

March 20, 1975
 SUPERSEDING
 Fed. Spec. GGG-G-15B
 November 6, 1970

FEDERAL SPECIFICATION
GAGE BLOCKS AND ACCESSORIES
(INCH AND METRIC)

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 precision gage blocks up to and including 20 inches (500 mm) in length, and accessories, in either the inch or metric system for use by laboratories, inspection shops, or as work gages for high accuracy machining operations. Notes for usage and definitions of terminology may be found in section 6.

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

1.2 Classification.

1.2.1 Styles, grades, classes, and types. The gage blocks shall be of the following styles, grades, classes, and types, as specified:

Styles (shapes).

- Style 1. Rectangular.
- Style 2. Square, with center accessory hole.
- Style 3. Other shapes as specified.

Grades:

Tolerance Grades.

- Grade 0.5 (Formerly grade AAA).
- Grade 1 (Formerly grade AA).
- Grade 2 (Formerly grade A+).
- Grade 3 (Compromise between former grades A and B).

Accuracy level grades (as specified, see 3.3.2).

- Accuracy level grade 1 microinch (0.03 micrometre).
- Accuracy level grade 2 microinch (0.05 micrometre).

Classes and types (material).

- Class I. Steel.
- Class II. Faced blocks, steel.
 - Type (1) Chromium plated.
- Class III. Carbide.
 - Type (1) Chromium carbide.
 - Type (2) Tungsten carbide.

2. APPLICABLE DOCUMENTS

2.1 The following documents, 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:

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Federal Specifications:

PPP-B-566 - Boxes, Folding, Paperboard.
 PPP-B-585 - Boxes, Wood, Wirebound.
 PPP-B-591 - Boxes, Fiberboard, Wood-Cleated.
 PPP-B-601 - Boxes, Wood, Cleated-Plywood.
 PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
 PPP-B-636 - Box, Shipping, Fiberboard.
 PPP-B-640 - Boxes, Folding, Fiberboard, Corrugated, Triple-Wall.
 PPP-B-676 - Boxes, Set-up.
 PPP-C-843 - Cushioning Material, Cellulosic.
 PPP-T-60 - Tape, Pressure-Sensitive Adhesive, Waterproof, for Packaging.
 PPP-T-97 - Tape, Pressure-Sensitive Adhesive, Filament Reinforced.

Federal Standard:

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

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, Publications, 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, D. C. 20402.)

(Single copies of this specification and other product 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, D. C., Atlanta, Chicago, Kansas City, Mo., Ft. Worth, Denver, San Francisco, Los Angeles, and Seattle, Washington.)

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

Military Specifications:

MIL-P-116 - Preservation, Packaging, Method of.
 MIL-B-121 - Barrier Material Grease-proofed, Flexible.
 MIL-B-131 - Barrier Material, Water Vaporproof, Flexible.

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
 MIL-STD-129 - Marking for Shipment and Storage.

(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.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply:

American National Standards Institute, (ANSI) Standard:

B46.1-1962 - Surface Texture, Surface Roughness, Waviness and Lay.

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

National Bureau of Standards (NBS) Publication:

Special Publication 330 - The International System of Units (SI).

(Application for copies should be addressed to the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.)

American Society for Testing and Materials (ASTM) Standard:

E276-54(1965). - Evaluating Cemented Carbides for Apparent Porosity.

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

National Motor Freight Traffic Association, Incorporated, Agent:

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations, Inc., Tariff Order Section, 1616 P Street N.W., Washington, D. C. 20036.)

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.)

(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 Styles. As specified (see 6.2), the gage blocks shall be style 1, style 2, or style 3 as applicable. The blocks shall conform to figures 1 or 2 as applicable. The style 1 metric system gage block dimensions shall be in accordance with table I. The style 1 inch system gage blocks of dimensions falling within the large specified tolerances in table I will be acceptable if they are consistent with each other. The style 1, inch system gage blocks of 0.531 x 1.500 inch dimensions shall be supplied only if specified (see 6.2). The style 2, inch and metric system gage blocks shall be in accordance with table I. The style 3 block dimensions shall be as specified (see 6.2).

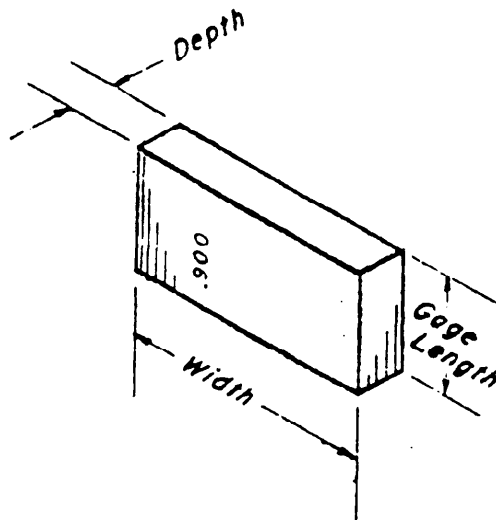


FIGURE 1. Style 1, rectangular.

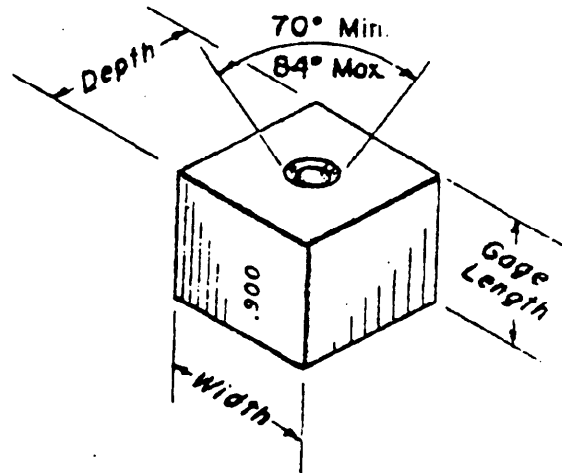


FIGURE 2. Style 2, square with center hole.

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TABLE I. Gage block dimensions and tolerances^{1/}

General length range	Style	Depth	Width	Hole diameter
Up to 0.010 in.	1	0.355 in. \pm 0.005 in.	0.787 in. \pm 0.340 - 0.229 in.	-----
Up to 0.3 in.	1	9 mm \pm 0.1 mm	20 mm \pm 0.2 mm	-----
0.010 in. thru 0.200 in.	1	0.355 in. \pm 0.020 - 0.010 in.	1.181 in. \pm 0.074 - 0.084 in.	-----
0.3 in. thru 10 in.	1	9 mm \pm 0.1 mm	30 mm \pm 0.2 mm	-----
Over 0.200 in. thru 20 in. inclusive	1	0.355 in. \pm 0.020 - 0.010 in.	1.378 in. \pm 0.01 - 0.207 in.	-----
Over 10 mm thru 500 mm	1	9 mm \pm 0.1 mm	35 mm \pm 0.2 mm	-----
0.05 in. thru 20 inches ^{2/}	1	0.531 in. \pm 0.005 in.	1.500 in. \pm 0.01 in.	0.250 in. \pm 0.005 in.
All inch lengths	2	0.950 in. \pm 0.010 in.	0.950 in. \pm 0.010 in.	0.265 in. \pm 0.005 in.
All metric lengths	2	24.1 mm \pm 0.2 mm	24.1 mm \pm 0.2 mm	6.7 mm \pm 0.1 mm

^{1/} Style 2 blocks shall be countersunk on both sides for blocks 0.2 inch (5 mm) and larger; blocks under 0.2 inch are not countersunk, and 0.10 inch (2.5 mm) carbide wear blocks are countersunk on one side only.

^{2/} This rectangular style of gage block has one 0.250-inch hole through the sides of the one inch length block, and two 0.250 inch holes through the sides of each block two inches in length and longer (not available from all manufacturers).

3.2 Sizes, gage length. The sizes (gage lengths) of the gage blocks shall be of the inch system as shown in table II, of the metric system, as shown in table III, or of special sizes, as specified (see 6.2).

TABLE II. Sizes of gage blocks, inch system^{3/}

Size	Size	Size	Size	Size	Size	Size	Size
Inch	Inch	Inch	Inch	Inch	Inch	Inch	Inches
0.0055	0.015	0.029	0.060	0.1007	0.121	0.145	0.400
.0060	.016	.030	.0625	.10075	.122	.146	.450
.0065	.017	.03125	.070	.1008	.123	.147	.500
.0070	.018	.040	.078125	.1009	.124	.148	.550
.0075	.019	.046375	.080	.101	.125	.149	.600
.0080	.020	.050	.090	.102	.126	.150	.650
.0085	.02005	.05005	.09375	.103	.127	.160	.700
.0090	.0201	.0501	.100	.104	.128	.170	.750
.0095	.0202	.0502	.10001	.105	.129	.180	.800
.010	.0203	.0503	.10002	.106	.130	.190	.850
.01005	.0204	.0504	.100025	.107	.131	.200	.900
.0101	.0205	.0505	.10003	.108	.132	.20001	.950
.0102	.0206	.0506	.10004	.109	.133	.20002	1.000
.0103	.0207	.0507	.10005	.109375	.134	.20003	2.000
.0104	.0208	.0508	.10006	.110	.135	.20004	3.000
.0105	.0209	.0509	.10007	.111	.136	.20005	4.000
.0106	.021	.051	.100075	.112	.137	.20006	5.000
.0107	.022	.052	.10008	.113	.138	.20007	6.000
.0108	.023	.053	.10009	.114	.139	.20008	7.000
.0109	.024	.054	.1001	.115	.140	.20009	8.000
.011	.025	.055	.1002	.116	.141	.20010	10.000
.012	.026	.056	.10025	.117	.142	.250	12.000
.013	.027	.057	.1003	.118	.143	.300	16.000
.014	.028	.058	.1004	.119	.144	.350	20.000
		.059	.1005	.120			
			.1006				

