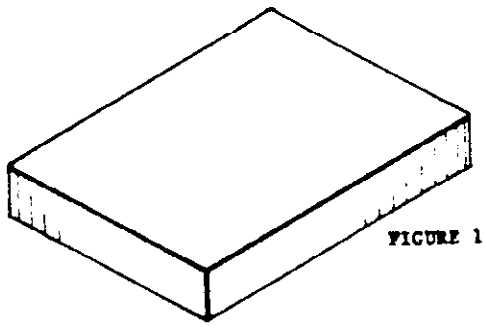


FIGURE 1. Style 1, plate, surface, no lip, rectangular.

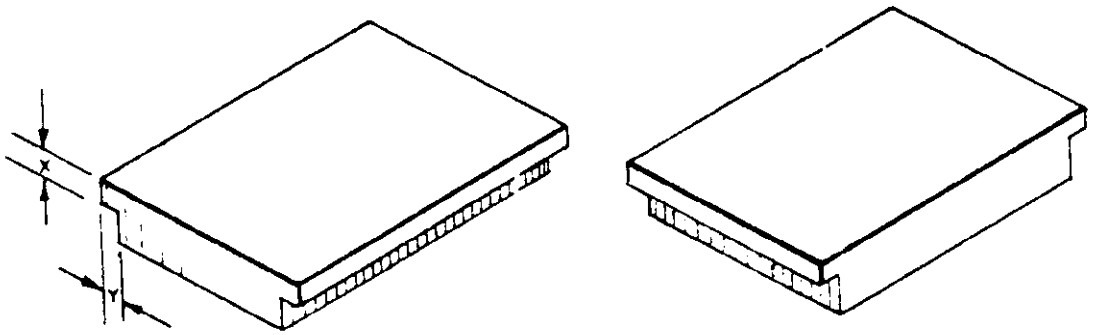


FIGURE 2. Style 2, plate, surface, 2 lip, either direction, rectangular.

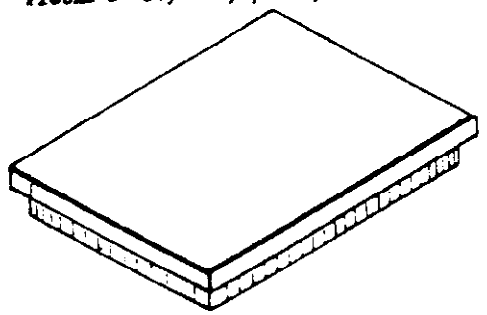


FIGURE 3. Style 3, plate, surface, 4 lip, rectangular.

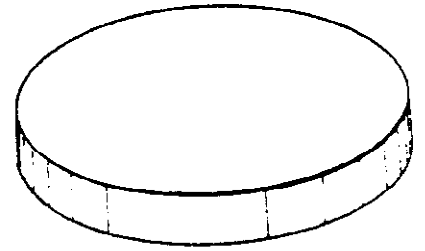


FIGURE 4. Style 4, plate, surface, no lip, round.

3.2.2 Size. Surface plates covered by this specification shall be of the sizes listed in table 1.

TABLE I. Standard sizes for granite surface plates
All linear dimensions in inches

	Width	Length	Thickness	Calculated Diagonal	Area (Sq.Ft.)
Rectangular					
	12	12	Specify thickness only if essential	17.0	1
	12	18		21.6	1.5
	18	18		25.5	2.25
	18	24		30.0	3
	24	24	See Appendix 30 and Tables XI an XII	33.9	4
	24	36		43.3	6
	24	48		53.7	8
	36	36		50.9	9
	36	48		60.0	12
	36	60		70.0	15
	36	72		80.5	18
	48	48		67.9	16
	48	60		76.9	20
	48	72		86.5	24
	48	96		107.3	32
	48	120		129.2	40
	60	120		134.2	50
	72	96		120.0	48
	72	144		161.0	72
Round				Diameter	
				12	.8
				18	1.8
				24	3.1
				36	7.1
				48	12.6

3.2.3 Thickness and stiffness. The surface plate shall have a thickness capable of supporting a total normal load equal to 50 pounds for each square foot of surface plate area loaded in the center of the plate without deflecting the plate along a diagonal or diameter more than one-half the flatness tolerance (see 4.5.3).

For abnormal loading conditions, the bidder should be notified of the intended use (during the "Request for Quote" period, see 6.2 (g)) for thickness modifications, if required (see appendix 30).

3.2.4 Clamping ledges (lips).

3.2.4.1 Clamping ledges on surface plates under 6 inches thick shall not be less than 40 percent of the surface plate thickness, in thickness (X, see figure 2) and the overhang (Y) shall be one-fourth of the surface plate thickness.

3.2.4.2 Clamping ledges on surface plates 6 inches thick or over shall not be less than 3 inches in thickness (X) and the overhang (Y) shall be not more than two inches (see figure 2 and appendix 70).

3.2.4.3 Ledge clamping surfaces shall be parallel with the working surface within 0.06 inch per foot.

3.2.5 Supports. Unless otherwise specified, support of the surface plate shall be by three fixed feet, located according to figures 5 and 6 to support the work surface properly, and to minimize sag and warp. When the three fixed supports have special requirements due to their location, abnormal load and/or vibration conditions, the supports and their locations shall be specified on the purchase order (see 6.2(e) and appendix 40).

3.2.5.1 Rectangular plates. The support pads shall be located no less than one-fifth or more than one-fourth of the length and width in from the ends and sides, respectively, with the exception that the single pad at one end shall be located in the center (see figure 5).

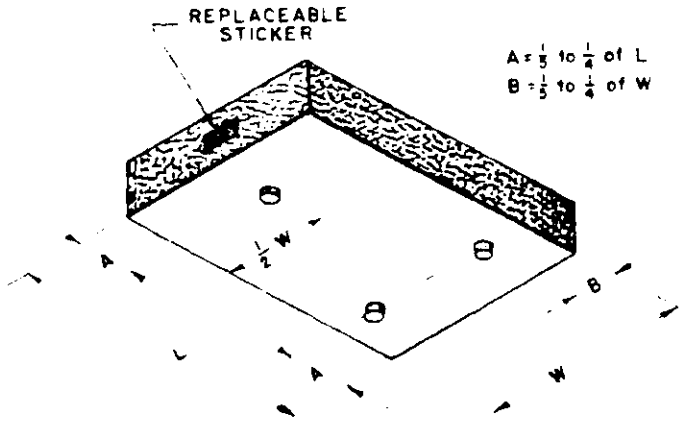


FIGURE 5. Support layout for rectangular surface plate.

3.2.5.2 Round plates. They shall be located at three equally spaced positions on a circle with a radius of approximately 0.7 radius of the plate measured from the center of the base surface (see figure 6).

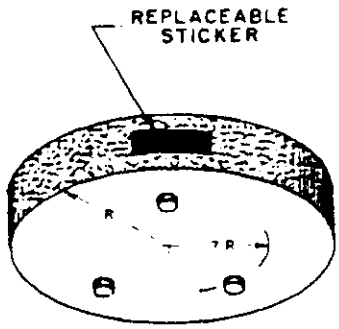


FIGURE 6. Support layout for round surface plate.

3.2.6 Holes, slots, and inserts Holes, slots, and inserts, when required, shall not deform or stress the work surface (see appendix 60).

