

## Goals

1. Use a gage standard to communicate the necessary craftsmanship and quality for each gage with strict attention to ease of use, repeatability, reproducibility, maintenance and cost of manufacturing the actual gage.
2. Have a common standard for gages to be constructed that will allow for predictable end results and common requirements for quoting activities from suppliers.
3. Consolidate GHSP gage system documents to one common standard that will be used for the development of all GHSP owned and sub-contracted gages.
4. Develop a gage standard that will be used by GHSP employees, gage suppliers and component suppliers to provide the means of expected performance to the end customer. This standard will be used for maintaining accountability for each shareholders responsibility.
5. Define liability for failure to meet gage standard.

## Preface

This standard has been prepared to provide adequate information to all GHSP component suppliers that are issued PO for construction of a GHSP owned gage, from gage design, gage construction, gage approval/acceptance, and liability.

In addition to providing a means to distribute technical information, this standard will supplement information contained on the purchase order and will be considered as such by GHSP.

This standard is not a means of relief for the supplier's responsibility in producing a quality gage. Any deviation from this gage standard must be approved in writing by the appropriate GHSP Supplier Development Engineer.

Due to modifications of the customer gauging requirements and to upgrade the gage internally, it may be necessary to revise this standard. Revisions are the responsibility of the GHSP Supply Chain Management Department and will be documented as to the date of the revision.

## Supplier Responsibility

All gages must be designed to meet or exceed the requirements detailed within this standard.

The supplier has the final responsibility for producing a gage that will meet all of the gage design and performance specifications/requirements. If the subject gage does not meet these specifications/requirements, then the necessary corrections to the gage will be made at the supplier expense. Gauging which does not meet design specifications can not be paid for until such time that it does meet design specifications or has GHSP approval to deviate. For complete gage acceptance standards, refer to the Acceptance Criteria section within this standard.

All gage designs are the property of GHSP. No part can given to another company or duplicated without the written approval of the Supplier Development Manager at GHSP.

The supplier will be responsible to maintain the cost and timing requirements as detailed in the Purchase Order. Any midstream changes to the design that would effect the committed delivery date and/or gage cost must be communicated to the Buyer and amended in the purchase order.

The supplier is responsible for failure costs that occur to GHSP and it's customers for gages that produce inaccurate results.

## Design Requirements

### A. Design Inputs

#### 1. Math Data

- a. May be provided to supplement the part print
  - i. GHSP will not translate math data tapes
  - ii. The supplier is responsible for all costs and timing

#### 2. Part Print

- a. Check fixtures and gages will be constructed from GHSP approved part print
- b. GHSP will provide to supplier

#### 3. Sample Part

- a. GHSP may provide to supplier when available

#### 4. Intent of Use

- a. Part characteristics that require inspection
- b. Method of measurement for each characteristic
  - i. Free-state
  - ii. Restrained
- c. Self contained measurements
- d. In conjunction with CMM or other gage devices
- e. Environment of gage
- f. Gage operator safety

### B. Engineering Record (Gage Drawing)

#### 1. Document Control

- a. All designs are property of GHSP
- b. Supplier is responsible for maintaining revisions of all data and prints until the gage is delivered and accepted by GHSP

#### 2. Design

- a. A set of updated final designs and a copy of the CAD design file shall be provided with PPAP submission. Where possible, gage drawings shall be submitted as a "tiff" file
- b. Sketches are permissible if they can clearly represent the gage build intent. If not, drawings are required
- c. Off the shelf individual gages do not require CAD design files

#### 3. Dimensioning & Tolerance

- a. Datum structure must be detailed on drawing
- b. Gage datums must match part print datums
- c. Gage features must be dimensioned back to datums
- d. Dimensioning must be suitable for gage certification and calibration
- e. Tolerances must be in conjunction with build tolerances detailed within this standard
- f. Must be dimensioned in accordance with ANSI Y14.5 – 1994
- g. Target areas for clamping must be dimensioned if clamping is used

#### **4. Drawing Views**

- a. Must have adequate views to detail characteristics that can not be accurately depicted in the final assembly views
- b. All auxiliary views must be dimensioned if not previously dimensioned and referenced back to main drawing views

#### **5. Complete Bill of Materials**

- a. Detail numbers reference to gage assembly via balloons
- b. Purchased component ordering numbers and supplier
- c. If not purchased component, list material type
- d. Note if modified from purchased condition and delineates nature of change
- e. Functional dimensions
- f. Quantity used for that item

#### **6. Revision block requirements for drawings or sketches**

- a. GHSP part number and revision level
- b. Gage engineering level and date
- c. Fixture / gage build source identification
- d. Revision change description