TABLE III. Sizes of gage blocks, metric system^{3/}

Size	Size	Size	Size	Size	Size	Size	Size	Size
μm	μm	μm	μm	μm	μm	μm	μm	μm
0.30	1.0005	1.15	1.39	2.006	2.21	2.45	11.00	23.00
.40	1.001	1.16	1.40	2.007	2.22	2.46	11.50	23.50
.405	1.002	1.17	1.41	2.008	2.23	2.47	12.00	24.00
.41	1.003	1.18	1.42	2.009	2.24	2.48	12.50	24.50
.42	1.004	1.19	1.43	2.010	2.25	2.49	13.00	25.00
.43	1.005	1.20	1.44	2.02	2.26	2.50	13.50	30.00
.44	1.006	1.21	1.45	2.03	2.27	2.60	14.00	40.00
.45	1.007	1.22	1.46	2.04	2.28	2.70	14.50	50.00
.46	1.008	1.23	1.47	2.05	2.29	2.80	15.00	60.00
.47	1.009	1.24	1.48	2.06	2.30	2.90	15.50	70.00
.48	1.01	1.25	1.49	2.07	2.31	3.00	16.00	75.00
.49	1.02	1.26	1.50	2.08	2.32	3.50	16.50	80.00
.50	1.03	1.27	1.60	2.09	2.33	4.00	17.00	90.00
.60	1.04	1.28	1.70	2.10	2.34	4.50	17.50	100.00
.70	1.05	1.29	1.80	2.11	2.35	5.00	18.00	125.00
.80	1.06	1.30	1.90	2.12	2.36	5.50	18.50	150.00
.90	1.07	1.31	2.00	2.13	2.37	6.00	19.00	175.00
1.00	1.08	1.32	2.0005	2.14	2.38	6.50	19.50	200.00
	1.09	1.33	2.001	2.15	2.39	7.00	20.00	250.00
	1.10	1.34	2.002	2.16	2.40	7.50	20.50	300.00
	1.11	1.35	2.003	2.17	2.41	8.00	21.00	400.00
	1.12	1.36	2.004	2.18	2.42	8.50	21.50	500.00
	1.13	1.37	2.005	2.19	2.43	9.00	22.00	
	1.14	1.38		2.20	2.44	9.50	22.50	
						10.00		
						10.50		

^{3/}This is not a complete list of available sizes. Some must be ordered as specials. Some are not available in all materials. Some are not available from all manufacturers.

3.3 Tolerance requirements.

3.3.1 Tolerance grades. The tolerance requirements for length, flatness, parallelism, and surface texture shall be as specified for the individual gage blocks of tolerance grades 0.5, 1, 2, and 3, in tables IV, VI, and VII (see 4.5.3).

3.3.2 Accuracy level grades. When a specific accuracy over the entire gaging surface is required (see 6.2), the gage blocks shall be supplied as specified (see 6.2) to accuracy level grade 1 $\mu\text{in.}$ (0.03 μm) or accuracy level grade 2 $\mu\text{in.}$ (0.05 μm) requirements for parallelism and flatness in table V, and to the surface texture requirements of tolerance grade 1. As specified (see 6.2) accuracy level grade gage blocks shall meet the length tolerance requirements of tolerance grade 2 or tolerance grade 3 gage blocks, tables VI and VII. Accuracy level grade designation indicates that the gage block, used singly, will provide a perpendicular length dimension anywhere between the gaging surfaces accurate to the designated value.

3.4 Material. As specified (see 6.2), material used in the manufacture of gage blocks shall be of classes I, II, or III, having qualities which will allow suitable hardness and refinement of surface texture for adequate wear life, and dimensional stability after proper seasoning treatment. Hardness shall be measured adjacent to a gaging surface (see 4.5.8), for through hardened blocks and on the gaging surface for faced blocks.

3.4.1 Class I, steel. Steel gage blocks and accessories shall have a hardness equivalent to Rockwell C 62 minimum.

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3.4.2 Class II, chromium plated steel. Chromium plated steel gage blocks shall be uniformly plated on the gaging surfaces with a hard chromium plate equivalent to Rockwell C 68 minimum applied directly to hardened steel equivalent to Rockwell C 58 minimum in such a manner as to insure against chipping or peeling under normal use.

3.4.3 Class III, carbide. As specified (see 6.2), carbide gage blocks sizes up through 4 inches (100mm), inside caliper jaws, and outside caliper jaws shall be furnished of solid tungsten carbide, or chromium carbide (see 3.6). They shall meet the porosity requirements (see 3.8.3.1). They shall have a minimum hardness equivalent to Rockwell C 70.

3.5 Sets of gage blocks. Gage blocks in sets as listed, and furnished with a case, shall be of the style, grade, class, type, and sizes, as specified (see 6.2). Accuracy level grade gage blocks in sets, furnished with a case, shall be of the style, grade, class, type, and sizes, as specified (see 6.2). Cases for gage blocks in sets, either with or without accessories, shall provide space for individual housing of all pieces (see 3.7) in the set plus those ordered additionally at the same time. If it is impractical to house an unusual number of additional pieces with the parent set, either a second or special case shall be provided as specified by the purchaser and shall meet the requirements of paragraph 3.7.

3.5.1 Inch system, gage block sets.

3.5.1.1 Gage block set No. 1-81-gage blocks. When specified (see 6.2), inch system, style 1, 2, or 3, tolerance grade 0.5, 1, 2 or 3, class I, II, or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.050	0.102	0.114	0.126	0.138	0.150	0.750
.100	.103	.115	.127	.139	.200	.800
.1001	.104	.116	.128	.140	.250	.850
.1002	.105	.117	.129	.141	.300	.900
.1003	.106	.118	.130	.142	.350	.950
.1004	.107	.119	.131	.143	.400	1.000
.1005	.108	.120	.132	.144	.450	2.000
.1006	.109	.121	.133	.145	.500	3.000
.1007	.110	.122	.134	.146	.550	4.000 in.
.1008	.111	.123	.135	.147	.600	
.1009	.112	.124	.136	.148	.650	
.101	.113	.125	.137	.149	.700	

3.5.1.2 Gage block set No. 4-88-gage blocks. When specified (see 6.2), inch system, style 1, 2, or 3, tolerance grade 0.5, 1, 2 or 3, class I, II, or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.050	0.1006	0.109375	0.122	0.135	0.148	0.700
.0625	.1007	.110	.123	.136	.149	.750
.078125	.1008	.111	.124	.137	.150	.800
.093750	.1009	.112	.125	.138	.200	.850
.100	.101	.113	.126	.139	.250	.900
.100025	.102	.114	.127	.140	.300	.950
.100050	.103	.115	.128	.141	.350	1.000
.100075	.104	.116	.129	.142	.400	2.000
.1001	.105	.117	.130	.143	.450	3.000
.1002	.106	.118	.131	.144	.500	4.000 in.
.1003	.107	.119	.132	.145	.550	
.1004	.108	.120	.133	.146	.600	
.1005	.109	.121	.134	.147	.650	

3.5.1.3 Gage block set No. 5-21-gage blocks. When specified (see 6.2), inch system, style 1 or 2, tolerance grade 1, 2, or 3, class I or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.010	0.0102	0.0105	0.0108	0.012	0.015	0.018
.01005	.0103	.0106	.0109	.013	.016	.019
.0101	.0104	.0107	.011	.014	.017	.020 in.

3.5.1.4 Gage block set No. 6-28-gage blocks. When specified (see 6.2), inch system, style 1 or 2, tolerance grade 1, 2, or 3, class I or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.010	0.0202	0.0206	0.021	0.025	0.029	0.060
.020	.0203	.0207	.022	.026	.030	.070
.02005	.0204	.0208	.023	.027	.040	.080
.0201	.0205	.0209	.024	.028	.050	.090 in.

3.5.1.5 Long gage block set No. 7-8-gage blocks. When specified (see 6.2), inch system, style 1 or 2, tolerance grade 1, 2, or 3, class I or II (type 1) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

5, 6, 7, 8, 10, 12, 16, and 20 inches.

The style 2, gage blocks in this set shall be furnished complete with knurled screws, studs, flat-head screws, slotted nuts, and tie rods.

3.5.1.6 Gage block set No. 8-36-gage blocks. When specified (see 6.2), inch system, style 1 or 2, tolerance grade 0.5, 1, 2, or 3, class I, II (type 1), or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.050	0.1003	0.1007	0.102	0.106	0.110	0.150	0.190	0.500
.100	.1004	.1008	.103	.107	.120	.160	.200	1.000
.1001	.1005	.1009	.104	.108	.130	.170	.300	2.000
.1002	.1006	.101	.105	.109	.140	.180	.400	4.000 in.

3.5.1.7 Gage block set No. 9-20-gage blocks. When specified (see 6.2), inch system, style 1, tolerance grade 1, 2, or 3, class I, II (type 1), or III (type 1 and 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.050	0.0502	0.0505	0.0508	0.052	0.055	0.058
.05005	.0503	.0506	.0509	.053	.056	.059 in.
.0501	.0504	.0507	.0510	.054	.057	

3.5.2 Metric system, gage block sets.

(In the metric system, certain sets may not be commercially available at this time in this country. Please check this before specifying.)

