

JCI Gage Standards

Johnson Controls and Supplier Managed Gages

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INTRODUCTION

TO OUR PARTNER GAGE SUPPLIERS

In today's global automotive industry, it is essential for a company's commitment to provide its customers with a high quality and defect-free part that is delivered on time. This can be quite a challenge due to the ever-changing requirements set forth by our customers. Yet, this is the expectation of our customers. Some companies struggle to maintain this high quality by implementing so-called "quick fix" strategies. These are only temporary. Johnson Controls maintains that in order to supply our customers with these high quality parts we have to implement long-term strategies that are industry proven. One of these strategies is the Partnership Supplier program. This program is crucial for the success of Johnson Controls. We know we cannot do it alone and therefore have to rely on our suppliers to help us. We feel it is, and always will be, a TEAM EFFORT.

The intent of this manual is to define the Johnson Controls' requirements for gages and fixtures. It also goes beyond the simple design and build requirements and sets forth other requirements for our Partner Gage Supplies. Since Johnson Controls has many customers, it is important to understand that our manual is to be used as a guide in conjunction with our customers' standards. **The intent is also to supersede any customer requirements that are more lenient but to utilize any customer requirements that are more demanding.** We understand that all customer requirements are different, but we believe that by using this manual, there will be less confusion and more consistency in designing and building gages for Johnson Controls. The intent of this manual IS NOT to dictate the process of HOW to build a gage but to GUIDE you in completing your task.

While this manual sets forth certain minimum gage and procedural requirements, it is not intended to be absolute. It is both Johnson Controls' and the Partner Gage Suppliers' responsibility to continuously improve and to be objective in its approach to any gage program. Therefore, your independent analysis of our requirements and suggested changes or improvements are welcomed. We do ask, however, that any proposed deviation from this manual be approved by the Johnson Controls Gage Engineer prior to its incorporation.

Your responsibility in our TEAM is a large one. The quality, functionality, value and timeliness of these gages are a direct reflection of your company. As a Partner, you have to not only show the expertise in your field, but also provide invaluable assets like integrity, dependability and ingenuity. Johnson Controls, in its effort to select the BEST Partner Gage Suppliers, recognized not only these assets in your company, but also a desire to be a member of the JOHNSON CONTROLS TEAM.

We value the "Partnership" that has been established. We appreciate your efforts.

Sincerely


Doug Stewart
Gage Engineer
Johnson Controls, Inc., North American Automotive Group

By signing below, the Gage Supplier acknowledges the receipt of this manual and also agrees to comply with its contents.


Astronetics


CG Model and Fixture


Jay-Enn


MetroCal


Michigan Gage Specialties


MP Components

SCOPE

This Gage Standard applies to all of Johnson Controls North American Automotive Group and its Partner Gage Suppliers.

This Gage Standard establishes requirements for gages and fixtures that are used in conjunction with the inspection, measurement, and evaluation of the part. Such gages and fixtures are Attribute gages, SPC gages, CMM holding fixtures or any combination of the previously mentioned. Generally, gages and fixtures are defined as:

FIXTURE

- A device that is used to hold one or more parts while various operations are performed. For instance, a fixture is used to hold the part while an inspection is performed.

GAGE

- An instrument that is used to measure the part. For instance, a gage is a fixture with an Attribute rail or SPC indicator port attached to it.

***PLEASE NOTE:** The terms fixture and gage are commonly referred to as the same piece of equipment. A fixture and a gage can be the same, but not always. If the measuring instrument is not attached to the holding device, then it is only a fixture [CMM holding fixture], whereas, if the measuring instrument is attached to the holding device [Attribute gage, SPC gage], it becomes a gage.*

This Gage Standard does not establish requirements for jigs, assembly fixtures, milling fixtures, assembly nests, headliner tub fixtures, calipers, micrometers and the like. It does, however, provide instructions or guidelines that could be used with these types of equipment.

Please note the following terms and their definitions as they are used in this document:

Term

JCI representative
Gage Engineer
Supplier

Definition

Johnson Controls North American Automotive Group representative
Johnson Controls North American Automotive Group Gage Engineer
Gage Supplier

GENERAL REQUIREMENTS

1. The Supplier must quote in compliance with the Reliability and Maintainability requirements as stated on the [Gage Request for Quote](#) or the [Gage Assumptions / Gage Cost Model](#) form. If these requirements cannot be met, the Supplier must either “no quote” the job or obtain a written deviation from the JCI representative.
2. Receipt of the hardcopy purchase order does not represent the start date of the work to be completed. The start date will be established when the purchase order number is sent via e-mail (or verbally) or the receipt of the CAD model or prints, whichever is later. The start date plus the quoted timing will establish the gage delivery date. All deviations from the delivery date must be communicated to the Johnson Controls’ team in writing. Only circumstances fully outside of the Supplier’s control will be considered as acceptable program delays.
3. All work that is started without a purchase order number and/or CAD model will be the Supplier’s responsibility if the program is delayed or canceled.
4. The Supplier is responsible for the accuracy of all gages. Work resulting from the use of “out of calibration” equipment or defective processes will be the Supplier’s responsibility and must be corrected without cost to Johnson Controls. This includes the equipment and processes for any sub-suppliers. [Return to Gage Build Requirements – Section A. Gage Certification, item #1](#)
5. If a gage was used to qualify a part or process and the it was found to be in error (i.e. built or certified with equipment that is out of calibration, a net surface is cut to the wrong side of material, etc.), the Supplier may be charged for prevailing layout cost, air freight part shipment charges, labor charges and/or other charges directly related to the discrepant gage. In addition, if a tool has been modified using a gage that was not dimensionally correct, the Supplier will be charged for the tool work to correct the part. Johnson Controls will make every effort to ensure the gages are re-verified within the same parameters (temperature, humidity) as the Supplier. To ensure that equipment changes are not done hastily or needlessly, the JCI representative must allow the Supplier to re-verify the gage before any changes are initiated. If there is a question or concern, the JCI representative, the Supplier and the Gage Engineer will meet to resolve the issue. [Return to Gage Build Requirements – Section A. Gage Certification, item #1.](#)
6. The Supplier is responsible for part to gage clearance issues regardless of when parts are available. If the gage is shipped to Johnson Controls prior to part availability, the return shipping cost will be Johnson Controls’ responsibility.
7. All gages must be warranted against manufactures’ defects for the life of the program. Warranty items may consist of substandard materials, poor labeling or any items that may cause bodily injury. Any detail in need of repair or replacement due to operator error, poor maintenance, or overall neglect is not considered warranty items. If a warranty item is in question, it will be brought to the Gage Engineer’s attention and decided upon jointly, between the Gage Engineer, the JCI representative, and the Supplier.
8. Throughout the life of the program, the Supplier may be requested to provide a cost breakdown for quoted and/or completed work. The [Johnson Controls Gage Cost Breakdown](#) form must be used to supply this information.
9. No fixtures will be modified from the original design without the prior consent of the JCI representative.
10. If a gage is to be used in a country other than the continental United States, all labeling and documentation must be in English and the respective native language. The [Gage Request for Quote](#) or the [Gage Assumptions / Gage Cost Model](#) form will indicate whether or not international labeling and documentation is required, but the JCI representative will make the final determination of which specific labels or documents are to be translated. The JCI representative will assist in the translations as required.
11. If Johnson Controls provides or assists in the development of new or innovative devices or techniques, the Supplier may not disclose this information (verbal or tangible) to anyone outside of Johnson Controls without the written permission of the Gage Engineer. This shall prevail for a period of three years after delivery of the gage. All trade secrets and/or patent rights are the property of Johnson Controls.
12. A Supplier shall not share any photograph or video images of any Johnson Controls gages with anyone outside of Johnson Controls without the written permission of the Gage Engineer. All images are the property of Johnson Controls.

SAFETY AND ERGONOMIC REQUIREMENTS

1. Every effort must be made to design and manufacture a gage or fixture that is operator friendly. Safety is top priority at Johnson Controls and it must be carried over into the equipment that is purchased. If an ergonomic issue is in question after a fixture is built then the JCI representative and Supplier must determine the course of action and financial responsibility. If agreement cannot be made the Gage Engineer will arbitrate.
2. The entire gage must be free of any sharp edges, or burrs, paying very close attention to the “operators area of movement.”
3. Attention must be given when purchasing or designing and building toggle clamps, hinge drops, and other movable details that can pinch the operator. Clamps that are free of pinch points must be used whenever possible.
4. Toggle Clamps and hinged drops must have mechanisms installed that prevent free falling onto the operator ([handle stops](#), [toggle clamp lockout](#), [hinge drop lockout](#)). This pertains not only in its built position but also if it will be rotated into a different orientation for inspection purposes.
5. Every effort must be taken to ensure that any removable detail does not exceed 40-lbs. In those circumstances the 40-lb. weight is exceeded, assist devices such as counter balances must be used. Also, considerations must be given to the ease of removal and assembly of these details. Hand cutouts, handles, forklift sleeves or eyebolts must be installed whenever possible.
6. The following weight restrictions apply:
 - Fixtures < 40 pounds must have [two \(2\) handles](#) installed.
 - Fixtures > 40 pounds but < 65 pounds must have [four \(4\) handles](#) installed.
 - Fixtures > 65 pounds but < 300 pounds must have a dedicated cart or table with casters.
 - Fixtures > 300 pounds must have [eyebolts](#) or [forklift sleeves](#) installed.

NOTE: The JCI representative is responsible to determine the method of procurement (internal fabrication, manufacturing plant purchase or Supplier fabrication) for the cart or table. Also, regardless of procurement method, the cart must be designed and fabricated with full and direct support on center of the fixture (center pillar with caster or leveling jack).
7. As a general practice, all handles that are attached to a gage should have a minimum grip length of 4”, a minimum grip width of 1”, and minimum hand access height of 1”.
8. The Supplier must make every effort to incorporate or allow for the following ergonomic information when designing and building a gage:

<u>Operator</u> (See anthropometric chart below)	<u>Gage design</u>	<u>Gage efficiency</u> (Operator motion efficiency)
Arm reach	Inspection tool placement	Task / operation time
Work envelope	Proper clearances	Operator postures
Arm elevation	Mechanisms are easily accessible	Operator fatigue
Work forces	Mechanisms are operated easily	Eliminate unnecessary motions
Motion – bending / twisting	Tools / mechanisms can be used by both right and left handed people	Minimize operator reaches per cycle
Right hand vs. left hand	Working height of gage is 41”	Part location on the gage

Anthropometric Measurements

Body Dimension	Range of Motion Low – High
Working (standing) elbow height	38 – 47
Maximum frequent arm elevation	50 – 62
Standing eye height	57 – 70
Optimal horizontal work envelope (measured from the center of rotation of the shoulder)	12 – 15
Functional non-extended horizontal reach (measured from the shoulder blade)	25 – 32

Range of Motion figures are in inches.

9. The Supplier must make every effort to design and build the gage in a manner that is “operator friendly”. Refer to the [Ergonomic Repetition Benchmark Matrix](#), [Ergonomic Force Benchmark Matrix](#), and the [Ergonomic Posture Benchmark Matrix](#) for further clarification. The Supplier may contact the Johnson Controls Ergonomics team for clarification.

[Go to Glossary of Terms](#)

QUOTATION REQUIREMENTS

1. Each [gage quotation](#) must contain the following information:
 - Johnson Controls program name
 - Part description
 - Detailed description of the work to be accomplished.
 - Any deviations from the quotation.
 - Itemized cost
 - Design
 - Build
 - Third Party Certification**
 - Gage R
 - Quotation total cost
 - Itemized timing
 - Design
 - Build (**NOTE:** Timing for internal Certification, Third Party Certification and Gage R must be included in the gage build timing.)

** See [Gage Build Requirements – Section B. Third Party Certification, Item #1](#) for Third Party Certification requirements.

2. The Supplier's quote must reflect the use of the materials listed in the Standard Materials list. Reference [Appendix C. Standard Material List](#).
3. If a Supplier intends to use recycled components on the gage, it must be identified on the quote. If it is not noted, the gage must be built using new components.
4. It is important that the Supplier understands the specific quote requirements at the time of quotation. Cost and timing must reflect these requirements. Further, any assumptions and/or exceptions that affect cost and timing must be clearly identified on the quotation.
5. When a quotation requires flush and feeler details, sheet metal representations, or part surface representations, aluminum or fixture plank must be used. Overall gage weight and/or detail wear resistance are items to consider when determining which material to use.
6. If a part requires CMM dimensional inspection on the underside of the part, then the part must be held a [minimum of nine \(9\) inches off the base](#), otherwise it may be held as close to the base as feasibly possible. [Return to Gage Design Requirements – Gage Design, Item #9](#)
7. The [gage base size](#) must be a minimum of four (4) inches larger on each side than the size of the part as held on the gage. The base type, MIC 6 tooling plate verses cast aluminum, will be determined by the gage size. For parts that require bases bigger than 400 in², a cast aluminum base will be required (a welded steel base may be used with the approval of the JCI representative). All other parts will require a MIC 6 tooling plate base. MIC 6 tooling plate bases must be a minimum of one (1) inch thick. In some cases, due to part configuration and/or fixturing requirements, a cast aluminum base smaller than 400 in² may be required. It is the Supplier's responsibility to ensure that the proper base size and type will be used. If the base is in question, the Supplier must contact the Gage Engineer or JCI representative for clarification. [Return to Gage Build Requirements – Section A. Bases, item #4](#)
8. If a Supplier chooses to "no quote" a gage or gage program, a 24-hour (or less) response time is required. This includes refusal of a package that is sourced using the Gage Assumptions / Gage Cost Model form.
9. Johnson Controls may use the Gage Assumptions / Gage Cost Model form to estimate and source plastic part gages. When this form is used, the Supplier is not required to provide a quote, unless directed by the JCI representative. If a cost breakdown is required, the Supplier will breakdown the Gage Cost Model cost vs. the supplier's quoted cost. The Gage Cost Model will not be used to estimate costs of engineering changes.

GAGE DESIGN REQUIREMENTS

A. CONCEPT DRAWING

NOTE: The concept drawing/design will be required on an “as needed” basis as dictated by the JCI representative.

1. The Concept drawing is to be drawn on an 8.5" x 11" sheet of paper.
2. The [Concept drawing](#) must show the “Gage Intent.” It should reflect the Geometric Dimensioning and Tolerancing (GDT) scheme and any special requirements reviewed at the quotation meeting. It should show approximate base size, part orientation, location of datums, location and orientation of clamps, location of flush rails / feeler rails, and location of SPC ports. The concept must be labeled with the Johnson Controls gage number and gage description.
3. The concept review and approval DOES NOT give the authority to order gage materials. As shown in the [Gage Design Requirements – Section B. Gage Design, item #11](#), approval of the gage design authorizes the ordering of materials and components. If gage materials have been ordered prior to final design approval, and changes are made to the gage design that affect these materials, the material costs for the unusable stock will be absorbed by the Supplier.

B. GAGE DESIGN

1. All gage designs produced for Johnson Controls must be computer generated. All designs must be in IGES format, both wire frame and surface data included. Whenever possible, the fixture must be designed using solid modeling software for proper interpretations during design signoffs.
2. The gage design is intended to be an accurate representation of the gage. It should reflect how the gage will be constructed and must include the basic information such as, base size and type, part orientation, location, size and orientation of all stanchions, details and clamps, size and location of datums, location of flush rails / feeler rails, and location of SPC ports. It must have all necessary section cuts to show detail and any required blow up sections. Also, all internally manufactured “one-of-a-kind” components need to be drawn and dimensioned on the design.
3. Datums that are located on or near parting lines, gates, ejector pins, welds or any similar features must be brought to the attention of the JCI representative for correction.
4. All stock items should be commercially purchased whenever possible.
5. All designs must have an isometric view of the gage on the design.
6. All designs must list all parts (assemblies, subassemblies or versions) that can be verified on the gage. Part numbers that are referenced must be the less finish part number(s) without color designation.
7. All designs will be drawn and dimensioned using the metric system (except Standard English stock sizes) unless otherwise specified by the JCI representative.
8. Each design must have three [Tooling balls](#) or two [Tooling holes and a Surface Target](#) with start coordinates labeled on the gage base. If a gage is to be sub-based, these items must be on each base.
9. All datum surfaces and locators must be labeled on the design with the respective GDT datum callout.
10. When a slot or similar feature is used as a Regardless of Feature Size (RFS) 4-way locator, it must be so designed as to allow each locating feature to move independently.
11. All [Pins and Blocks](#) used for part inspection (i.e. go/nogo pin, plug gage, virtual condition pin) must be labeled on the design with their respective size as well as the calculation(s) used to obtain that size.
12. If the design reflects a coordinate system other than the automotive X, Y, Z system, then the design must be clearly identified with the appropriate coordinate references (i.e. H, W, L).
13. If the part is to be positioned in a different coordinate system than the CAD model (tool die draw or workline verses body position), the design must be labeled in a distinct manner with the appropriate rotation points and angles to move to and from the original system. [Return to Gage Build Requirements – Section K. Labeling, item #3](#)
14. The design must show the storage locations for [removable details or interchangeable details](#), and [loose components](#) (SPC Indicator, GO-NOGO pins, Plug gages). Also, when loose details or components are needed, a general note for tethering of the details is required to be on the design. [Return to Gage Build Requirements – Section E. Removable Details, item #1](#)
15. The design must reflect the proper clearance for dimensional layout inspection. [Reference Quotation Requirements – Item # 4.](#)
16. The JCI representative must approve the initial gage design and subsequent design changes. It is recommended that two reviews take place – one at or about 50% completion and one at 100% completion. The design does not have to be signed at the 50% review, but must be for the 100% review. The JCI representative and the Supplier must sign the final design. Other signatures may be required, as dictated by the customer design standards and/or the JCI representative. It is the Supplier's responsibility to notify the JCI representative prior to completing the design to determine who is required to sign the final design.

17. Design approval gives the authority for the Supplier to order gage materials. If materials have been ordered prior to final design approval and changes are made to the gage design that affect these materials, the material costs for the unusable stock will be absorbed by the Supplier. [Return to Gage Design Requirements – Section A. Concept Drawing, item #3](#)
18. All design changes must be recorded in a standard change column on the design.
19. All gage details must be confined within the [boundaries of the base](#), including details that move (toggle clamps, hinge drops, etc.)
20. The approved (signed) design is the property of Johnson Controls and will be stored at the Supplier. An electronic copy (and hard copy as required by the JCI representative) must be supplied with the gage each time the design is updated. [Reference Gage Build Requirements – Section H. Records, Item #2.](#)
21. Johnson Controls will supply all CAD models in its native format (CATIA, UNIGRAPHICS, etc.). Every effort will be made to minimize the file size while ensuring all the critical data is supplied. All IGES translation errors or problems are the Supplier's responsibility.
22. In the event that the customer requires a manual design, items 2 – 14 above and standard gage design practices apply. The original design must be drawn on Mylar and must be neat and legible.
23. Consideration for [maximum CMM access](#) must be given when designing the clamp type and location. Horizontal handle or bayonet type clamps should be used when CMM access is a priority.

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GAGE BUILD REQUIREMENTS

A. BASES

1. It is the Supplier's responsibility to ensure that the base meets the flatness, parallelism and squareness tolerances as specified below. The [datum scheme for these base measurements](#) is defined as the base bottom as it sits in the horizontal position.

	0.10	A
	0.20	A
	0.10	A
	0.15	

Per 300 mm²

Not to exceed over entire base

Between top and bottom surfaces

All machined edges

NOTE: All Tolerances specified are in millimeters.

2. All edges must be machined square and beveled.
3. The base must have the [J-Corner identified](#).
4. All Tooling plate bases smaller than 200 in² require [four \(4\) jig feet](#), one at each corner. Bases between 200 in² and 400 in² require [five \(5\) jig feet](#), one at each corner and one in the center. Bases larger than 400 in² a cast aluminum base is required. A welded steel base may be used with the approval of the JCI representative. [Reference Quotation Requirements – Item # 5](#).
5. Tooling plate bases must be a minimum of 1" thick.
6. Cast aluminum, welded aluminum or steel bases must be stress relieved.
7. All bases must be of [uniform thickness](#). It is the Supplier's responsibility to inspect the base for uniformity before construction. If the gage is constructed and the base is found to be varying in thickness, the base will have to be replaced and reconstructed at the expense of the Supplier.

B. TOOLING BALLS / TOOLING HOLES

1. Three (3) Tooling balls or Tooling holes must be located and identified with the start coordinates on the base of the gage. These features will be used to establish the [origin of the fixture](#) for certification and part layout. Reference [Gage Build Requirements – Section D. Details, Item #11](#), for tooling ball requirements as single point net representations (datum target).
2. Tooling ball size will be .500 inch. Tooling hole size will be a minimum of 10 millimeters.
3. Each Tooling ball must have a protective cover. The cover must not interfere with the start coordinate labels.

C. RISERS and STANCHIONS

1. The risers and stanchions must be attached to the base securely with a minimum of two (2) dowels and two (2) cap screws unless specified in the design as a removable detail. Reference [Gage Build Requirements – Section E. Removable Details](#).
2. Risers and stanchions may be relieved or cut away in certain areas to gain access to the part for dimensional inspection. It is the Supplier's responsibility to ensure the area(s) that are removed do not affect the integrity or stability of the gage.

D. DETAILS

1. All details must be attached to the base securely with dowels and cap screws. It is the Supplier's responsibility to ensure that the correct quantities of dowel and cap screws are used. If the quantity is substandard, the Supplier must fix or replace the detail without costs to Johnson Controls. Reference [GAGE BUILD REQUIREMENTS – Section E. Removable Details](#) for details that are to be built as removable.
2. Details shall not be shimmed during construction.
3. Details used as net surfaces must be made of steel. Steel plates located on aluminum details may be used.
4. Flush rails, feeler rails and sheet metal representations must be constructed of aluminum or fixture plank. Fixture plank must be sectioned into details no larger than 400 mm in length each.
5. A 6 mm gap distance is to be used, unless otherwise specified by the JCI representative customer gage build standards.
6. All net details that net around the area of a hole or cutout in the part must have [CMM probe clearances](#) cut into the detail. These clearances must be a minimum of five (5) mm deep and two (2) mm bigger than the part feature.

7. All loose details (Plug gages, Go/NoGo pins) must be tethered to the gage using chain, Car-Lane cable, or retractable spring-loaded cases with cable lockouts. These chains or cables may be removed if the detail is to be used when the part is scanned.
8. All noncircular plug gages must be keyed for orientation.
9. Unless otherwise specified by the customer, a plug gage located in a bushing and clamped on top will be the method to represent a [screw or fastener pin](#).
10. When a single point datum target is required, a tooling ball must be used. The associated clamp must be adjusted to not deform the part. [Return to Gage Build Requirements – Section B. Tooling Balls – Item #1](#)
11. Each feeler rail must have an associated go/nogo feeler pin that reflects the proper tolerance.