3.3 Work surface.

3.3.1 Workmanship of work surface. The work surface shall be fine precision lapped, free from rough lapping marks, and objectionable scratches for the work surface area, (see 3.3.4.1). Evidence of loosely bound crystals on the surface of grade AA plates shall be cause for rejection. When periodically cleaned with soap and water or any other noncorrosive cleaner, the work surface shall have a quality of negligible stickiness when in contact with clean precision objects.

3.3.2 Surface texture. The surface roughness, average of five readings shall not exceed 32 microinches arithmetical average for grade AA and A plates and 64 microinches arithmetical average for grade B (see 4.5.4). To prevent sticking and permit free sliding of workpieces and accessories, the surface roughness shall not be less than 16 microinches.

3.3.3 Tolerances on repeat reading measurement. Tolerances on repeat reading measurement, when the work surface is scanned with the repeat reading gage, are given in table II (see 4.5.5 for test procedure). If the smallest tolerance is required, specify it on invitation for bid, contract or order (see 6.2(m)). If it is intended that small objects be measured on large surface plates, it should be noted that a larger tolerance in flatness over small areas is permitted on larger plates.

TABLE II. Tolerances for repeat reading of measurement

Diagonal or diameter range	Grade AA	Grade A	Grade B	Obtained
Inches	Full indicator movement (FIM) microinches			
Thru 30	35	60	110	
Over 30 thru 60	45	70	120	
Over 60 thru 90	60	80	160	When not specified
Over 90 thru 120	75	100	200	
Over 120 thru 150	90	120	240	
Over 150	100	140	280	
All sizes	25	50	100	When specified

3.3.4 Flatness tolerance. All points of the work surface (as measured with .375-inch diameter flat contacts or probes) shall be contained between two parallel planes, the base plane and the roof plane, separated a distance no greater than that specified for the respective grades. The enveloping planes shall be parallel to the reference plane (see figure 9). The work surface flatness tolerance for the three grades of plates are given in table III and 3.3.4.1. The tolerances on the A and B grade plates are 2 and 4 times respectively, those of grade AA. Listed values in table III do not necessarily comply with formula in 3.3.4.1 because they conform with commercial practice.

TABLE III. Total flatness tolerance in microinches

Rectangular plates Width	Length	Grade AA	Grade A	Grade B
Inches				
12	12	50	100	200
12	18	50	100	200
18	18	50	100	200
18	24	75	150	300
24	24	75	150	300
24	36	100	200	400
24	48	150	300	600
36	36	150	300	600
36	48	200	400	800
36	60	250	500	1000
36	72	300	600	1200
48	48	200	400	800
48	60	300	600	1200
48	72	350	700	1400
48	96	500	1000	2000
48	120	700	1400	2800
60	120	750	1500	3000
72	96	600	1200	2400
72	144	1100	2200	4400
Round plates diameter				
	12	50	100	200
	18	50	100	200
	24	75	150	300
	36	100	200	400
	48	125	250	500

3.3.4.1 Flatness tolerances for unlisted surface plate sizes. The flatness tolerances for unlisted grade AA plates are obtained from the following formula:

$$\text{Total flatness tolerance in microinches} = 40 + \frac{D^2}{25}$$

where D = diagonal or diameter of the plate in inches. The calculated flatness tolerance for grade AA is rounded off to the nearest 25 microinches. The tolerances on the A and B grade plates are 2 and 4 times, respectively, those for grade AA.

3.3.4.2 Working surface area. The flatness tolerance shall not include the surface along the edge of each size plate as specified in table IV.

TABLE IV. Restrictions on surface area for flatness tolerance - all values in inches

Diameter or diagonal of plate	Distance in from edges All grades
12 thru 48	1.0
over 48	1.5

1/ Under the supplier is responsible for the performance of

3.4 General workmanship.

3.4.1 Surface plates covered by this specification shall be new or resurfaced and of the quality necessary to produce good appearance.

3.4.2 Edges and corners. The work surface edges and corners shall be approximately 0.2-inch radius for plates one foot in diameter or length and 0.1-inch radius larger for each additional foot in size up to 0.5-inch maximum radius. All other edges and corners shall be smoothly rounded.

3.4.3 Sides adjacent to work surface, ledge surfaces and squareness. The four sides adjacent to work surface and all ledge surfaces shall have a surface texture such as is commercially produced by a wire saw cutting operation or better and shall be square with each other within 0.06-inch per foot.

3.4.4 Bottom surface. Bottom surface may have a surface texture as rough as is commercially produced by a gang saw or equal.

3.5 Nameplate and replaceable sticker.

3.5.1 Nameplate. The nameplate shall be permanent and withstand washing with surface plate cleaning solvents.

3.5.2 Location of the replaceable sticker.

3.5.2.1 Rectangular plates. The replaceable sticker shall be located on the side nearest to the single support pad (see figure 5).

3.5.2.2 Round plates. The replaceable sticker shall be located on the side nearest a support pad (see figure 6).

3.5.3 Information on nameplate. Unless otherwise specified (see 6.2(f)) the following information shall be permanently and legibly marked:

Manufacturer's name.
Manufacturer's serial number and grade.

3.5.4 Information on replaceable sticker at time of certification.

Flatness tolerance or maximum flatness deviation in microinches.
Full indicator movement of repeat reading gage in microinches.
Calibration thermal gradient and whether the higher temperature is at the top or bottom of plate.
Position dimensions from edge or edges for key points and secondary points.
Method of calibration.
Date of calibration and identification of certifier.

3.6 Covers. When specified (see 6.2(i)) the surface plates shall be furnished with properly fitted masonite, durable wood, plywood covers or other suitable material to protect the work surface when plates are not in use. The cover shall be so designed as to protect the edges as well as the work surface. Each masonite or wood cover shall be given at least two coats of varnish conforming to TT-V-121 or such paint as specified.

3.7 Seams and color streaks. Seams (see 6.3(v)) are cause for rejection. Color streaks have no effect on the serviceability of the granite (see 4.5.8) and are acceptable.

3.8 Certificate of conformance. All plates shall be furnished with a certificate of conformance which states that the plate meets the requirements of GGG-P-463c and which gives the rock type and an average value for the modulus of elasticity.

3.9 Report on flatness calibration. When a calibration report is requested on the quotation, bid, or purchase order (see 6.2(j)), the test procedure in 4.5.9 shall be followed and the results recorded for the patterns shown in figure 8.

3.10 Workmanship. The working surface shall have a uniform smooth finish free of uneven texture as evidence of rough preparatory finishing operations. All nongaging surfaces shall be finished free of snags, cavities, and sharp irregularities which interfere with cleaning and mounting. Mounting surface areas may have a uniformly textured flat surface for the adhesion of mounting pads. All other mounting surfaces shall be sufficiently smooth and flat to accommodate the intended mounting system.

3.11 Color. The surface plate color shall be the natural granite color, unless otherwise specified (see 6.2(n)).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform or have performed for it any of the inspections set forth in the specification to assure that supplies and services conform to prescribed requirements.

4.1.1 Inspection of materials and components. In accordance with 4.1 above, the supplier is responsible for insuring that materials and components used were manufactured, tested, and inspected in accordance with the requirements of referenced subsidiary specifications and standards to the extent specified herein, or, if none, in accordance with this specification.