3.5.2.1 Gage block set No. 1M-45-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 0.5, 1, 2, or 3, class I or III (type 1 or 2), gage blocks; in the following sizes shall be furnished in a case (see 3.7):

1.000	1.006	1.03	1.05	1.6	4.0	10	70
1.001	1.007	1.04	1.10	1.7	5.0	20	80
1.002	1.008	1.05	1.2	1.8	6	30	90
1.003	1.009	1.06	1.3	1.9	7	40	
1.004	1.01	1.07	1.4	2.0	8	50	
1.005	1.02	1.08	1.5	3.0	9	60	

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3.5.2.2 Gage block set No. 2M-88-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 0.5, 1, 2, or 3, class I or III (type 1 or 2), gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.5	1.008	1.09	1.19	1.29	1.39	1.49	6.0	30
1.0	1.009	1.10	1.20	1.30	1.40	1.5	6.5	40
1.0005	1.01	1.11	1.21	1.31	1.41	2.0	7.0	50
1.001	1.02	1.12	1.22	1.32	1.42	2.5	7.5	60
1.002	1.03	1.13	1.23	1.33	1.43	3.0	8.0	70
1.003	1.04	1.14	1.24	1.34	1.44	3.5	8.5	80
1.004	1.05	1.15	1.25	1.35	1.45	4.0	9.0	90
1.005	1.06	1.16	1.26	1.36	1.46	4.5	9.5	100 mm.
1.006	1.07	1.17	1.27	1.37	1.47	5.0	10	
1.007	1.08	1.18	1.28	1.38	1.48	5.5	20	

3.5.2.3 Gage block set No. 3M-112-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 0.5, 1, 2, or 3, class I or III (type 1 or 2), gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.5	1.008	1.09	1.19	1.29	1.39	1.49	6.0	11.0	16.0	21.0	75
1.0	1.009	1.10	1.20	1.30	1.40	1.5	6.5	11.5	16.5	21.5	100 mm.
1.0005	1.01	1.11	1.21	1.31	1.41	2.0	7.0	12.0	17.0	22.0	
1.001	1.02	1.12	1.22	1.32	1.42	2.5	7.5	12.5	17.5	22.5	
1.002	1.03	1.13	1.23	1.33	1.43	3.0	8.0	13.0	18.0	23.0	
1.003	1.04	1.14	1.24	1.34	1.44	3.5	8.5	13.5	18.5	23.5	
1.004	1.05	1.15	1.25	1.35	1.45	4.0	9.0	14.0	19.0	24.0	
1.005	1.06	1.16	1.26	1.36	1.46	4.5	9.5	14.5	19.5	24.5	
1.006	1.07	1.17	1.27	1.37	1.47	5.0	10	15.0	20.0	25	
1.007	1.08	1.18	1.28	1.38	1.48	5.5	10.5	15.5	20.5	50	

3.5.2.4 Gage block set No. 4M-45-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 0.5, 1, or 2, class I, II, or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

[1.0]	2.009	2.1	4	50
2.0	2.01	2.2	5	60
2.001	2.02	2.3	6	70
2.002	2.03	2.4	7	80
2.003	2.04	2.5	8	90 mm.
2.004	2.05	2.6	9	
2.005	2.06	2.7	10	
2.006	2.07	2.8	20	
2.007	2.08	2.9	30	
2.008	2.09	3	40	

3.5.2.5 Gage block set No. 54-88-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 0.5, 1, or 2, class I, II, or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.5	2.006	2.07	2.17	2.27	2.37	2.47	6.0	30
1.0	2.007	2.08	2.18	2.28	2.38	2.48	6.5	40
1.5	2.008	2.09	2.19	2.29	2.39	2.49	7.0	50
2.0	2.009	2.10	2.20	2.30	2.40	2.50	7.5	60
2.0005	2.01	2.11	2.21	2.31	2.41	3.0	8.0	70
2.001	2.02	2.12	2.22	2.32	2.42	3.5	8.5	80
2.002	2.03	2.13	2.23	2.33	2.43	4.0	9.0	90
2.003	2.04	2.14	2.24	2.34	2.44	4.5	9.5	100 mm.
2.004	2.05	2.15	2.25	2.35	2.45	5.0	10	
2.005	2.06	2.16	2.26	2.36	2.46	5.5	20	

3.5.2.6 Gage block set No. 64-112-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 0.5, 1, 2, or 3, class I, II, or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.5	2.007	2.09	2.20	2.31	2.42	4.0	9.5	15.0	20.5	.75
1.0	2.008	2.10	2.21	2.32	2.43	4.5	10.0	15.5	21.0	100 mm.
1.5	2.009	2.11	2.22	2.33	2.44	5.0	10.5	16.0	21.5	
2.0	2.01	2.12	2.23	2.34	2.45	5.5	11.0	16.5	22.0	
2.0005	2.02	2.13	2.24	2.35	2.46	6.0	11.5	17.0	22.5	
2.001	2.03	2.14	2.25	2.36	2.47	6.5	12.0	17.5	23.0	
2.002	2.04	2.15	2.26	2.37	2.48	7.0	12.5	18.0	23.5	
2.003	2.05	2.16	2.27	2.38	2.49	7.5	13.0	18.5	24.0	
2.004	2.06	2.17	2.28	2.39	2.5	8.0	13.5	19.0	24.5	
2.005	2.07	2.18	2.29	2.40	3.0	8.5	14.0	19.5	25	
2.006	2.08	2.19	2.30	2.41	3.5	9.0	14.5	20.0	50	

✓ All inclusive sizes between the brackets are not available in tolerance grade 0.5.

3.5.2.7 Gage block set No. 74-17-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 2 or 3, class I or III (type 1 or 2) gage blocks; in the following sizes shall be furnished in a case (see 3.7):

0.30	0.43	0.48	0.80
0.40	0.44	0.49	0.90 mm.
0.405	0.45	0.50	
0.41	0.46	0.60	
0.42	0.47	0.70	

3.5.2.8 Long gage block set No. 84-8-gage blocks. When specified (see 6.2), metric system, style 1 or 2, tolerance grade 1, 2, or 3, class I or II gage blocks; in the following sizes shall be furnished in a case (see 3.7):

125, 150, 175, 200, 250, 300, 400, and 500 mm.

The style 2, gage blocks in this set shall be furnished complete with knurled screws, studs, flat-head screws, slotted nuts, and tie rods.

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3.6 Sets of accessories. Sets of accessories shall meet the requirements of table IV, and paragraphs 3.8.4.2 to and including 3.8.4.9. Accessories in sets as listed, and furnished in a case with gage blocks shall be of the style, class, and size, as specified (see 3.7 and 6.2). If specified (see 6.2), a case shall be supplied for accessories furnished as individual sets. Accessories for gage block sets of class III are made of steel except that caliper jaws are available in carbide and in chromium plated steel.

3.6.1 Accessories for gage blocks of style 1. A set of accessories for style 1, inch system, gage blocks shall consist of all or any part of the following, as specified (see 6.2): Two each of 0.100, 0.200, and 0.250 inch half round inside jaws; two each of 0.250, 0.500 and 0.750 inch outside jaws; 60° center point, two tram points; scriber; two straight-edges; footblock; and adjustable holders of various lengths having appropriate clamps. For metric system, gage blocks, the accessories shall consist of like items of sizes, as specified (see 6.2). The inside half round jaws shall be 2.5 and 5 mm and the base shall be 25 mm thick minimum.

3.6.2 Accessories for gage blocks of style 2. A set of accessories for style 2, inch system, gage blocks shall consist of all or any part of the following, as specified (see 6.2): Two each of 0.125 and 0.250 inch inside caliper jaws, two outside caliper jaws; scriber; 60° center point; and triangular or square base with hole or holes to accept the gage block tie rods. Base accessories shall include knurled screws, studs, flat-head screws, slotted nuts, and threaded tie rods. For metric system gage blocks, the accessories shall consist of like items of nearly equivalent sizes, as specified (see 6.2). The inside, half round jaws shall be 3 and 6 mm and the base 12 mm thick minimum.

3.7 Cases.

3.7.1 Material. The case shall be of such material and so constructed as to withstand normal handling. The material or treatment thereof must retard the absorption of moisture and must not stain, scratch nor corrode the gage blocks and accessories. The protective coating shall not adversely affect the case material.

3.7.2 Design. Cases shall be so designed that when the case is open the blocks or accessories are readily removable, but when closed and fastened they shall be held in place. Cases shall be provided with positive type, self-latching, dual catch fasteners. Cases shall provide at least two slots for wear blocks except for sets under 0.100 inch and 1 mm or over 4 inches and 100 mm.

3.7.3 Identification marking. The case in which gage blocks and accessories are furnished shall be marked with set serial number and with the manufacturer's name or trademark of such known character that the source of manufacture may be readily determined. If the sizes of the gage blocks, as marked upon them are not visible when the blocks are in their respective compartments, each size shall be marked in the case immediately adjacent to the appropriate compartment.

3.7.4 Coefficient of linear thermal expansion marking for gage blocks. A plate or label bearing the coefficient of expansion, shall be attached to the case (not mandatory for tolerance grade 3 steel gage blocks 4 inches (100 mm) and smaller).

3.8 Gage blocks and accessories.

3.8.1 Blocks and accessories ordered individually. Individual gage blocks shall be furnished in the style, grade, class, type, and size in the inch or metric system, in accordance with table II or III, or in special sizes, as specified (see 1.2, 3.6, and 6.2). Individual accessories shall meet the requirements of table IV, and paragraphs 3.8.4.2 to and including 3.8.4.9, and shall be furnished in the style, class, and size, as specified (see 6.2).

3.8.2 Wear blocks. Wear blocks, available in pairs, 0.020, 0.050, and 0.100 inch or 1.0, 2.0, and 2.5 millimeter in length shall comprise a set of two blocks of the material, tolerance grade and length, specified (see 6.2). Wear blocks are furnished with complete gage block sets, or in individual sets and cases, as specified (see 6.2).

3.8.3 Coating surfaces of the gage blocks and accessories.

3.8.3.1 Surface defects. Gaging surfaces shall be free from all burrs, nicks, fractures, sharp corners, raised edges, lapping streaks, corrosion, and other defects which may affect accuracy or serviceability. Fine lapping scratches and a few occasional stray scratches^{5/} which do not affect the accuracy or use of the block or accessory are permitted provided the block meets the peak to valley height requirement. A width not exceeding 0.01 inch (0.3mm) along the edges of the wringing surfaces shall be smoothly radiused or chamfered and chamfered edges smoothly rounded. The porosity of carbide gage blocks shall not exceed carbide A4 per ASTM designation B-276-54 (1972).

3.8.3.2 Parallelism and flatness. Tolerance grade gage blocks and accessories shall have their gaging surfaces flat, parallel with each other, and lapped within the tolerances specified in table IV for tolerance grades, and in addition, accuracy level grades shall meet the requirements of table V.

