

J.H. BUSCHER, INC.
Standard Specification SS01H
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GAGE CALIBRATION

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<i>Revisions</i>			
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REVISION STATUS and CONTENTS

Reason for Change: General update. Description of Change: 1) Removed reference to obsolete procedure SS013 in 1.2.3. 2) Added Par. 1.8 and ref to 1.8 in 1.3.

<i>Section</i>	<i>Description</i>	<i>Revision</i>	<i>Page</i>
1	General Notes	A	2
2	Documentation	~	3
3	Environment	~	4
4	Dimensional Gages	~	5
5	Pressure Gages	~	8
6	Flow Meters	~	9
7	Outside Calibration	~	9
8	Limited Use	~	9
9	Out-of-Tolerance Condition	~	10
10	All Other Gages	~	10

1) GENERAL NOTES

1.1) Scope

This procedure shows how to verify, adjust and record the accuracy of simple measurement and test equipment such as micrometers, calipers, height gages, dial indicators and pressure gages.

1.2) Exclusions

This procedure does not cover:

1.2.1) Transducer Calibration

Gages with an electrical signal output such as pressure, flow, or displacement transducers are covered by JHBI Document SS003, *Calibration Requirements for Transducers*.

1.2.2) Measurement Procedures

Gaging techniques and tool selection by feature are covered by SS00V, *Inspection*. Guide to functional and acceptance testing is given by the Acceptance Test Procedure (ATP) for the product.

1.2.3) Statistical Sampling

Unless otherwise directed by Work Order or Purchase Order, sampling requirements are referenced by SS00V.

1.2) Responsibility and Authority

Verification and calibration of instruments can be performed by anyone who is qualified to use them. Whoever does the calibration is responsible for the creation or updating of the record. Maintenance of records is the responsibility of the Quality Department.

1.3) Calibration Interval

Default calibration intervals are given in Table 1. More frequent verification may be specified for tools in frequent or heavy use – see 2.2.5. An instrument should also be verified if it has provided suspicious results. Gages that have experienced unexpected shock, e.g. dropping, are to be rechecked per 1.8.

<i>Gage</i>	<i>Calibration Interval</i>
Micrometers	6 Months
Calipers	6 Months
Pressure Gages	12 Months
Thermocouples & temp readouts	12 Months
Dial Indicators	12 Months
Gage pins or uncertified blocks	Measure with calibrated tool before each use.
Electronic Equipment (excluding transducers)	24 Months
Weights	36 Months
Gage Blocks	48 Months
Surface Plates	48 Months
Other Measuring Devices	12 Months, unless otherwise indicated
Surface Finish Visual Standards	As long as corrosion-free

Table 1, Standard Calibration Intervals

1.4) Criterion for Calibration

Any gage used to determine product or component acceptance is to be calibrated.

1.5) Selection of Standards

Unless otherwise directed, calibration standards are to have an accuracy at least 10 times greater than the instrument being calibrated. All standards are to be traceable to NIST (National Institute of Standards and Technology) unless otherwise indicated.

1.6) Identification

All JHBI instruments subject to calibration are each identified by a part number and calibration indicator (See Section 2.3).

1.7) Documentation

Additional JHBI or other documentation will be referenced herein. Unless otherwise directed, use the latest revision.

1.8) Gage Shock

If any measurement tool experiences a violent event such as a drop, it must be rechecked – and recalibrated if necessary – before any inspection can proceed.

2) DOCUMENTATION

2.1) New Gages

Before first use to accept products or components, gages must have information entered as described in 2.2.

2.2) Gage Log

Records of calibration for each gage is recorded in a file with the following information:

Header Information, filled out once

- 2.2.1) Part Number, generally the JHBI PN, but could be customer or vendor.
- 2.2.2) Description
- 2.2.3) Manufacturer
- 2.2.4) Gage Range *including units, example 0-1”*
- 2.2.5) Calibration Interval *This value is the requirement. Table 1 values are used unless given here*
- 2.2.6) Model Number (Optional)
- 2.2.7) Location
- 2.2.8) Property of: *who owns gage -- may be JHBI, customer, vendor or employee.*

Information to be filled out with each calibration. If information is included on a document from an outside calibrator, reference the document.