4.2 Inspection by dimensional metrology laboratories. When specified (see 6.4.1.), surface plates shall be delivered to the Government or commercial dimensional metrology laboratory designated in the contract or order for the tests and inspections specified in 4.5, or elsewere in the contract, prior to acceptance.

4.3 Sampling procedures. Sampling procedures shall be in accordance with MIL-STD-105. Data for sampling shall be as stated in table V. The sample unit shall consist of one surface plate.

TABLE V. Sampling data

Category	Sample unit	Inspection level	Acceptable quality level (AQL)	AQL expressed in terms of	Reference
Visual examination	1 ea	II	Major 2.5 Minor 6.5	Percent defective	4.4.1
Dimensional examination	1 ea	II	6.5	Percent defective	4.4.2
Testing:					
Group A	1 ea	II	1.5	Percent defective	4.5.1
Group B	1 ea	II	1.0	Percent defective	4.5.2
Preparation for delivery	one container	S-2	4.0	Defect per unit	4.6

4.4 Examination.

4.4.1 Visual examination. Each sample unit shall be examined for any nonconformance in design, material, workmanship and marking. Defects are listed in table VI.

TABLE VI. Classification of defects

Category	Defects
Critical	None defined
Major	
101	Style or size not as specified.
102	Evidence of chips, fractures, seams, rough edges and rough lapping marks.
103	Support pads not as specified.
104	Manufacturer's report of calibration or certificate of conformance if required, missing.
105	Marking: Manufacturer's name, serial number or information on replaceable sticker, missing.

4.4.2 Dimensional examination. Each sample sent shall be examined for any nonconformance with dimensional requirements of 3.2.2 and 3.2.4.

4.5 Testing. Each sample unit shall be tested in accordance with 4.5.1 through 4.5.8, without damage to working surface except if seam exists, in accordance with the established procedures of the laboratory making the test. The temperature gradients that occur in the plate create significant distortion (see appendix B0). This thermal distortion is included in the calibration for flatness. Therefore, for the calibration to have significance the plate should be maintained at the same thermal condition as when calibrated. If these conditions are kept alike within the limits expressed in table VII, the flatness distortion will not exceed one-half of the tolerance given in table III. It is realistic to match the anticipated thermal gradients of the air at the level and position the plate is to occupy. Also, local thermal gradients can be reduced by not mounting on the surface plate those calibrating instruments with built-in heat sources.

After the thermal soaking time has past and just before calibration starts, the thermal gradient in the plate for original calibration shall not exceed 0.12°F per inch of plate thickness. When the original calibration on the new plate is certified by a second party, the direction of the thermal gradient shall be maintained.

TABLE VII. Thermal gradient in granite

Grade	Degree Fahrenheit per inch of thickness of plate
AA	0.05
A	0.1
B	0.2

4.5.1 Group A tests. Each sample unit shall be subjected to the applicable tests of 4.5.3 thickness and stiffness, 4.5.4 surface texture, 4.5.7 squareness, and 4.5.8 seams. Data for testing is stated in table VIII.

4.5.2 Group B tests. Each sample unit shall be subjected to the applicable tests of either 4.5.5 repeat reading measurement and 4.5.6 flatness of work surface. Data for testing is stated in table VIII.

TABLE VIII. Data for testing

Tests	Section 4 reference	Section 3 reference
Group A		
Thickness and stiffness	4.5.3	3.2.3
Surface texture	4.5.4	3.3.2
Squareness	4.5.7	3.4.3
Seams	4.5.8	3.7
Group B		
Repeat reading measurement	4.5.5	3.3.3
Flatness of work surface	4.5.6	3.3.4

4.5.3 Thickness and stiffness test. A thick circular steel plate, with a minimum thickness the larger of 0.5 inch or 0.0005 inch times the load in pounds, and a diameter approximately equal to 1/6 the diameter or diagonal of the surface plate is placed on the center of the plate. The surface plate shall be supported on three feet as specified in 3.2.5.1 and 3 2.5.2. A rigid beam is supported on feet located at the extremes of the plate diameter or diagonal and an indicator with sufficient range and sensitivity is positioned half way between the feet on this beam. A cage for transmitting the load to the surface plate straddles the beam and rests on the circular plate. The area where the indicator point contacts the circular plate shall be flat. The difference in indicator readings before and after loading the cage at 50 pounds per square foot of surface plate area shall not exceed 1/2 the work surface tolerance. The rigid beam for sag measurements on round plates shall be located to pass over one support pad. Other methods for measuring the deflection may be used as long as the results are comparable.

4.5.4 Surface texture. The surface roughness shall be assessed with a tracer type surface profile measuring instrument using 0.03-inch cut-off which meets the requirements of the current issue of American National Standard B46.1. The surface plate shall be sampled near the center and at four random positions away from the center. See 3.3.2 for allowable arithmetical average (AA) surface roughness values.

4.5.5 Test for repeat reading. A repeat reading gage in general conformance with figure 7 shall be used to indicate the variation in surface flatness. Place the repeat reading gage in the center of the surface plate on the longest center line and zero the indicator. For plates with diagonals or diameters under 18 inches, the scanning pattern of the gage is random. For larger plates scan the eight-line pattern shown in figure 8 and additional equally spaced coordinate lines such that no spacing between scanned lines exceeds 6 inches. The FIR shall not exceed the values given in table II. The least graduation of the meter or dial may be 10 microinches o 1/5 of the FIR value, whichever is the larger.

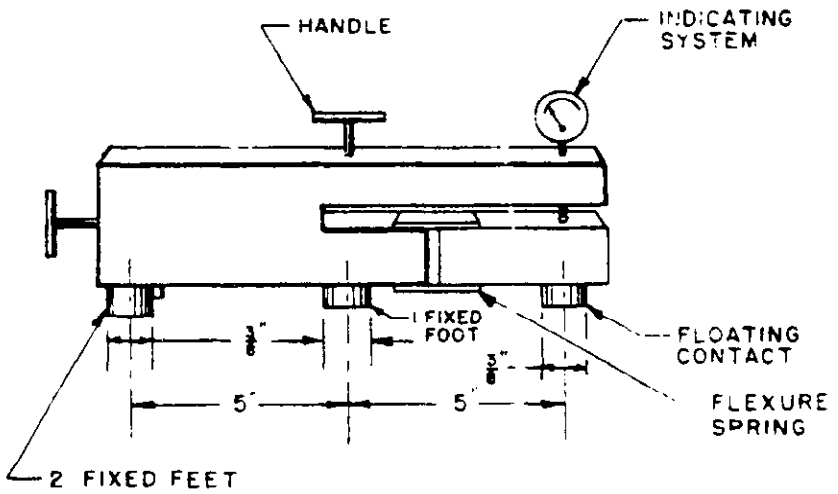


FIGURE 7. Repeat reading gage.

4.5.6 Acceptance tests for flatness. One test consists of two diagonal profile runs from the corners for rectangular plates or two orthogonal profile runs for round plates intersecting at the center and a third profile run which passes through the intersection point and the point of maximum departure found by scanning the work surface with repeat reading gage. The reference plane is established by balancing the ends of the profile lines as given in section 4.5.9. The third line is also balanced. The sum of the maximum upward and maximum downward deviation from the reference plane shall not exceed the flatness tolerance of section 3.3.4. The surface plate shall also meet the test requirements of 4.5.5. If the results from these tests are challenged, the referee test of section 4.5.9 shall be carried out.