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E. REMOVABLE DETAILS

1. All removable details must use [hardened bushings and bullet nose dowels](#). The bushings must be in the detail and the dowels must be in the mating component. Reference [Design Requirements – Section B. Gage Design, item #14](#).
2. When there are similar removable details used on the same gage, the details must have a unique locating scheme for each. Each detail and storage location must be clearly labeled or color-coded.
[Reference Gage Build Requirements – Section C. Risers and Stanchions – Item #1](#)
[Reference Gage Build Requirements – Section D. Details – Item #1](#)

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F. HINGED DETAILS

1. All hinge drop details must be counterbalanced or have a [lock out mechanism](#) installed. This also pertains if the gage will be tipped 90° to inspect the part.
2. All hinge drop details must have rubber stops installed to prevent damage.

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G. LOCATING PINS

1. All locating pins must be tapered and spring-loaded (RFS pin). The Gage Engineer or JCI representative must approve all other pins (MMC pin, LMC pin).
2. All tapered RFS pins must locate the part approximately at the mid point of the taper.
3. All locating pins must be made of hardened steel.
4. If a locating pin must be locked out to load the part, the [lockout mechanism](#) must be positive. For instance, if a detail has an “L” shaped cut to lockout the locating pin, the cut must have enough lead in to disengage the locating pin and hold it out of position.
5. The locating pin spring pressure must be strong enough to locate the part without distortion when clamped.
6. Spring loaded locating pins must move freely in all directions except the locating direction using graphite lubricant.

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H. CLAMPS

1. All clamps must have a [clamp direction](#) of 90° to the part surface.
2. Clamps that are spring loaded must have a positive [lockout mechanism](#).
3. When clamping over a hole, the clamp foot must be cut to allow access to the hole.
4. When engaging a clamp, it must not interfere with the part or any other detail(s) on the gage.
5. Clamp pressure must be the minimum required to locate the part, but stronger than the opposing spring-loaded features.
6. All clamp pressure feet must be mar-proof. Examples are rubber, neoprene or nylon. If metal clamp feet are required, they must be free of burrs and sharp edges and have a mar-proof coating.

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I. SCRIBE LINES / TOLERANCE BANDS

1. All scribe lines and tolerance bands must be scribed or milled into the surface. Painted lines on the surface are not acceptable.
2. All scribe lines and tolerance bands must be identified with a distinct color to ensure good visibility for measurement. If a nominal line is included in the tolerance band, the nominal line must be contrasting color within the tolerance band.
3. Every effort must be made to minimize or eliminate the effect of the parallax error.
4. As required by the Customer or JCI representative, gage bases may have bodylines scribed on them. It is recommended that the bodylines are scribed every 100 mm for smaller fixtures and 200 mm for larger fixtures. These bodylines must be labeled with the appropriate body coordinate and left hand (-) or right hand (+) signification.

J. SPC INDICATORS

1. The SPC indicator type to be used on all gages supplied to Johnson Controls will be Mitutoyo series 543 or 575. Specific indicator features (resolution, discrimination, travel, and sensitivity) will be dictated by each application.
2. Master set blocks will be at a length of 31mm and 50mm for applications that require more CMM access.
3. All indicators must be set up to zero out in the approximate center of its travel length. For instance, if an indicator has a 1-inch travel, the indicator must be zeroed out at .5 inch.
4. The SPC indicator bushing and port sizes will be 3/8" I.D. and O.D. respectively.
5. The check direction of each indicator must be 90° to the surface it is measuring.
6. The proper indicator tip must be used for each application. Examples are listed below:
 - Ball point / spherical / conical tip – used to check a point on a compound surface or overall length indicating on a Micro slide.
 - Flat tip – used to check a part edge that has a radius at the checkpoint.
 - Knife blade (chisel) tip – used to check a part edge with a flat contour.
7. Indicator extensions should be used sparingly or only as the application dictates. Extensions must be kept to the shortest length possible to obtain an accurate measurement.
8. All indicator extensions and tips must be tightened without using lock-tite or other chemical fasteners.
9. A feather-light indicator must be used if the inspection point on the part is flexible or touch sensitive.

K. BUILD TOLERANCES

NOTE:

- Tolerances are established using the following [gage certification datum scheme](#) - the primary datum is the surface plane established by the tooling balls or tooling holes, the secondary datum is the longer line established by the tooling balls or tooling holes and the tertiary datum is the shorter line established by a single tooling ball or surface target.
- The [check direction](#) is defined as the direction(s) in which the part is to be held.
- The [non-check direction](#) is defined as the direction(s) that the part is not to be held.
- All tolerances are in millimeters unless otherwise noted.

1. Net Surfaces

	0.20	A	B	C	Check direction
	1.00	A	B	C	Non-check direction

2. Round Pin Locators (4-way / 2-way)

	∅ 0.10	A	B	C	Check direction
	∅ 0.50	A	B	C	Non-check direction

3. All other Locators

	0.10	A	B	C	Check direction
	0.50	A	B	C	Non-check direction

4. Attribute rail – flush and/or feeler [vector check]

	0.40	A	B	C
--	------	---	---	---

5. Attribute rail – flush and/or feeler [set two check one check]

	0.40	A	B	C
--	------	---	---	---

6. Sheet metal representation

	0.30	A	B	C
--	------	---	---	---

7. SPC port location

	∅ 0.20	A	B	C	Check direction
	∅ 0.50	A	B	C	Non-check direction

8. Scribe lines

	0.60	A	B	C
---	------	---	---	---

9. Sight checks (painted)

	1.00	A	B	C
---	------	---	---	---

10. Slides

	0.10	A	B	C
---	------	---	---	---

 Entire travel

11. Check pin location (MMC, LMC or VC pin)

	\varnothing 0.15	A	B	C
---	--------------------	---	---	---

 Check direction

12. Go Pin size

+0.00 / -0.02

13. Nogo Pin size

+0.02 / -0.00

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L. LABELING

- All labeling on the gage must be legible and descriptive. The labeling must be placed in such a manner that it is readable when the part is on the fixture. Labels may be engraved, printed or stamped. If tags are used, they must be permanently attached to the gage.
- The following detail types must be labeled on the gage:
 - All datums (net surfaces and locators)
 - Clamp sequence
 - Flush rail location and offset measurement
 - Feeler rail location and offset measurement
 - Go/NoGo pin sizes
 - Indicator port reference number
 - Master set block offset measurement
 - Body line references (appropriate customer references – XYZ or LWH)
 - Specific measurement locations
- Tooling balls or tooling holes on the base must be clearly labeled with their respective [start coordinates](#). If there are more than three (3) tooling balls or tooling holes on the base, the three (3) that are used to certify the fixture must be labeled with the word "Origin" next to the coordinate. Coordinates will be assumed to be in body position, but if they are in work line or other, they must be clearly identified with the coordinate system used. Reference [Gage Design Requirements, Section B. Gage Design, item #7](#).
- Each gage must have a [Supplier Identification tag](#) permanently attached to it. Each tag must be labeled with the following information:
 - Supplier name, address and phone number
 - Supplier job number
 - Customer
 - Johnson Controls Gage Number (84xxxx)
 - Gage Description
 - Part Revision Level
 - Certification date
 - Program name(s) and part name(s)As Required
 - Third party source name, address, phone number and certification date
 - List of part numbers and names (if gage checks multiple parts)
- Gage instructions must be affixed to each gage. Reference [Gage Build Requirements - Section P. Gage Instructions, item #2](#).

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M. CORROSION PROTECTION

- All steel components must be black oxidized.
- All non-mating surfaces must be painted with the customer-required color. If a color is not specified, blue is to be used.

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N. GAGE CERTIFICATION

1. It is the Supplier's responsibility to ensure that the cutter path and certification data are correct. See [General Requirements – item #4](#) & [General Requirements – item #5](#) for clarification. The accuracy of the gage must be verified using a certified CMM (traceable to a national standard). One of a kind details, like step blocks or thickness feelers, may be certified with traceable hand held equipment (micrometers, calipers). Purchased inspection details and devices (gage pins, scales, protractors, indicators) may be certified by including the certification report from the manufacturer. If a report is not sent, the detail must be certified using appropriate means.
2. The [Supplier Internal Certification](#) must use a vector check for all net surfaces, sheet metal representations and compound surfaces. A “set two, check one” check may be used on details that represent a one-direction check like a net point, flush rail, or feeler rail. SPC bushing locations must be verified and reported in the check direction but only verified in the non-check direction. Pin size and location and hole size and location must be verified and reported.
3. The number of certification masters developed for each detail is dependent on the size and complexity of the detail. It is the Supplier's responsibility to develop a sufficient amount of points to demonstrate that the gage is dimensionally correct. As an example, on a typical 25 mm x 25 mm net block, it is recommended that a minimum of five (5) masters be used. There must be enough masters to evaluate any single or combination of elements of size, location, orientation and profile.
4. All gage certifications must include a “road map” of the certification points.

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O. THIRD PARTY CERTIFICATION

1. A [Third Party Certification](#) is required on all gages that are manufactured by a Supplier who's certification department IS NOT accredited to a nationally recognized laboratory or inspection standard (i.e. ISO Guide 25 or ISO Guide 17025). This accreditation must be performed by a duly recognized accreditation body (American Association for Laboratory Accreditation – A2LA or equivalent). Certification to the QS9000 or TE9000 standard DOES NOT supersede this requirement; it is in conjunction with it. Refer to the AIAG QS9000 manual paragraph 4.11.2.b.1 for clarification.

This Third Party certification must be performed one of two ways:

- The third party source verifies the certification masters against the CAD model and inspects the gage at the third party facility.
- The third party source develops new certification masters and inspects the gage at the third party facility.

[Return to Quotation Requirements – item #1](#)

2. It is the Supplier's responsibility to ensure the accuracy and on time delivery of the Third Party Certification.
3. If the Third Party Certification is found to be discrepant, it is the Supplier's responsibility to correct it without cost to Johnson Controls, up to and including the internal and Third Party recertification.

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P. GAGE INSTRUCTIONS

1. All gages must have gage instructions attached to the gage. Also, an electronic copy must be supplied on a CD upon delivery of the gage. Reference [Gage Build Requirements – Section H. - Gage Records, item #2](#).
2. The [gage instructions](#) must be detailed and understandable with references to the gage clearly labeled. They must identify the gage preparation, loading, clamping, inspection and unloading of the part. The instructions must include all part configurations. They must include a picture of the gage with the appropriate references identified (locators, net surfaces, check points, etc). [Return to Gage Build Requirements – Section K. – Labeling, Item #5](#)

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Q. FUNCTION CHECK

1. A function check must be performed prior to delivery of the gage. The Supplier may utilize their own completion checklist, but it must include all the items listed on the [gage completion checklist](#) in the appendix. The function check of the gages must consist of the following steps as a minimum:
 - A. Evaluate the gage against the gage design.
 - B. Function all components on the gage.
 - C. Using the gage instructions, load the part on the gage.
 - D. Identify and remove all interferences.
 - E. Document the results.
 - F. Correct any discrepancies.
2. It is the Supplier's responsibility to request parts for the function check. If the gage is to be delivered prior to part availability, all items above must be performed, with the exception of items C and D. When parts become available, it is the responsibility of the Supplier to complete the function check.

R. MEASUREMENT SYSTEMS ANALYSIS

1. A Measurement Systems Analysis study (Gage R) must be performed prior to delivery and/or final buy off of the gage. For engineering changes, refer to step #8.

The primary function of the gage, when delivered will determine which study is to be performed. Reference matrix below.

- For a single-function gage (CMM holding fixture, SPC gage, Attribute gage), one study must be performed.
- For a single-function gage that will become a multi-function gage (CMM/SPC gage, CMM/Attribute, SPC/Attribute) later in the program, a study must be performed at each build phase.
- For a multifunctional gage that is built from the initial kickoff, only one study is to be performed, of which the easiest variable study takes precedence.

Gage Type	1 st Build	Perform MSA study referring to this Step # below	2 nd Build	Perform MSA study referring to this Step # below
CMM holding fixture	C	2.1.1	N/A	N/A
SPC gage	S	2.1.2	N/A	N/A
Attribute gage	A	3.1.1	N/A	N/A
CMM – SPC gage	C – S	2.1.2	N/A	N/A
CMM – SPC gage	C	2.1.1	S	2.1.2
CMM – Attribute gage	C – A	2.1.1	N/A	N/A
CMM – Attribute gage	C	2.1.1	A	3.1.1
CMM – SPC – Attribute gage	C – S – A	2.1.2	N/A	N/A
CMM – SPC – Attribute gage	C	2.1.1	S – A	2.1.2
SPC – Attribute gage	S – A	2.1.2	N/A	N/A
SPC – Attribute gage	S	2.1.2	A	3.1.1
Key: C = CMM holding fixture S = SPC gage A = Attribute gage				

2. The [Gage R](#) study will use one (1) operator loading one (1) part ten (10) times.
 - 2.1. The study must be performed one of two ways as listed below:
 - 2.1.1. CMM HOLDING FIXTURE
 - A. Obtain one (1) part from the JCI representative.
 - B. Using the CAD model, obtain nine (9) body coordinate points, three in each direction (X, Y, and Z) to show the most variation in each axis.

NOTE: The JCI representative may choose the points for the study or consensus must be gained from the JCI representatives to use the points chosen by the Supplier. It is preferred that each point be on an edge to allow the CMM to “shank” check the part, checking only in the primary check direction. [GR Study Coordinates](#)
 - C. Using the gage instructions, load the part on the gage.
 - D. Using a CMM, measure each of the body coordinates. Record the deviation from the master check direction for each coordinate.
 - E. Unload the part.
 - F. Repeat steps C–E until the ten (10) trials are complete.
 - G. Input data into form, calculate and analyze the result.
 - H. If study is found to be unacceptable, the JCI representative and the Supplier must jointly determine the improvements needed to obtain an acceptable result.
 - 2.1.2. SPC GAGE
 - A. Obtain a part from the JCI representative.
 - B. Using the gage instructions, load the part on the gage.
 - C. Measure each SPC location. Record the measurement(s).
 - D. Unload the part.
 - E. Repeat until the ten (10) readings at each SPC location have been obtained.
 - F. Input data into form, calculate and analyze the result.
 - G. If study is found to be unacceptable, the JCI representative and the Supplier must jointly determine the improvements needed to obtain an acceptable result.

2.2. Acceptance criteria for the study will be as follows:

>20%	Will not be accepted without approval from the JCI representative.
10% - 20%	Borderline acceptable. Must investigate cost and timing impact to improve measurement system. JCI representative must approve plan.
0% - 10%	Acceptable.

3. The [Attribute study](#) will use two (2) operators loading twenty (20) parts two (2) times each.

3.1. The Attribute study must be performed as listed below:

3.1.1. ATTRIBUTE GAGE

A. Obtain twenty (20) parts from the JCI representative.

NOTE: The parts used in this study should represent acceptable and rejectable parts. If the JCI representative deems acceptable, the parts may be modified (trim or sand an edge, ream a hole) to ensure that the parts are rejectable.

B. Using the gage instructions, load a part on the gage.

C. Using all the attribute inspection devices, measure the part. Record the inspection result for each device.

D. Unload the part.

E. Repeat steps B-D until the twenty (20) parts have been measured.

F. Repeat steps B-E for the second operator.

G. Repeat steps B-F for the second trial.

H. Input data into form, calculate and analyze the result.

I. If study is found to be unacceptable, the JCI representative and the Supplier must jointly determine the improvements needed to obtain an acceptable result.

3.2. Acceptance criteria for the Attribute study will be as follows:

PASS	Acceptable
FAIL	Will not be accepted without approval from the JCI representative.

4. If an engineering change is completed that affects the locating or measurement scheme of the gage, the Measurement Systems Analysis process must be re-verified. If the engineering change is in question, it is the Suppliers' responsibility to contact the JCI representative for clarification.

5. Completion of the Gage R study or Attribute study does not waive the Supplier's responsibility to repair or adjust the gage (at no cost to Johnson Controls) if the Gage Repeatability and Reproducibility study or Attribute study required for PPAP is unacceptable. The JCI representative and the Supplier must jointly determine the improvements needed to obtain an acceptable result.

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S. SHIPPING / TRANSPORTATION

1. All gages must be completely protected from the elements when being shipped.

2. All gages must be secured when shipped.

3. Johnson Controls will accept full responsibility of the gage when it is delivered and unloaded at Johnson Controls' receiving location.

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T. PREVENTIVE MAINTENANCE INSTRUCTIONS

1. All gages must have [Preventive Maintenance instructions](#) supplied electronically on the CD upon delivery.

2. The Preventive Maintenance instructions must be detailed and understandable with references to the gage clearly labeled. They must identify the maintenance instructions, recommended frequency of maintenance, recommended chemicals / solutions to use for maintenance and long-term storage preparation instructions. **NOTE:** If the chemicals / solutions cannot be purchased "over the counter", then a hardcopy of the MSDS sheet must be included with the gage upon delivery.

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U. RECORDS

1. The Supplier is responsible to provide an itemized [Gage Timing chart](#) for each gage from initial kickoff to delivery on a periodic basis. The report will be due every week but may be modified by the JCI representative. Delays in program timing must be reported immediately, first verbally, then on the hardcopy timeline. For gages with total timing of less than three (3) weeks, no timeline is required.

2. The Supplier is responsible to provide two (2) electronic copies of the latest documents and data on a Compact Disk each time the gage is modified*. One copy will be attached to the gage and the other will be delivered to the JCI representative. This disk must contain the following:

- Native CAD model
- Gage Design
- Gage Certification
- Gage R and/or Attribute study or studies
- Gage Instructions
- Gage Preventive Maintenance Instructions
- Digital picture of the gage
- Any other pertinent documents as required
- Final gage timeline - OPTIONAL
- Final gage checklist - OPTIONAL
 - * Modified is defined as any change to the fixture or its documents due to a Johnson Controls or OEM directed change, repair, correction, etc. All modifications do NOT necessarily constitute a JCI representative level change.

[Return to Gage Design Requirements – Section B. Gage Design, Item #21](#)

[Return to Gage Build Requirements – Section C. Gage Instructions, Item #2](#)

3. The CD jacket must be labeled with the Supplier name, Supplier job number, Johnson Controls' Tool Number, Gage Description, and revision level.
4. All documents that require signed approval will be in original hard copy format and kept at the Supplier.

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V. SPECIALTY GAGING

NOTE: Specialty Gaging is defined as any fixture or gage that employs the use of non-contact or technologically advanced devices used in place of more commonly used analog devices. Examples may include Lasers probes, Vision systems, or Magnetic systems.

1. The Supplier is responsible to prove-out and validate Specialty Gaging using the same methods as a fixture or gage as defined in this standard. In addition, the Supplier is responsible to verify all software applications and/or written code provided with the gage. This verification is to be performed by testing the input and output relationships and results with a minimum of 3 replications on 10 different parts. This verification study must be documented and supplied with the gage.
2. Specialty gages must meet the JCI Special Equipment General Specifications (SEGS) and Special Equipment Safety Specifications (SESS) as well as any applicable industry standards that may not be covered in the SESS and SEGS documents. If aspects of these manuals are in question, contact the JCI representative or Capital Equipment Buyer for clarification.

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W. AUTOMATED and SEMI-AUTOMATED GAGING

NOTE: Automated Gaging is defined as piece of equipment that is used to assess the acceptability of the part without operator intervention, except for loading and unloading of the part. Semi-Automated Gaging is defined as a piece of equipment that is used to assist the operator in loading, clamping, measurement and/or unloading of the part. Examples for both types of gages may include pneumatic equipment or electronic equipment.

1. Prior to design and build of any Automated Gaging, the JCI Representative must complete an Equipment Specification sheet. This sheet will be used in place of the Gage Request for Quote or Gage Assumptions / Cost Model sheet. The Supplier is responsible to meet all requirements of the Equipment Specification.
2. The Supplier is responsible to prove-out and validate Automated and Semi-Automated Gaging using the same methods as a fixture or gage as defined in this standard. In addition, the Supplier is responsible to verify all software applications and/or written code provided with the gage. This verification is to be performed by testing the input and output relationships and results with a minimum of 3 replications on 10 different parts. This verification study must be documented and supplied with the gage.
3. Automated and Semi-Automated gages must meet the JCI Special Equipment General Specifications (SEGS) and Special Equipment Safety Specifications (SESS) as well as any applicable industry standards that may not be covered in the SESS and SEGS documents. If the Supplier is in need of a copy of these manuals or if aspects of these manuals are in question, contact the JCI representative or Capital Equipment Buyer for clarification.
4. The Supplier is responsible for dry cycling the Automated and Semi-Automated gaging. This dry cycle will consist of a continuous 20 hours of operation or as defined by the JCI representative. The dry cycle results must be documented and supplied with the gage.