- 2.2.9) Calibration Standard(s) *JHBI standard used to calibrate*
- 2.2.10) Calibration Procedure -- this document, customer, vendor or other procedure.
- 2.2.11) Results
- 2.2.12) Date of Calibration
- 2.2.13) Date of Next Calibration *will be automatically created by computer files*
- 2.2.14) Any additional notes, e.g. “Limited Use”
- 2.2.15) Acceptable for use? Y/N
- 2.2.16) Initials of Person who performed calibration

The log may be paper or a computer spreadsheet file -- see Figure 1 for an example. Any computer file must have as its filename the JHBI PN of the gage. The log is appended with every calibration. All computer files must link to the master file as described in Section 2.3.

GAGE CALIBRATION RECORD					P/N:	UCXXX	
OK for Use?			Y				Due Next
Description:	Dial Calipers				Range:	0-6"	Aug 2011
Manufacturer:	ACE				Months Interval:	6	
Model:	A1234				Cal Procedure:	SS01H	
Location:	Inspection				Property of:	JHBI	
<i>Actual</i>	<i>Measured</i>	<i>Correction</i>	<i>A/R</i>	<i>Date of Cal</i>	<i>Standard(s)</i>	<i>Cal by</i>	<i>Notes</i>
1.000	1.000	0	1	2/30/11	<i>Enter list of calibration standards for this gage</i>	XYZ	
2.000	2.000	0	1				
3.000	3.000	0	1				
4.000	4.000	0	1				
5.000	5.000	0	1				
Parallelism	0	0	1				
Flatness	0	0	1				

FIGURE I, Sample Calibration Log File

2.3) Calibration Sticker

Measuring tools will have a sticker indicating calibration date, next scheduled calibration date and initials of the person who performed the calibration. When impractical, or on tools too small (gage blocks, thread gages) to bear a sticker, it may be omitted but there must be a sticker on the tool container or case.

2.4) Master Calibration List

A single computer spreadsheet file, CAL_LIST.xxx (extension depends on spreadsheet), will link to all available computer calibration log files, and provide a list of calibration due dates.

3) ENVIRONMENT

3.1) Temperature

Calibration is to be performed at $70 \pm 20^\circ\text{F}$. Both the gage blocks and the instrument must be at the same temperature. If the instrument has been stored or used in a place with a higher or lower ambient temperature, keep both the instrument and the gage blocks under the same ambient conditions for at least 20 minutes before calibration.

3.1) Cleanliness

Standards used for verification, measuring faces of the instrument under calibration, and any additional tools (surface plate, V-blocks, etc.) must be clean. Carefully wipe surfaces with isopropyl alcohol using lint-free tissue or paper towel.

4) DIMENSIONAL GAGES

All dimensions in inches unless otherwise specified.

4.1) Micrometers

Refer to Table 2 for calibration procedure by micrometer type. Standards required: gage blocks, gage ball, gage pin. Inspect micrometer for correct functioning. For all micrometer types:

- Does spindle operate smoothly and freely with minimal play? If not, clean, lubricate and adjust per manufacturer's instructions.
- Parallelism, see Figure 2a. Secure a smooth ground diameter approx. 1" long (e.g. gage pin) lightly between the anvil and spindle near one end of the rod. Rotate the part 180° minimum. If the part pivot on the high spots or has gaps as shown, the micrometer must be repaired or replaced.
- Concavity, see Figure 2b. Measure a precision ball across various spots of the measuring surfaces. Apply uniform spindle pressure while taking readings for each location to detect minute errors in surface flatness. If the variation exceeds .0002, the micrometer must be repaired or replaced.
- Five points minimum are to used that use at least 75% of the range. Use at least one additional point for each additional inch of range.
- For electronic micrometers, verify legible display. Replace battery or repair as required.
- If the micrometer meets accuracy requirements, update the calibration log sheet per Section 2.2 and apply a new sticker per Section 2.3.