4.5.7 Test for squareness of sides. Squareness of sides shall be checked with a machinist square and feeler gages or by equivalent test.

4.5.8 Test for seams and color streaks. Test for seam is to wet the smooth surface of the granite where the seam or color streaks appears; then dry it off. If the streak remains wet or damp, it is a seam.

If the results are still questionable, proceed with the following test:

Support the surface plate on a strip of wood under the center line of the streak. Upon two strips of wood, one on each side of the streak, as remote as possible from the streak support a load of 200 lb for each square foot of surface area. This load is to be central to the two supports. If the plate breaks the mark was a seam or crack.

4.5.9 Flatness calibration and referee test. The eight-line (four sides, two diagonal and two orthogonal center lines - see figure 8) grid pattern shall be used in calibrating a surface plate whenever the test results from sections 4.5.5 and 4.5.6 are challenged. The reference plane passes through the intersection point of the diagonal profiles. The intersection point is arbitrarily set to zero and the reference plane is balanced equal distant from the end points of the diagonal profiles. The data points,

equally spaced for each profile, shall be selected so that one exists at the middle of each profile line. The elevation of each data point shall be reported with respect to the reference plane and recorded on the eight-line pattern. The maximum vertical displacement (+) upward above the reference plane locates the roof plane and the maximum vertical displacement (-) downward below the reference plane locates the base plane (see figure 9). When stepping off the profile lines rigid triangulation shall be adhered to and the intersection points of all lines shall fall within a 0.3-inch diameter circle of each other, therefore, adjustable pad spacing sleds shall be required for the diagonal profile runs if fixed pad spacing sleds do not meet the requirements for precise triangulation. The minimum number of steps per profile run shall be 6, the maximum step spacing shall be 12 inches and the number of steps shall always be an even number. The contact probe or the two pads on the sleds which trace the profile line shall be 0.375-inch in diameter with sharp (not beveled) edge. The outrigger pad on sleds may be a minimum of 0.375-inch diameter or dimensioned approximately 0.4 x 0.5 inches for uniform pad wear (see figure 10).

A similar system of diagonals, perimeter and center lines may be calibrated on plates, and especially on small ones, by using a precision calibrated straight edge, adjustable supports and a suitably mounted indicator or by using the in-line flatness gage with master flat or straight edge for zero setting the indicator (see 6.3(z)).

Most instruments do not work satisfactorily close to the edge as specified in table IV, therefore, the eight-line grid pattern may be reduced to size, but the edge profile shall be tied to the pattern by other instrumentation, such as master straight edge with indicator or in-line flatness gage.

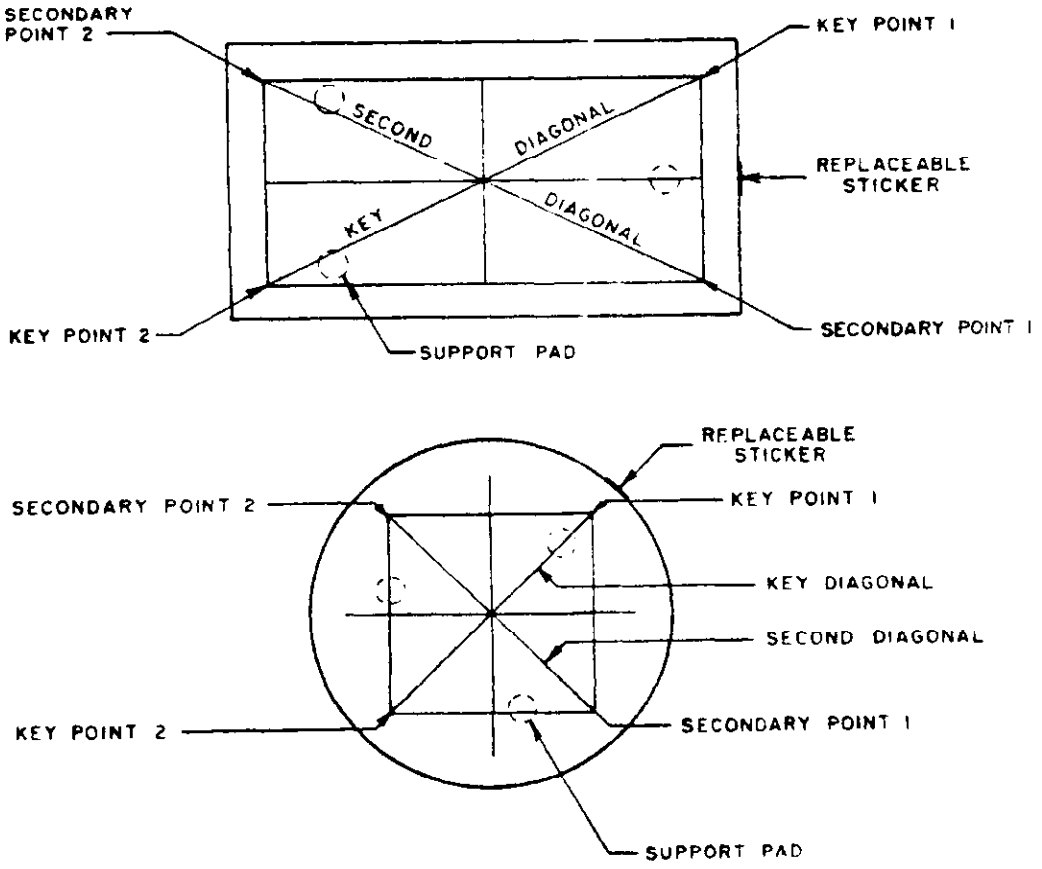


FIGURE 8. Eight-line calibration pattern for rectangular and round surface plates.

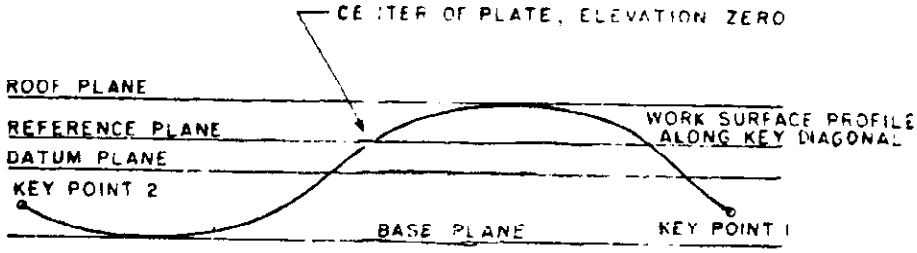


FIGURE 9 Plane identification.

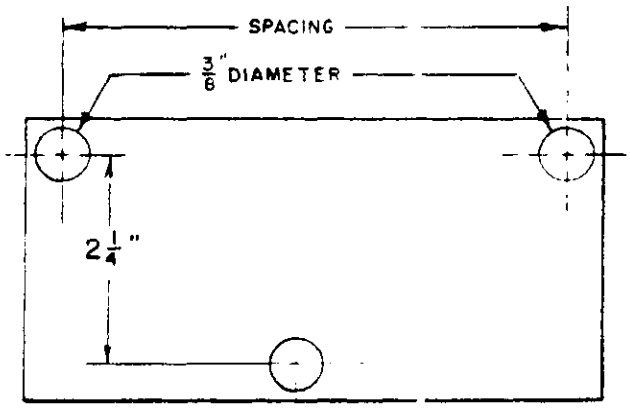


FIGURE 10. Pad locations on mirror or detector carriage.

