*TB 9-5210-205-40

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR GAGE BLOCKS, GRADES AS-1 AND AS-2

Headquarters, Department of the Army, Washington, DC
6 January 2009

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also send in your comments electronically to our E-mail address: 2028@redstone.army.mil or by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: https://amcom2028.redstone.army.mil. Instructions for sending an electronic 2028 can be found at the back of this manual.

*This bulletin supersedes TB 9-5210-205-50, dated 26 October 2005.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument identification. This bulletin provides instructions for the calibration of Gage Blocks, Grades AS-1 and AS-2. ASME B89.1.9-2002 was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Variations among models are described in text.

b. Time and Technique. The time required for this calibration is approximately 20 minutes per block, using the physical technique.

2. Forms, Records, and Reports. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

DEVIATION FROM FLATNESS TOLERANCE t_f		
Nominal length range for l_n	Deviation from flatness tolerance t_f in μm (μin.)	
	Style and grade	
	AS-1 All styles former grade 3	AS-2 All styles
0.5 mm up to 50 mm	0.15	0.25
0.010 in. up to 2 in.	(6)	(10)
50 mm up to 150 mm	0.15	0.25
2 in. up to 6 in.	(6)	(10)
Over 150 mm up to 500 mm	0.18	0.25
Over 6 in. up to 20 in.	(7)	(10)

Table 1. Calibration Description – Continued

MAXIMUM PERMITTED DEVIATIONS OF THE LENGTH AT ANY POINT AND PARALLELISM TOLERANCES FOR METRIC GAGE BLOCKS					
Nominal Length Range, l_n (mm)	Grade AS-1 (former Grade 3) (µm)			Grade AS-2 (µm)	
	$\pm t_e$[1]	t_v[2]		$\pm t_e$[1]	t_v[2]
$l_n \leq 0.5$	0.30	0.16		0.60	0.30
$0.5 < l_n \leq 10$	0.20	0.16		0.45	0.30
$10 < l_n \leq 25$	0.30	0.16		0.60	0.30
$25 < l_n \leq 50$	0.40	0.18		0.80	0.30
$50 < l_n \leq 75$	0.50	0.18		1.00	0.35
$75 < l_n \leq 100$	0.60	0.20		1.20	0.35
$100 < l_n \leq 150$	0.80	0.20		1.60	0.40
$150 < l_n \leq 200$	1.00	0.25		2.00	0.40
$200 < l_n \leq 250$	1.20	0.25		2.40	0.45
$250 < l_n \leq 300$	1.40	0.25		2.80	0.50
$300 < l_n \leq 400$	1.80	0.30		3.60	0.50
$400 < l_n \leq 500$	2.20	0.35		4.40	0.60
MAXIMUM PERMITTED DEVIATIONS OF THE LENGTH AT ANY POINT AND PARALLELISM TOLERANCES FOR INCH GAGE BLOCKS					
Nominal Length Range, l_n (in)	Grade AS-1 (former Grade 3) (µin.)			Grade AS-2 (µin.)	
	$\pm t_e$[1]	t_v[2]		$\pm t_e$[1]	t_v[2]
$l_n \leq 0.05$	12	6		24	12
$0.05 < l_n \leq 0.4$	8	6		18	12
$0.45 < l_n \leq 1$	12	6		24	12
$1 < l_n \leq 2$	16	6		32	12
$2 < l_n \leq 3$	20	6		40	14
$3 < l_n \leq 4$	24	8		48	14
$4 < l_n \leq 5$	32	8		64	16
$5 < l_n \leq 6$	32	8		64	16
$6 < l_n \leq 7$	40	10		80	16
$7 < l_n \leq 8$	40	10		80	16
$8 < l_n \leq 10$	48	10		104	18
$10 < l_n \leq 12$	56	10		112	20
$12 < l_n \leq 16$	72	12		144	20
$16 < l_n \leq 20$	88	14		176	24

[1] $\pm t_e$ = Limit deviations of length at any point from nominal length.

[2] t_v = Tolerances for parallelism.