#### **7. Title Block Requirements**

- a. Gage identification number
- b. Gage builder name and address
- c. Units of measure
- d. Projection Angle
- e. Number of sheets / pages
  - i. report in X of Y
- f. Drawn by
- g. GHSP Gage Standard and it's revision level
- h. Gage builder job number and/or quote number
- i. No block (default) tolerances allowed

## C. Authorization to Proceed with Check Fixture / Gage Build

1. A copy of preliminary and final designs shall be submitted to the GHSP supplier development engineer at the designated times of review
2. No check fixture/gage are authorized to be built unless design drawings or sketches have Supplier Development Engineers approval signature
3. GHSP and the supplier should both retain a copy of the signed-off design drawings or sketches. Signed-off design drawings or sketches will be the final word in all disputes
4. No check fixture/gage are authorized to be built unless a GHSP Purchase Order has been received
5. Verbal authorization is not acceptable

## D. Construction

### 1. Bases and Risers

- a. Bases should be made of cast aluminum when possible
- b. Base plate thickness must be such that the base plate remains flat and parallel and does not deflect under normal usage
- c. Top and bottom of base must be flat and parallel within 0.0001" per 1.000" length
- d. Adjacent edges of base must be square to each other within 0.0001" per 1.000" length
- e. All bases will have handles and jig feet
- f. Tooling balls may be used as reference only for gage build. Tooling balls will not be any part of gage certification
- g. Risers will be flat black with white identification stamped or cast aluminum with blue identification stamped. Black oxide is permissible on dimensionally controlled surfaces
- h. Risers will be screwed and doweled in place. No tapered dowels allowed
- i. Risers and base will be correspondingly numbered for identification and location on base. Numbers used must match item number in bill of materials
- j. No shims or adjustability are allowed on any check fixture detail unless otherwise specified in the design drawing or sketch
- k. Net surfaces to be made of hardened steel 0.120" thickness minimum and black oxide. Surfaces must be screwed and doweled in place
- l. Feeler gage surfaces to be made of harden steel 0.120" thickness minimum and black oxide. Surfaces must be screwed and doweled in place

- m. Datum locating points shall be hardened deck points with a 0.120" maximum flat diameter on top contact surface and black oxide
- n. All 2 way and 4 way locators must be RFS unless otherwise specified and approved
- o. All corners to be broken – no sharp edges
- p. Gages weighing over 35 lbs must be quoted with gage cart
  - i. Gage cart must be itemized on the quote
  - ii. Gage cart must be stable with consideration to it's center of gravity

## 2. Details

- a. Multiple use details (loose pins, plugs, feelers, etc.) will be correspondingly numbered with base for identification and location of use and storage
- b. Multiple use details will have appropriate storage provision provided
- c. Storage provisions must be finished and attached to the base
- d. All details will clearly identify feature size
- e. Details will be cable attached to the base and have a storage provision
- f. Swing details must be strong enough not to deflect when pressure is applied and must be contained within the base perimeter
- g. Sliding members may either be made from steel that meets a minimum of 60 Rc or cast aluminum containing hardened bushings, and have secondary pin & bushing locking feature
- h. Precision located checking features must be doweled to the base plate with hardened dowels and screws
- i. Non-contact details such as riser blocks or clamp blocks may be made of aluminum or other suitable light weight structural material
- j. Positional checking pins, locating pins and go / no go pins on sliding details must be hardened to a minimum of Rc 60
- k. Positional checking pins and locating pins on sliding details are to be slip fit. With respect to looseness, fitting condition must maintain gage standard tolerance at the point of part interface
- l. Vertically mounted sliding details or flush pin checks must have a handle attached to the sliding detail
  - i. Handles must be threaded into the sliding detail to provide positive return of pin
  - ii. Handles must be easily accessible when part is loaded in gage
- m. Stab pins (go / no go) must be fixed to base when possible

## 3. Statistical Process Control Features

- a. Master (zero) blocks will permanently affixed to the base
- b. Master block will be 30.00 mm minimum set position

- c. All probe bushings are to be replaceable
- d. Probe bushings are to be 0.500" inside diameter unless otherwise specified in the gage design drawing or sketch
- e. Probe bushings are required at all SPC ports and on the master set block
- f. Probe bushings are to be of hardened steel
- g. Probe collars are to be 0.500" outside diameter to provide a slip fit unless otherwise specified in gage design drawing or sketch
- h. Appropriate storage provision must be provided on the base for all probes and fully encapsulate the entire perimeter