4.6 Inspection of packaging requirements prior to delivery. An inspection shall be made to determine that packaging, packing, and marking comply with the requirements in section 5 of this specification. Defects shall be scored in accordance with table II-A of MIL-STD-105 and as shown in table IX. For examination of interior packaging, the sample unit shall be one shipping container fully prepared for delivery, selected at random just prior to the closing operations. Sampling shall be in accordance with MIL-STD-105. Defects of closure listed shall be examined on shipping containers fully prepared for delivery. The lot size shall be the number of shipping containers in the end item inspection lot. The inspection level shall be S-2, with an AQL of 4.0 percent defects per 100 units.

TABLE IX. Classification of preparation for delivery defects

Examine	Defects
Markings (exterior and interior)	Omitted; incorrect; illegible; improper size; location, sequence or method of application.
Materials	Any component missing or damaged.
Workmanship	Inadequate application of components such as incomplete closure of container flaps, loose strapping, inadequate stapling. Distortion of container.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging.

5.1.1 Level A. Plates not exceeding 40 pounds in weight shall be individually packaged in containers conforming to PPP-B-676, PPP-B-636, or PPP-B-665. Plates shall be cushioned, blocked, and braced within containers in accordance with method III of MIL-P-116. In addition, the top surface of the plates shall be protected with a layer(s) of barrier material conforming to PPP-B-1055. Barrier material shall be so applied as to prevent marring of the surface. Plates exceeding 40 pounds in weight shall be individually packed, as specified in 5.2.1.2, and shall have top surfaces protected as specified for plates less than 40 pounds in weight.

5.1.2 Level C. Packaging shall be in accordance with the manufacturer's commercial practice.

5.2 Packing.

5.2.1 Level A.

5.2.1.1 Plates (less than 40 pounds). Plates packaged as specified in 5.1 shall be packed in wood-cleated-plywood, or nailed wood boxes conforming to PPP-B-601 overseas type or PPP-B-621 class 2. Boxes shall be closed and strapped in accordance with the applicable container specification. The gross weight of boxes shall not exceed 150 pounds.

5.2.1.2 Plates (more than 40 pounds). Plates exceeding 40 pounds in weight shall be individually packed in nailed wood boxes or fully sheathed crates conforming to PPP-B-621 class 2 or PPP-C-650. Boxes shall be modified by the addition of nominal 2 x 4-inch skids placed flat for weights exceeding 150 pounds, except that when the net weight of plate exceeds 500 pounds, the plate shall be packed in a fully sheathed crate.

5.2.2 Level B.

5.2.2.1 Plates (less than 40 pounds). Plates packaged as specified in 5.1 shall be packed in cleated plywood, nailed wood, or fiber board boxes conforming to PPP-B-621 class 1, PPP-B-636 class domestic, and PPP-B-601 domestic types, respectively. Particle board may be substituted for the wood or plywood members of nailed wood or cleated plywood boxes provided that the performance requirements of the box specifications are met. Gross weight of shipping containers shall not exceed 200 pounds. Methods of cushioning and materials required to protect items from shock shall be in accordance with MIL-STD-1186.

5.2.2.2 Plates (more than 40 pounds). Plates exceeding 40 pounds in weight shall be packed in accordance with 5.2.1.2 except that the boxes conforming to PPP-B-636, class domestic may be used.

5.2.3 Level C. Plate packaged in accordance with 5.1 shall be packed to assure carrier acceptance and safe delivery at destination. Containers shall comply with the requirements of the Uniform Freight Classification or National Motor Freight Classification.

5.3 Marking.

5.3.1 Civil agencies. In addition to any special marking specified in the contract or order, unit packages and shipping containers shall be marked in accordance with Federal Standard No. 123.

5.3.2 Military agencies. In addition to any special marking required by the contract or order, unit packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use.

6.1.1 Select the grade and size of surface plate with a flatness tolerance which does not exceed between 1/5 to 1/10 of the blueprint tolerance, and that is appropriate for the size of items to be measured. The user must also consider the additional flatness error introduced into the work surface due to the laboratory or workshop environment (see appendix B0).

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Style required (see 1.2.1). In style 2, indicate whether the ledges are required along the short or long dimension.
(c) Sizes (see 3.2.2 and table I). Specify thickness only if required.
(d) Grade required (see 1.2.1, 3.3.4, 6.1.1, tables II and III).
(e) Position of supports (see 3.2.5.1, 3.2.5.2 and appendix A0).
(f) Name plate requirements, if different (see 3.5).
(g) Abnormal loading conditions, if required (see 3.2.3 and appendix B0).
(h) Holes, slots, and inserts, if required (see 3.2.6 and appendix C0).
(i) Covers, if required (see 3.6).
(j) Flatness calibration report, if required (see 3.9).
(k) Levels of packaging and packing (see section 5).
(l) Special marking, if required (see 5.3).
(m) Smallest repeat reading measurement, if required (see 3.3.3).
(n) Dye coloring for appearance, if required (see 3.11).

6.2.1 Data with bid. The purchaser, in his request for bid, shall refer to various paragraphs of this specification which the bidder shall accept in his bid. Each bidder shall furnish with his bid, complete data covering the items he proposes to furnish under this specification which are not in agreement with the purchaser's invitation to bid.

6.3 Definitions.

(a) Granite. The definition for granite is given in ASTM-C119-71, 1972, Vol. 12.

(b) Inch. The unit of length is the inch which is defined as exactly 0.0254 meters.

(c) Microinch. The microinch unit of length is equal to 0.000001 inch.

(d) Grade. Grade is the classification of a surface plate according to specific manufacturing tolerances on work surface flatness.

(e) Error of measurement. Error of measurement is the difference in magnitude between the true value of a quantity and its measured value.

(f) Precision. Precision is the amount of agreement between a randomly distributed group of measurements of the same quantity.

(g) Flatness. Flatness of a surface plate is the shortest distance between the roof plane and the base plane.

(h) Surface texture. Surface texture is the repetitive or random deviations from the nominal surface which forms the pattern of the surface and includes roughness, pits and scratches.

(i) Waviness of a surface plate. Waviness of a surface plate is the widely spaced repetitive components of surface texture with spacing widths of 1-inch and larger.

(j) Localized deviations. Localized deviations are departures of points on the work surface from a true plane or a very large radius sphere. They include low and high places, voids, and some waviness amplitudes.

(k) Key point 1. Key point 1 is the starting point on the surface on the eight-line grid pattern for the calibration of the work surface flatness. When one faces the replaceable sticker on rectangular plates, it is located to the right of the replaceable sticker near the corner on the surface and on circular plates at a point on the surface on a radial line to the replaceable sticker.

(l) Key point 2. Key point 2 on rectangular plates is located at a point on the surface near the edge and opposite key point 1 on the near right to far left diagonal. Key point 2 on circular plates is located on the surface at a point near the far end of a line passing from key point 1 through the center of the surface.