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APPENDIX A – Documents

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APPENDIX A1. Supplier Internal Certification

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ABC Corporation 123 West 12th Street Somewhere MI 99998

ABC Job#: 1290A

Customer: Johnson Controls
Part Name: GMT236 Overhead Console
Part Number: 9999998

Date Chkd: 04/Mar/00
Chkd By: D. P.
File: 1290

START COORDINATES

X = 3820.000 Y = -580.000 Z = 350.000

Detail No.	X Master	X Check	X Diff	Y Master	Y Check	Y Diff	Z Master	Z Check	Z Diff	Vec. Dev.	Chk Type	Ln #	Pt #	Dim.
Net Surface - Datum A1														
1	2691.010	2690.981	-0.029	-827.998	-827.996	0.002	770.456	770.512	0.056	-0.063	Surf Rd	1	1	
1	2691.010	2690.989	-0.021	-826.552	-826.497	0.055	794.329	794.346	0.017	0.061	Surf Rd	1	2	
1	2702.691	2702.777	0.086	-827.116	-827.108	0.008	783.204	783.202	-0.002	-0.086	Surf Rd	1	3	
1	2713.000	2712.996	-0.004	-827.788	-827.801	-0.013	770.456	770.499	0.043	0.045	Surf Rd	1	4	
1	2713.000	2713.026	0.026	-827.998	-827.996	0.002	794.329	794.361	0.032	0.041	Surf Rd	1	5	
Net Surface - Datum A2														
2	3030.000	3030.001	0.001	-827.351	-827.359	-0.008	769.233	769.303	0.070	-0.070	Surf Rd	1	6	
2	3030.000	3029.910	-0.090	-827.265	-827.259	0.006	749.962	749.976	0.014	0.091	Surf Rd	1	7	
2	3042.000	3042.019	0.019	-827.279	-827.261	0.018	758.999	758.999	0.000	-0.026	Surf Rd	1	8	
2	3055.000	3055.000	0.000	-827.198	-827.189	0.009	769.233	769.233	0.000	0.011	Surf Rd	1	9	
2	3055.000	3054.995	-0.005	-827.000	-827.989	-0.989	749.912	749.919	-0.003	0.011	Surf Rd	1	10	
Net Surface - Datum A3														
3	3262.000	3261.999	-0.001	-858.205	-858.199	0.006	920.000	919.995	-0.001	0.006	Surf Rd	1	11	
3	3262.000	3262.000	0.000	-859.191	-859.215	-0.024	897.919	898.007	0.003	0.024	Surf Rd	1	12	
3	3286.000	3286.000	0.000	-859.676	-859.728	-0.052	898.000	898.007	0.007	-0.052	Surf Rd	1	13	
3	3286.000	3286.006	0.006	-837.471	-837.491	-0.020	920.000	920.000	0.000	0.021	Surf Rd	1	14	
Centerline of Hole - Datum A3														
4-WAY PIN	3275.806	3275.811	0.005	-858.726	-858.758	-0.032	911.116	911.200	0.084	0.090	Hole	1	15	6.789
Net Surface - Datum A4														
4	3520.000	3520.009	0.009	-837.558	-837.577	-0.019	975.000	975.003	0.003	0.021	Surf Rd	1	16	
4	3520.000	3520.010	0.010	-837.432	-837.466	-0.034	975.000	975.000	0.000	-0.035	Surf Rd	1	17	
4	3545.000	3544.989	-0.011	-837.337	-837.378	-0.041	950.000	950.073	0.073	0.084	Surf Rd	1	18	
4	3545.000	3545.000	0.000	-837.185	-837.247	-0.062	950.000	950.011	0.011	-0.063	Surf Rd	1	19	
Centerline of Hole - Datum A4														
2-Way PIN	3534.555	3534.547	-0.008	-837.471	-837.392	0.079	962.500	962.511	0.011	0.080	Hole	1	20	7.032

APPENDIX A2. Third Party Certification

[Return to Gage Build Requirements, Section B. Third Party Certification, Item #1.](#)
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FCS - Fixture Certification Service

1001 Springs Road
 Somewhere, MI 99998
 Office - (810) 123-0987 Fax - (810) 123-7890

FCS Job #: FCS9684

Customer: Johnson Controls
Part Name: GMT236 Overhead Console
Part Number: 9999998

Date Chkd: 12/Mar/00
Chkd By: R. S.
File: FCS9684

START COORDINATES

X = 3820.000 Y = -580.000 Z = 350.000

Detail No.	X Master	X Check	X Diff	Y Master	Y Check	Y Diff	Z Master	Z Check	Z Diff	Vec. Dev.	Chk Type	Ln #	Pt #	Dim.
Net Surface - Datum A1														
1	2691.010	2691.005	-0.005	-827.998	-828.002	-0.004	770.456	770.521	0.065	-0.065	Surf Rd	1	1	
1	2691.010	2690.998	-0.012	-826.552	-826.549	0.003	794.329	794.369	0.040	0.042	Surf Rd	1	2	
1	2702.691	2702.721	0.030	-827.116	-827.191	-0.075	783.204	783.205	0.001	-0.081	Surf Rd	1	3	
1	2713.000	2713.059	0.059	-827.788	-827.816	-0.028	770.456	770.502	0.046	0.080	Surf Rd	1	4	
1	2713.000	2712.961	-0.039	-827.998	-828.009	-0.011	794.329	794.336	0.007	0.041	Surf Rd	1	5	
Net Surface - Datum A2														
2	3030.000	3030.058	0.058	-827.351	-827.419	-0.068	769.233	769.230	-0.003	-0.089	Surf Rd	1	6	
2	3030.000	3030.021	0.021	-827.265	-827.305	-0.040	749.962	749.950	-0.012	-0.047	Surf Rd	1	7	
2	3042.000	3042.034	0.034	-827.279	-827.276	0.003	758.999	759.002	0.003	-0.034	Surf Rd	1	8	
2	3055.000	3054.953	-0.047	-827.198	-827.191	0.007	769.233	769.190	-0.043	0.064	Surf Rd	1	9	
2	3055.000	3055.035	0.035	-827.000	-827.069	-0.069	749.922	749.921	-0.001	0.077	Surf Rd	1	10	
Net Surface - Datum A3														
3	3262.000	3261.976	-0.024	-858.205	-858.210	-0.005	920.000	920.019	0.019	0.031	Surf Rd	1	11	
3	3262.000	3262.000	0.000	-859.191	-859.150	0.041	897.999	898.052	0.053	0.067	Surf Rd	1	12	
3	3286.000	3286.016	0.016	-859.676	-859.678	-0.002	898.000	898.017	0.017	-0.023	Surf Rd	1	13	
3	3286.000	3286.012	0.012	-837.471	-837.416	0.055	920.000	920.009	0.009	0.057	Surf Rd	1	14	
Centerline of Hole - Datum A3														
4-WAY PIN	3275.806	3275.798	-0.008	-858.726	-858.715	0.011	911.116	911.112	-0.004	0.014	Boss	1	15	6.789
Net Surface - Datum A4														
4	3520.000	3520.023	0.023	-837.558	-837.512	0.046	975.000	975.012	0.012	0.053	Surf Rd	1	16	
4	3520.000	3520.010	0.010	-837.432	-837.500	-0.068	975.000	975.008	0.008	-0.069	Surf Rd	1	17	
4	3545.000	3545.069	0.069	-837.337	-837.307	0.030	950.000	950.003	0.003	0.075	Surf Rd	1	18	
4	3545.000	3545.004	0.004	-837.185	-837.178	0.007	950.000	950.019	0.019	-0.021	Surf Rd	1	19	
Centerline of Hole - Datum A4														
2-Way PIN	3534.555	3534.570	0.015	-837.471	-837.432	0.039	962.500	962.498	-0.002	0.042	Boss	1	20	7.032

APPENDIX A3. Gage Repeatability Study

[Return to Gage Build Requirements, Section E. Measurement System Analysis, Item #2.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)



Gage Repeatability Study Sheet

Measurement Analysis

n	X	\bar{X}	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.35	0.356	-0.006	0.0000
2	0.36	0.356	0.004	0.0000
3	0.34	0.356	-0.016	0.0003
4	0.38	0.356	0.024	0.0006
5	0.35	0.356	-0.006	0.0000
6	0.34	0.356	-0.016	0.0003
7	0.38	0.356	0.024	0.0006
8	0.37	0.356	0.014	0.0002
9	0.35	0.356	-0.006	0.0000
10	0.34	0.356	-0.016	0.0003

Date: 3/3/00

Part Name: GMT 236 Overhead Console

Characteristic: Overall Length

Gage Name: Overhead Console Assembly fixture

Gage No: 849111

Gage Type: CMM / SPC fixture

TOLERANCE = 1.50

Sum of all $(X - \bar{X})^2 = 0.0022$

$(X - \bar{X})^2 / 9 = 0.0002$

$\sqrt{0.0002} = 0.0158$

$0.0158 \times 5.15 / 0.972 = 0.0836$

$0.084 / 1.50 = 0.0557$

GAGE R % = 0.0557 X 100 = 5.6%

APPENDIX A4. Gage Completion Check List

[Return to Gage Build Requirements, Section Q. Function Check, Item #1.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)



GAGE CHECK LIST

GAGE #: 849111

DESCRIPTION: Overhead Console Assembly

DATE: 03/02/00

SUPPLIER: ABC Corporation

PROJECT: 2001 GMT236

ITEM DESCRIPTION	RESULT		
DELIVERABLES	YES	NO	N/A
Documentation	Documentation		
Compact disk	X		
> Math Data	X		
> Design	X		
- Approved	X		
> Certification	X		
- Meets specification	X		
> 3rd Party certification	X		
- Meets specification	X		
> Gage R	X		
- Meets specification	X		
APPEARANCE	APPEARANCE		
Identification	Identification		
> Gage source tag	X		
- Company information	X		
- Internal job number	X		
> Gage identification	X		
- Gage (tool) description	X		
- Gage (tool) number	X		
- Certification date	X		
- E/C level	X		
Labeling	Labeling		
> Gage Instructions	X		
> J-Corner	X		
> Set up coordinates	X		
> Certification targets	X		
> Datums	X		
> Clamp sequence	X		
> Flush / feeler rails			X
> SC points	X		
> Zero block set dimension	X		
> Scribelines			X
> Special notes	X		
MISCELLANEOUS ITEMS	MISCELLANEOUS ITEMS		
Miscellaneous	Miscellaneous		
> Handles / eye bolts installed	X		
> Attribute pin & block details tethered			X
> Indicator in storage box	X		
> Gage painted	X		
> Nets black oxidized	X		
> Clamp pads contoured	X		
AUTOMATED GAGING	AUTOMATED GAGING		
Function	Function		
> Pneumatics work properly			X
> Electronics work properly			X
> Data collection work properly			X

ITEM DESCRIPTION	RESULT		
FUNCTIONALITY	YES	NO	N/A
Micro Slides	Micro Slides		
> Move freely	X		
> Protective stops	X		
> Certification pin attached	X		
Stanchions	Stanchions		
> Securely fastened	X		
> Sharp edges rounded		X	
Net blocks	Net blocks		
> Securely fastened	X		
> Sharp edges rounded	X		
Spring loaded details	Spring loaded details		
> Moves freely	X		
> No lateral movement	X		
> Lock out pin installed	X		
Clamps	Clamps		
> Operates freely	X		
> Adequate spring pressure	X		
> Properly adjusted		X	
> Anti-pinch handle stops installed	X		
> Gravity lock outs installed			X
> Correct clamp direction	X		
Indicators	Indicators		
> Indicator powers up	X		
> Indicator fits zero block and bushings	X		
> Correct indicator tip installed	X		
> Indicator tip tight	X		
Hinged details	Hinged details		
> Moves freely			X
> No lateral movement			X
> Gravity lock outs installed			X
Removable details	Removable details		
> Easy assembly / disassembly			X
> Symmetrical details Poke yoked			X
> Storage area on gage			X
Attribute details	Attribute details		
> Plug gages tethered and stored			X
> Symmetrical plug gages Poke yoked			X
> Plug gages locate easily			X
> Pin / step gages tethered and stored			X
> Attribute details function properly			X
Scribelines	Scribelines		
> Easy to read			X
Part fit	Part fit		
> All part versions tested	X		
> Part nets on gage	X		
> Gage does not interfere with part		X	
> Gage does not distort part when clamped	X		
> Measurement contours match part	X		
> Indicator hit part (all locations)	X		

ADDITIONAL COMMENTS

Edges had to be rounded on two stanchions - COMPLETE. 2-way clamp needed to be adjusted - COMPLETE. Stanchion on net #2 had to be relieved to eliminate part interference - COMPLETE.

Approving Signatures: ABC Corporation
Joe Smith
 Signature

Foreman
 Position

Johnson Controls
John Johnson
 Signature

AGE
 Position

APPENDIX A5. Supplier Quotation

[Return to Quotation Requirements, Item #1.](#)

[Go to Appendix List](#)

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ABC Corporation

123 West 12th Street Somewhere MI 99998

March 30, 2000

Mr. John Johnson
Johnson Controls
921 E 32nd Street
Holland, MI 49435

Dear Mr. Johnson:

SUBJECT: CMM HOLDING FIXTURE – GMT236 Overhead Console

ABC Corporation is pleased to submit this quotation for your approval on the above subject. Our quotation is based on the following assumptions:

Assumptions:

- ABC Corporation to construct one (1) CMM holding fixture.
- Design will be a computer generated 3D model with views and sections as required.
- Customer to supply all CAD models and GDT information
- Fixture will be 180° out of body
- Fixture to include:
 - 1 - aluminum tooling plate with 4 jig feet
 - 4 – U/D net pads
 - 1 – C/C & F/A 4-way RFS tapered pin
 - 1 – C/C 2-way RFS tapered pin on a slide
- Design and Build Requirements to meet Johnson Controls and OEM gage standard Requirements.
- Quote to include internal certification.
- Cost and timing as stated in this letter will remain in effect for 60 day from the date of this letter.

Cost Summary:

	<u>GMT236 Overhead Console</u>	
Design	(Delivery 2 wks)	\$ 750.00
Build	(Delivery 5 wks)	5200.00
3rd Party Certification		350.00
Gage R & R study		<u>250.00</u>
	GRAND TOTAL	\$ 6550.00

Thank you for giving ABC Corporation the opportunity to provide this quotation. If you have any questions, please feel free to contact me at (110) 123-4567.

Sincerely,

Joe Smith

Joe Smith
Account Representative

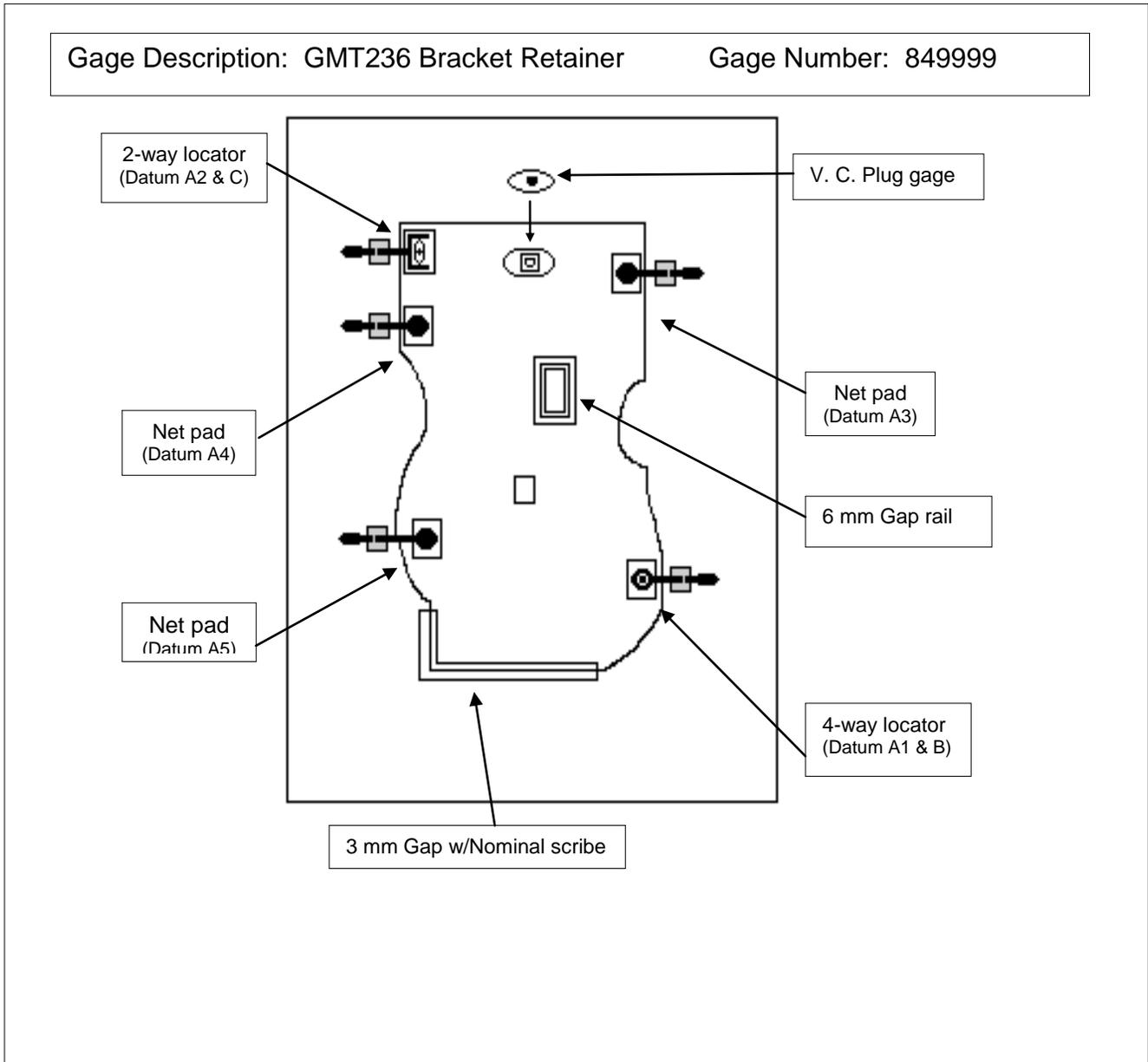
FN: 330119.doc

ABC #330119

cc: R. Thomas C. McPherson

APPENDIX A6. Gage Concept Drawing

[Return to Gage Design Requirements, Section A, Concept Drawing, Item #2.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)



APPENDIX A7. Supplier Identification Tag

[Return to Gage Build Requirements, Section L. Labeling, Item #4.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)

ABC Corporation

123 West 12th Street
Somewhere, MI 99998
Office - (810)123-4567
Fax - (810)123-7654

ABC Corp. JOB NUMBER: 1290A

Gage Number 849999

Part Description GMT236 OHC Bracket Retainer

Customer: General Motors

Eng. Level: Rel.

APPENDIX A8. Gage Request for Quote (page 1)

[Return to General Requirements, Item #1.](#)

[Return to General Requirements, Item #10.](#)

[Go to Appendix List](#)

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GAGE REQUEST FOR QUOTE

Date: 11/02/99 **Program Name:** GMT 236 Overhead Console
Program Number: 12345 **Customer:** GENERAL MOTORS
Contact: Doug Stewart **Phone:** 8199

Use Gage standards produced by GENERAL MOTORS & JOHNSON CONTROLS

Sequence	Gage / Child Number	Gage Description	Gage Delivery Date Required	Quote Elements					Gage Type			Attached Information					
				Design	Build	Certification	3rd Party Cert.	Gage R	CMM	Attribute	SPC	Sketch	Print	Math Data	Part	GD&T	Assy. Draw.
1	841999	Overhead Console Assembly	02/14/01	X	X	X	X	X	X			X	X	X			
2	849999	Bracket Retainer	02/14/01	X	X	X	X	X	X	X	X	X	X	X	X		
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

PROGRAM REQUIREMENTS

PROGRAM INFORMATION	ENVIRONMENTAL CONDITIONS
Program Duration: 4	Operating Temperature: 30° - 150°
Annual Volume: 200k - 300k	Operating Humidity: 0% - 100%
Shifts per Day: 2	*Presence of Chemical: No
Frequency of Use: 2 - 4	*Presence of Vibration: No

*If Yes, describe type of chemical or vibration below:

Special Requirements

RELIABILITY and MAINTAINABILITY TARGETS

Targeted Gage Life:	Production life + 1 year
Targeted Mean-Time-To-Repair, (MTTR):	< 1 week
Targeted Mean-Time-To-Maintain, (MTTM):	3 - 7 days
Targeted Mean-Time-Between-Failures, (MTBF):	> 6 months
Targeted Mean-Time-Between-Maintenance, (MTBM):	15 - 30 minutes

APPENDIX A8. Gage Request for Quote (page 2)

[Return to General Requirements, Item #1.](#)

[Return to General Requirements, Item #10.](#)

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JOHNSON CONTROLS		GAGE ASSUMPTIONS			
Date: 11/02/1999		Program Name: GMT 236 Overhead Console		Project #: 12345	
Gage Number:		841999	849999		
Gage Description:		Overhead Console Assembly	Bracket Retainer		
Part Size in millimeters (approximate)	Length (F/A):	305	355		
	Width (C/C):	200	305		
	Depth (U/D):	25	12		
	Cubic millimeters:	1525000	1299300		
Orientation	Body Position:	Rotated 180°	In Body		
Net Pads	Quantity:	4	4		
4-way Locator	Type:	RFS pin for hole	RFS pin for hole		
	Describe as required:				
2-way Locator (#1)	Type:	RFS pin for hole on slide	RFS pin for slot		
	Describe as required:				
2-way Locator (#2)	Type:	NONE	NONE		
	Describe as required:				
2-way Locator (#3)	Type:	NONE	NONE		
	Describe as required:				
SPC Point (#1)	Type:	NONE	4-way to 2-way		
	Qty Describe as required:		1		
SPC Point (#2)	Type:	NONE	NONE		
	Qty Describe as required:				
Attribute Rail #1	Type:	NONE	Internal feature - gap		
	Length (mm.) Describe as required:		300 Sun glass bin opening		
Attribute Rail #2	Type:	NONE	Localized blocks - gap		
	Length (mm.) Describe as required:		150 Front edge (2 x 75mm)		
Go-Nogo / Plug Gage #1	Type:	NONE	Feature size & location		
	Describe as required:		Rear oval opening		
Go-Nogo / Plug Gage #2	Type:	NONE	NONE		
	Describe as required:				
Scribe Line	Type:	NONE	Nominal Line		
	Describe as required:		Front edge and interior feature		
Special Features #1	Type:	NONE			
	Describe as required:				
Special Features #2	Type:	CMM access on bottom side	CMM access on bottom side		
	Describe as required:				
Special Requirements:					

APPENDIX A9. Gage Instructions

[Return to Gage Build Requirements, Section E. Measurement System Analysis, Item #2.1.1.](#)

[Go to Appendix List](#)

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GAGE OPERATING INSTRUCTIONS

GAGE #: 849999 **GAGE NAME:** GMT236 Overhead Console Bracket Retainer

E/C LEVEL: Rel **E/C DATE:** 10/14/99 **RECERT. FREQ:** Bi-Annually

TYPE OF FIXTURE: CMM SPC ATTR

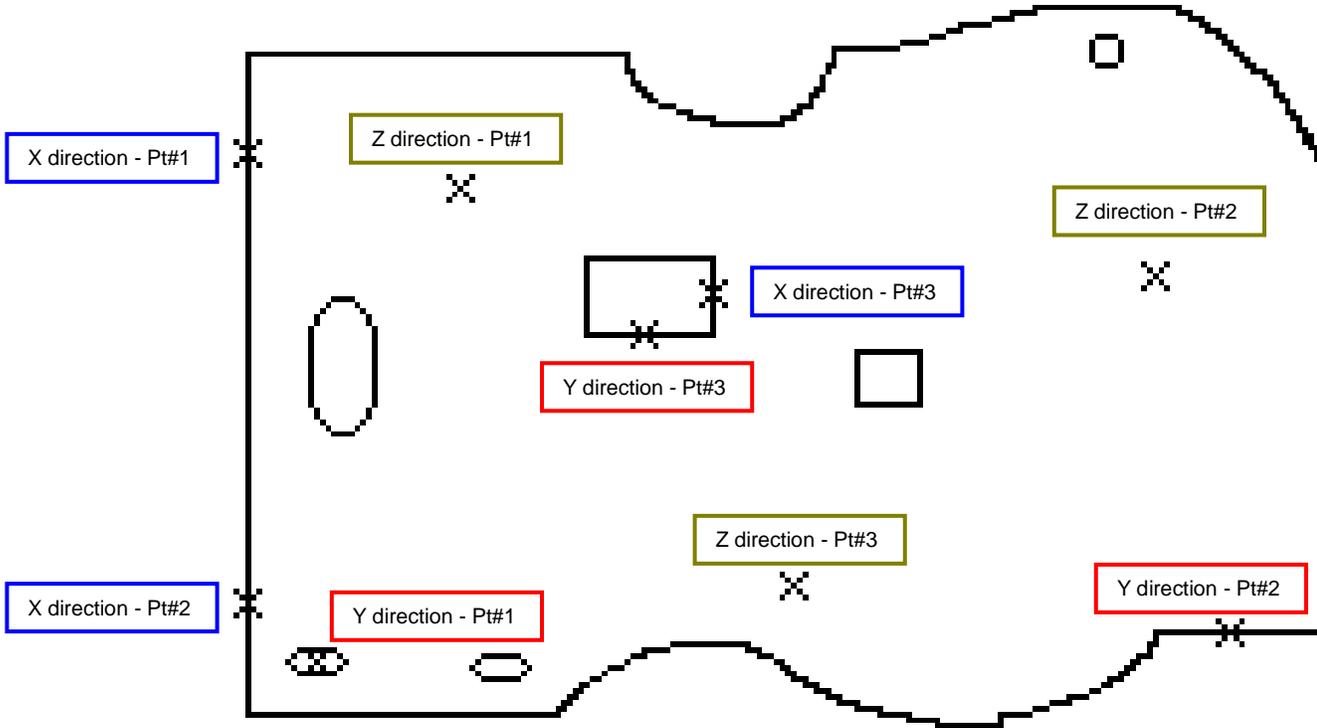
GAGE CHECKS PART NUMBER(s): 999998 and 999999

INSTRUCTIONS:

1	Inspect fixture for damage.
2	Disengage all clamps.
3	Load part onto 4-way locator and 2-way locator pins, ensuring part is resting on all nets.
4	Starting with clamp #1, engage all clamps in sequence.
5	Turn the SPC indicator on, place it in the master set block and press the "zero" button.
6	Place the indicator in the SPC port and record reading.
7	Remove the indicator from the SPC port and place it in the storage box.
8	Place the plug gage into hole. Record results.
9	Remove the plug gage and place it in its storage clip.
10	Using the Go/Nogo gage, inspect the gap rail at the opening in the part and at the front edge. Record result for each inspection area.
11	Place the plug gage into its storage clip.
12	Turn the SPC indicator off.
13	Open all clamps and remove part.
14	

APPENDIX A10. Gage Repeatability Study Coordinates

[Return to Gage Build Requirements, Section E. Measurement System Analysis, Item #2.1.1.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)



APPENDIX A11. Gage Cost Breakdown

[Return to General Requirements, Item #8.](#)

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JOHNSON CONTROLS, Inc.