<i>Micrometer Type</i>	PROCEDURE
Outside, Blade, Disc, Indicator, Anvil, Point	Move the standard back and forth a few times in the gage. Using gage blocks, check and record points per 4.1d throughout the range.*
Groove, Inside	Using gage blocks, establish gaps per 4.1d. Measure and record the gap readings throughout the range.*
Depth, Head	Using gage blocks, establish a minimum of five heights on a surface plate. Measure and record readings throughout the range.
Micrometer Accuracy Requirement: for the first inch, $\pm .0001$. After the first inch, $\pm .0001$ in/in. Adjustments may be made to the spindle position per manufacturer's instructions.	
<i>*Three points should be taken .008" apart to check for possible lead error.</i>	

TABLE 2, Micrometer Calibration Procedures

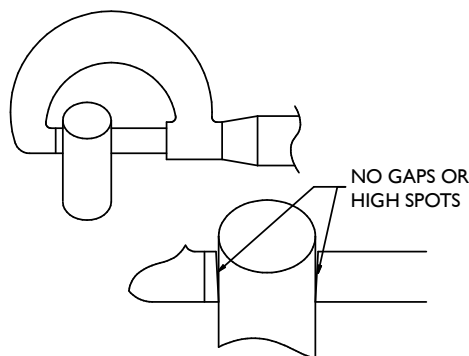


FIGURE 2a
 Micrometer Parallelism

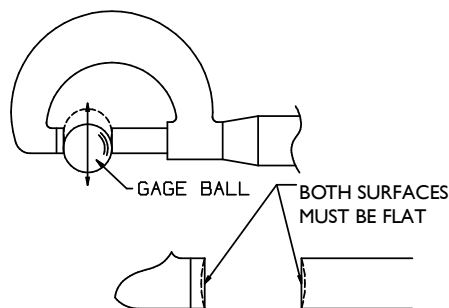


FIGURE 2b
 Micrometer Concavity

4.2) Calipers

This procedure applies to dial, vernier and digital (electronic) calipers. Standards required: Gage block set, surface plate.

- a. Visually examine for raised nicks, burrs, damage, grit and hard sliding action. If unsatisfactory condition is found, clean, lubricate and adjust per manufacturer's instructions.
- b. Bring outside measuring jaws together over clean paper and pull through jaws to clean the jaw faces.
- c. Place a .100" gage block between jaws at edge of tips. Observe value on vernier scale or dial. Move gage block to end of jaws and observe value, the two readings should be within .0010.
- d. Measure a minimum of 4 points along the beam with a range at least 75% of the gage range.
- e. Variation of outside measurement is not to exceed ± 0.001 for the first 6 inches, and ± 0.001 for each 6 inches after.
- f. Check one point of the inside measuring jaws using a gage block stack of at least .250.
- g. Depth rod measurement is taken over gage blocks resting on a surface plate. A minimum of four readings shall be taken.
- h. Variation of inside and depth measurements is not to exceed ± 0.003 for the first 6 inches, and ± 0.003 for each 6 inches after.
- i. If any defects have been found that would affect the accuracy or function of the caliper, discontinue calibration, have the caliper repaired and recalibrated, used with restrictions per Section 8 or taken out of service.
- j. For electronic calipers, verify legible display. Replace battery or repair as required.
- k. If the calipers meet accuracy requirements, update the calibration log sheet per Section 2.2 and apply a new sticker per Section 2.3.

4.3) Dial Indicators

This procedure applies to \pm dial indicators with angled contacts as seen in Figure 3. Standards required: Gage block set, surface plate, height gage.

- a) Clean the indicator with alcohol. If any damage or deterioration is discovered, discontinue calibration, and have the indicator repaired and recalibrated, used with restrictions per Section 8 or taken out of service.
- b) Mount the indicator horizontally in a height gage.
- c) Set the indicator to read positive displacement.
- d) Move the contact to full travel several times. The indicator shall have smooth operation. The dial must return to the starting point and not be loose.