(m) Key diagonal. The key diagonal joins key points 1 and 2 which are equal distance from reference plane.

(n) Second diagonal. On rectangular plates, the second diagonal runs from the near left, when facing the replaceable sticker, to far right corner. On circular plates, the second diagonal runs at right angles through the center of the key diagonal.

(o) Secondary point 1. Secondary point 1 is located to the left on the end of the second diagonal profile run.

(p) Secondary point 2. Secondary point 2 is located on the opposite end to the secondary point 1 on the second diagonal profile run.

(q) Reference plane. The reference plane is arbitrarily set on elevation zero and is balanced equal distance from the end points of the key diagonal and from the end points of the second diagonal.

(r) Datum plane. The datum plane is a plane parallel to the reference plane and located midway between the points on the work surface having maximum positive and maximum negative normal displacements measured from the reference plane. The datum plane is located midway between the base plane and the roof plane. Note: Vertical displacements are measured positively (+) upward and negatively (-) downward.

(s) Base plane. The base plane is a plane, parallel to the reference plane, passing through the point on the work surface that has the maximum vertical displacement measured below the reference plane.

(t) Roof plane. The roof plane is a plane, parallel to the reference plane, passing through the point on the work surface that has the maximum vertical displacement measures above the reference plane.

(u) Stiffness. The stiffness of a granite is the resistance to sag under load.

(v) Seam. A seam is a flaw or crack in the granite.

(w) Color streak. A color streak is either, (1) a ribbon of different color granite due to a different crystal formation during the cooling process, or (2) a seam which has healed over with granite of a different color.

(x) Calibration thermal gradient. The calibration thermal gradient is the difference in temperature from top to bottom of the surface plate at time of certification after lapping or at time of calibration.

(y) Repeat reading gage. The repeat reading gage (see figure 7) is a height gage consisting of a 5-inch base with 3 fixed feet in a tripod configuration, an extension arm to support an indicating system 5 inches from the base and a flexure spring supported floating arm with contact foot located between the indicator sensor and test surface. The centerline through the floating contact and the front foot of the base is normal to and bisects the centerline between the two rear feet. This instrument estimates the ability to reproduce a measurement of a fixed height anyplace on the surface of the plate.

(z) In-line flatness gage. The in-line flatness gage is similar to the repeat reading gage except that two of the fixed feet in the base are in-line with the floating contact. Their spacings are equal. Interchangeable pairs of fixed feet provide correct stepping distances for profile runs. This instrument produces data to establish profiles which can be assembled to determine flatness.

6.4 Designation of testing facility. The originating activity should designate the commercial dimensional metrology laboratory or the Government testing laboratory which they desire to conduct the test and examination specified in 4.2.

6.4.1 The Government testing laboratory designated should be within the same Government department as the originating activity, whenever applicable (see 4.2).

6.5 Supersession data. Styles 1, 2, and 4 have been added, grade AA has been added, class I and II has been deleted, hardness 1 and 2 has been deleted, physical characteristics have been deleted, and wear resistance test has been deleted.

APPENDIX

10. Scope. The following material is not part of the Federal Specification. It is intended as advisory information only.

20. Mineralogical, physical qualities, and physical tests. The mineralogical physical qualities and physical tests of the rock types are referenced in the National Bureau of Standards Research Paper RP 1320 (see table X).

TABLE X. Granite rock-types, physical properties and mineral components

Rock-type	Natural color	Texture	Mineral constituents in descending order of abundance	Modulus of elasticity 10^6 psi range
Biotite granite	Bluish gray	Fine-grained	Orthoclase, smokey quartz(1), oligoclase, albite, biotite, muscovite, magnetite and zircon	3.5 to 7.0
Biotite granite	Light gray	Medium-grained	Oligoclase, orthoclase and microcline, quartz, biotite, apatite and zircon	3.5 to 7.0
Biotite granite	Pink	Medium-grained	Orthoclase with a small amount of microcline, plagioclase, quartz(1), biotite, magnetite and garnet	5.0 to 9.0
Biotite hornblende granite	Reddish brown	Fine-grained	Orthoclase and microcline, quartz(1), hornblende, biotite, plagioclase and magnetite	6.0 to 9.0
Biotite-muscovite	Light gray	Medium to fine-grained	Microcline, quartz, plagioclase, biotite, muscovite and magnetite	5.0 to 7.0
Diabase	Dark gray	Fine-grained	Plagioclase, pyroxene and magnetite	9.0 to 12.0
Hypersthene Gabbro	Dark gray	Fine-grained	Plagioclase, pryroxene, hornblende, magnetite and biotite	10.0 to 12.0
Muscovite-biotite granite-gneiss	Light gray	Medium-grained	Microcline and orthoclase, oligoclase, quartz, rutile, muscovite, biotite and apatite	3.5 to 8.0

(1) 28 to 32 percent quartz by volume. Under certain conditions, high quartz content tends to increase wear life.

30. Thickness. The following information is only useful in calculating the thickness for rectangular plates when the plate is supported on three supports at 1/5 L positions as shown in figure 5.

$$t = \sqrt[3]{\frac{WL^2 \, f\left(\frac{L}{W}\right)}{Ed}}$$

where

t = Thickness of plate in inches.
W = Concentrated load in pounds at center (pounds per square foot times area in square feet).
L = Length of plate in inches.
w = Width of plate in inches.
E = Modulus of elasticity (see table X).
d = Total deflection, center below extreme corners.
$f\left(\frac{L}{w}\right)$ = Values derived by Research Institute of the University of Dayton.

$\frac{L}{w}$	$f\left(\frac{L}{w}\right)$
1.0	.12
1.5	.14
2.0	.18
2.5	.22
3.0	.26
4.0	.34
6.0	.55

Recommended minimum thicknesses for rectangular granite plates for deflection equal to or slightly less than one-half of the flatness tolerance, for three values of modulus of elasticity and for concentrated center loading of 50 and 100 pounds per square foot of work surface area are tabulated in tables XI and XII.

There is no empirical equation available for calculating the thickness of circular granite surface plates. The present practice is to make the thickness equal to 1/3 of the diameter. This thickness supports a concentrated load equivalen to 50 pounds per square foot for a granite with modulus of elasticity as low as 3×10^6 psi.

TABLE XI. Recommended minimum thickness for normal loading at 50 pounds per square foot on rectangular granite surface plates on three supports.

Size Inches			Area	Total load	Granite Thickness in Inches[2]								
					AA Grade			A Grade			B Grade		
Width w	Length L	Diagonal	Sq. Ft.	W lbs	a	b	c	a	b	c	a	b	c
12	12	17.0	1	50	2	2	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 based on $E = 9.0 \times 10^6$ psi.
Column b based on $E = 5.5 \times 10^6$ psi.
Column c based on $E = 3.0 \times 10^6$ psi.
where E is Young's Modulus of Elasticity

[2] An Ad Hoc surface plate committee made these minimum thickness recommendations in line with present manufacturing practice, therefore, some thicknesses are greater than the the values calculated with the equation given in section 30.

TABLE XII. Recommended minimum thickness for abnormal loading at 100 pounds per square foot for ructangular granite surface plates on three supports.