GAGE COST BREAKDOWN WORKSHEET

Gage Shop: ABC Corporation **Date:** 11/24/00
 123 West 12th Street **Quote #:** ABC1234
 Somewhere, MI 99998 **Invoice #:** 12345
Contact: Jim Smith **Purchase Order #:** M999888

Program Name: 2001 GMT236 OHC

Gage Desc: Overhead Console **Gage Number:** 849999

Change Description / Comments:

<u>FUNCTION</u>	<u>HOURS</u>	<u>x</u>	<u>RATE</u>	<u>=</u>	<u>TOTAL</u>	<u>COMMENTS</u>
1 Gage Design	32		\$ 60.00		\$ 1,920.00	
2 NC Programming	4		\$ 60.00		\$ 240.00	
3 NC Machining	16		\$ 60.00		\$ 960.00	
4 Assembly	38		\$ 60.00		\$ 2,280.00	
5 Gage R&R study	8		\$ 60.00		\$ 480.00	
6 Internal certification	12		\$ 60.00		\$ 720.00	
7 Third party certification	14		\$ 60.00		\$ 840.00	
SUB TOTAL (LABOR):					\$ 8,640.00	

<u>MATERIALS</u>	<u>TOTAL</u>	<u>COMMENTS</u>
8 Gage Base	\$ 900.00	
9 Gage Components	\$ 750.00	
SUB TOTAL MATERIALS:	\$ 1,650.00	

TOTAL GAGE COST: \$ 10,290.00

APPENDIX A12. Gage Preventive Maintenance Instruction

[Return to Gage Build Requirements, Section G. Preventive Maintenance instructions, Item #1.](#)

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GAGE PREVENTIVE MAINTENANCE INSTRUCTIONS

GAGE #: 849999 **GAGE NAME:** GMT236 Overhead Connsolse Bracket Retainer

E/C LEVEL: Rel **E/C DATE:** 10/14/99 **RECERT. FREQ:** Bi-Annually

TYPE OF FIXTURE: CMM SPC ATTR

GAGE CHECKS PART NUMBER(s): 999998 and 999999

INSTRUCTIONS:

	INSTRUCTIONS:	RESP.	MAINTENANCE FREQUENCY	TOOLS NEEDED
1	Inspect fixture for damage.	JCI	Every use	None
2	Inspect electronic equipment for damage and ensure it powers up.	JCI	Every use	None
3	Remove all loose debris and wipe clean.	JCI	End of shift	Broom, rag, mild soap.
4	Lubricate moving parts. Ensure all screws and bolts are tight.	JCI	Once a month	Light oil, silicone spray, allen wrench.
5	Inspect fixture for loose clamps or mechanisms, and wore details.	JCI / Gage	Once a month	None
6	Remove rust and small scratches.	JCI / Gage	Annually	Wet/Dry sand paper, steel wool, light oil.
7	Replace batteries in electronic equipment.	JCI	Annually	#2 phillips screwdriver, battery #EV321
8				
9				
10				

APPENDIX A13. Attribute Study

[Return to Gage Build Requirements, Section E, Measurement System Analysis, Item #3.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)



6/8/00
 INN-MOS-FR-11-01-04b-E Rev. 02
 MSA - Attribute

Attribute Gage R&R - Data / Calculation sheet

Gage Name: Example Attribute study	Part Name: 00 Front Trimplate	Date: 1/1/00
Gage Number: 840123	Part Number: VE4567	Performed By: Lewis
Gage Type: Go/Nogo pin check	Characteristic: Gap to Console	Phone #: 555-1211
Accept Criteria - GO: 1.50	Reject Criteria - NOGO: 4.50	Units: mm

ATTRIBUTE GAGE R and R RESULTS

FAIL

PART	APPRAISER A		APPRAISER B	
	Mike		Mary	
	TRIAL 1	TRIAL 2	TRIAL 1	TRIAL 2
1	g	g	g	g
2	g	g	g	g
3	ng	g	g	g
4	ng	ng	ng	ng
5	g	g	g	g
6	g	g	g	g
7	ng	ng	ng	ng
8	g	g	g	g
9	g	g	g	g
10	ng	ng	ng	ng
11	g	g	g	g
12	g	g	g	g
13	ng	ng	ng	ng
14	ng	ng	ng	ng
15	g	g	g	g
16	ng	ng	ng	ng
17	g	g	g	g
18	g	g	g	g
19	ng	ng	ng	ng
20	g	g	g	g

APPENDIX A14. Gage Timing Chart

[Return to Gage Build Requirements, Section H, Records, Item #1.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)

ID	Task Name	Duration	Start	Finish	3rd Quarter			4th Quarter			1st Quarter			2nd Quarter		
					Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
1	840123 - A pillar RH	6.2 wks	Mon 8/7/00	Mon 9/18/00												
2	Gage Kickoff	0 days	Mon 8/7/00	Mon 8/7/00												
3	Design	2 wks	Mon 8/7/00	Fri 8/18/00												
4	Design Approval	1 day	Mon 8/21/00	Mon 8/21/00												
5	Build	3 wks	Tue 8/22/00	Mon 9/11/00												
6	Certification	1 day	Tue 9/12/00	Tue 9/12/00												
7	3rd Party Certification	2 days	Wed 9/13/00	Thu 9/14/00												
8	Gage R	1 day	Fri 9/15/00	Fri 9/15/00												
9	Function Check	1 day	Mon 9/18/00	Mon 9/18/00												
10	GAGE DELIVERY	0 days	Mon 9/18/00	Mon 9/18/00												
11	Quoted Timing	8 wks	Mon 8/7/00	Fri 9/29/00												
12	840124 - A pillar LH	8.2 wks	Mon 8/14/00	Mon 10/9/00												
22	Quoted Timing	8 wks	Mon 8/14/00	Fri 10/6/00												
23	PPAP DATE	0 days	Tue 3/6/01	Tue 3/6/01												

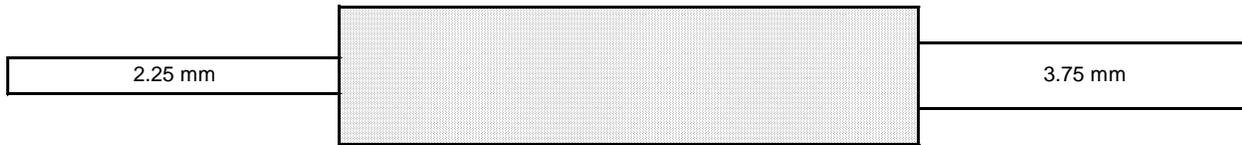
APPENDIX A15. Check Pin and Check Block Calculation

[Return to Gage Design Requirements, Section B. Gage Design, Item #6.](#)

[Go to Appendix List](#)

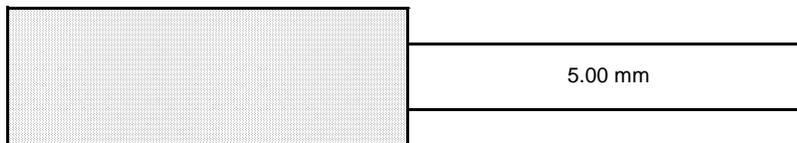
[Go to Table of Contents](#)

Go / Nogo Pin



Feeler rail = 3.00 mm
Tolerance = +/- .75 mm
Go pin = 3.00 - .75 = 2.25 mm
Nogo pin = 3.00 + .75 = 3.75 mm

Virtual Condition Pin



Hole Size = 8.00 mm
Hole Size Tolerance = +/- .50 mm
Hole Location Tolerance = +/- 2.50 mm
Virtual Condition pin = 8.00 - .50 - 2.5 = 5.00 mm

APPENDIX A16. Ergonomic Repetition Benchmarks matrix

[Return to Safety and Ergonomic Requirements, Item #9.](#)

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Repetition Benchmarks

<u>LOW</u>	<u>MODERATE</u>	<u>HIGH</u>
Leisurely Pace Frequent Pauses Non- cyclical Tasks	Steady Pace Infrequent Pauses	Rapid Pace No Rest Pauses Bottleneck Stations High Frequency of Similar Tasks

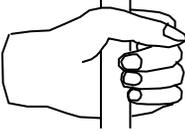
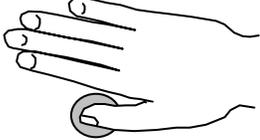
APPENDIX A17. Ergonomic Force Benchmarks matrix (page 1)

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Force Benchmarks

TYPE OF HANDLING	ILLUSTRATION	LOW	MODERATE	HIGH
POWER GRIP		< 14#	14# - 21#	21# - 48#
2 POINT PINCH		< 3#	3# - 4.5#	4.5# - 9#
3 POINT PINCH		< 4#	4# - 6#	6# - 14#
LATERAL PINCH		< 4#	4# - 6#	6# - 14#
THUMB PUSH		< 7#	7# - 10.5#	10.5# - 19#
PALM PRESS		< 10#	10# - 15#	15# - 35#
FOOT CONTROL		< 10#	10# - 16#	16# - 37#
OTHER POSTURES		NO EFFORT NEEDED (<= 20% Average Maximum Effort)		GREATEST EFFORT POSSIBLE (>= 60% Average Maximum Effort)

APPENDIX A18. Ergonomic Posture Benchmarks matrix (page 2)

[Return to Safety and Ergonomic Requirements, Item #9.](#)

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Posture Benchmarks

		Low Risk	Moderate Risk	High Risk
H A N D a n d W R I S T	0-15° EXTENSION		15 - 30° EXTENSION 0 - 15° FLEXION	30 ° EXTENSION >15° FLEXION OR unsupported hand/forearm
	0-15° ULNAR DEVIATED WRIST		5-15° ULNAR DEVIATED WRIST	>15° ULNAR DEVIATED WRIST
	NEUTRAL & RELAXED FINGER GRIP		TENSED / AWKWARD FINGER GRIP	TENSED / AWKWARD FINGER GRIP
A R M a n d S H O U L D E R	RELAXED or SUPPORTED ELBOW		<45° EXTENDED >70° FLEXION ELBOW	<70° FLEXION ELBOW
	NEUTRAL or SUPPORTED FOREARM		UNSUPPORTED FOREARM	REACH & UNSUPPORTED FOREARM
	SUPPORTED or NEUTRAL UPPER ARM		REACHING / SHOULDER <60° FLEXION	REACHING / SHOULDER >60° FLEXION
	NEUTRAL SHOULDERS		SLOUCHED / FORWARD SHOULDERS	ASSYMETRICAL / TENSED SHOULDERS

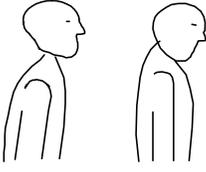
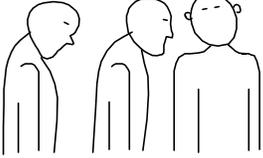
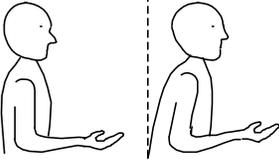
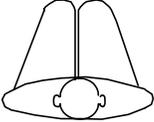
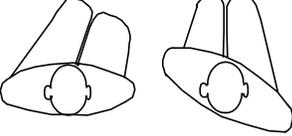
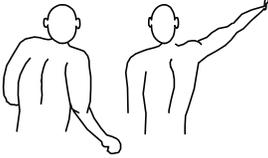
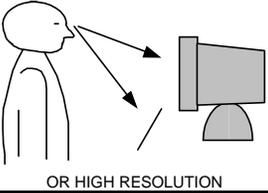
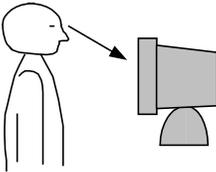
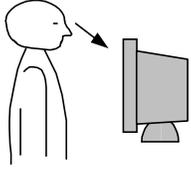
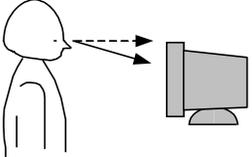
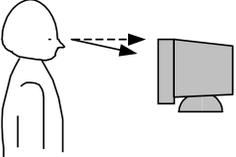
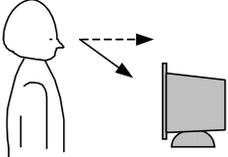
APPENDIX A18. Ergonomic Posture Benchmarks matrix (page 3)

[Return to Safety and Ergonomic Requirements, Item #9.](#)

[Go to Appendix List](#)

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Posture Benchmarks

	Low Risk	Moderate Risk	High Risk
H E A D C K &	NEUTRAL	<15° FLEXION & CHIN IN	>15° FLEXION or CHIN PROTRUDED
			
T O R S O	RECLINE	VERTICAL	FLEXED
			
	SYMETRICAL	TWISTED	BEND / REACH / LIFT
			
D I S T A N C E	15" - 24" TO SCREEN 14" - 16" TO DOCUMENT	<16" TO SCREEN	8" - 12" TO SCREEN
			
A N G L E	15 - 30°	<15 or <30°	>10 or <35°
			

APPENDIX A19. Gage Assumptions / Gage Cost Model (page 2)

[Return to General Requirements, Item #1.](#)

[Return to General Requirements, Item #10.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

Date: 11/02/1999		Program Name: GMT 236 Overhead Console		Project #: 12345	
Gage Number:		841999	849999		
Gage Description:		Overhead Console Assembly	Bracket Retainer		
Part Size in millimeters (approximate)	Length (F/A):	305	350		
	Width (C/C):	200	305		
	Depth (U/D):	25	13		
	Cubic millimeters:	1525000	1387750		
Orientation	Body Position:	Rotated 180°	In Body		
Net Pads	Quantity:	4	4		
4-way Locator	Type:	RFS pin for hole	RFS pin for hole		
	Describe as required:				
2-way Locator (#1)	Type:	RFS pin for hole on slide	RFS pin for slot		
	Describe as required:				
2-way Locator (#2)	Type:	NONE	NONE		
	Describe as required:				
2-way Locator (#3)	Type:	NONE	NONE		
	Describe as required:				
SPC Point (#1)	Type:	NONE	4-way to 2-way		
	Qty Describe as required:		1		
SPC Point (#2)	Type:	NONE	NONE		
	Qty Describe as required:				
Attribute Rail #1	Type:	NONE	Internal feature - gap		
	Length (mm.) Describe as required:		300 Sun glass bin opening		
Attribute Rail #2	Type:	NONE	Localized blocks - gap		
	Length (mm.) Describe as required:		150 Front edge (2 x 75mm)		
Go-Nogo / Plug Gage #1	Type:	NONE	Feature size & location		
	Describe as required:		Rear oval opening		
Go-Nogo / Plug Gage #2	Type:	NONE	NONE		
	Describe as required:				
Scribe Line	Type:	NONE	Nominal Line		
	Describe as required:		Front edge and interior feature		
Special Features #1	Type:	NONE			
	Describe as required:				
Special Features #2	Type:	NONE	NONE		
	Describe as required:				
Gage Cart	Size:	Not Required	Not Required		
	Cost Estimate:				
Cost Model Estimate:		\$6,100	\$8,300		
Expert Estimate Override:					
Build Timing:		7 wks	8 wks		

QE SIGNATURE: _____

DATE: _____

Special Requirements:

APPENDIX B - Diagrams

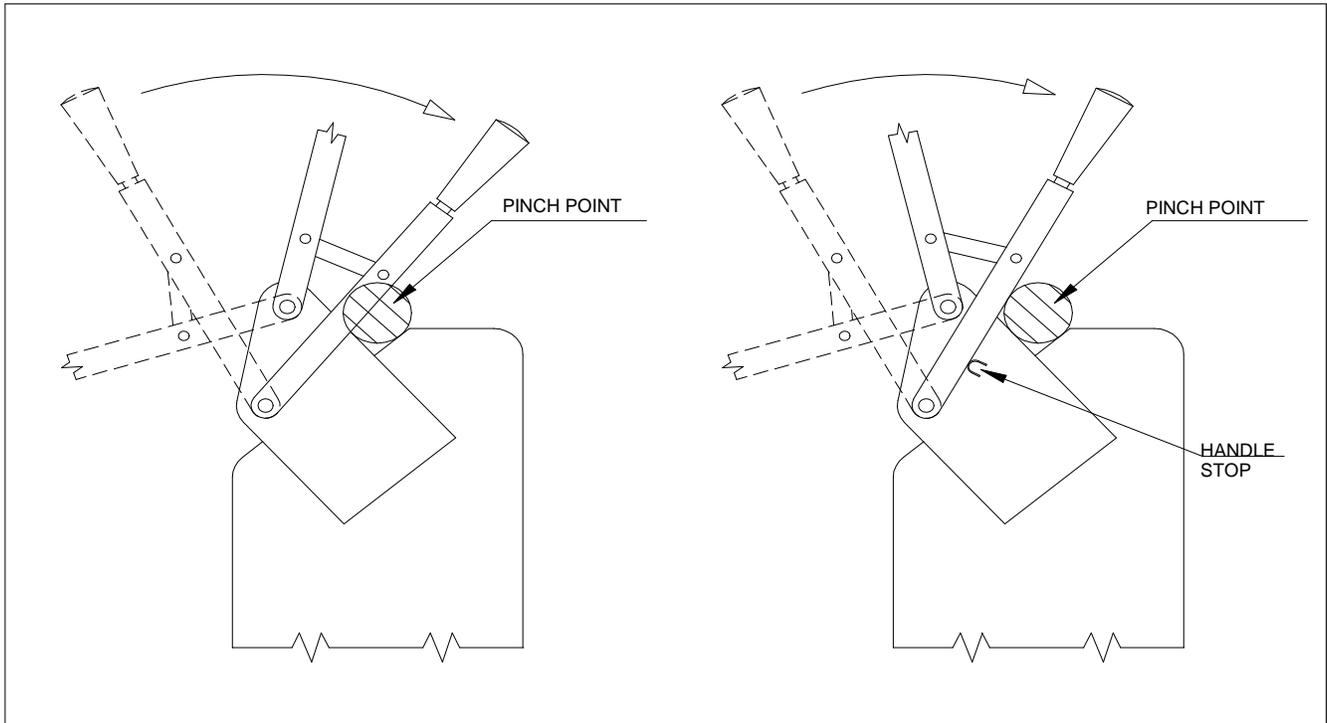
<u>DESCRIPTION</u>	<u>APPENDIX #</u>	<u>PAGE #</u>
Toggle Clamp with Handle Stop	B1	41
Toggle Clamp with Lock-out Pin	B2	42
Hinged Drop Detail with Lock-out Pin	B3	43
Minimum CMM Probe Access Distance	B4	44
Gage Base Size	B5	45
Tooling Ball Labeling	B6	46
Go / NoGo Gage and Screw Pin Tethering and Storage	B7	47
Removable Detail Tethering and Storage	B8	48
Details Overhanging Base	B9	49
J-Corner Identification	B10	50
Jig Foot Location	B11	51
Base Thickness Uniformity	B12	52
Hole Clearance for CMM Access	B13	53
Bullet Nose Dowel Location	B14	54
Locating Pin with Lock-out Pin	B15	55
Bayonet Clamp Location to Allow for CMM Access	B16	56
Clamp Lock-out Mechanism	B17	57
Handle Installation	B18	58
Forklift Sleeve Installation	B19	59
Datum Scheme for Base Certification	B20	60
Gage Certification Datum Set-up	B21	61
Check direction / Non-check Direction for Certification	B22	62
Fastener Pin Representation	B23	63
Eyebolt Installation	B24	64
Tooling Ball Origin Identification	B25	65
Clamping Direction	B26	66
Tooling Hole	B27	67

APPENDIX B1. Toggle Clamp with Handle Stop

[Return to Safety and Ergonomic Requirements, Item #4.](#)