TABLE IV. Tolerances on flatness, parallelism, and surface texture of gaging surfaces (see 4.5.3)

Tolerance grade gage blocks and accessories	Tolerances on flatness (free state), parallelism on gaging surface excluding 0.02 in. (0.5 mm) width of gaging surface from sides of block (see 4.5.9 and 4.5.10)								Surface texture			
	Blocks 2 inches (50 mm) in length and smaller		Blocks over 2 in. (50 mm) in length thru 4 in. (100 mm)		Blocks over 4 in. (100 mm) in length thru 8 in. (200 mm)		Blocks over 8 in. (200 mm) in length thru 20 in. (500 mm)		Maximum Predominant peak to valley height ^{6/} (see 4.5.5.1.2)		Arithmetical Average Roughness Height (see 4.5.5.1.1)	
	μ in.	μm	μ in.	μm	μ in.	μm	μ in.	μm	μ in.	μm	μ in.	μm
0.5	1	0.03	1	0.03	—	—	—	—	3	0.07	0.7	0.02
1	2	.05	3	.07	3	0.07	4	0.10	3	.07	0.7	.02
2	4	.10	4	.10	4	.10	5	.12	4	.10	1.0	.03
3	5	.12	5	.12	5	.12	6	.15	4	.10	1.0	.03
Accessories ^{7/}	5 ^{8/}	.12	—	—	—	—	—	—	4	.10	1.0	.03

^{5/}Stray scratch is a groove produced by an abrasive particle after the lapping process. The depth of stray scratches (absolutely free of burrs) shall not exceed 12 μ in. (0.30 μm).

^{6/}On a lapped surface, numerous peak to valley heights will exceed 2 times this value and occasionally 3 times.

^{7/}Accessories are not graded. They are available only as specified. However, parallels are available in tolerance grades 2 and 3.

^{8/}Tolerances on base block flatness and parallelism for span of gaging surface (see 6.3), shall not exceed 3 μ in. (0.07 μm) per 0.500 in. (12 mm) of length. Measurements exclude 0.06 inch (1.5 mm) width of surface from sides of base block. Flatness tolerance for half round inside jaws is 10 μ in. (0.25 μm).

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TABLE V. Accuracy level grade gage block tolerances on flatness and parallelism for individual gage blocks (see 3.3.2, 4.5.3, 6.1 and 6.3)

Accuracy level grade	Maximum parallelism deviation	Maximum flatness deviation
	All values in microinches (micrometres)	
1 microinch (0.03 micrometre)	1.0 (0.03)	0.5 (0.01)
2 microinch (0.05 micrometre)	2.0 (0.05)	1.0 (0.03)

3.8.3.3 Surface texture. The surface texture of gaging surfaces shall meet the requirements of table IV. Surface texture shall be determined by either the arithmetical average roughness height requirements or the maximum predominant peak to valley requirements (4.5.5.1). On all nongaging sides of gage blocks over 1 inch (25 mm) in length, the surface texture shall be uniform in appearance.

3.8.3.4 Squareness of sides. The sides of the gage blocks 0.4 inch (10 mm) or longer shall be square with the gaging surfaces and with each other within 5 minutes.

3.8.4 Tolerances on length.

3.8.4.1 Gage length. Gage blocks shall be of the specified length at 68°F (20°C.) within the tolerances specified in tables VI and VII.

TABLE VI. Tolerances on length for gage blocks at the reference point, (see 4.5.3)

Inch system								
Nominal size	Tolerance grade							
	0.5 (formerly grade AAA)		1 (formerly grade AA)		2 (formerly grade A+)		3 (compromise between former grades A and B)	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
Inches	Tolerances in microinches							
1 or less	1	1	2	2	4	2	8	4
2	2	2	4	4	8	4	16	8
3	3	3	5	5	10	5	20	10
4	4	4	6	6	12	6	24	12
Long gage blocks	5		7	7	14	7	28	14
	6		8	8	16	8	32	16
	7		9	9	18	9	36	18
	8		10	10	20	10	40	20
	10		12	12	24	12	48	24
	12		14	14	28	14	56	28
	16		18	18	36	18	72	36
20			20	20	40	20	80	40

TABLE VII. Tolerances on length for gage blocks, metric system, at the reference point (see 4.5.3)

Metric system								
Nominal size	Tolerance grade							
	0.5 (formerly grade AAA)		1 (formerly grade AA)		2 (formerly grade A+)		3 (compromise between former grades A and B)	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
mm	Tolerances in micrometres							
10 or less	0.03	0.03	0.05	0.05	0.10	0.05	0.20	0.10
over 10 thru 25	.04	.04	.08	.08	.15	.06	.30	.15
over 25 thru 50	.05	.05	.10	.10	.20	.10	.40	.20
over 50 thru 75	.06	.06	.13	.13	.25	.12	.45	.22
Over 75 thru 100	.08	.08	.15	.15	.30	.15	.60	.30
Long gage blocks	125		.18	.18	.35	.18	.70	.35
	150		.20	.20	.40	.20	.80	.40
	175		.23	.23	.45	.22	.90	.45
	200		.25	.25	.50	.25	1.00	.50
	250		.30	.30	.60	.30	1.20	.60
	300		.35	.35	.70	.35	1.40	.70
	400		.45	.45	.90	.45	1.80	.90
	500		.50	.50	1.00	.50	2.00	1.00

3.8.4.2 Inside jaw and extension inside jaws. The thickness at any point measured from the highest line of the inside jaw to the wringing surface shall not vary from the nominal size by more than 30 μ in. (0.75 μ m).

3.8.4.3 Center point. The distance between the wringing surface and the axis of the cone shall be within 0.0003 inch (7.5 μ m) of the nominal distance. The half-angles of the cone with reference to the wringing surface shall be 30° within \pm 15 minutes. The cone angle shall be 60°. The point may be blunted to 0.010 inch (0.254 mm) diameter.

3.8.4.4 Tram point. The distance between the wringing surface and the axis of the point, measured near the extreme point, shall be within 0.0003 inch (7.5 μ m) of the nominal distance.

3.8.4.5 Base or footblock. The thickness or height shall be within 20 μ in. (0.5 μ m) of the nominal thickness or height which is 0.500 inch (12 mm or 12.5 mm).

3.8.4.6 Knife edge and straight edge. The total deviation of the edge or edges from a line shall not exceed 5 μ in. (0.125 μ m) per inch (25 mm) of span. The edge shall be radiused for greater wear life.

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3.8.4.7 Outside jaw and extension outside jaws. The thickness at any point of a jaw shall not vary from nominal size by more than 50 μ in. (1.25 μ m). See table IV for tolerances on flatness and parallelism for span of gaging surface.

3.8.4.8 Parallels. Parallels (available in tolerance grades 2 and 3 from some manufacturers) shall meet the tolerances for length, parallelism, and flatness given in tables IV, VI, and VII for the specified gage block tolerance grade (see 6.2).

3.8.4.9 Scriber. The scriber point shall not lie outside the plane of the wringing surface by more than 0.0003 inch (7.5 μ m).

3.8.5 Identification marking. Markings which are required to be on gage blocks and accessories shall be legible, permanent, and made in such a manner as not to affect the accuracy of the block. When marked on a wringing surface, the middle one-third of the gaging surface shall be free of marking.

3.8.5.1 Size marking. Each gage block or gaging accessory with lapped surfaces shall be plainly, legibly and permanently marked to show its nominal size.

3.8.5.2 Identification number. Each gage block and gaging accessory with lapped surfaces shall bear an identification number. Such number may be the serial number of the set in which the block is furnished. Wear blocks shall have unique serial numbers and may be marked "WEAR" (see 3.8.5.5).

3.8.5.3 Grade marking. Grade marking is not required. If it is requested in purchase order (see 6.2), marking on nongaging face is preferable.

3.8.5.4 Trademark. Gage blocks and gaging accessories shall be marked with the manufacturer's name or with a trademark of such known character that the source of manufacture may be readily determined.

3.8.5.5 Code for material identification. Each gage block in tolerance grade 0.5, 1, and 2, and all accuracy level grades, shall be marked with a code identifying the material if it is not positively identified as being part of a set of one class. Marking on nongaging face is preferable.

Code symbols: CC for Chromium carbide
CP for Chromium plated
none for Steel
TC for Tungsten carbide

3.9 Manufacturer's report of calibration. If a report of calibration is required (see 6.2), it shall be furnished with each gage block or set of gage blocks showing the results obtained at the manufacturer's final inspection of each individual block and containing the following information:

- (a) Nominal size of each gage block.
- (b) Block identification number of all blocks (tolerance grades 0.5, 1, and 2, and accuracy level grades 1 μ in. (0.03 μ m) and 2 μ in. (0.05 μ m)).
- (c) Length deviation from nominal size at reference point for tolerance grade 0.5, 1, and 2 blocks. Inch system in microinches; metric system in 0.01 μ m or microinches, as specified in the contract or order. Certify that tolerance grade 3 length tolerance is met.
- (d) Certify length tolerances of accuracy level grade gage blocks are met.
- (e) Certify that parallelism and flatness requirements are met.
- (f) The nominal coefficient of linear thermal expansion for the set of blocks certified accurate to 10 percent of stated value between 60 and 90°F. or 15 and 30°C.
- (g) Statement on traceability of calibration to NBS shall include NBS test number and date.
- (h) Certification that the gage blocks are made of suitable materials and processed to meet the dimensional stability requirements of table VIII.

TABLE VIII. Dimensional stability

Grade	Maximum change in length per inch, per year in microinches	Maximum change in length per 25 mm, per year in micrometres	Maximum change in flatness in one year in microinches	Maximum change in flatness in one year in micrometres
Accuracy level grades tolerance grade 0.5	0.5	0.02	1.0	0.03
Tolerance grades 1 and 2	1.0	.03	2.0	.05
Tolerance grade 3	2.0	.05	3.0	.07

3.10 Accuracy level grade calibration. When specified (see 6.2), the length calibration of accuracy level grade gage blocks shall be made to an accuracy of 1 μ in. (0.03 μ m), and the measurement of the flatness and parallelism shall also be made. The calibration shall not be done by the manufacturer, but shall be done by the commercial dimensional metrology laboratory or the National Bureau of Standards as designated in the contract or order (see 6.2).