Size Inches			Area	Total load	Granite Thickness in Inches (2)								
					AA Grade			A Grade			B Grade		
Width W	Length L	Diagonal	Sq. Ft.	W lbs	a	b	c	a	b	c	a	b	c
12	12	17.0	1	100	3	3	3	3	3	3	3	3	3
12	18	21.6	1.5	150	4	4	5	4	4	4	4	4	3
18	18	25.5	2.25	225	4	4	5	4	4	4	3	4	3
18	24	30.0	3	300	4	5	6	4	4	5	4	4	4
24	24	33.9	4	400	5	6	6	4	5	5	3	4	4
24	36	43.3	6	600	6	7	9	5	6	7	4	5	6
24	48	53.7	8	800	8	9	12	6	8	9	5	6	7
36	36	50.9	9	900	6	7	9	5	6	7	5	5	6
36	48	60.0	12	1200	8	9	11	6	7	9	6	6	7
36	60	70.0	15	1500	10	11	13	8	9	11	6	7	8
36	72	80.5	18	1800	12	13	16	10	10	13	8	8	10
48	48	67.9	16	1600	8	10	12	6	8	10	6	6	8
48	60	76.9	20	2000	10	11	13	8	9	10	6	7	8
48	72	86.5	24	2400	12	12	15	10	10	12	8	8	9
48	96	107.3	32	3200	14	16	19	12	13	15	10	10	12
48	120	129.2	40	4000	16	18	23	14	15	18	12	12	14
60	120	134.2	50	5000	16	18	23	14	15	18	12	12	14
72	96	120.0	48	4800	14	15	19	12	12	15	10	10	12
72	144	161.0	72	7200	18	21	25	16	17	20	14	14	16

Column a based on E = 9.0×10^6 psi.
Column b based on E = 5.5×10^6 psi.
Column c based on E = 3.0×10^6 psi.
where E is Young's Modulus of Elasticity

40. Supports. There are working and loading conditions where the standard three point supports are not satisfactory. These cases should be individually engineered. When four or more supports are used, shims or adjusting screws are necessary to make all supports receive their share of the load. If a plate is used for a particularly heavy load, adjustable supports, which indicate the lift they are applying, may be considered. The supports could be spotted under the loading points and set to approximately equal the loading. Sometimes the work surface flatness can be improved by shifting support positions. Fulcrum, air, and hydraulic supports are available. Whenever nonstandard supports are used, the surface plate shall be calibrated at the site for compliance to the flatness tolerance. When supports at their permanent location are not attached to the plate, a diagram shall be supplied showing the proper location of supporting points for calibration purposes.

40.1 Resilient supports. Resilient supports may be used on surface plates. They are necessary where there is excessive seismic and cultural vibration present in the area. The resilient supports should have the following characteristics.

40.1.1 Three resilient supports should be used on all plates unless excessive size and weight or extreme loading conditions dictate additional supports. These supports may be servo controlled for leveling if desired.

40.1.2 The resilient supports should be resilient in the two horizontal axes and the vertical axis. Damping in each of the three axes shall be a minimum of 10 percent of critical damping and should not be damped by friction.

40.1.3 To effectively isolate the vibration, a mou ting system with a natural frequency of less than 2.5 hz should be used. When very sensitive work is be ng performed or when the disturbing vibration frequency is low, a much lower natural frequency isolation system must be employed.

40.2 Resilient support effects. The use of resili nt supports (an isolation system) reduces the effects of seismic and cultural vibrations in the floor. The percentage of the reduction will be a function of the vibration frequency and the natural frequency of the isolation system, i.e., the lower the natural frequency, the greater the isolation.

50. Flatness and surface texture. The work surface geometry may change rapidly on granite plates with rougher finishes than section 3.3.2 permits. When fin particles become embedded in the gage base or base of an inspection part, the charged base can abrade the work surface.

60. Holes, slots, and inserts. Holes, slots, or inserts are not recommended on the work surface of grade AA surface plates because their use may cause the surface contour to change. They may be used on grades A and B plates. They should be used with caution.

60.1 Torque on threaded inserts. Do not exceed the following maximum torque values by using a torque wrench to limit distorting the work surface and pulling the insert.

TABLE XIII. Permissible torque clamping on threaded inserts.

Thread size	Torque
0.250 inch	7 ft lb
.3125 inch	15 ft lb
.375 inch	20 ft lb
.500 inch	25 ft lb
.625 inch	30 ft lb

70. Clamping ledges on grade AA surface plates. There is danger of distorting the work surface flatness beyond tolerance when a heavy item rests on the ledge or an item is clamped to the ledge.

80. Thermal gradients. Thermal gradients between the top and bottom surfaces of a granite plate distort the work surface. Figure 11 gives the theoretical values in microinches for the sagitta heights per degree Fahrenheit temperature difference between top and bottom of surface plate for all sizes and thickness of plates covered by this specification. This graph is for an average granite coefficient of thermal expansion of 3.5×10^{-6} inch per degree Fahrenheit. If the temperature at the top of the granite plate is hotter, the work surface is convex and if it is colder, the work surface is concave.

80.1 Example. Grade A granite plate size 2-feet by 3-feet by 6 inches with temperature gradient of 2.3°F and with work surface at the higher temperature. From table I, its diagonal is 43.3 inches. The work surface diagonal is 43.3 - (2 x 1.5) = 40.3 inches (see table IV). On graph figure 11, locate 40.3 inches on horizontal base boundary line; follow this position vertically to the intersection of the slanted line for 6-inch thickness; then follow this level horizontally to the left vertical boundary line and read the value 122 microinches/°F. Multiply 122 by 2.3°F and you get 281 microinches rise at the work surface center with respect to the corners.

90. Temperature soaking time[3]. Before granite surface plates are measured for work surface flatness, the granite should remain in the calibration area until it has reached the room temperature. Large plates require more soak-out time than smaller ones. The following will help in estimating the soak-out time.

[3] Research by E. R. McClure, Lawrence Livermore Laboratory, Livermore, California.