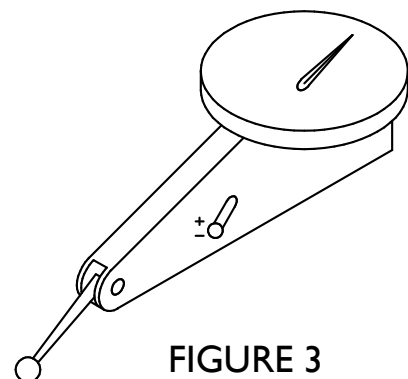


FIGURE 3
 \pm Dial Indicator

- e) Using gage blocks, check and record a minimum of three points throughout through a range of .005 for thousandths indicators or .002 for tenths indicators, unless the gage log otherwise specifies.
- f) Change the \pm position indicator to negative and repeat steps d and e.
- g) Variations must not exceed ± 0.0001 for tenths indicators, ± 0.0005 for thousandths indicators.
- h) If the indicator meets accuracy requirements, update the calibration log sheet per Section 2.2 and apply a new sticker per Section 2.3.

4.4) Plunge Indicators

This procedure applies to vertical dial or digital indicators as seen in Figure 4.

Standards required: Gage block set, surface plate, height gage.

- a) Mount the indicator vertically in a height gage.
- b) Manually move the indicator through its full travel a few times. Lubricate the plunger if the operation is not smooth and repeatable. The dial must return to the starting value.
- c) Using gage blocks, check and record a minimum of five points throughout a minimum of 75% of the gage range, unless the gage log otherwise specifies.
- d) Variations must not exceed ± 0.001 per inch.
- e) For electronic indicators, verify legible display. Replace battery or repair as required.
- f) If the indicator meets accuracy requirements, update the calibration log sheet per Section 2.2 and apply a new sticker per Section 2.3.

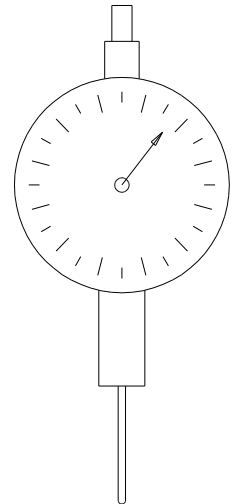


FIGURE 4
Plunge Indicator

4.5) Height Gage

This procedure applies to dial or digital height gages. Standards required: Gage block set, surface plate.

- a. Visually inspect gage for smooth operation. Look for obvious damage.
- b. Mount a dial indicator (as described in Section 4.3) horizontally in the gage.
- c. Zero the dial indicator against the surface plate or reference surface of a gage block. The indicator is used only to establish position.
- d. Using gage blocks, check and record a minimum of five points throughout a minimum of 5 inches of the gage range, unless the gage log otherwise specifies.
- e. Variations must not exceed ± 0.001 for the first 6 inches, plus $\pm .001$ each additional 6 inches.
- f. For electronic height gages, verify legible display. Replace battery or repair as required.
- g. If the indicator meets accuracy requirements, update the calibration log sheet per Section 2.2 and apply a new sticker per Section 2.3.

4.6) Gage Pins

Gage pins are to be measured with a calibrated micrometer before each use.

- a. Clean pin with alcohol.
- b. Measure the diameter at both ends and near the center.
- c. Provided the variation is not more than 0.0002, they are acceptable to use as the measured -- not necessarily indicated -- value.
- d. No calibration log or sticker is needed.

4.7) Surface Plates

Surface plates used for product acceptance inspection must be calibrated to Grade B or better. As of the release of this document, all surface plate calibration is done by an outside source per Section 7.

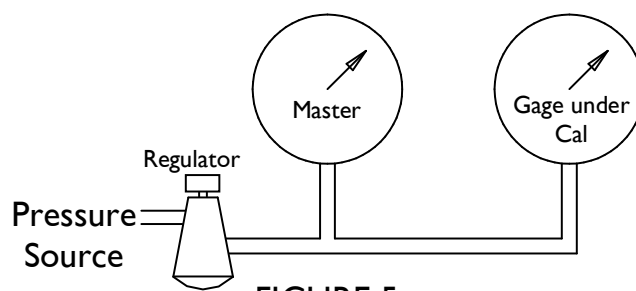
4.8) Other Dimensional Gages

Gages not covered in the preceding sections may be calibrated per MIL-STD-120 or by outside sources. All gages must have NIST traceable standards if available. If the gage is used to accept or reject components, update the calibration log sheet per Section 2.2 and apply a new calibration sticker per Section 2.3.