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Reference Calibration Standards Set NSN 4931-00-621-7878. Alternate items may be used by the calibrating activity. The items selected must be verified to perform satisfactory prior to use and must bear evidence of current calibration. The equipment must meet or exceed minimum use specifications listed in table 2.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
COMPARATOR	Range: 0 to 20 in. Resolution: 0.1 µin.	Edmunds 20″ Gage Block comparator 5022000 (5022000)
GAGE BLOCKS	Range: 0.050 to 20 in. Accuracy: See test report	(7901765), (7901267), (7901363), (7901961), (13534020), and (13534021)
INTERFEROMETER	Flatness Accuracy: 1 µin.	Davidson Optronics Inc., Model D327-100 (13440047)
OPTICAL FLATS	Flatness Accuracy: 3 µin.	(7902794)

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph **4** above and are used in this calibration procedure. When necessary, these items may be substituted by equivalent items, unless specifically prohibited.

Table 3. Accessories Required

Common name	Description (part number)
ALCOHOL	Ethyl, 1-gallon container (MIL-E-463A) (95% USP) 51-A-1965
BARRIER MATERIAL	Polyethylene (MIL-B-121)
BEAKER	Glass, capacity 1000 ml (6640-240-6829)
BRUSH	1-1/16-in. length; 3/4-in. diameter ferrule (8020-224-8024)
BRUSH	8-1/2-in. o/a length; 1/2-in. diameter x 3 in. long (7920-223-8002)
CAN[1]	Bench, safety, 9-1/2 x 4-1/2 in. (Justrite No. 10370)
CAN[1]	Safety (w/screen), 5-gallon capacity (McMasters Can No. 429lX3, Screen No. 429lX8)
ULTRASONIC CLEANER	Crest Company (4931-682-1027)
CUSHIONING MATERIAL[1]	Kimpac or equivalent
DEMAGNITIZER	Taft-Pierce, No. 9801-2 (7910422)
DEBURRING KIT	Various abrasive tools w/case (7913148)
FORCEPS	Straight, 5 in.
FORCEPS	Straight, 10 in.
GLOVES[1]	Rubber or plastic, insulated
HEATSEALER WITH THERMOSTATIC CONTROL	115 V ac
MONOCHROMATIC LIGHT	Van Keurin, Model C-2 (7902779)
OIL	Fed Spec W.-L-800 (9150-231-6689)

See footnote at end of table.

Table 3. Accessories Required - Continued

Common name	Description (part number)
POLISHING CLOTH	Cotton, batiste, white, 4 x 6 inch (7920-263-2765)
POLYETHYLENE TUBING[1]	Lay flat, Fed Spec L-F-378b. Packaging aids Corp. Stock numbers, 1CT, 11/2CT, 2CT, and 21/2 CT
SCISSORS	6- or 8-in. size
SOLVENT	Mineral spirits
TAPE	Pressure sensitive masking tape (PPP-T-60)
WOODEN TRAY[1]	15 x 10 x 3/4 in.

[1]Procure locally.

SECTION III
CALIBRATION PROCESS

6. General Information

a. Acceptance Convention

(1) Tolerances for surface finish, flatness, parallelism, and size will be within those specified for gage blocks and accessories found in table 1.

(2) Optical flats with a monochromatic light or interferometer may be used for flatness tests. Refer to figure 1 for interpretation of fringe lines for allowable tolerances.

b. Requirements for Calibration Interval Extension of Non-used Gage Blocks. To reduce the quantity of gage blocks being recalibrated without adversely affecting accuracy, adhere to the following requirements:

(1) Positive evidence of non-use. At the end of the calibration cycle, blocks that remain sealed in polyethylene display positive evidence of non-use.

(2) The calibration interval will not be extended beyond 6 years from the date of sealing for those gage blocks which are unused (sealed). A statement of the date of initial sealing will be completed and retained with calibration worksheets.

NOTE

Gage blocks that are reserved for use as reference standards for calibration of other gage blocks need not be sealed.

7. Preliminary Instructions

a. The instructions outlined in paragraphs **7** and **8** are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name.