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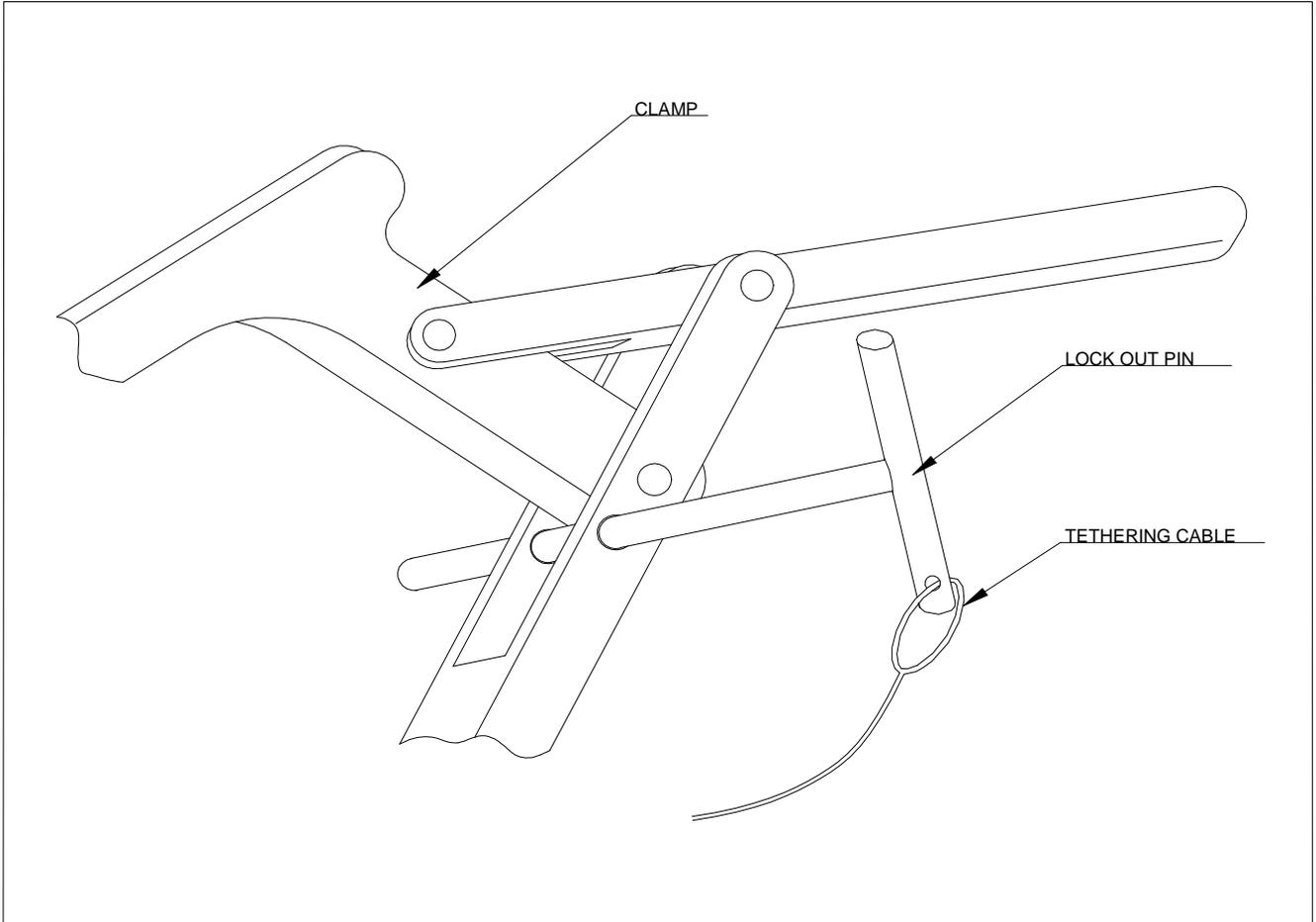


APPENDIX B2. Toggle Clamp with Lock-out Pin

[Return to Safety and Ergonomic Requirements, Item #4.](#)

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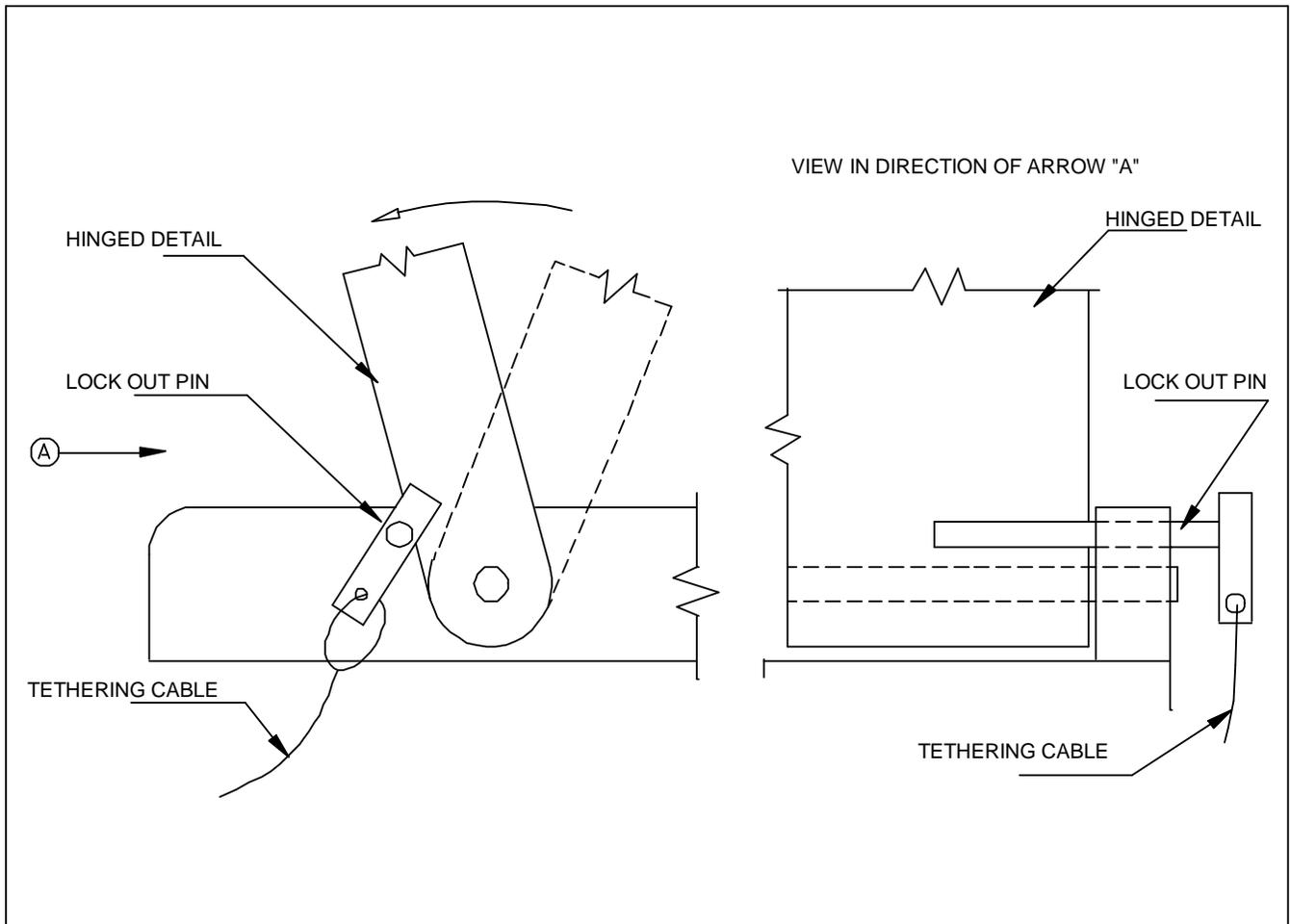
APPENDIX B3. Hinge Drop Detail with Lock-out Pin

[Return to Safety and Ergonomic Requirements, Item #4.](#)

[Return to Build Requirements, Section F. Hinged Details, Item #1.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

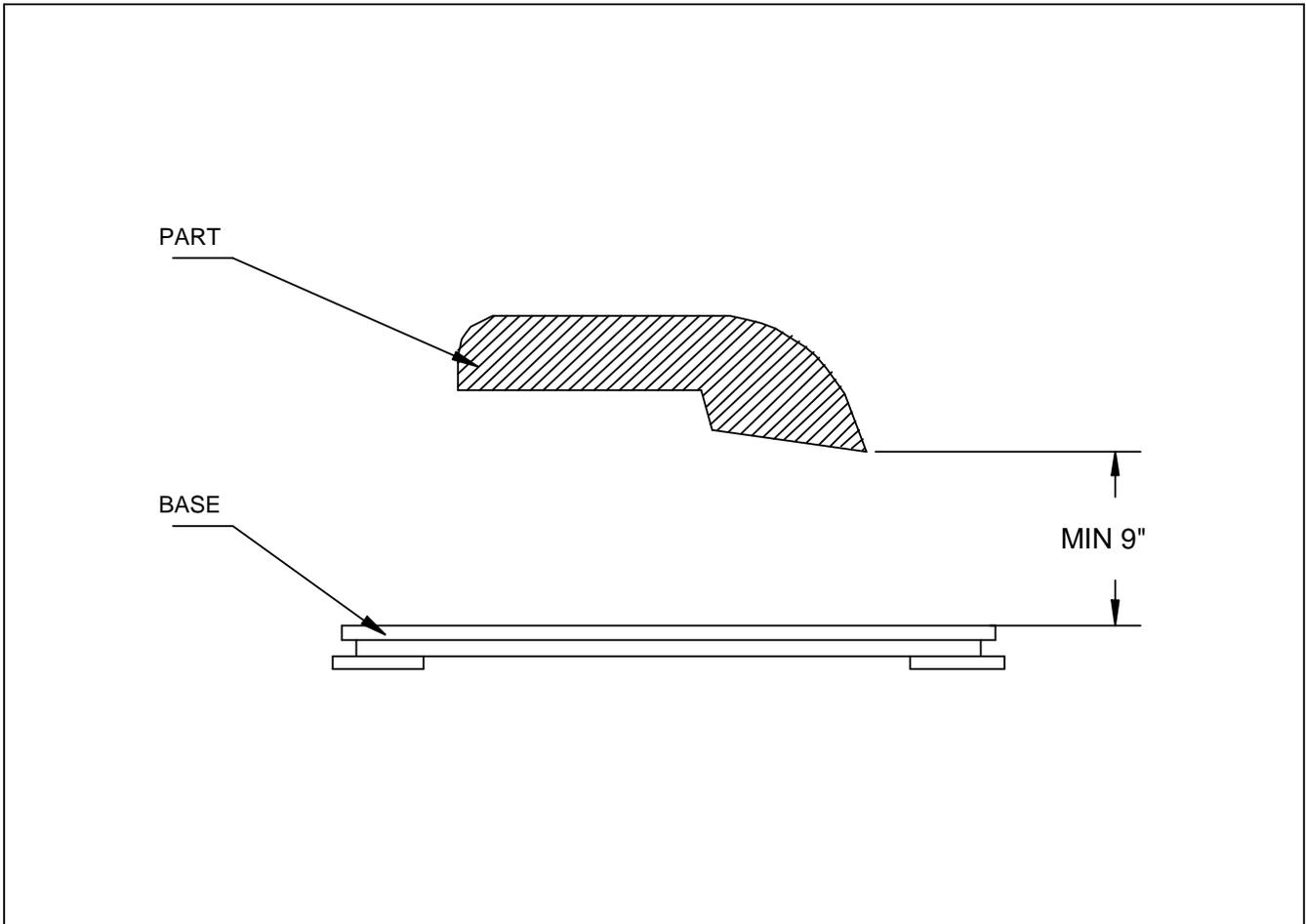


APPENDIX B4. Minimum CMM Probe Access Distance

[Return to Quotation Requirements, Item #4.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

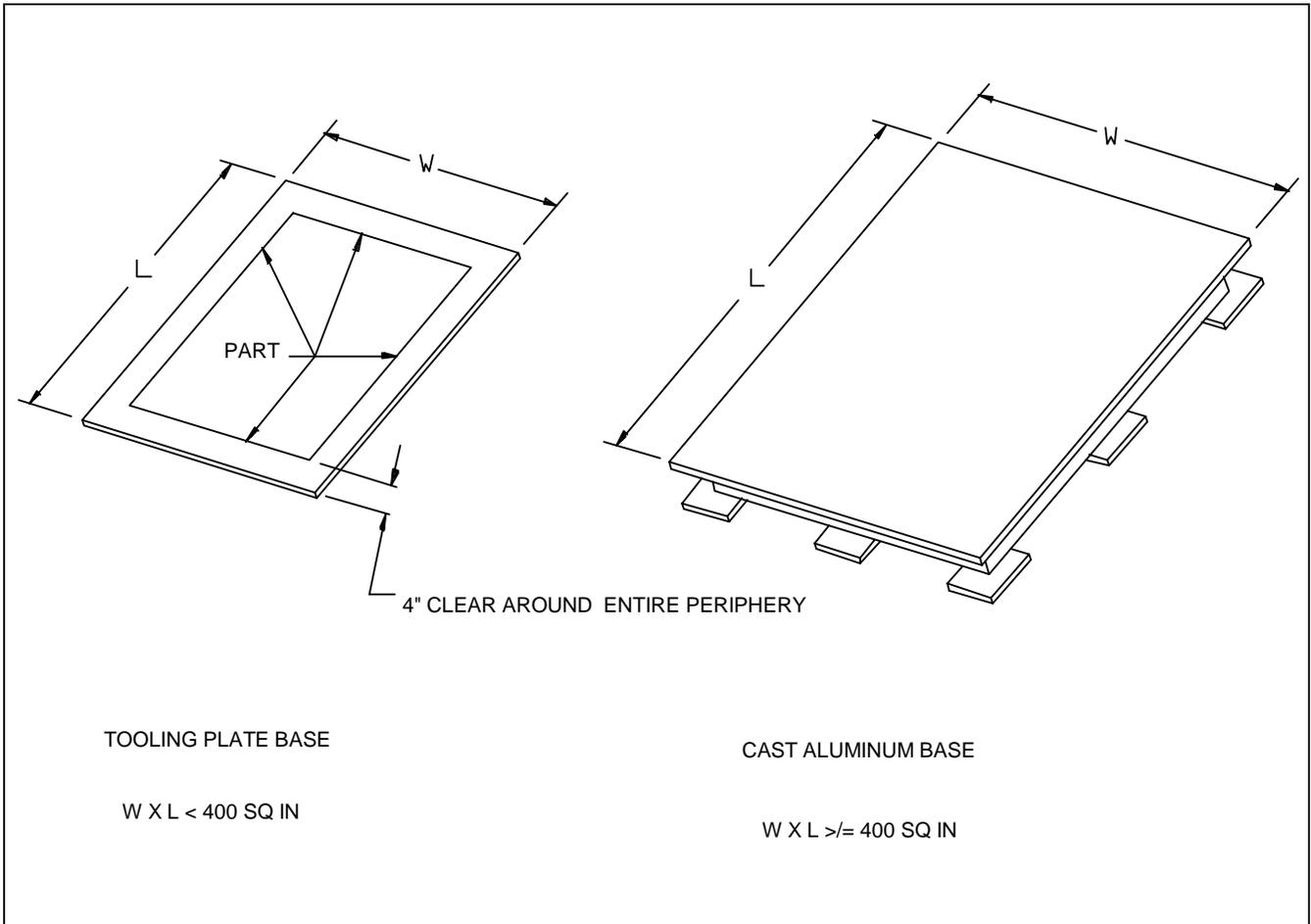


APPENDIX B5. Gage Base Size

[Return to Quotation Requirements, Item #5.](#)

[Go to Appendix List](#)

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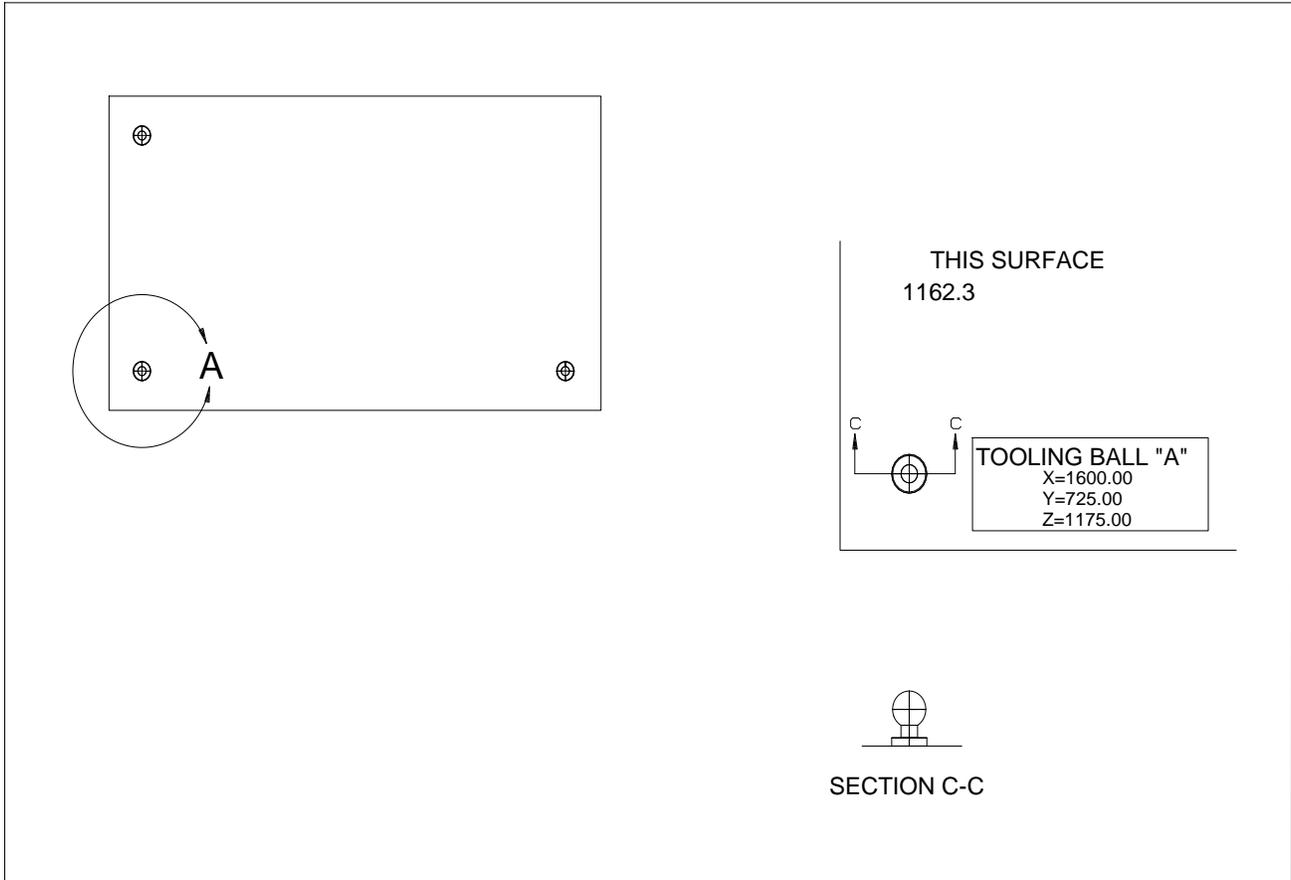
APPENDIX B6. Tooling Ball Labeling

[Return to Design Requirements, Section B. Design, Item #8.](#)

[Return to Build Requirements, Section L. Labeling, Item #3.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

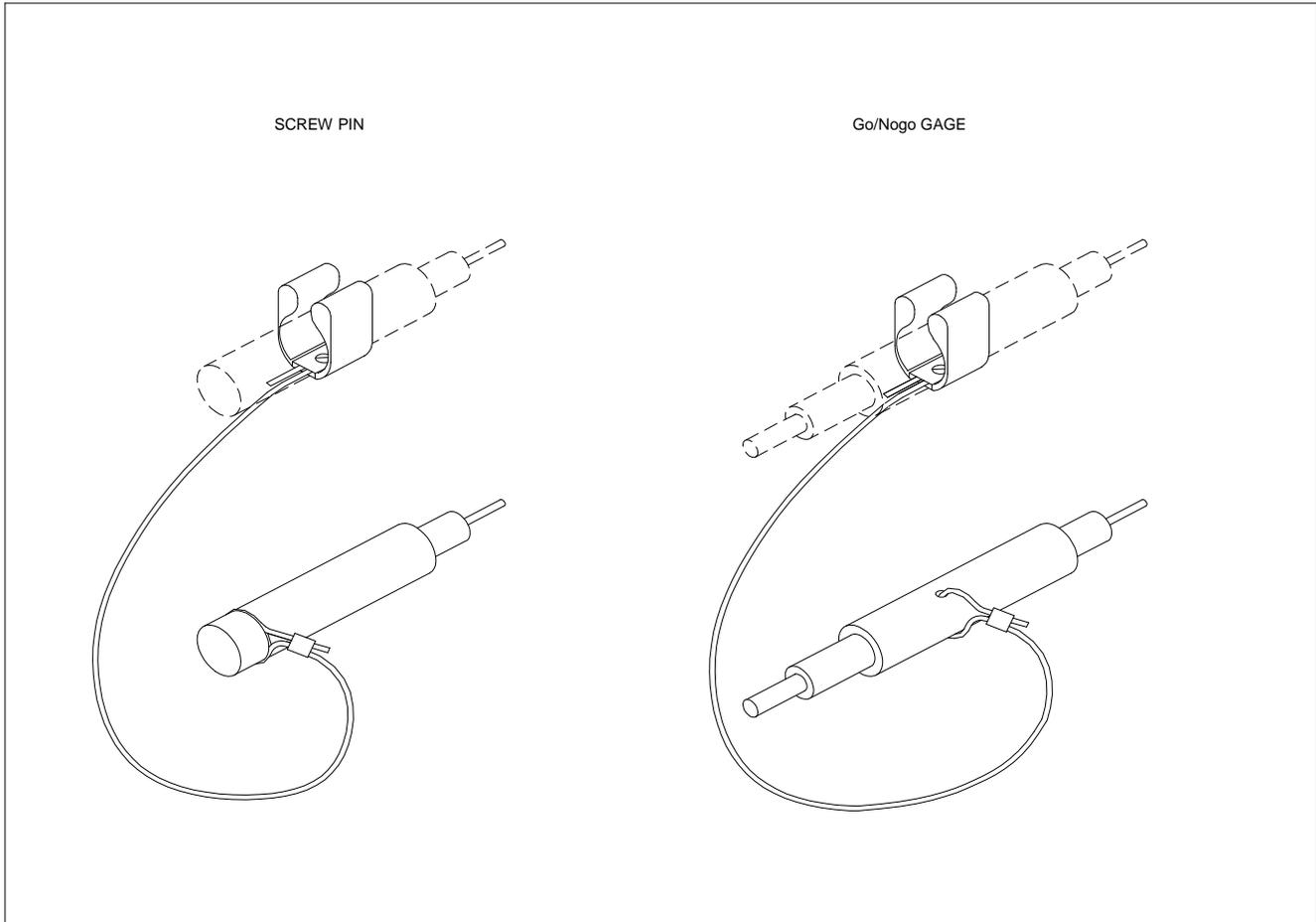


APPENDIX B7. Go / NoGo Gage and Screw Pin Tethering and Storage

[Return to Design Requirements, Section B. Gage Design, Item #14.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