5) PRESSURE GAGES

This procedure does not apply to pressure transducers -- see Section 1.2.1.

Standard required -- calibrated dead weight tester, manometer or master gage. If a dead weight tester is used, refer to manufacturer's instructions. All standards must be NIST traceable.



- a. Visually inspect gage for obvious damage.
- b. Connect a pressure source must supply both the gage under cal and the master as shown in Figure 5.
- c. Measure and record at least 4 points that cover at least 75% of the range of the gage under calibration.
- d. Make corrective adjustments as necessary to the gage under calibration to achieve minimum difference between the gages.
- e. If, after adjustment, the variation between measured and master readings does not exceed 1% full scale, no correction table is required. Update the calibration log sheet per Section 2.2 and apply a new calibration sticker per Section 2.3.
- f. If the variation between readings exceeds 1% full scale, a correction table must be affixed to the gage. See Figure 6. The table contains the information on a calibration sticker, so no additional sticker is needed.

5.1) Proof Pressure Gages

Gages used for proof and burst testing on hand pumps do not need to be calibrated in the range they are used, as this is often in excess of the capacity of the dead weight tester. However, they must be calibrated to as high of a range as possible. No *Limited Use* sticker (See Section 8) is needed.

6) FLOW METERS

For calibration of gas and liquid flow meters, refer to JHBI Standard Specification SS01B. If calibration is satisfactory, update the calibration log sheet per Section 2.2 and apply a new sticker per Section 2.3.

7) OUTSIDE CALIBRATION

Calibration from outside sources must be done with NIST traceable standards. The vendor must supply the following information:

- a. JHBI PN
- b. Gage description
- c. Date of calibration
- d. Person performing calibration
- e. Standards used
- f. Record of adjustment, if any

8) LIMITED USE

If a gage is found to be usable over only a part of its range -- or for a multipurpose gage, have not all functions of sufficient accuracy -- the tool may still be used in the acceptable range or with the only the calibrated functions. In addition to the calibration sticker of Section 2.3, apply a "LIMITED USE" identifier that lists the restrictions. See Figure 7 for examples. The identifier can be of any legible form. Update calibration log sheet per Section 2.2, and note the limited use restrictions per 2.2.14.

P/N UC029 Pressure Gauge 0 to 20 PSIG Cal Date: 02/30/11 Due Date: 02/30/12		
Actual	Read	Error
0	-0.1	0.1
2	1.9	0.1
4	4.00	0
6	6.00	0
8	8.00	0
10	10.05	-0.05
12	12.05	-0.05
14	14.05	-0.05
16	16.10	-0.1
18	18.20	-0.2
20	20.25	-0.25

FIGURE 6, Sample Pressure Gage Correction Label



FIGURE 7
 Examples of Limited Use Identifiers

9) OUT-OF-TOLERANCE CONDITION

If, during the calibration of a gage, the error is found to exceed the allowable limits as detailed in the applicable Section or independent specification, impact assessment must be done in the following sequence:

- a. Reinspect any parts that are known to have been inspected with the errant gage. If the parts are still in tolerance, no further action is needed.
- b. If the out-of-tolerance condition can be traced to an event (For example, a gage was dropped), recalibrate the gage, and reinspect any parts measured after the event.
- c. If the error was substantial (2 x error limit or greater), and it is believed that shipped product was accepted using the suspect gage, an effort should be made to reinspect parts from the same lot as those inspected with the suspect gage. If no discrepancy is found, no further action is needed.
- d. If a discrepancy is found, that in the judgment of the cognizant program manager or project engineer has resulted in a customer receiving out-of-spec parts, the customer should be made aware. Should a sample examination of customer product prove acceptable, no further action is needed. If examination proves customer product to be out of acceptable tolerance, a corrective action decision, in conjunction with the customer, must be made. This may be a customer request for discrepant material acceptance or product recall.

10) ALL OTHER GAGES

Gages not listed that are used to determine product or component acceptance must be calibrated. See gage Manufacturer's instructions or MIL-STD-120. Internal or external calibration is acceptable. For master gages and accuracy requirements, consult the quality department or the cognizant project manager.