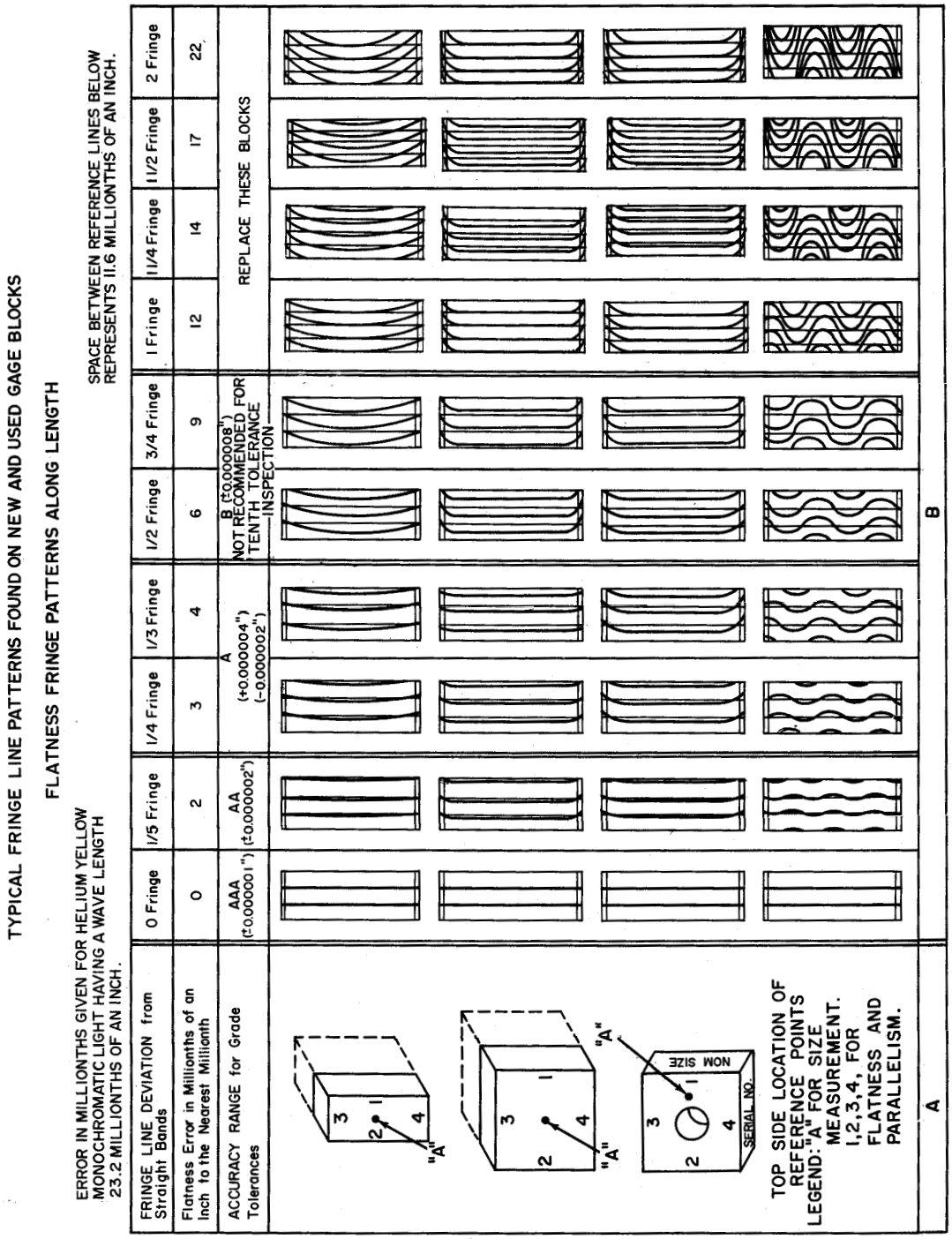

Figure 1. Typical gage block calibration data.