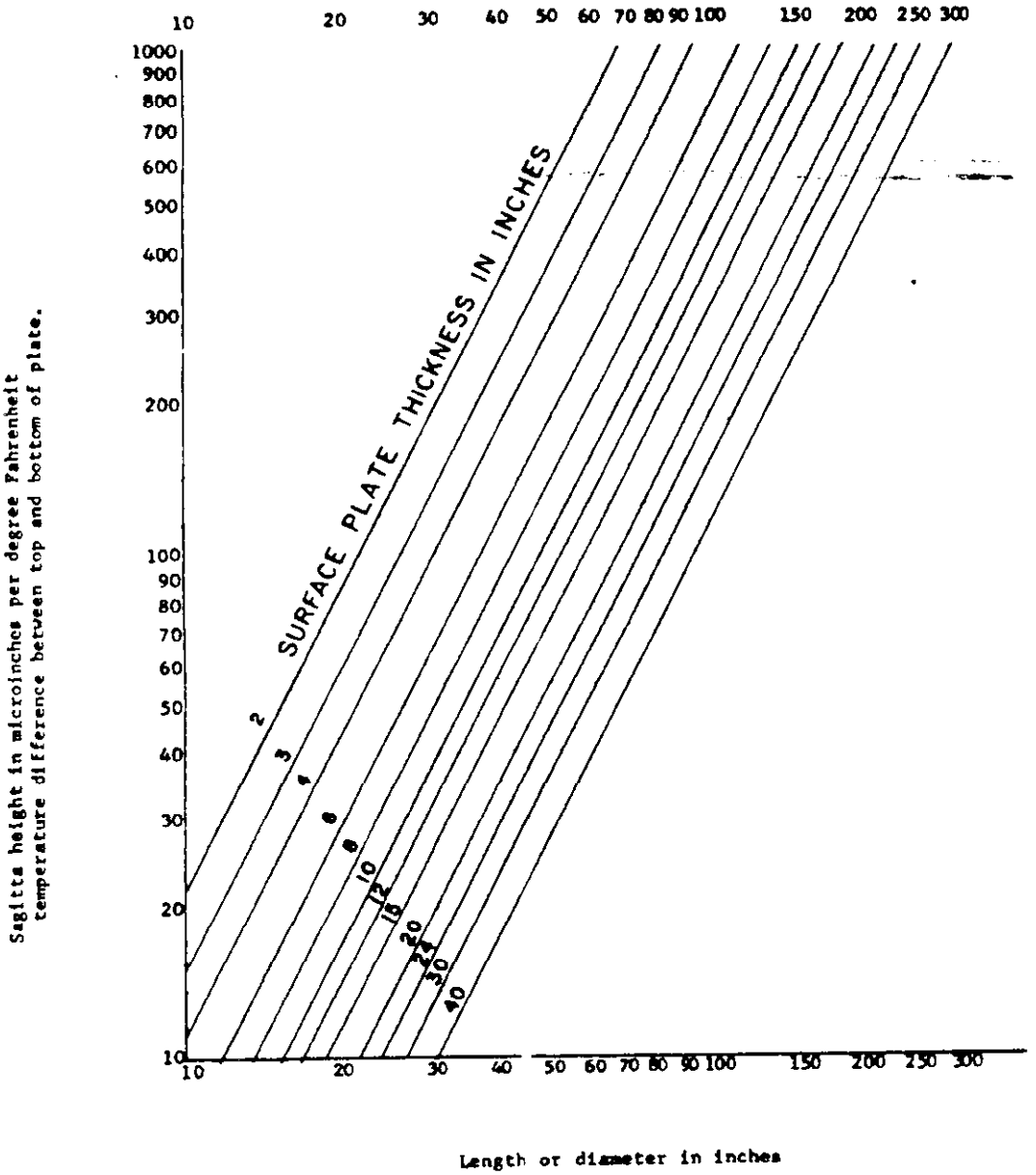


FIGURE 11. Work surface distortion due to thermal gradients in surface plate.

$$\text{Soak-out time} = K \frac{16.2}{\frac{1}{L} + \frac{1}{w} + \frac{1}{H}} \text{ hr. (rectangular) plates}$$

$$= K \frac{8.1}{\frac{1}{2R} + \frac{1}{D}} \text{ hr. (round) plates}$$

where L = Length of surface plate in ft.
w = Width of surface plate in ft.
H = Height of surface plate in ft.
D = Diameter of surface plate in ft.

and K is a multiplier determined as follows:

given T_1 = Temperature of granite before soak-out, °F.

T_2 = Temperature of granite at time of measurement, °F.

$\Delta T = T_2 - T_1$ = Temperature change of environment, °F.

RTO = Residual Temperature Offset, or required closeness to final temperature, °F.

Calculate RTO/ΔT and read K from chart, figure 12.

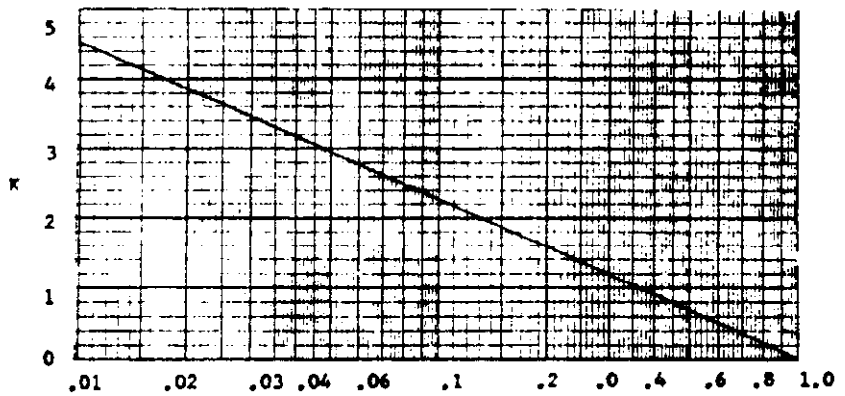


FIGURE 12.

90.1 Example. Given a surface plate that is subjected to a change in environment temperature of 50°F, how much time must elapse before inspection can proceed if the temperature of the plate is to be within 1°F of the final temperature? The dimensions of the plate are 18 inches x 18 inches x 4 inches.

Solution: L = 3/2 ft.
w = 3/2 ft.
H = 1/3 ft.

RTO = 1°F.
ΔT = 50°F.
RTO/ΔT = .02

From figure 12, K = 3.8

Estimated soak-out time = $3.8 \frac{16.2}{2/3 + 2/3 + 3}$ = 14.2 hours.

100. Care of the granite surface plate.

100.1 Cleaning and moisture. Plates shall be cleaned thoroughly and given 6 hours to dry before testing for tolerance. (This time can be included in the temperature soaking time.) Water base cleaners which have not dried out will make iron parts rust if left in contact on the surface overnight. Plates should undergo their drying time in a room with less than 50 percent relative humidity.

100.2 Scratches and nicks. Whenever scratches and nicks appear on granite plates, the resulting burrs should be removed with a flat silicon carbide stone. Any bump which shatters the surface raises fractured material at the rim of the crater.

100.3 Rotation of plate. When a specific work surface area receives hard usage, it is suggested that the plate be rotated 180° on a periodic basis to increase wear life. The production of a contour map during calibration is particularly helpful in locating the parts of the plate which should be given most use.

110. Periodic recalibration. Periodic recalibration of granite surface plates is recommended to determine resurfacing or replacement needs. The interval between calibrations will vary with the grade of plate, wear resistance, and with the conditions and frequency of use. Surface plates used in manufacturing departments might be recalibrated every six months, whereas plates used in the laboratory may be recalibrated every year. Frequent monitoring of the work surface by scanning it with the repeat reading gage is desirable. When these results differ from those marked on the replaceable sticker, you should recalibrate the plate.

120. Instrumentation. Instrumentation for calibrating surface plate flatness are autocollimator, electronic level, laser interferometer, master straight edge with a traveling indicator or with beam gage, laser beam and detector, and in-line flatness gage.

130. Downgrading, resurfacing, or replacement levels. At recalibration period, it is suggested that surface plates which deviate from the work surface flatness tolerance, which show repeat readings that exceed your inhouse requirements or which have objectionable scratches and nicks in the work area shall be downgraded, resurfaced, or replaced.

MILITARY CUSTODIANS:

Air Force - 84

Preparing activity:

NBS

Review Activities:

Army - MU

CIVIL AGENCY COORDINATING ACTIVITY:

GSA-FSS

User Activities:

Army - MI
Navy - SH

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OMB Approval
No. 22-R255

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B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

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☐ YES ☐ NO *(If "Yes", in what way?)*

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SUBMITTED BY *(Printed or typed name and address - Optional)*

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