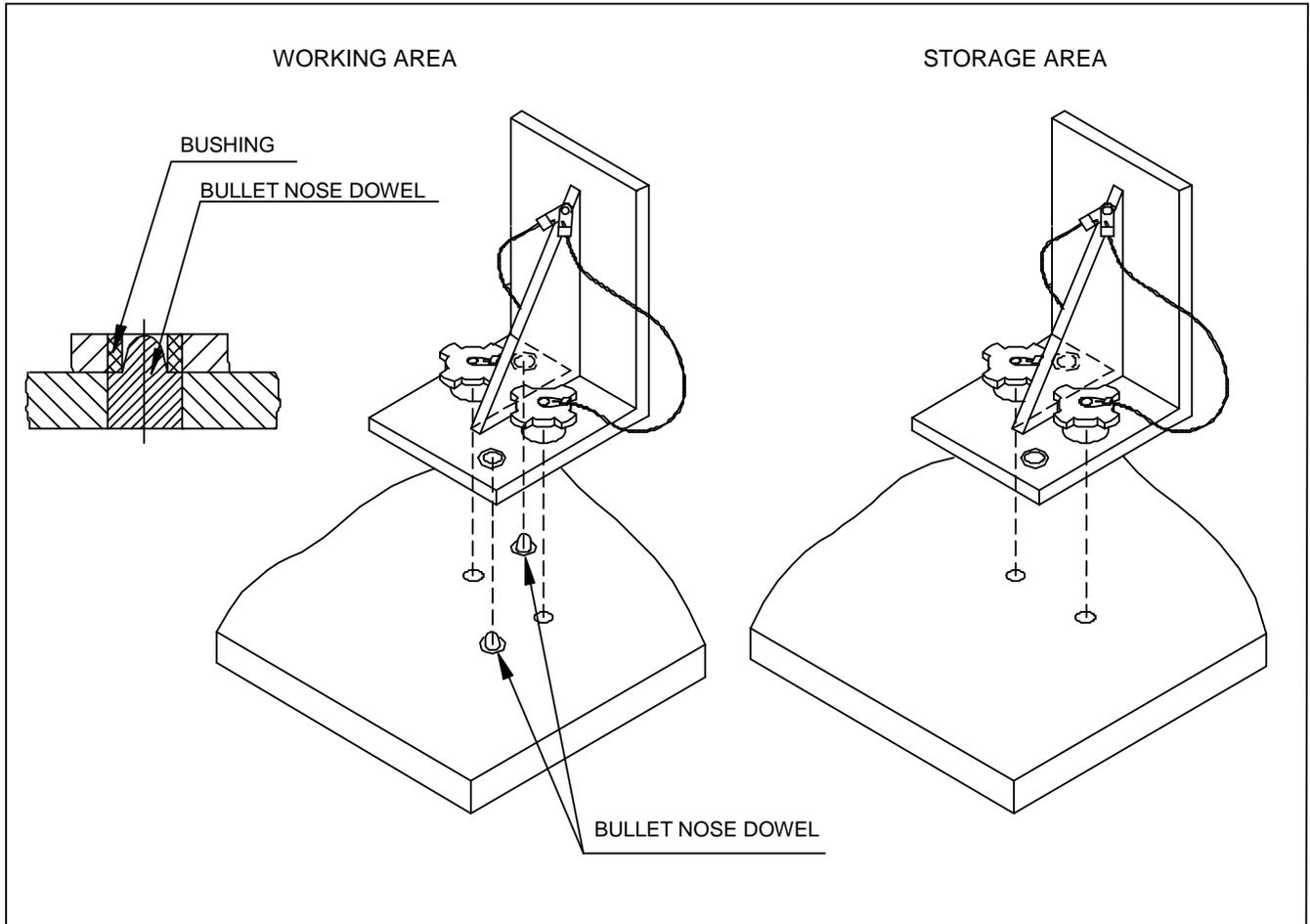


APPENDIX B8. Removable Detail Tethering and Storage

[Return to Design Requirements, Section B. Gage Design, Item #14.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

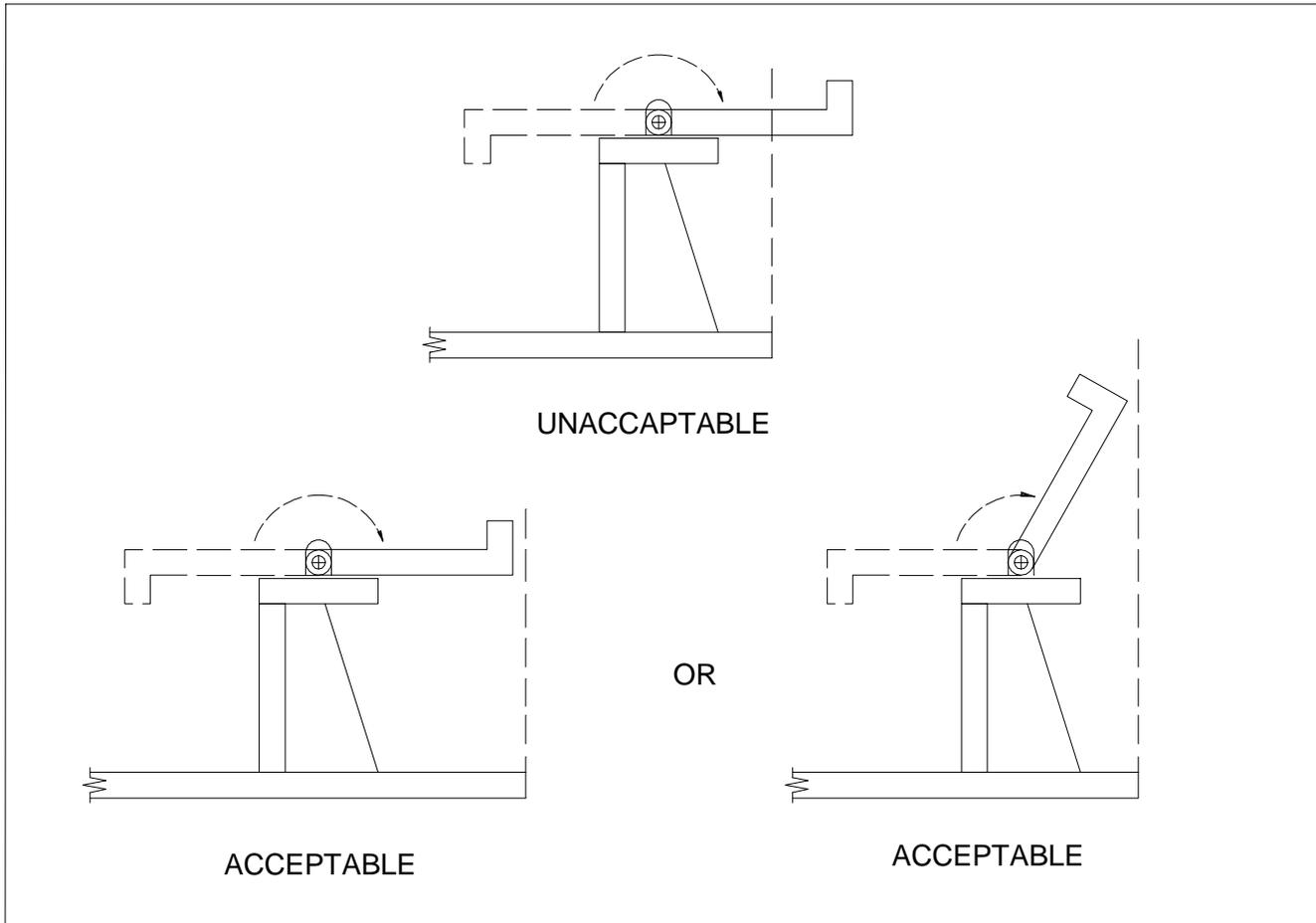


APPENDIX B9. Details Overhanging Base

[Return to Design Requirements, Section B. Gage Design, Item #20.](#)

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[Go to Table of Contents](#)

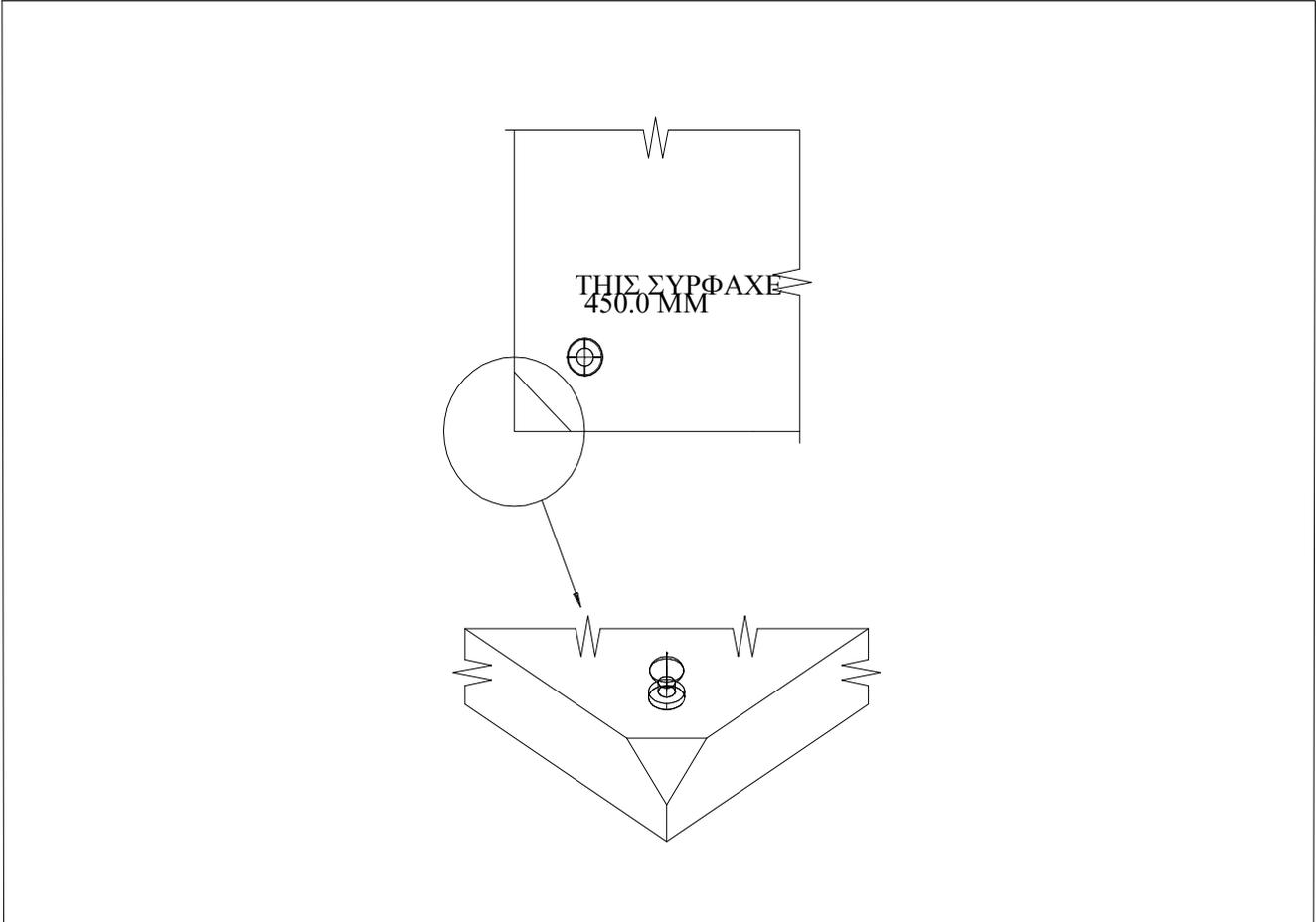


APPENDIX B10. J-Corner Identification

[Return to Build Requirements, Section A, Bases, Item #3.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

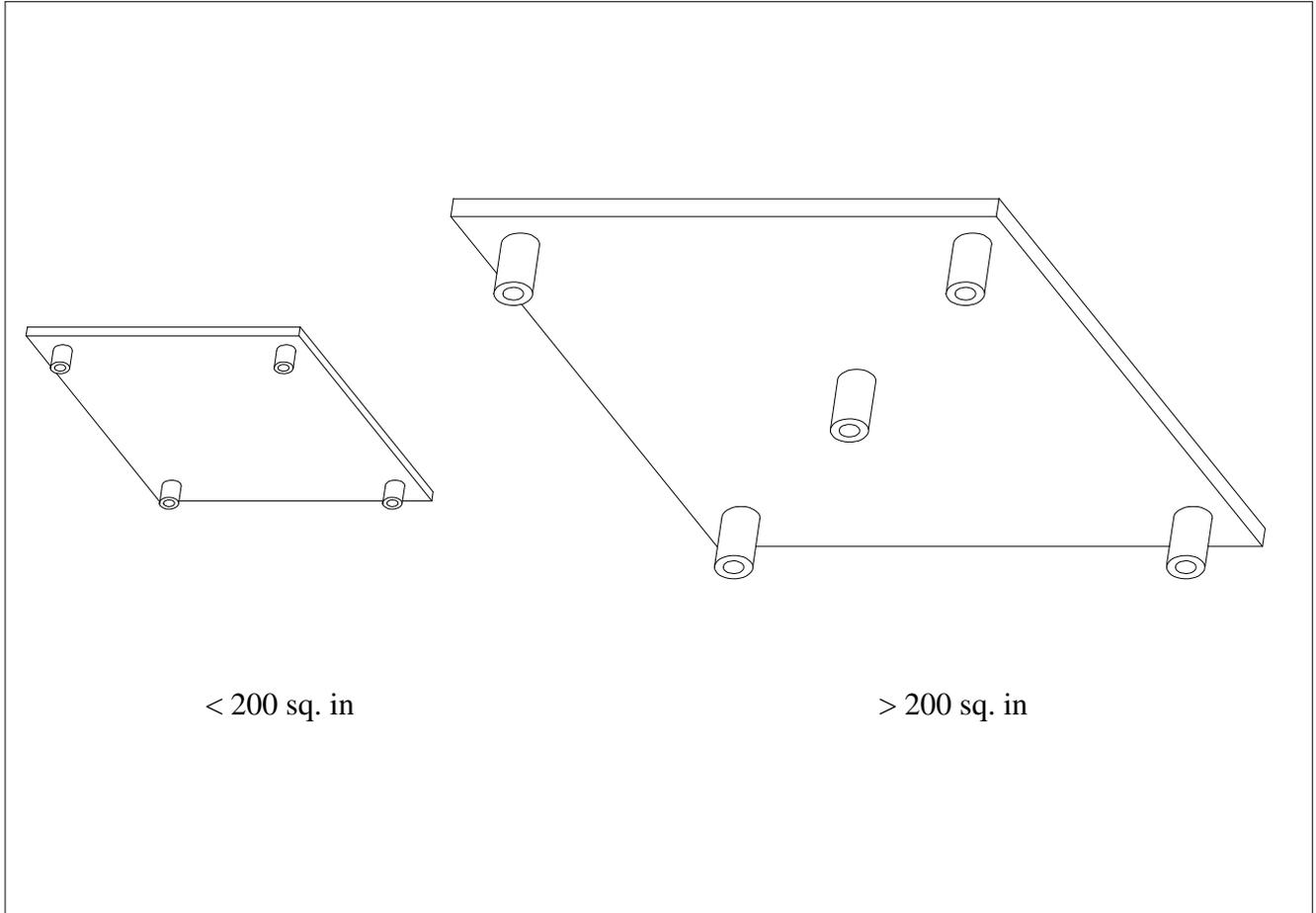


APPENDIX B11. Jig Foot Location

[Return to Build Requirements, Section A, Bases, Item #4.](#)

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[Go to Table of Contents](#)

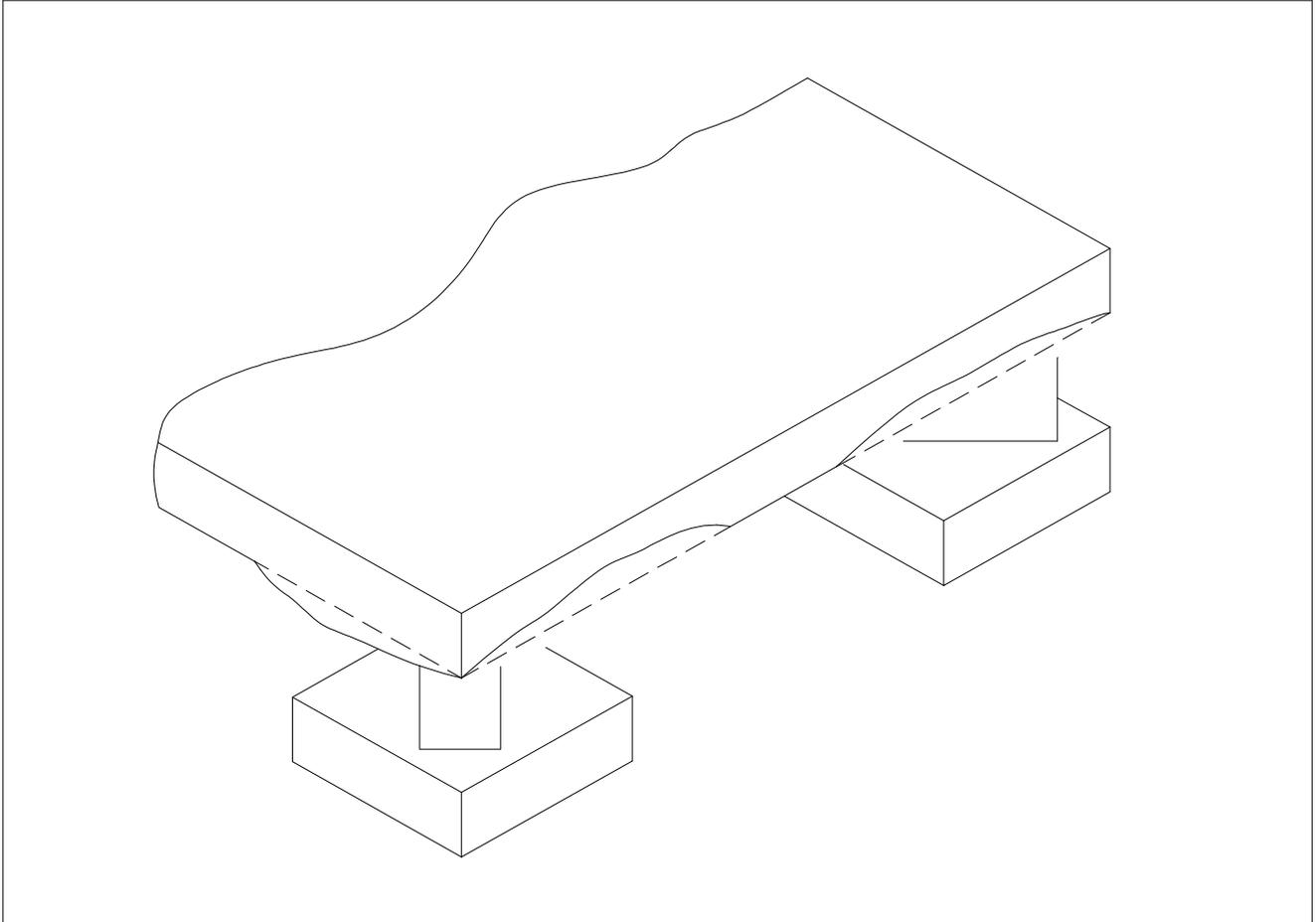


APPENDIX B12. Base Thickness Uniformity

[Return to Build Requirements, Section A. Bases, Item #6.](#)

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[Go to Table of Contents](#)

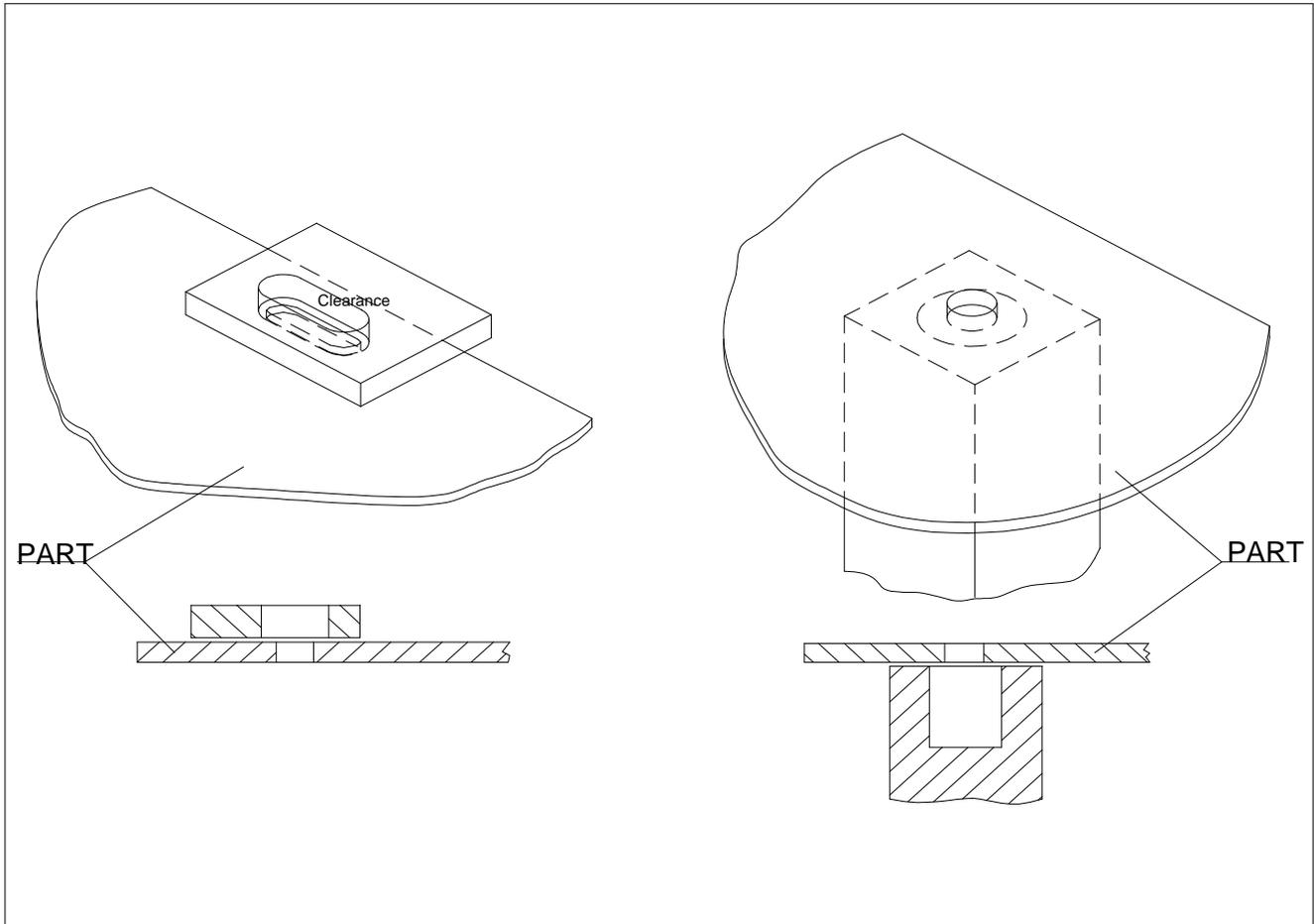


APPENDIX B13. Hole Clearance for CMM Access

[Return to Build Requirements, Section D. Details, Item #7.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