8. Equipment Setup

a. Clean the TI, using light duty cycle of an ultrasonic cleaner. Place a beaker of alcohol or mineral spirits into an energized tank of water. Wait approximately 5 minutes and insert TI into beaker. If necessary, use a soft brush to remove dirt, grime, or grease. If ultrasonic cleaner is not available, use the alternate in paragraph **b** below.

b. Clean TI with solvent and wipe dry with a soft polishing cloth. Use brush for cleaning holes in square TI.

c. Discard all blocks containing pits that might prevent accurate calibration.

d. Clean TI with alcohol or mineral spirits and place on polishing cloth in a wooden tray.

e. Clean inside of TI case.

f. Check for residual magnetism by holding each TI near a suspended, very light piece of steel with low permeability.

g. Demagnetize if residual magnetism is perceptible, using demagnetizer.

h. Visually inspect each TI for scratches, burrs, nicks, and other surface defects.

i. If necessary, slide the wringing surfaces of each TI across a deburring plate, applying light pressure to shear off any large burrs that may be present.

j. Small burrs may be removed by using a deburring stone.

k. Clean TI with alcohol or mineral spirits, wipe dry, and place on cloth in wooden tray.

l. To ensure good wringing quality completely remove burrs. Questionable blocks may be tested for wringing quality by barely wetting the surface in question with oil and wringing it to a known good block from the TI set.

m. Allow gage blocks to normalize at a controlled room temperature of 68°F (20°C) for at least 8 hours with an additional 1 hour per inch for gage blocks larger than 1 inch.

9. Calibration for Flatness

a. Performance Check

NOTE

Handle blocks with gloves or forceps.

(1) Test the wringing surfaces of TI for flatness, as follows:

(a) Place TI on the platen of the interferometer and adjust until the desired fringe pattern appears (B, fig.1)

(b) Arrange the fringes to appear first in one direction on TI and then the other.

(c) Interpret flatness errors from fringe patterns (B, fig. 1) and record four results from each block (two from each wringing surface).

(2) The TI will not exceed the applicable flatness value listed in table 1.

NOTE

Since the majority of gage blocks under 0.100 inch (2.5 mm) in length are not precisely flat, the test for parallelism is considered sufficient. The interferometer will be used to examine blocks under 0.100 inch (2.5 mm) in length for scratches, dents, or other damage that would prevent accurate calibration or usage. Blocks showing such damage will be rejected.

10. Parallelism and Size Measurement

a. Performance Check

(1) Arrange TI and gage blocks (hereafter called master block) side by side according to size on soaking area.

(2) Allow sufficient time for normalizing of TI. Observe such factors as elapsed time between handling and stability of room temperature.

NOTE

Handle blocks with forceps. Gloves may be used for blocks over 4 inches.

(3) Place master block on anvil of comparator and align master block so that gauging head contact tips of comparator will contact reference point for length measurement.

(4) Zero the comparator.

(5) Remove master block and insert TI.

NOTE

Copies of the calibration worksheet located in **Appendix A** may be used to record values and facilitate calculations.

(6) Record meter reading (μin.) at reference point A (fig. 1) with proper signs and algebraically add reading to test reported deviation for master block. Record value on calibration worksheet as the length deviation of the TI.

(7) Remove TI and insert master block to ensure that proper setting of instrument was maintained during measurement; remove master block and re-insert TI.

NOTE

Zero drift should not exceed approximately 25% of the tolerance of the gage block being measured.

(8) Take readings at reference points 1, 2, 3 and 4 (fig. 1) avoiding the area of block 0.020″ from edge of the block, back to the edge. Record the four readings in respective columns on calibration worksheet in millionths of an inch with proper signs. The largest algebraic difference between any two points 1, 2, 3 and 4 will be within limits found in table 1 t_v column.

NOTE

Due to size and shape variations among gage blocks, the location of the reference points mentioned in step (8) above may vary in order to accommodate the size markings. These variations will not adversely affect the parallelism verification provided that the reference points are evenly distributed over the measured surface.

(9) Repeat steps (3) through (8) above for each TI in set being calibrated.

b. Adjustments. No adjustments can be made.