#### **4. General Requirements**

- a. All sharp corners are to be broken or radiused
- b. If necessary, gage cart should be quoted with each gage
  - i. Gage Cart Construction Requirements: The gage cart should be made so that gage working surface does not exceed 42" in height with 1" - 2" square tubing and 4 casters. 2 of which are locking and 2 are rotating. Top must be made of 1/8" steel plate with welded corners. Cart must have one shelf and one handle on opposite end of non-swivel casters. Gage cart should be painted Rust-oleum Gloss Royal Blue # 7727
  - ii. Off-the-shelf Gage Cart: The cart should adequately support the gage
- c. Gage must be securely attached to cart. Gage must be removable from cart
- d. Mitutoyo digital indicator, with a holder that attaches to the base must be included. Indicator must read both +/- directions, but with no manual choice to change +/- direction
- e. Design to incorporate shear side measurement of stampings whenever possible
- f. Finished weight of the gage is to be considered in design. Gages over 35 lbs must be identified as, "Weight over 35 lbs"
- g. Clamping must not impede part loading, unloading or gage operation
- h. Clamping must be directly in line with datum targets
- i. Indicators must provide a minimum resolution that will provide ability to measure 10% of part specification
- j. In the event that pad eyes are needed, eye inside diameter must be 2", thread to be 1/2" and pad eyes must be "eye to the sky" positioned
- k. Clamps must be identified for sequence of clamping

## 5. Build Tolerances

<u>FEATURE</u>	<u>RELATIONSHIP</u>	<u>TOLERANCE</u>
Net & Datum	Primary Axis	+/- 0.02mm
Surfaces	Secondary Axis	+/- 0.10mm
Four Way	Primary Axis	+/- 0.00mm
Locators	Secondary Axis	N / A
	Perpendicularity	+/- 0.01mm
SPC Bushings	Primary Axis	+/- 0.05mm
	Secondary Axis	+/- 0.10mm
	Perpendicular to itself	+/- 0.01mm
Go/No Go Features	Go	+0.02 / -0.00mm
	No Go	+0.00 / -0.02mm
Non-Cylindrical Features		
Go/No Go	Go	+0.02 / -0.00mm
Feelers	No Go	+0.00 / -0.02mm
Non-Cylindrical Features		
MMC Pins	Size	+0.002 / -0.00mm
Non-Cylindrical	Primary Axis	+/- 0.00mm
Features	Secondary Axis	+/- 0.10mm
	Perpendicularity	+/- 0.01mm
Feeler Surfaces		+/- 0.10mm
Flush Surfaces		+/- 0.10mm
Sight Check		+/- 0.15mm

-or-

10% of Specific Dimensional Tolerance, which ever is tighter.  
For go / no go features, apply half (5%) to go and the other half (5%) to the no go end

	Nominal Size		Tolerance
	Above	To & Including	
<b>Cylindrical Plug &amp; Ring Gage</b>	0.029"	0.825"	0.00004"
	0.825"	1.150"	0.00006"
	1.150"	2.150"	0.00008"
	2.150"	4.150"	0.00010"
	4.150"	6.150"	0.00013"
	6.150"	9.010"	0.00016"
	9.010"	12.010"	0.00020"

- GO Cylindrical Plug Gages – Plus tolerance (+)
- NO GO Cylindrical Plug Gages – Minus tolerance (-)
- Master Cylindrical Plug Gages- Bilateral tolerance (+/-)
- GO Cylindrical Ring Gages – Minus tolerance (-)
- NO GO Cylindrical Ring Gages – Plus tolerance (+)
- Master Cylindrical Ring Gages- Bilateral tolerance (+/-)

## E. Gage Identification

### 1. Identification plate

- a. Must be permanently affixed to the base with minimum content as follows:
  - i. GHSP Item Number(s)
  - ii. Customer (OEM) Part Number if applicable
  - iii. Gage Name (description)
  - iv. GHSP Gage Number
  - v. Customer to which the gage is owned
  - vi. Gage Design Revision Level and Date
  - vii. Fixture / Gage Build Source Identification
- b. Plate must be Aluminum or Plastic

## F. Acceptance Criteria

### 1. Gage Review Check

- a. Completed by gage supplier
- b. Supplied with delivery of gage or PPAP

### 2. 3<sup>rd</sup> Party Certification Report

- a. Must be performed by an accredited A2LA, ISO Guide 025 or ISO Guide 17025 inspection source
  - i. 3<sup>rd</sup> party must be identified on quote
- b. Supplied with delivery of gage
- c. Copy of inspection source certification must accompany the certification report
- d. Certification Report must detail the following:
  - i. Clear identification of characteristic being checked
  - ii. Specification (All applicable axis)
  - iii. Tolerance (as noted in tolerance section of this standard)
  - iv. Actual measurement. Pass / Fail with deviation from tolerance
  - v. Certification results to be reported in datum position as coordinates or origins
  - vi. Ballooned gage print
  - vii. Gage certification corresponds correctly to ballooned gage print