3.11 Workmanship. Workmanship shall be of the highest grade throughout and equal in every respect to good commercial practice.

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 any of the inspections set forth in the specification where such inspections are deemed necessary 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 6.2), gage blocks and accessories of all grades when procured individually or in sets shall be delivered to the Government or commercial dimensional metrology laboratory designated in the contract or order for the tests specified in 4.5, prior to acceptance (see 6.2).

4.3 Sampling procedures. Sampling procedures shall be in accordance with MIL-STD-105. Data for sampling shall be as stated in table IX. The sample unit shall consist of one gage block or accessory when not purchased in sets, or one complete set when purchased in sets.

TABLE IX. Sampling data

Category	Sample unit	Inspection level	Acceptable quality level	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: ^{9/} Group A (except hardness)	1 ea.	II	1.5	Percent defective	4.5.1
Group B Tolerance grades 0.5, 1, and 2 Accuracy level grade 1 microinch (0.03 micrometre) Accuracy level grade 2 microinch (0.03 micrometre)			100% Inspection ^{10/}		
Tolerance grade 3	1 ea.	II	1.0	Percent defective	4.5.2
Hardness	---	---	---	-----	4.5.3
Preparation for delivery	one container	8-2	4.0	Defects per hundred units	4.6

^{9/}Recommended testing order is as follows: 4.5.4 (burrs), 4.5.5 (surface texture), 4.5.6 (wringing), 4.5.7 (squareness), 4.5.9 (flatness), 4.5.10 (parallelism), and 4.5.11 (length).

^{10/}No sampling - All units in lot shall be inspected for requirements of 4.5.2.

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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 X.

TABLE X. Classification of defects

Categories	Defects
Critical:	None defined.
<u>Major</u>	
101	Style, class and type not as specified.
102	Not of inch or metric system as applicable.
103	Size marking, missing or illegible.
104	Middle third of gaging surface not free of identification marking.
105	Identification or number marking missing, or illegible.
106	Material identification marking missing (except grade 3).
107	Set incomplete; parts missing.
108	Evidence of burrs, nicks, fractures, sharp corners, raised edges or lapping streaks.
109	Manufacturer's report of calibration if required-missing.
<u>Minor</u>	
201	Case will not accept blocks or accessories.
202	Blocks and accessories not readily removable from case.
203	Blocks and accessories not held in place when case is closed.
204	Marking, manufacturer's name or trademark missing, incorrect, illegible, or not permanent.

4.4.2 Dimensional examination. Each sample unit shall be examined for any nonconformance with cross sectional dimensional requirements of 3.1.

4.5 Testing. Each sample unit shall be tested in accordance with 4.5.1, and 4.5.2, without damage to the wringing or gaging surfaces. The supplier may use other test methods to assure compliance with the requirements, however, for referee purposes, the test methods specified herein shall be used.

4.5.1 Group A tests. Each sample unit shall be subjected to the applicable tests of 4.5.4 (burrs), 4.5.5 (surface texture), 4.5.6 (wringing), 4.5.7 (squareness), and if specified 4.5.8 (hardness). Data for testing is stated in table XI.

4.5.2 Group B tests. Each unit shall be subjected to the applicable tests of 4.5.9 (flatness), 4.5.10 (parallelism), and 4.5.11 (length). Data for testing is stated in table XI.

TABLE XI. Data for testing

Tests	Section 4 reference	Section 3 reference
<u>Group A</u>		
Burrs	4.5.4	3.8.3.1
Surface texture	4.5.5	3.8.3.2
Wringing	4.5.6	3.8.3.3
Squareness (nongaging surfaces)	4.5.7	3.8.3.4
Hardness (if specified)	4.5.8	3.4 thru 3.4.5
<u>Group B</u>		
Flatness	4.5.3, 4.5.9	3.8.3.2
Parallelism	4.5.3, 4.5.10	3.8.3.2
Length	4.5.3, 4.5.11	3.8.4, tables VI, VII

4.5.3 Measurement uncertainty allowance. There are many factors which affect the accuracy of length, parallelism and flatness measurements of gage blocks. To eliminate borderline disputes, the additional length deviations in table XII shall be added to the tolerances in tables VI and VII for the tolerance grade 0.5, 1, 2, and 3 and the accuracy level grade 1 μ in. (0.03 μ m) and 2 μ in. (0.05 μ m) gage blocks before the item is rejected. Both the plus and minus length tolerances are increased by the amount given in table XII. The additional flatness and parallelism deviations in table XII shall be added to the tolerances in table IV for tolerance grade 0.5, 1, 2, and 3 gage blocks before the item is rejected. No additional flatness and parallelism deviations shall be added to the tolerances in table V for accuracy level grade 1 μ in. (0.03 μ m) and 2 μ in. (0.05 μ m) gage blocks. If any one measurement exceeds these limits, the item shall be rejected.

TABLE XII. Allowance for measurement uncertainty

Nominal size		Tolerance grade							
		0.5		1		2		3	
		Length	Flatness Parallelism	Length	Flatness Parallelism	Length	Flatness Parallelism	Length	Flatness Parallelism
Inches	Millimetres	Values in microinches (micrometres)							
4 or less	100 or less	1 (0.03)	1 (0.03)	2 (0.05)	1 (0.03)	2 (0.05)	1 (0.03)	2 (0.05)	2 (0.05)
over 4 thru 8	over 100 thru 200	--	--	3 (0.07)	1 (0.03)	6 (0.15)	1 (0.03)	6 (0.15)	2 (0.05)
over 8 thru 12	over 200 thru 300	--	--	4 (0.10)	1 (0.03)	8 (0.20)	1 (0.03)	8 (0.20)	2 (0.05)
over 12 thru 20	over 300 thru 500	--	--	5 (0.12)	1 (0.03)	10 (0.25)	1 (0.03)	10 (0.25)	2 (0.05)

4.5.4 Burrs and raised edges. Each block shall be wrung to a tungsten carbide block. If block fails to wring, use light box flatness inspection techniques to locate the defects. With a 30 percent reflective coating such as titanium oxide on the quartz flat, the burrs or raised edges will show up as colored spots or sharp changes in fringe continuity. Edges may be tested with microinterferometer. The entire set shall be rejected if more than two blocks have raised burrs on edges exceeding 1 μ in. or 0.03 μ m.

4.5.5 Surface texture on gaging surfaces. All gage blocks and accessories in a set, or those not supplied in sets, after thorough cleaning, shall be arranged in an array on a tray and the gaging surfaces examined. Those appearing to have the rougher surface texture shall be compared visually with samples known to conform to the maximum limits specified in table IV. Those blocks which appear to be questionable shall be subject to the tests of 4.5.5.1 and 4.5.6.

4.5.5.1 Surface texture measurement. The surface texture measurement shall be made either by the tracer type surface analyzer (4.5.5.1.1) or by microinterferometry (4.5.5.1.2). The microinterferometer method shall be used for referee test.

4.5.5.1.1 Arithmetical average roughness height. The arithmetical average roughness height shall be measured with a calibrated tracer type surface roughness analyzer which meets the requirements of the ANSI B46.1 standard.

4.5.5.1.2 Peak to valley height. The predominant peak to valley height shall be determined by microinterferometry or from a chart produced on a surface roughness analyzer (see 3.8.3.3). The narrowest width ribbon with parallel sides and parallel to the mean line but not necessarily straight is drawn on a continuous series of micrographs or a chart where it truncates the highest peak and the lowest valleys. The sum of the individual truncation widths of the clipped peaks and valleys shall each be 10 percent of the micrograph or chart length. This length is 0.03 inch or 0.75 mm times the horizontal magnification. The ribbon width is divided by the appropriate vertical magnification to obtain the microinch or micrometre predominant peak to valley height which shall meet the requirements in table IV.

4.5.6 Wringing quality. Only those blocks which are questionable on the visual surface texture test of 4.5.5 shall be tested for wringing quality. The gaging surface and an optical flat surface (preferably fused silica) shall be washed with ethyl alcohol and wiped clean with cloth or tissue. The gaging surface shall be wetted with a thin film of rust inhibiting oil by either contacting it to an oil-coated optical flat or dust free lightly oiled cloth. The oiled gaging surface shall be wiped nearly free of oil then slid into contact with the clean dry optical flat. No color or trace of oil film shall appear through the clear optical flat over the entire wringing gaging surface for the tolerance grade 0.5, 1, and 2, and accuracy level grades 1 μ in. (0.03 μ m) and 2 μ in. (0.05 μ m) gage blocks. The tolerance grade 3 blocks shall have not less than 80 percent of colorless wringing area.

4.5.7 Squareness of gaging surfaces to sides. Squareness shall be tested either mechanically or optically.

4.5.8 Hardness test. If specified (see 6.2), material used in gage blocks and accessories shall be tested for the hardness specified in 3.4.1 through 3.4.4 on partially finished blocks and accessories only. Three (3) samples shall be selected from the initial lot and tested for hardness. Three (3) readings shall be taken from each sample unit. Any sample that does not meet the hardness requirement shall cause rejection of the lot represented by the samples.

4.5.9 Flatness of gaging surface. (See tables IV, V, and XII; and 4.5.3).

4.5.9.1 For tolerance grades 0.5 and 1 and accuracy level grades 1 μ in. (0.03 μ m) and 2 μ in. (0.05 μ m), the flatness deviations of the gaging surfaces on blocks 0.100 in. (2.5 mm) and longer shall be measured unwrung in an interferometer with a master reference flat using collimated monochromatic light of known wavelength and viewed within 2° of normal incidence. The flatness deviation in any direction over the gaging surface, excluding 0.02 in. (0.5 mm) on the edges, shall not exceed the tolerances given in tables IV, V, and XII as applicable. (Blocks of tolerance grades 0.5 and 1 and accuracy level grades 1 μ in. (0.03 μ m), and 2 μ in. (0.05 μ m) under 0.100 in. (2.5 mm) shall be measured for flatness when they are wrung to a fused silica optical flat.)