11. Final Procedure

a. Verify that TI length and flatness deviations recorded on calibration worksheet are within the tolerances listed in table 1. For out-of-tolerance conditions, perform one of the following:

(1) If less than 25% of blocks are out-of-tolerance then replace with same size gage blocks, if available and return unserviceable blocks to unserviceable stock.

(2) If 25% or more of AS-1 gage blocks are out-of -tolerance, downgrade entire set to lower grade (AS-2) if possible, and affix DA Label 163 annotating new grade designation.

(3) If 25% or more of AS-2 gage blocks are out-of -tolerance then annotate and affix DA Form 2417 (Unserviceable or Limited use tag) to the entire set.

(4) Individual blocks which deviate more than twice the length, flatness or parallelism tolerances or which have lost their wringing qualities are to be replaced. Discard all unserviceable blocks.

b. Transfer individual block identification and length deviation to a test results report. One copy will be maintained by the calibration facility and one will be packaged with the TI. Add all pertinent information.

NOTE

The test results report is not a correction chart. It is used to compare length deviation between calibration intervals.

c. Preserve TI as follows:

(1) Wipe each TI with clean polishing cloth and apply thin coat of oil. Ensure that all surfaces are covered.

(2) Wrap and seal TI as described in (a) through (d) below:

(a) Select appropriate size polyethylene tubing and cut length of tubing long enough to completely sheath TI.

(b) Seal one end of tubing prior to inserting TI.

(c) Insert TI in tubing and seal close to TI with heat sealer.

(d) Remove excess overhang to approximately 1/16 inch from seal line to minimize bulkiness. Check seams for adherence to assure effective sealing.

(3) Insert TI in appropriate place in carrying case. Use cushioning material to protect TIs as required.

d. Package TI as listed in (1) through (6) below:

(1) Place smooth side of barrier material directly on top of TI in opened case.

(2) Package calibration worksheets in suitable envelope and place in clear polyethylene.

(3) Place a copy of test results on top of barrier material.

(4) Place the following notice conspicuously on lid of storage box:

The polyethylene protective cover on gage blocks is a control measure. Do not break seal of protective cover on gage blocks which are not required to perform an operation or measurement. Discard polyethylene cover after seal is broken. Seal Date: _____

(5) Close lid and make sure that clasps are secure.

(6) Bind the closed case with tape to prevent case from coming open during transit.

e. At the end of the extended interval, all TIs (regardless of last calibration date) will be recalibrated. If TIs are within tolerance, they will be resealed and the cycle repeated.

f. Annotate and affix DA label/form in accordance with TB 750-25.

APPENDIX A

Calibration Worksheet

ID #	Nom. Size	Flatness				Size			Parallelism					
		Top		Bottom		Master Dev. (Test Report)	TI A	Length Dev.	1	2	3	4	Max Error	Pass/ Fail
		1-2	3-4	1-2	3-4									

By Order of the Secretary of the Army:

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To be distributed in accordance with STD IDS No. RLC-1500, 2 January 2003, requirements for calibration procedure TB 9-5210-205-40.

INSTRUCTIONS FOR SUBMITTING AN ELECTRONIC 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" whomever@redstone.army.mil
To: <2028@redstone.army.mil

Subject: DA Form 2028

1. **From**: Joe Smith
2. Unit: home
3. **Address**: 4300 Park
4. **City**: Hometown
5. **St**: MO
6. **Zip**: 77777
7. **Date Sent**: 19-OCT –93
8. **Pub no:** 55-2840-229-23
9. **Pub Title**: TM
10. **Publication Date**: 04-JUL-85
11. Change Number: 7
12. Submitter Rank: MSG
13. **Submitter FName**: Joe
14. Submitter MName: T
15. **Submitter LName**: Smith
16. **Submitter Phone**: 123-123-1234
17. **Problem**: 1
18. Page: 2
19. Paragraph: 3
20. Line: 4
21. NSN: 5
22. Reference: 6
23. Figure: 7
24. Table: 8
25. Item: 9
26. Total: 123
27. **Text**

This is the text for the problem below line 27.

PIN: 085246-000