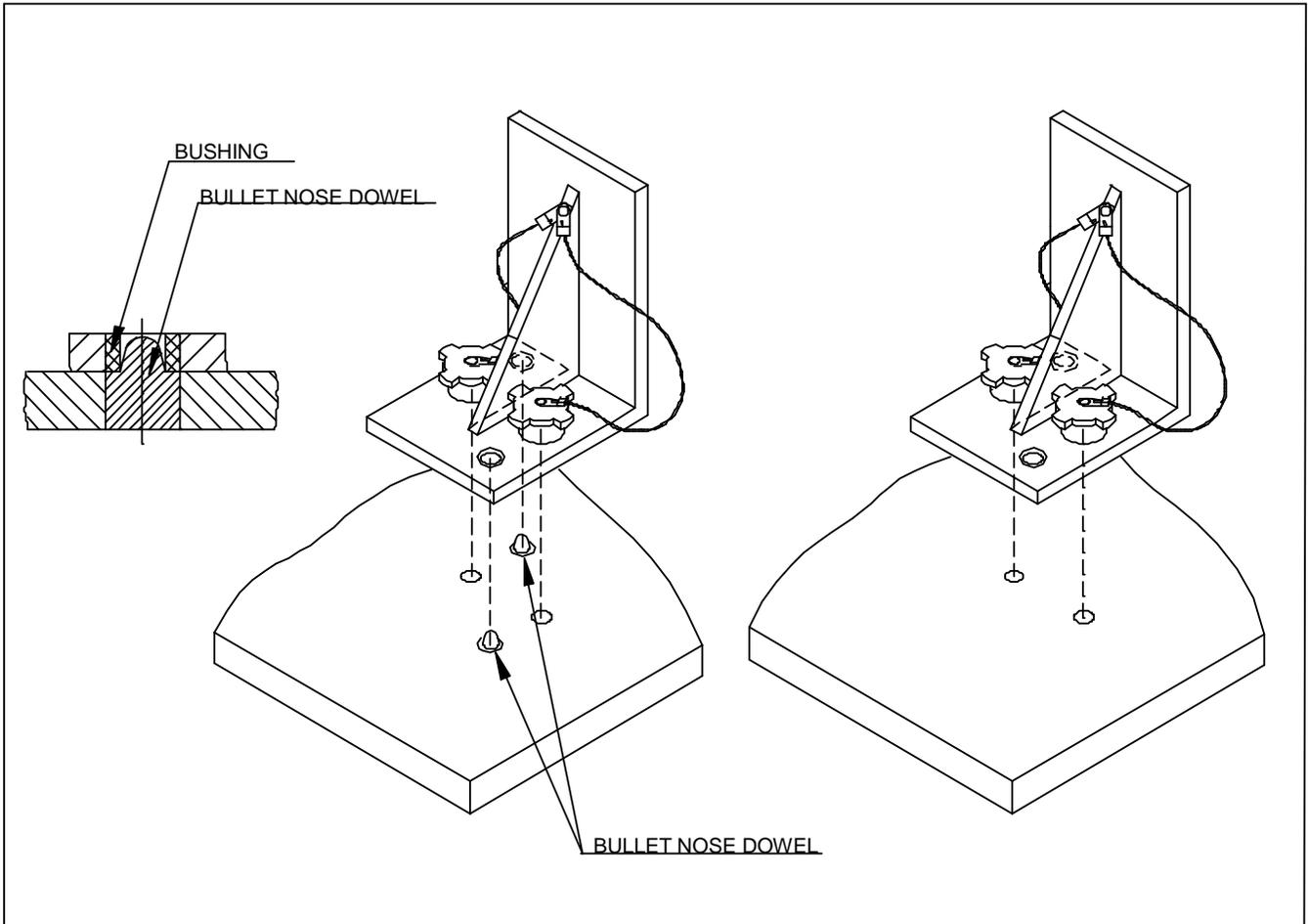


APPENDIX B14. Bullet Nose Dowel Location

[Return to Build Requirements, Section E. Removable Details, Item #1.](#)

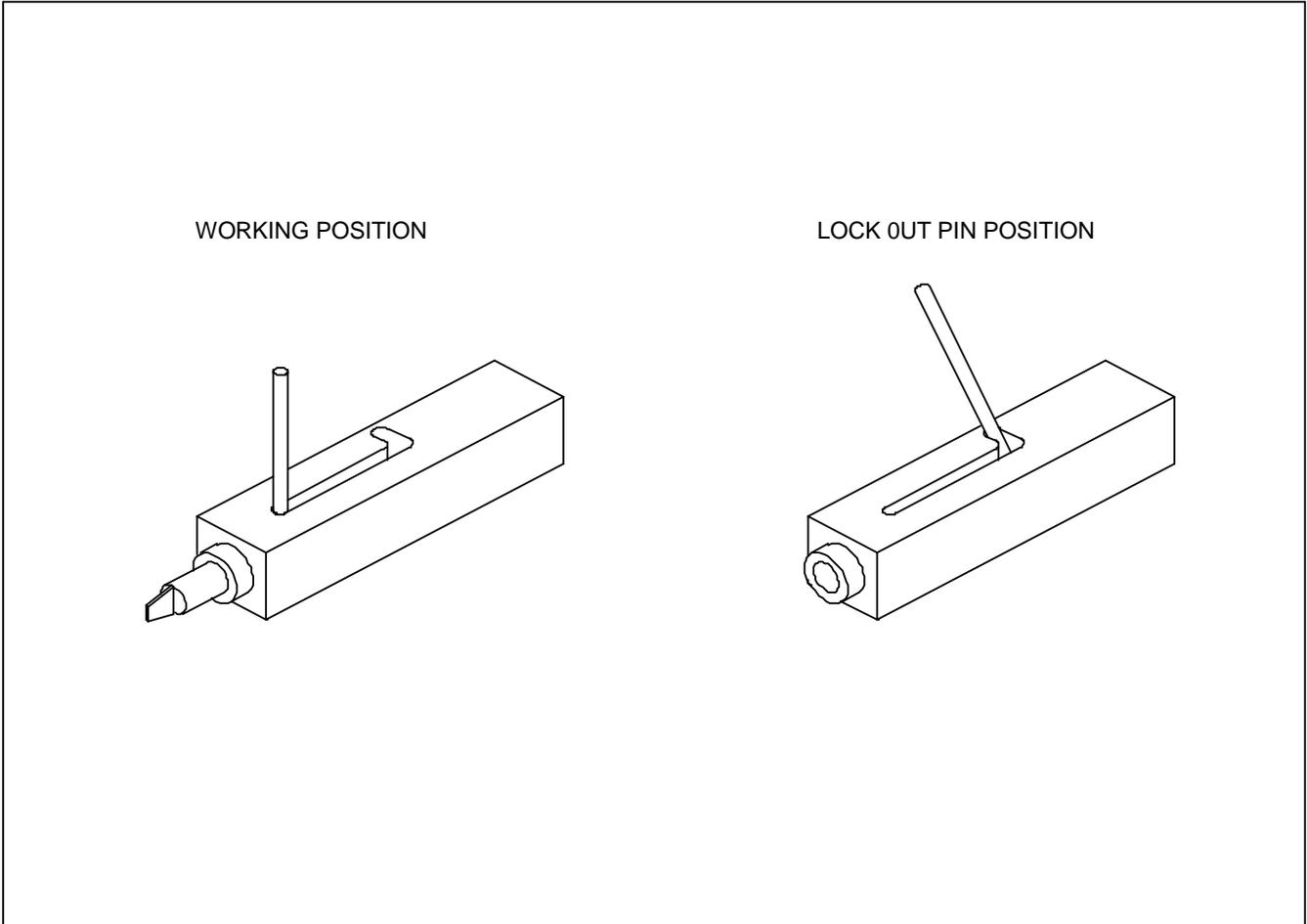
[Go to Appendix List](#)

[Go to Table of Contents](#)



APPENDIX B15. Locating Pin with Lock-out Pin

[Return to Build Requirements, Section G. Locating Pins, Item #4.](#)
[Go to Appendix List](#) [Go to Table of Contents](#)

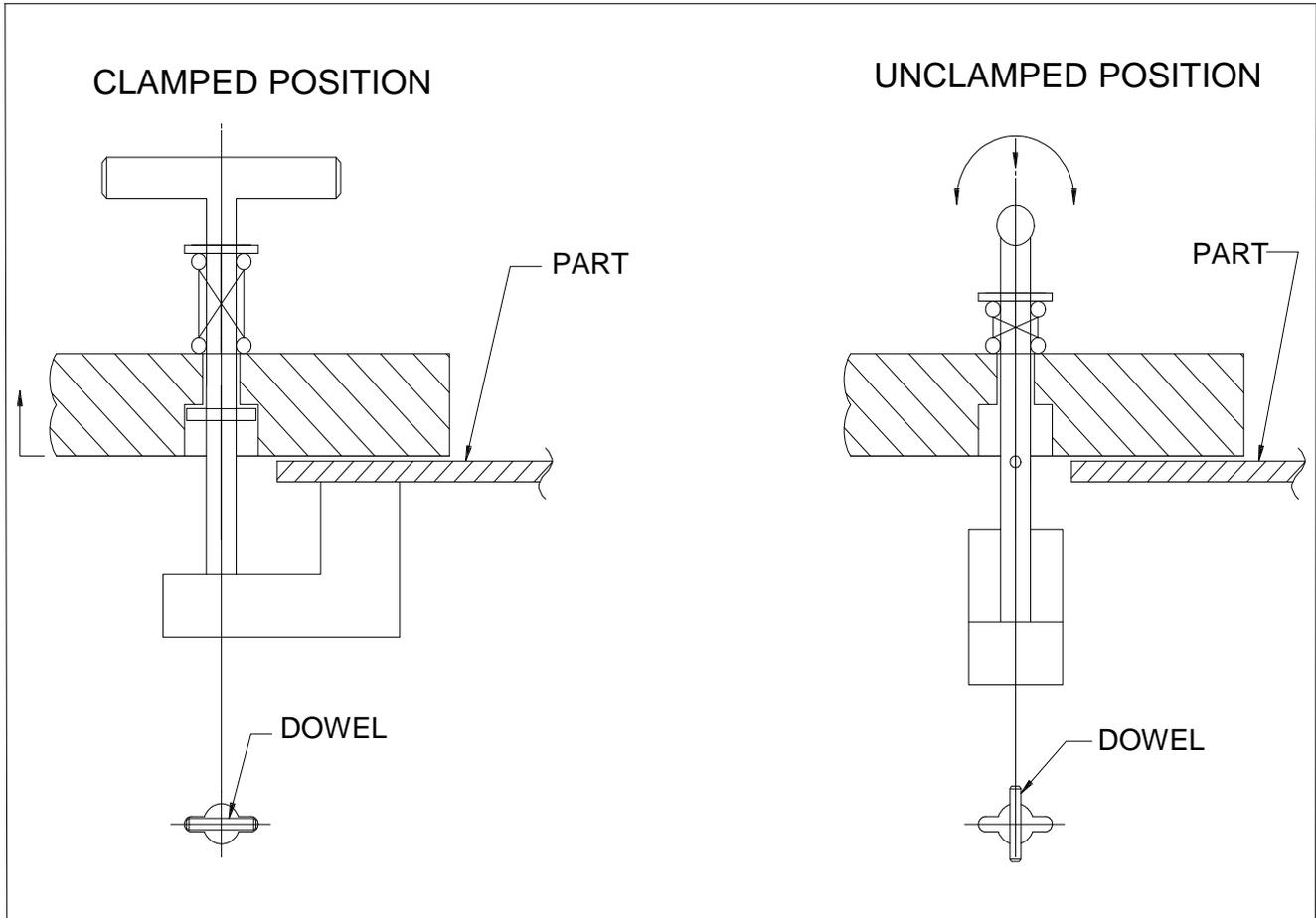


APPENDIX B16. Bayonet Clamp Location to Allow for CMM Access

[Return to Build Requirements, Section H. Clamps, Item #1.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)

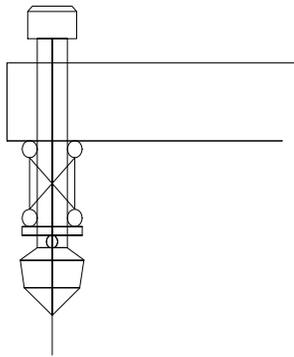


APPENDIX B17. Clamp Lock-out Mechanism

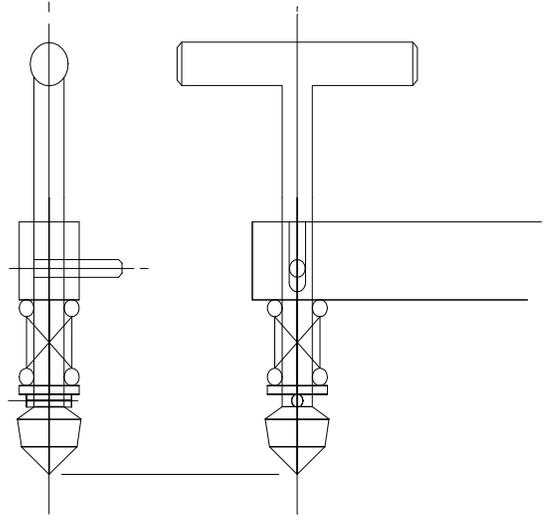
[Return to Build Requirements, Section H. Clamps, Item #3.](#)

[Go to Appendix List](#)

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UNACCEPTABLE



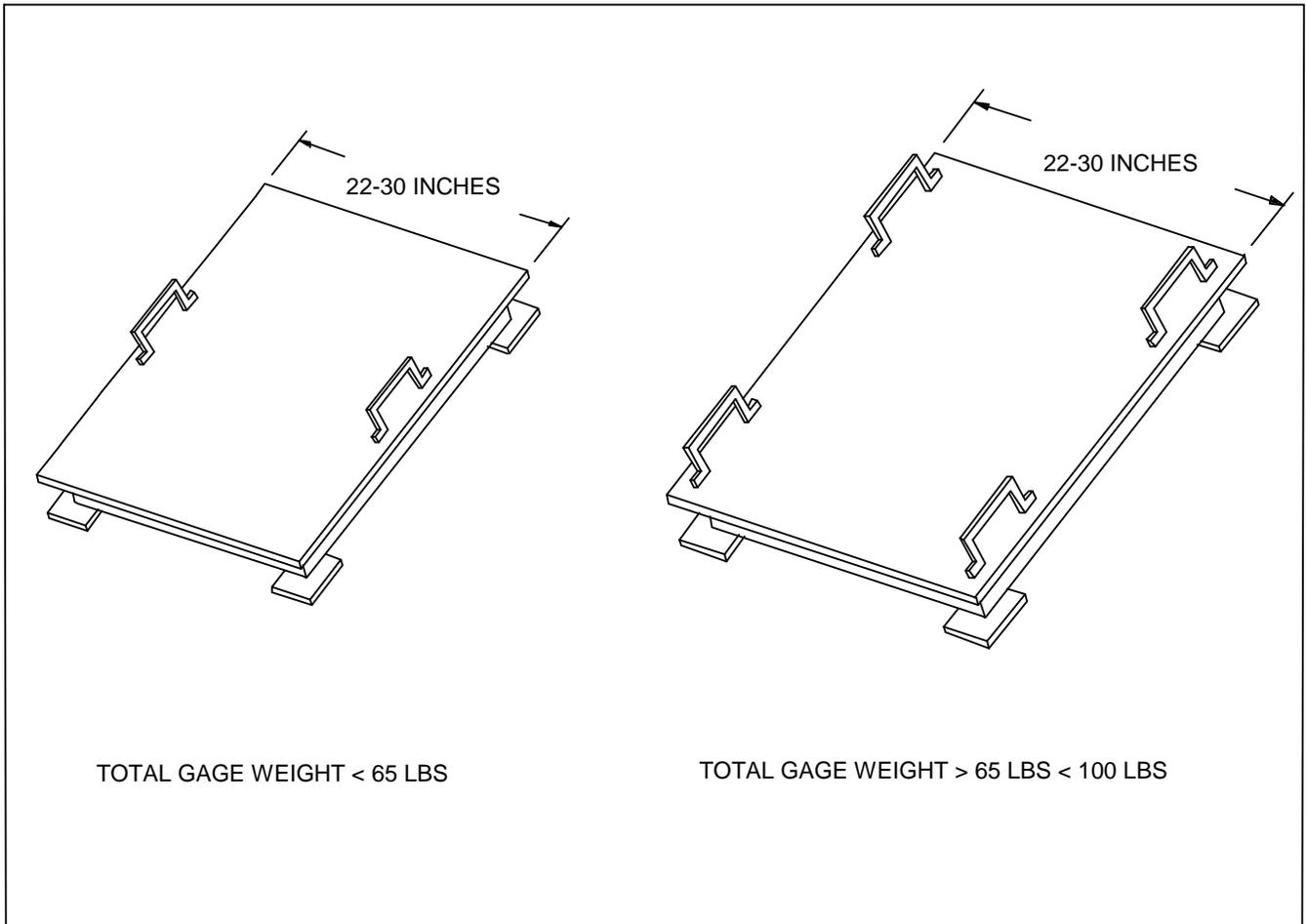
ACCEPTABLE

APPENDIX B18. Handle Installation

[Return to Safety and Ergonomic Requirements, Item #6.](#)

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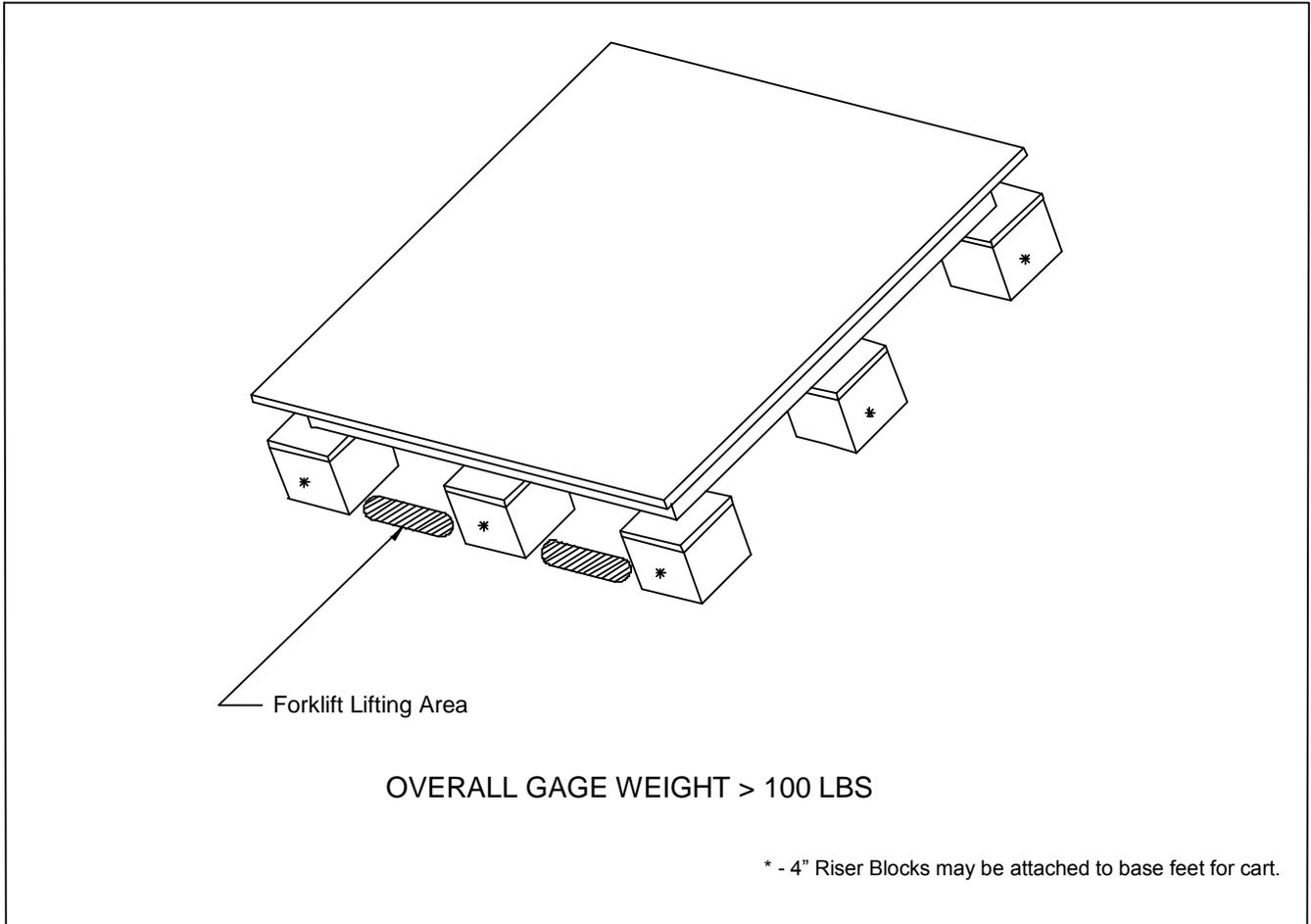


APPENDIX B19. Forklift Sleeve Installation

[Return to Safety and Ergonomic Requirements, Item #6.](#)

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[Go to Table of Contents](#)

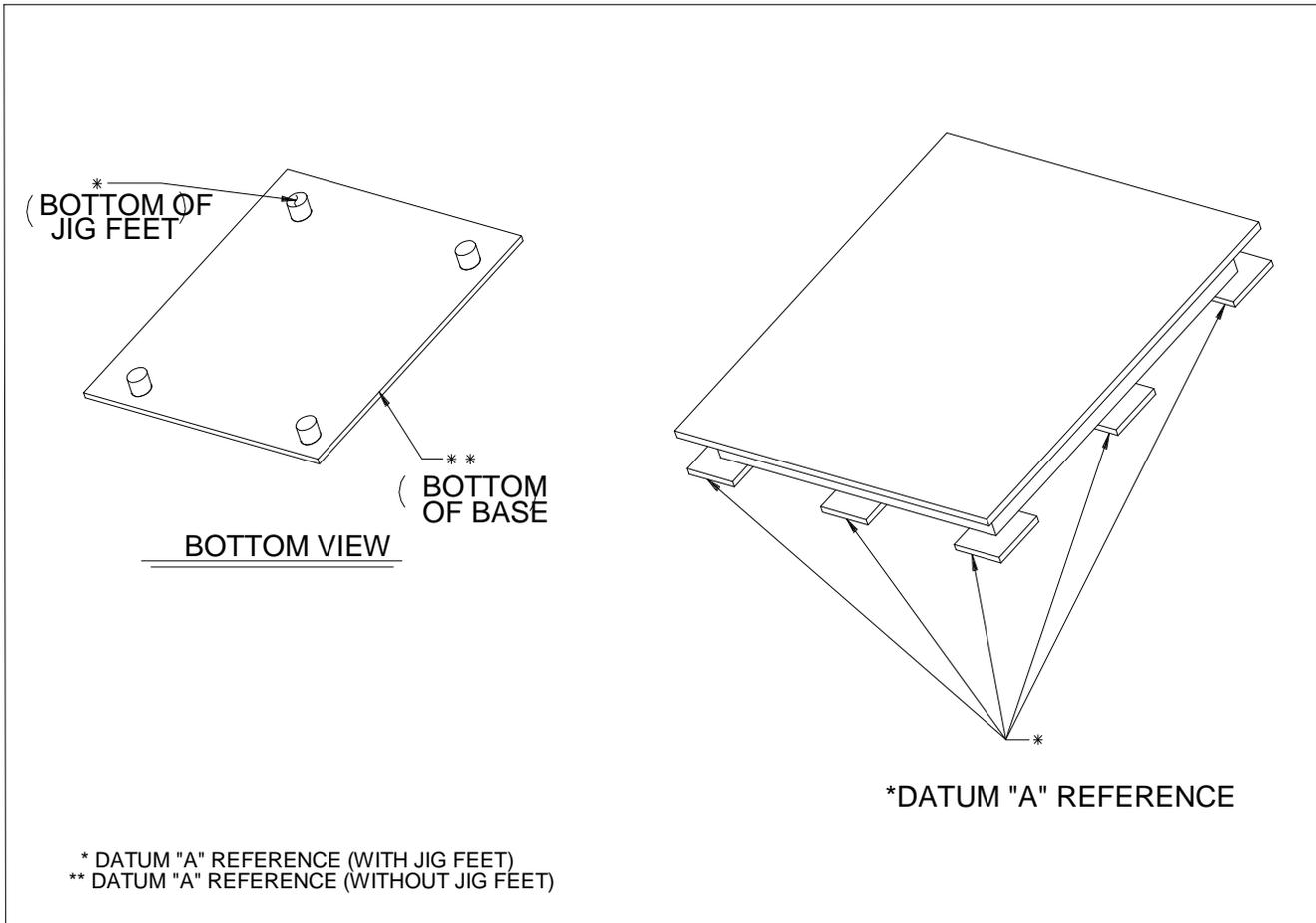


APPENDIX B20. Datum Scheme for Base Certification

[Return to Build Requirements, Section A. Bases, Item #1.](#)