4.5.9.2 For tolerance grades 2 and 3, the flatness deviations of gaging surfaces on blocks 0.100 in. (2.5 mm) and longer and accessories as applicable shall be measured either in an interferometer or a light box. If the light box method is used, the deviations shall be measured with a master optical flat and monochromatic light of known wavelength. The interference fringe shall be viewed at an angle within 10° of normal incidence. The flatness deviation in any direction over the gaging surface, excluding 0.02 in. (0.5 mm) or 0.06 in. (1.5 mm) where applicable on the edges, shall not exceed the tolerance given in table IV. Since the majority of tolerance grades 2 and 3 blocks under 0.100 in. (2.5 mm) in length are not precisely flat in their free state, the test for parallelism (see 4.5.3 and 4.5.10), is considered sufficient.

4.5.10 Parallelism of gaging surfaces. The deviation in parallelism shall be the maximum variation in length between the gaging faces, excluding 0.02 in. (0.5 mm) at the edges of the faces, and shall meet the requirements of table IV and 4.5.3. For all tolerance grades of gage blocks, and accessories as applicable, measurements of the parallelism deviation shall be made interferometrically or mechanically. For sizes of blocks less than 0.100 in. (2.5 mm), the tolerance for tolerance grades 2 and 3 applies to the variation in length determined by a point to point mechanical measurement. For accuracy level grades 1 μ in. (0.03 μ m) and 2 μ in. (0.05 μ m), measurements of the parallelism deviation shall only be made interferometrically.

4.5.11 Measured gage block length. The measured gage block length shall be either the interferometric mean gage length (see figure 3), or the corrected mechanical gage length.

4.5.11.1 The interferometric mean gage length by absolute interferometry. The interferometric mean gage length of a gage block, measured by absolute interferometry, shall be the mean of two perpendicular distances between the effective reflecting plane of the auxiliary surface and the effective reflecting plane which passes through the reference point where both the auxiliary surface and the gaging surface are of identical phase and when the gage block is wrung to the auxiliary surface in both aspects to account for the variation in flatness and wringing characteristics of both gaging surfaces. If all surfaces are not identical, a correction accounting for the differences in phase must be applied (see figure 4).

4.5.11.2 The mechanical gage length. The mechanical gage length shall be the length obtained by comparison to an interferometrically measured gage block applying the necessary deformation corrections (see 4.5.11.5.3.1).

4.5.11.3 Reference point, style 1. The reference point shall be a point located in the middle of either gaging surface (see figure 5).

4.5.11.4 Reference point, style 2. The reference point shall be a point of either gaging surface located midway between the hole or outer edge of countersink and the edge of the block nearest to the size marking. In the case of blocks marked on the top gaging surface, the top reference point shall be located midway between the hole and the edge of the block to the right of the size marking (see figure 6). The bottom reference point shall be the mirror image point of the top reference point (see figure 6).

4.5.11.5 Length. Depending on the tolerance grade, lengths of gage blocks shall be measured by absolute interferometry or by comparison with calibrated length standards, using extremely precise means of comparison, taking all precautions possible to assure that the accuracy of the final results is compatible with the tolerances, as specified in tables VI and VII.

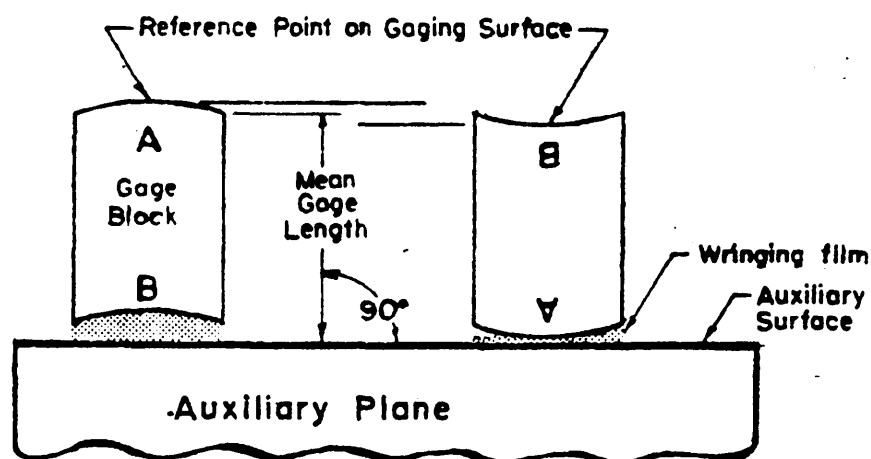


FIGURE 3. Mean gage length.

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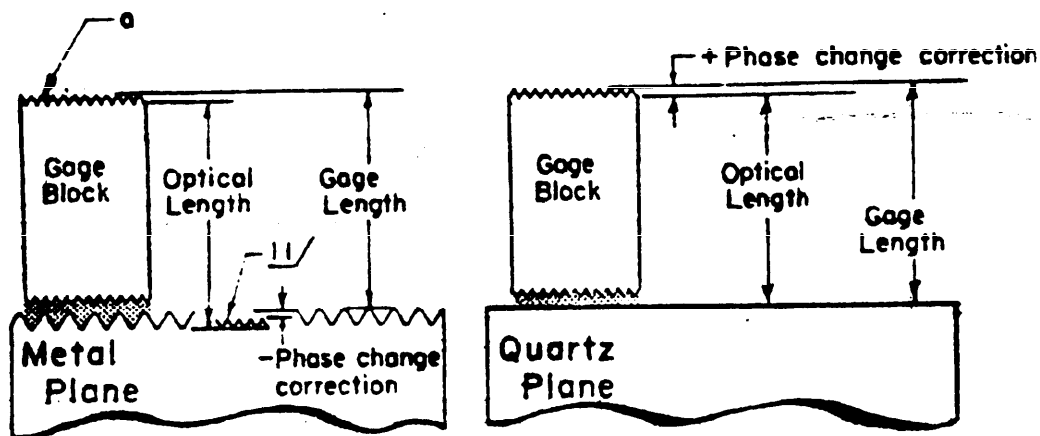


FIGURE 4. Phase change correction. It is required when surface texture of gaging surface of gage block and auxiliary plane are not the same or their material are not the same.

11/ That portion of the phase change which is equivalent to the phase change of the gage block surface marked "A".

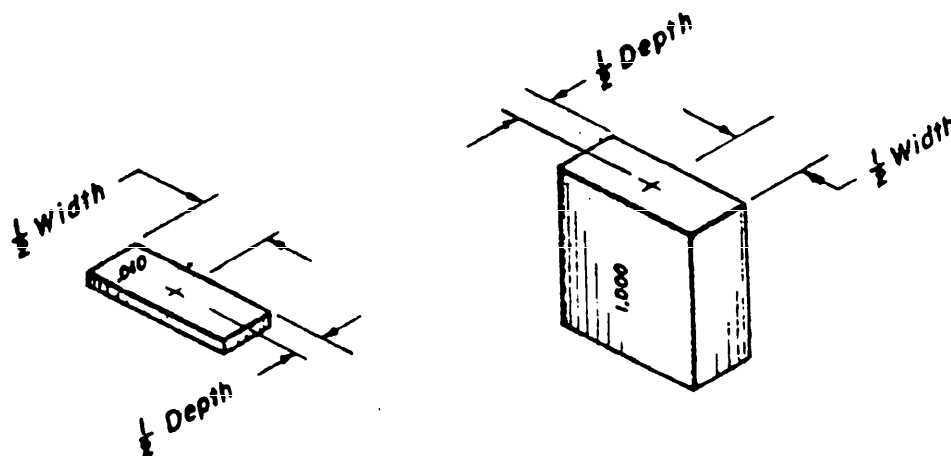


FIGURE 5. Reference point, style 1.

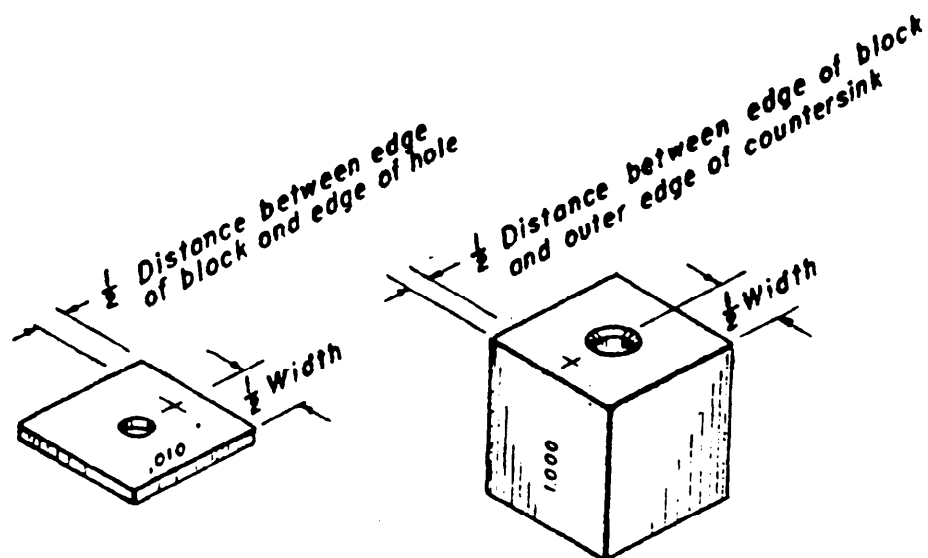


FIGURE 6. Reference point, style 2.

4.5.11.5.1 Length of tolerance grade 0.5 gage blocks shall be measured absolutely by interferometry (see table XII and 4.5.3). Dimensional metrology laboratories with gage block interferometers may be requested to test the length on questionable blocks. Only as a last resort, the National Bureau of Standards may be requested to act as referees.

4.5.11.5.2 Length of tolerance grade 1 gage blocks shall be measured by absolute interferometry or by mechanical comparison with accuracy level grade 1 μ in. (0.03 μ m) gage blocks (see tables V, XII, and XIV; and 4.5.3). However, rejected blocks shall be tested absolutely by interferometry if their mechanical values are questioned.