### 3. Acceptable Gage R & R

- a. Completed by gage supplier
- b. Report supplied with delivery of gage
- c. Minimum requirements of R & R
  - i. Attribute gage R & R - 20 parts, 2 operators and 2 trials
  - ii. Variable gage R & R 10 parts, 2 operators and 3 trials
  - iii. Must be repeatable and reproducible within the Table Below

0 - 10%	Preferred
10 - 30%	Gage acceptable only with Quality Team Leader approval
Over 30%	Gage is not acceptable
  - iv. GHSP will provide parts to supplier for R & R
- d. AIAG MSA to be used as an associated standard
- e. Component supplier will also perform and document R & R, which will be used as the fail gage approval
- f. R & R must be performed for each checking feature of the gage

## Project Management

### A. Timing Requirements

#### 1. Project tracking

- a. Reports of delays
- b. Compressed timing requests by GHSP to supplier shall be discussed and agreed upon in writing, including all costs at the time of the request

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## **2. Reportable Phases**

- a. Design
- b. Build
- c. Validation
- d. Delivery

## **B. Release of Project**

### **1. PO Number**

- a. Part Number
- b. Part Name
- c. Part Revision Level
- d. Agreed upon costs
- e. Delivery requirements
- f. Description of work to be done

## **C. Applicable Forms & Reference Documents**

- 1. GHSP Gage Standard Checklist
- 2. Electronic PO database
- 3. PTR - Corrective Action
- 4. GHSP QE 015 - Attribute Gage Study short method
- 5. GHSP QE 016 - Variable gage R & R
- 6. AIAG MSA Manual – latest revision [www.aiag.org](http://www.aiag.org)
- 7. GHSP supplier Request for Product / Process Deviation ([www.ghsp.com](http://www.ghsp.com))

## **GHSP Approval**

### **A. Payment**

1. Payment will be per the terms of the Purchase Order pending completion of the acceptance criteria
2. GHSP SDE must provide approved GHSP Gage Standard before payment can be processed

## **GHSP Internal Processing**

### **A. Records**

- 1. Gage Math Data**
  - a. Gage builder to retain
- 2. Drawing or Sketches**
  - a. PPAP database
- 3. Complete forms**
  - a. PPAP database
- 4. Quotes**
  - a. Supplier Retain

## **Supplier Requirements**

### **A. Overview**

1. GHSP gage suppliers are to be committed to providing the best built gages in a timely and cost effective manner. These gages must be structurally and mechanically sound as well as being highly capable of providing excellent measurement repeatability and reproducibility.
2. This is standard will supplement information provided on the purchase order and will be used to clarify the minimum expectations regarding standard practices to be used when designing and building GHSP gages.
3. The contents of this standard do not eliminate the supplier's responsibility for sound engineering judgment and any deviations from these standards are expected when deemed sensible. The appropriate GHSP SDE however, must approve deviations in writing before delivery of

the gage. Deviations must accompany the GHSP Gage Standard approval from the supplier.

4. This GHSP Gage Standard may require periodical updates when necessary to meet our customer's requirements. These updates shall be the responsibility of the GHSP Supply Chain Management Department and will be documented on the revision index. Suppliers are responsible to verify gage standard revision level prior to quote on [www.ghsp.com](http://www.ghsp.com) web site.

## **B. Gage Supplier Performance**

1. All gages from GHSP suppliers may be subjected to in process checks at preliminary design, final design and delivery using this standard and the GHSP Gage Standard Checklist.
2. The GHSP SDE may request the supplier to provide a corrective action upon discovering that this standard has been violated.

## **C. Supplier sub-contracted work**

1. The gage supplier shall maintain validation records of work done by outside sources per this standard.

## **Definitions**

- Off-the-shelf: A store bought item; not construction per customer specifications
- Shear side: The process of trimming a part, side of part that is not broke out
- Primary: Major relationship to feature
- Secondary: Minor relationship to feature(s)
- Net Surface: Part gage contact area
- Riser: Perpendicular feature to base
- Hardened Deck Points: Same as net surface

## **Standard Updates**

### **A. Revision History**

1. Released April 2, 2007