4.5.11.5.3 Length of tolerance grades 2 or 3 gage blocks and gaging accessories and accuracy level grade gage blocks having tolerance grade 2 or tolerance grade 3 length accuracy shall be measured by comparison with accuracy level grade 2 μ in. (0.05 μ m) gage blocks, or better (see tables V, XII, and XIV; and 4.5.3).

4.5.11.5.3.1 Stylus deformation corrections shall be applied when mechanically comparing steel gage block masters to steel blocks of differing surface texture and when mechanically comparing gage blocks with masters of a different class of material. Since the radius of the contact stylus and the contact areas are continually changing from wear, the use of theoretical corrections for elastic deformation are not always practical.

4.5.11.5.3.1.1 Determination of deformation correction for upper stylus of single or dual head gage block comparator. Measurements are made on two accuracy level grade 1 μ in. (0.03 μ m) gage blocks of different compositions or of different surface textures (see table V). Blocks about 0.150 in. or 3.5 mm in length are carefully wrung together and then the combination is allowed to reach a room temperature of 68° F (20° C). Blocks are moved under the stylus with forceps. The combination is read in the two aspects, (see figure 7). The difference in readings is the correction to be applied for deformation.

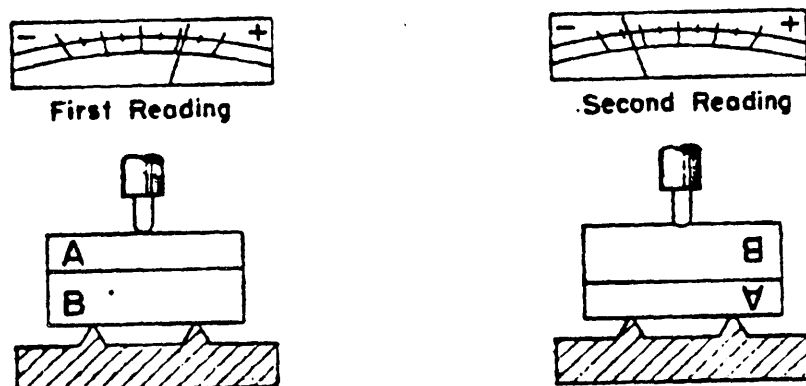


FIGURE 7. Deformation correction for upper stylus of single or dual head gage block comparator.

4.5.11.5.3.1.2 Determination of deformation correction for lower stylus of dual head gage block comparator. Measurements are made on two accuracy level grade 1 μ in. (0.03 μ m) gage blocks of different materials or surface textures (see table V). Each block is moved over the lower stylus using the 5 ounce force (150 gram force) of the upper stylus to position the block firmly on the table (see figure 8).

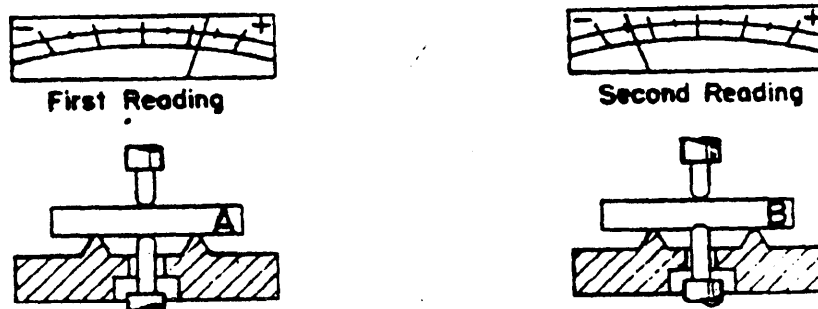


FIGURE 8. Deformation correction for lower stylus of dual head gage block comparator.

4.5.11.5.3.2 Thermal expansion corrections shall be applied when mechanically comparing gage blocks of different compositions (see 6.5).

4.6 Inspection of preparation for delivery requirements. An inspection shall be made to determine that packaging, packing, and marking requirements of section 5 of this specification are complied with. Defects shall be scored in accordance with table XIII. For examination of contents, the sample unit shall be one shipping container fully prepared for delivery selected just prior to the closing operations. 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 expressed in terms of defects per hundred units.

TABLE XIII. Classification of defects

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

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be level A, B, or C, as specified (see 6.2). When gages are shipped or reshipped, the gage block case shall be taped with 1-inch wide or wider reinforced filament tape conforming to PPP-T-97, type I, or equivalent to hold the case together and blocks in place when case cracks or breaks or latches fail (see figure 9). Bands of tape along the length and width of the case shall not be over five inches apart nor more than three inches from the corners.

5.1.1 Level A.

5.1.1.1 Cleaning and drying procedure before applying preservatives. The gage blocks and accessories shall be cleaned in accordance with MIL-P-116, process C-5 (petroleum solvent cleaning followed by fingerprint remover) and dried by procedure D-4 (wiping the surface with clean, dry, lint free cloth). Do not touch cleaned gaging surfaces because body oils and salts cause stains under the preservative coating.

5.1.1.2 Preservation application; gage blocks and accessories sets with case. Unless otherwise specified (see 6.2), each gage block or accessory shall be coated with type P-2, P-3, or P-6 preservative or, when specified (see 6.2), may be protected with type P-18 (volatile corrosion inhibitor paper) in accordance with MIL-P-116.

5.1.1.2.1 Gage blocks and accessories without case. Each gage block and accessory, except the deburring stone, furnished individually shall be preserved as specified in 5.1.1.2.

5.1.1.3 Unit packaging; (see figure 9).

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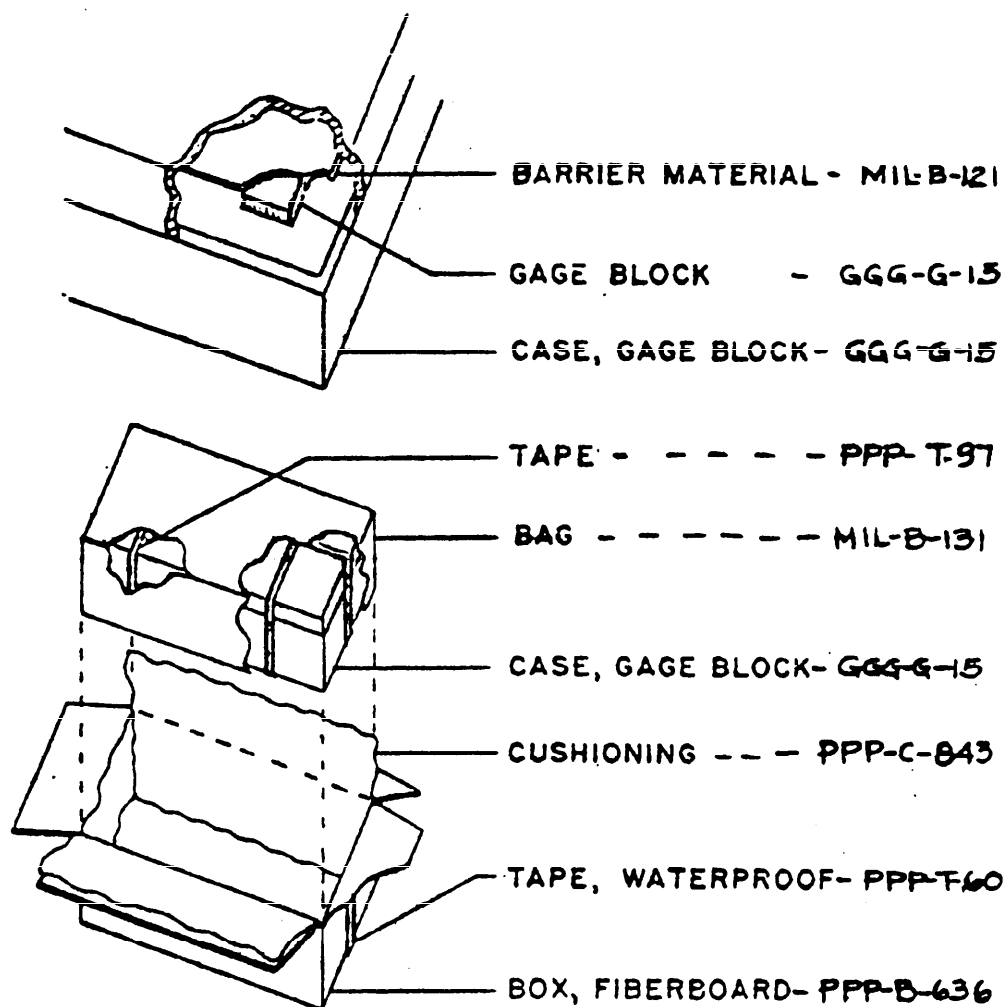


FIGURE 9. Taping and packaging illustration.

5.1.1.3.1 Gage blocks or accessories furnished in a case. The gage blocks or accessories furnished with a case, preserved in accordance with 5.1.1.2, shall be inserted in the applicable slots. Folded material conforming to MIL-B-121, grade A, shall be used to cover the items in the case to shield the preservative and secure the items within the case when it is closed. Thickness of this material shall be such that it will not exert excessive stress on the blocks, hinges, or latches. The case shall be closed, taped, and packaged Method 1A-14, in accordance with MIL-P-116. Wooden cases shall be wrapped in kraft paper prior to putting the tape on the case. Alternatively, masking tape shall be put around the case and the filament tape placed over the masking tape. The bagged item shall then be packaged in a container conforming to PPP-B-636, type CP, variety SW, class weather-resistant, cushioned with material conforming to PPP-C-843, type II and taped in accordance with the appendix to the container specification.

5.1.1.3.2 Gage blocks and accessories without cases, or outside the case. Each gage block or accessory, with the exception of the deburring stone, furnished individually, preserved in accordance with 5.1.1.2, shall be packaged Method 1C-1 Method III. The items shall be further packaged individually in close fitting boxes conforming to PPP-B-566 or PPP-B-676. Closure shall be effected by taping.

5.1.2 Level B. The gage blocks and accessories shall be preserved and packaged in accordance with the requirements for level A, except that the barrier bag required for Method 1A-14 may be omitted.

5.1.3 Level C. The gage blocks and accessories shall be packaged in accordance with the supplier's commercial practice.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Level A. Gage blocks and accessories of like description treated and packaged as specified in 5.1.1.3.1 or 5.1.1.3.2, shall be packed in close fitting boxes conforming to PPP-B-585, class 3; PPP-B-591, class II; PPP-B-601, overseas type; PPP-B-621, class 2; PPP-B-636, class weather resistant; or PPP-B-640, class 2; style A. The gross weight of the triple-wall fiberboard box and the wood boxes shall not exceed approximately 200 pounds. Strapping shall be in accordance with the appendix to the applicable box specification.

5.2.2 Level B. Gage blocks and accessories of like description treated and packaged as specified in 5.1.1.3.1 or 5.1.1.3.2, shall be packed in close fitting boxes conforming to PPP-B-585, class 1; PPP-B-591, class 1; PPP-B-601, domestic type; PPP-B-621, class 1; and PPP-B-636, class domestic. The gross weight of the wood boxes shall not exceed approximately 200 pounds.

5.2.3 Level C. The gage blocks and accessories shall be packed to assure carrier acceptance and safe delivery to destination. Containers shall comply with the requirements of the Uniform Freight Classification Rules or National Motor Freight Classification Rules, as applicable to the mode of transportation.

5.3 Marking.

5.3.1 Civil agencies. In addition to markings required by the contract or order, the packages and shipping containers shall be marked in accordance with Fed. Std. No. 123.

5.3.2 Military activities. In addition to markings required by the contract or order, the packages and shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The gage blocks covered by this specification are intended to be used as follows:

- (a) Tolerance grade 0.5 gage blocks are special standards which are required for extremely high precision gaging work. These blocks are not recommended for general use, therefore they should be ordered individually for specific applications.
- (b) Tolerance grade 1 gage blocks are laboratory reference standards. They are used for calibrating inspection gage blocks and for high precision gaging work.
- (c) Tolerance grade 2 gage blocks generally are inspection and tool room standards.
- (d) Tolerance grade 3 gage blocks are generally used as shop standards.
- (e) Accuracy level grade gage blocks permit the purchaser to obtain blocks with special flatness and parallelism requirements which provide controllable microinch and micrometre dimensions for specific applications when the blocks are used with their calibration report. Generally, accuracy level grade 1 μ in. (0.03 μ m) or 2 μ in. (0.05 μ m) gage blocks would be used as masters for calibrating gage blocks and master ring gages.

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- (f) Blocks under 0.100 inch (2.5 mm) in length in their free state (see table IV), are very difficult to make to the flatness tolerance for tolerance grades 0.5 and 1. Since thin blocks are comparatively difficult to wring over their entire wringing surface, they are not recommended for high accuracy use. Where more complete wringability is desired, thin tungsten carbide blocks are more suitable.
- (g) Steel gage blocks with hardness greater than the equivalent of RC-62 tend to have greater gage life and scratch resistance but may lack maximum dimensional stability.
- (h) When long gage blocks are used in horizontal position, they shall be supported at the Airy positions. The supports are located 0.2115 L in from each end of the block.

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, grade, class, and type of gaging blocks (see 1.2.1, 3.1, 3.3, and 3.4).
- (c) If style 1, inch system gage blocks 0.531 x 1.500 inch dimensions are required (see 3.1).
- (d) Dimensions of style 3 gage blocks, if required (see 3.1).
- (e) If accuracy level grade gage blocks are required, specify only if absolutely essential (see 3.3.2).
- (f) Whether accuracy level grade 1 μ in. (0.03 μ m) or 2 μ in. (0.05 μ m) gage blocks are required (see 3.3.2).
- (g) Whether accuracy level grade gage blocks shall meet the length requirements of tolerance grade 2 or tolerance grade 3 gage blocks (see 3.3.2).
- (h) Sizes of blocks, inch or metric (see table II or III), and set requirements (see 3.5 through 3.5.2.6).
- (i) Requirements of accessories furnished in a case with gage blocks (see 3.6 through 3.6.2).
- (j) Whether a case is required for accessories furnished as individual sets (see 3.6).
- (k) Requirements for gage blocks and accessories ordered individually (see 3.8.1).
- (l) Wear block length, set (see 3.8.2).
- (m) Whether tolerance grade 2 or tolerance grade 3 parallels are required (see 3.8.4.8).
- (n) If tolerance grade marking is required (see 3.8.5.3).
- (o) If manufacturer's report of calibration is required (see 3.9).
- (p) If accuracy level grade calibration is required, and whether it is to be done by the Government designated commercial dimensional metrology laboratory or the National Bureau of Standards (see 3.10).
- (q) If inspection is to be conducted at a Government or Government designated commercial laboratory (see 4.2).
- (r) If hardness test is to be made (see 4.5.8).
- (s) Level of preservation, packaging, and packing required (see 5.1 and 5.2).
- (t) Special marking, if required (see 5.3).
- (u) If caliper jaws are required in carbide or chromium plated steel (see 3.6).

6.3 Definitions.

- (a) Gage length. The gage length of a gage block is the perpendicular distance between an auxiliary dielectric true plane, quartz or glass, upon which the block is vertically wrung and the block's reference point located on the wringing plane for that surface.
- (b) Inch. The unit of length equal to 0.0254 metre.
- (c) Metre. The international unit of length defined as 1,650,763.73 vacuum wavelengths of the unperturbed transition $2P_{10} - 3d_5$ in krypton isotope 86.
- (d) Microinch (μ in.). The unit of length equal to 0.000 001 inch.
- (e) Micrometre (μ m). The unit of length equal to 0.000 001 metre.
- (f) Tolerance grade. The classification of a gage block according to specific manufacturing tolerances on flatness, parallelism, nominal size and surface texture.
- (g) Tolerance grade number. The number which designates the grade of gage block.
- (h) Accuracy level grade. Classification which defines the accuracy capability of a gage block or an entire set of gage blocks when used individually, without regard for the reference point, but within the length limitations stated in the calibration report.
- (i) Accessories. Items having gaging surfaces and also items having nongaging or locating surfaces such as clamps and fasteners.
- (j) Parallelism. The difference in two length measurements taken at opposite edges of the gaging surfaces.
- (k) Flatness. The distance between two theoretical parallel planes which just envelop the gaging surface.
- (l) Span of gaging surface. The longest straight line distance on the gaging surface disregarding for gage blocks 0.020 inch (0.5 mm) or for accessories 0.060 inch (1.5 mm) width of the surface along the edges.
- (m) Surface texture. Random and repetitive micro deviations from the nominal surface which form the pattern of the surface and which include roughness, waviness, lay, and flaws.
- (n) Measurement error. The difference in magnitude between the actual value of a quantity and its measured value due to systematic and random errors generated by instrumentation environment and the human element.

6.4 The originating activity should designate the commercial dimensional metrology laboratory or the Government testing laboratory which it desires to conduct the test and examination specified in 4.2. It should not designate the National Bureau of Standards as the Government testing laboratory except by special prior arrangement with that Bureau. When an activity requires the calibration of master gage blocks by the National Bureau of Standards, it should place its order directly with that Bureau.

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

6.5 In using carbide blocks to measure steel parts, the accuracy of length measurements is affected by differences from standard temperature. Any deviation in temperature from 68° F. (20° C.) should be measured and the actual gage block length calculated. The coefficients of thermal expansion are given in the manufacturer's certificate of inspection (see 3.9). The tabulation of materials and coefficients of expansion (see table XIV) are given to emphasize the need for knowing the correct information for a given set of gage blocks.

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TABLE XIV

Thermal Coefficient of Linear Expansion

Gage block composite	Microinches/inch °F (Micrometres/metre °F)	Microinches/inch °C (Micrometres/metre °C)
Chromium carbide	4.7 ⁺² -0.7	8.5 ⁺³ -1.3
Steel	6.4 ⁺² -0.4	11.5 ⁺⁴ -0.8
Tungsten carbide	3.6	6.5

6.6 Deburring used gage blocks. Used gage blocks require removal of burrs on the gaging surfaces before recalibration. Optically flat deburring stones are required. Granite or Arkansas stones are used on steel blocks. Silicon carbide or sintered aluminum oxide stones are required on tungsten and chromium carbide blocks. Unless the used gage blocks are thoroughly cleaned and burrs on the gaging surfaces removed, the blocks cannot be accurately measured and accordingly the calibration report will be of no significance.

6.7 Periodic recalibration. Periodic recalibration of used gage blocks is recommended to determine replacement needs. The interval between calibrations will vary with the class of block and with the conditions and frequency of usage. Gage blocks utilized in manufacturing departments might be recalibrated monthly whereas blocks used in the calibrating of other blocks may be maintained adequately with annual recalibration. The following suggested schedules are typical of practices prevalent in industry:

Tolerance grade 0.5	Annually
1	Annually
2	Monthly to semi-annually
3	Monthly to quarterly

6.8 Replacement levels. At recalibration periods, it is suggested that individual blocks which deviate more than twice the length, flatness or parallelism tolerances for new blocks or which have lost their wringing qualities should be replaced. Blocks which have only undergone a length change do not need replacement if corrections from a calibration report are applied in usage. When recalibration indicates that 25 percent or more of the blocks in a set should be replaced, the entire set normally should be assigned to lower accuracy work. Recommended testing order for used sets of gage blocks is as follows: 4.5.4 (burrs), 4.5.9 (flatness), 4.5.6 (wringing), 4.5.10 (parallelism), 4.5.11 (length), and 4.5.5 (surface texture).

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6.9 Superseding data. The metric block series in all metric sets except for the 2M-88 set and the long set were modified. Two additional metric sets with the two millimeter base were added. Class IV and the alternate set of accessories were deleted.

MILITARY INTEREST:Custodians:

Army - GL
Navy - SH
Air Force - 84

Review activities:

Army - GL
Navy - SH
Air Force - 84

User activities:

Army - CE, ME, MU, WC
Navy - AS, MC, OS, TD

Preparing activities:

GSA-FSS
COM-NBS

CIVIL AGENCY INTEREST:

COM-NBS
GSA-FSS

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