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[Go to Table of Contents](#)

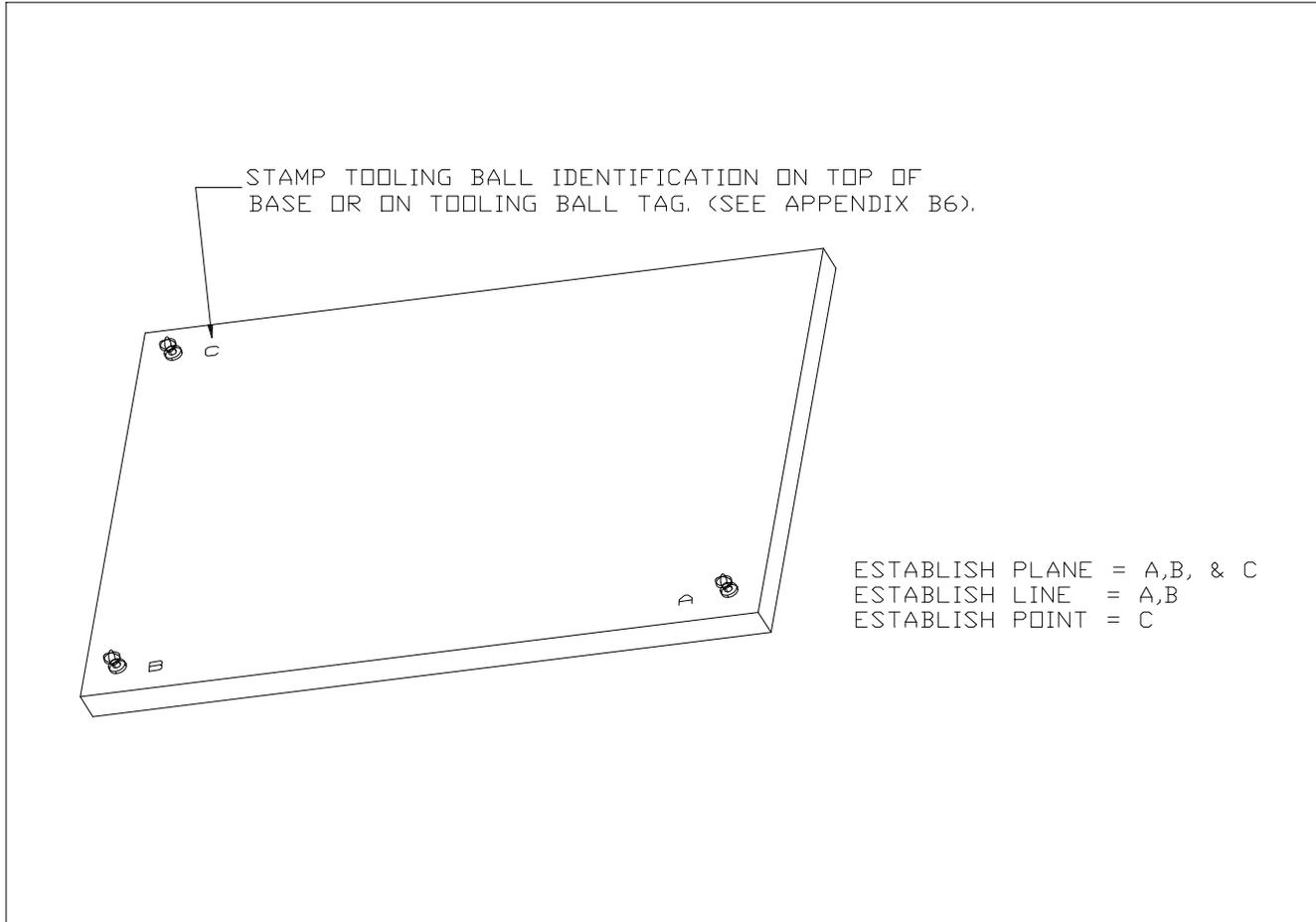


APPENDIX B21. Gage Certification Datum Set-up

[Return to Build Requirements, Section K. Build Tolerances, Note #1.](#)

[Go to Appendix List](#)

[Go to Table of Contents](#)



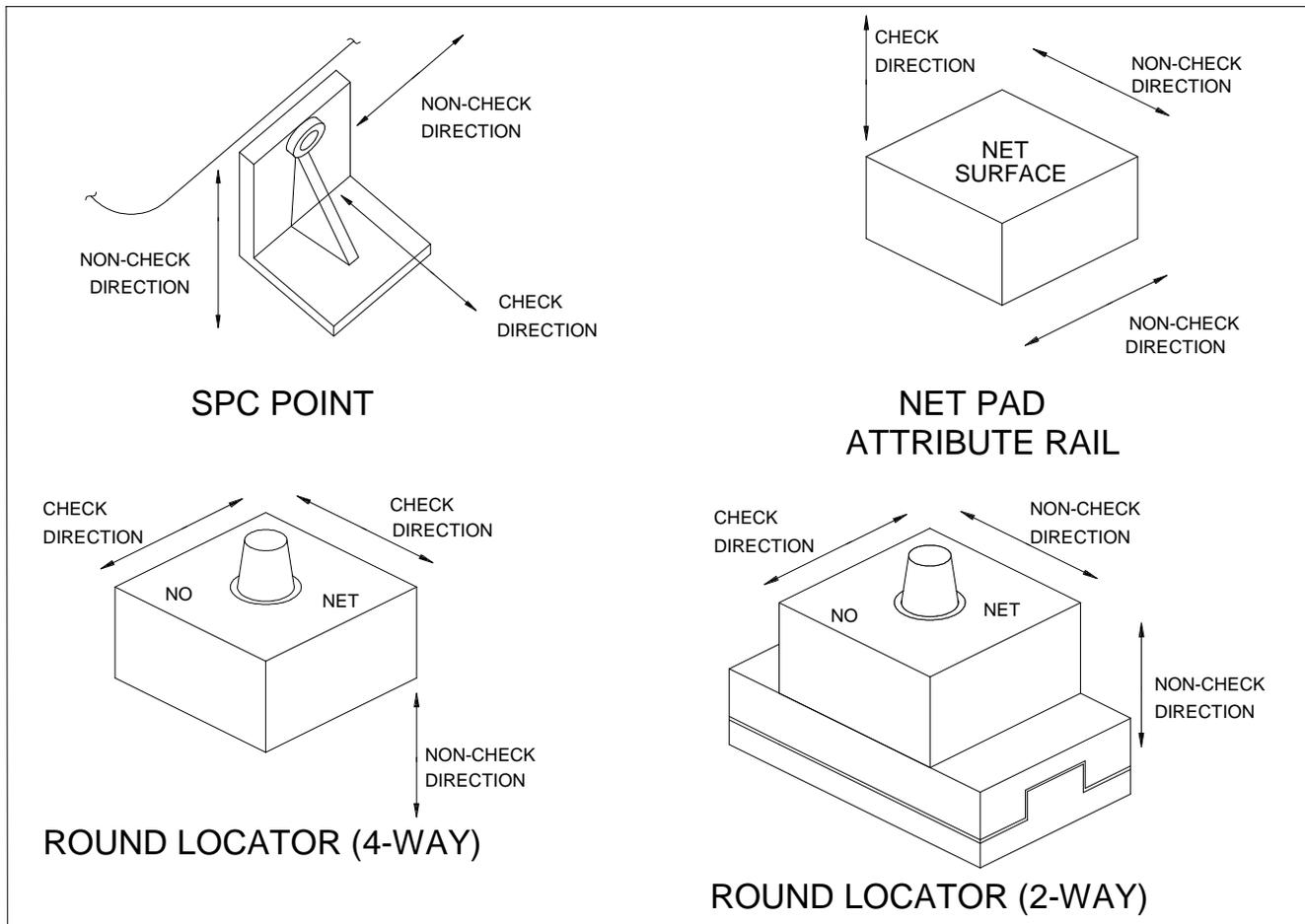
APPENDIX B22. Check Direction / Non-check Direction for Certification

[Return to Build Requirements, Section K. Gage Build Tolerances, Note #2.](#)

[Return to Build Requirements, Section K. Gage Build Tolerances, Note #3.](#)

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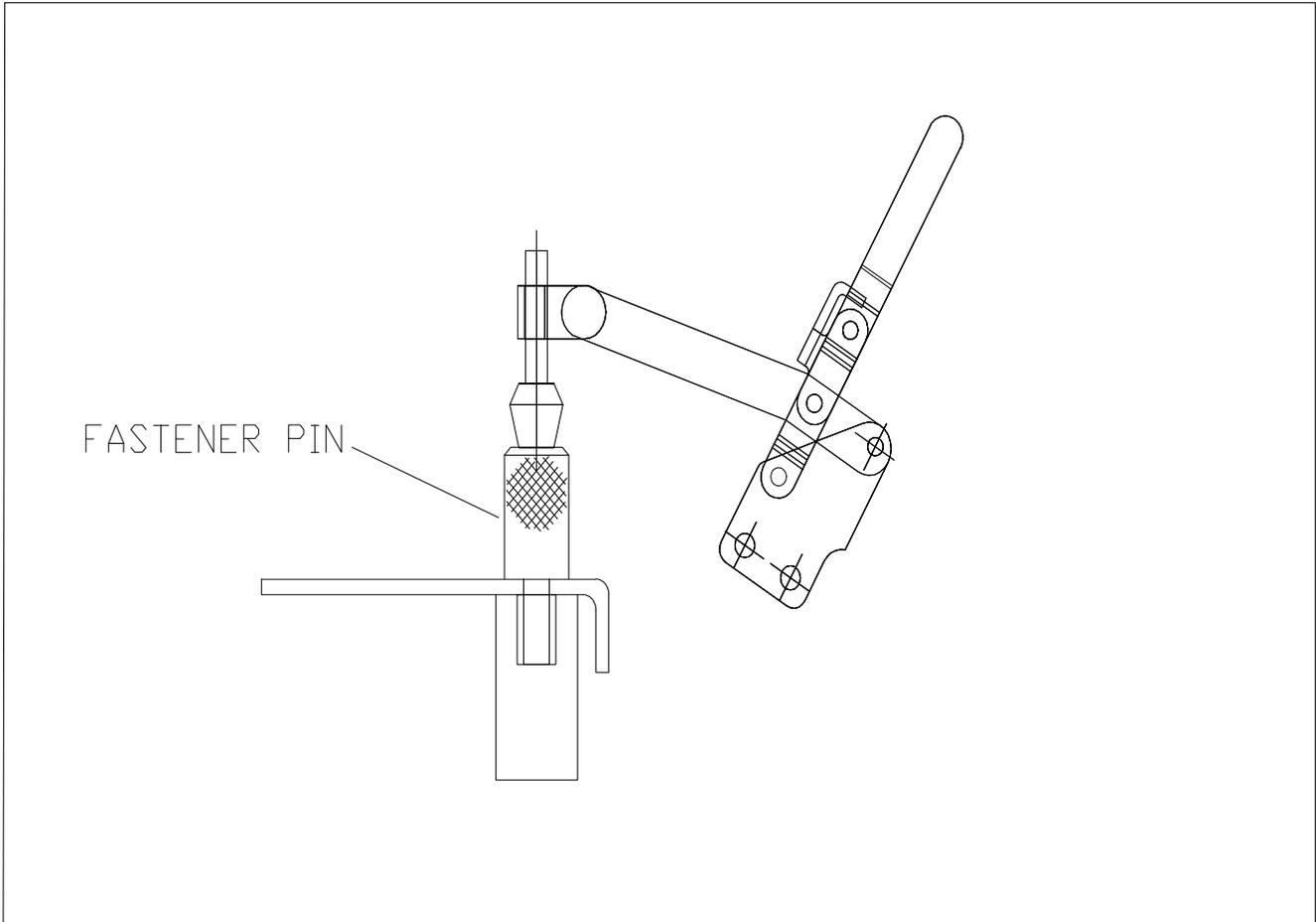


APPENDIX B23. Fastener Pin Representation

[Return to Build Requirements, Section D. Details, Item #10.](#)

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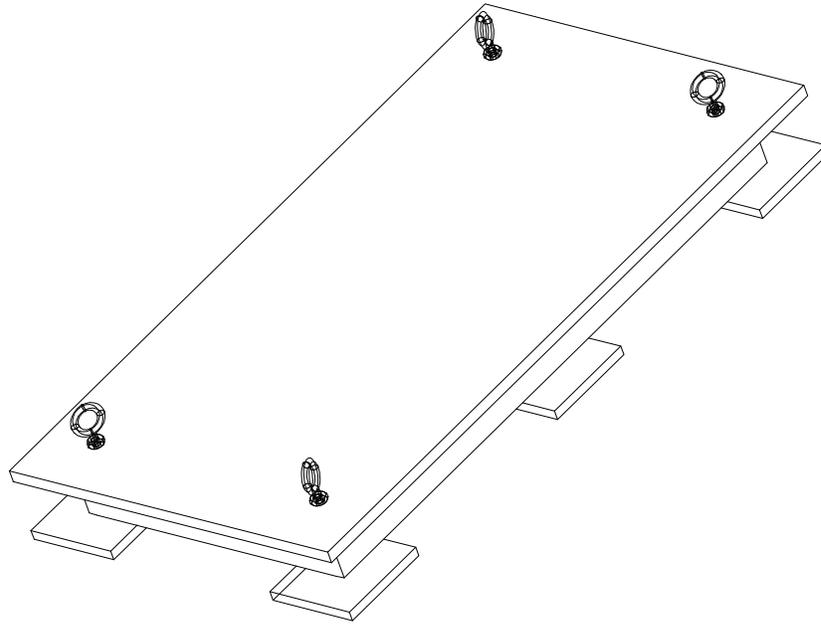


APPENDIX B24. Eyebolt Installation

[Return to Safety and Ergonomic Requirements, Item #6.](#)

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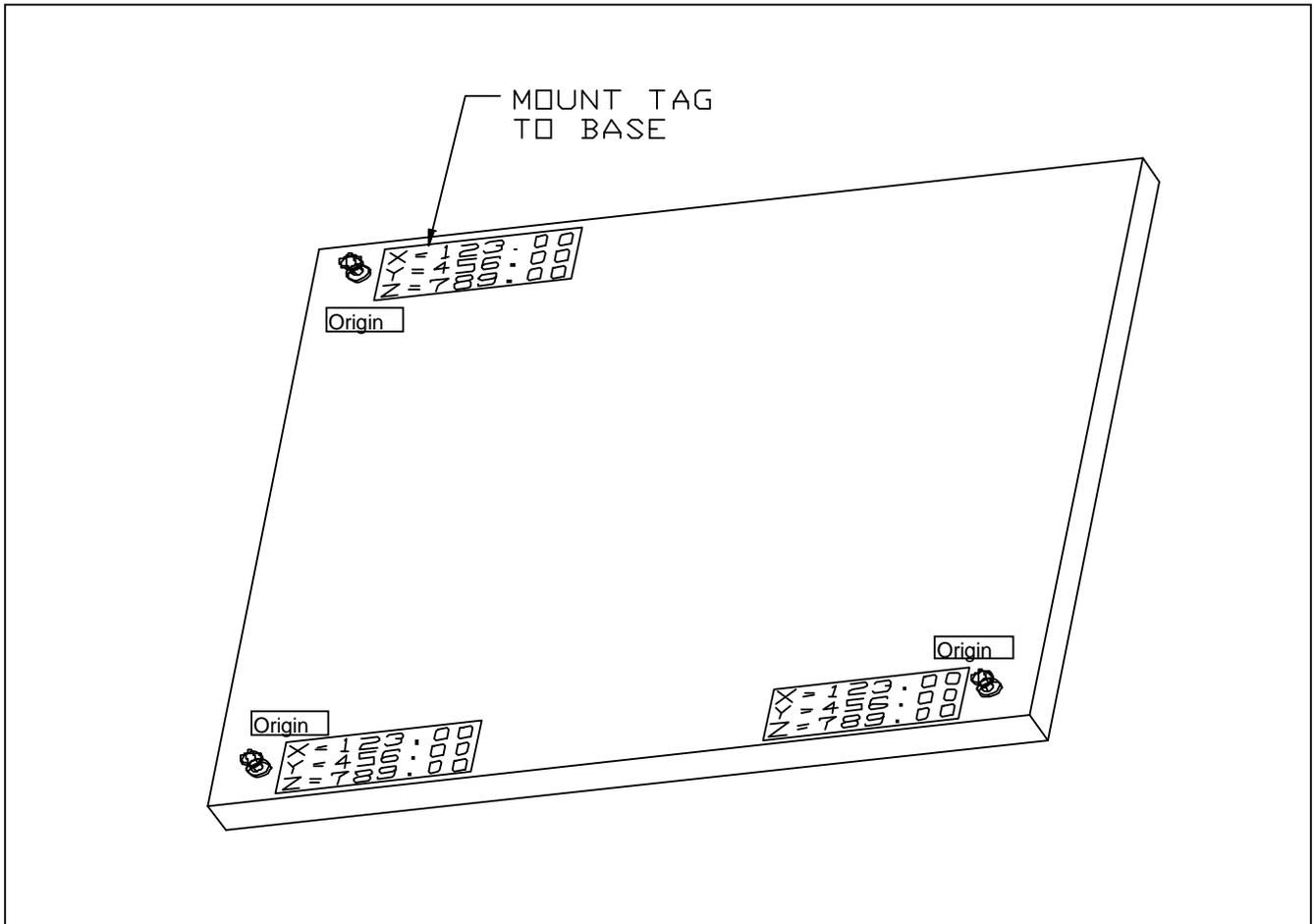
TOTAL GAGE WEIGHT > 100 LBS.

APPENDIX B25. Tooling Ball Origin Identification

[Return to Build Requirements, Section A, Bases, Item #1.](#)

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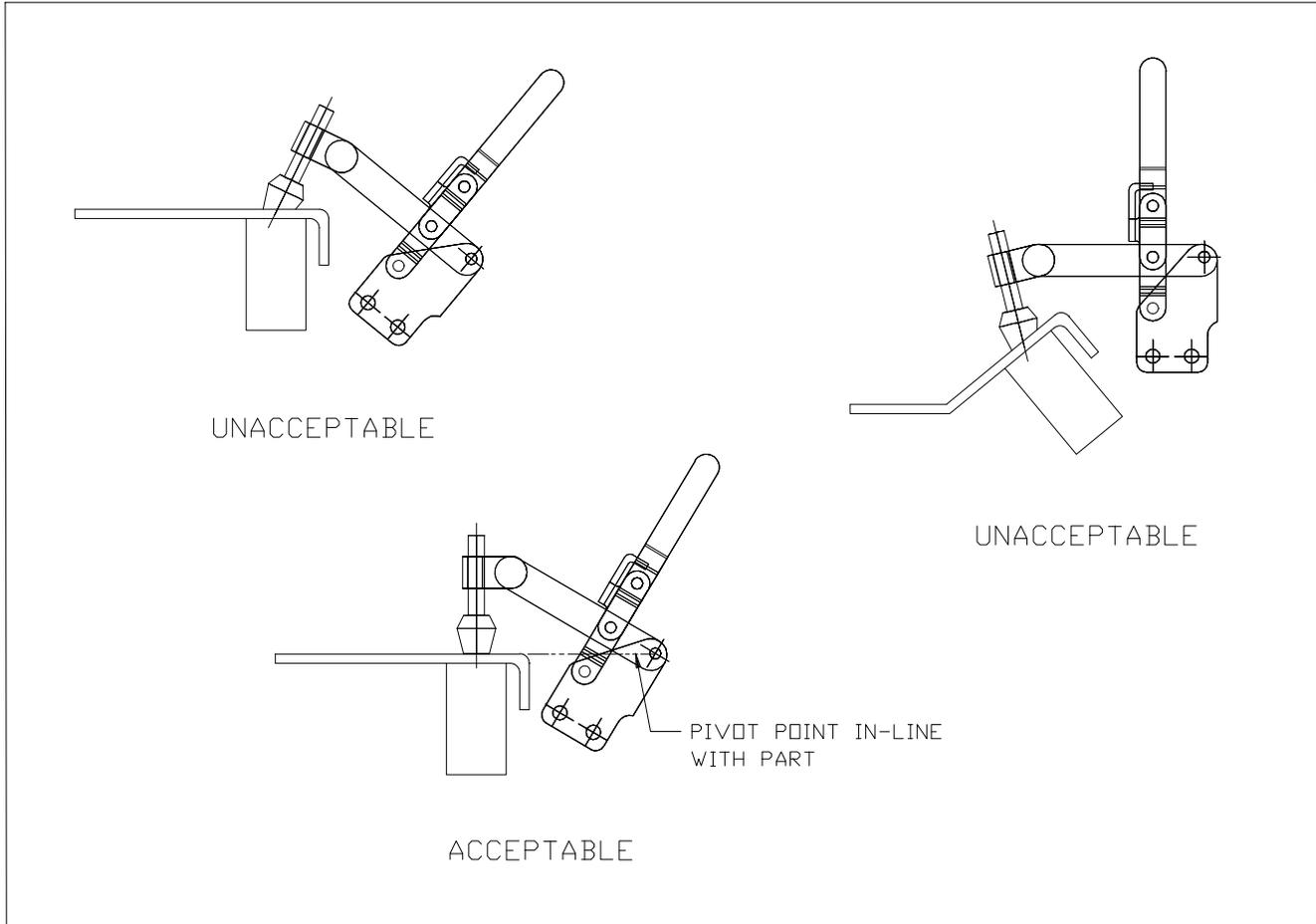


APPENDIX B26. Clamping Direction

[Return to Build Requirements, Section H. Clamps, Item #2.](#)

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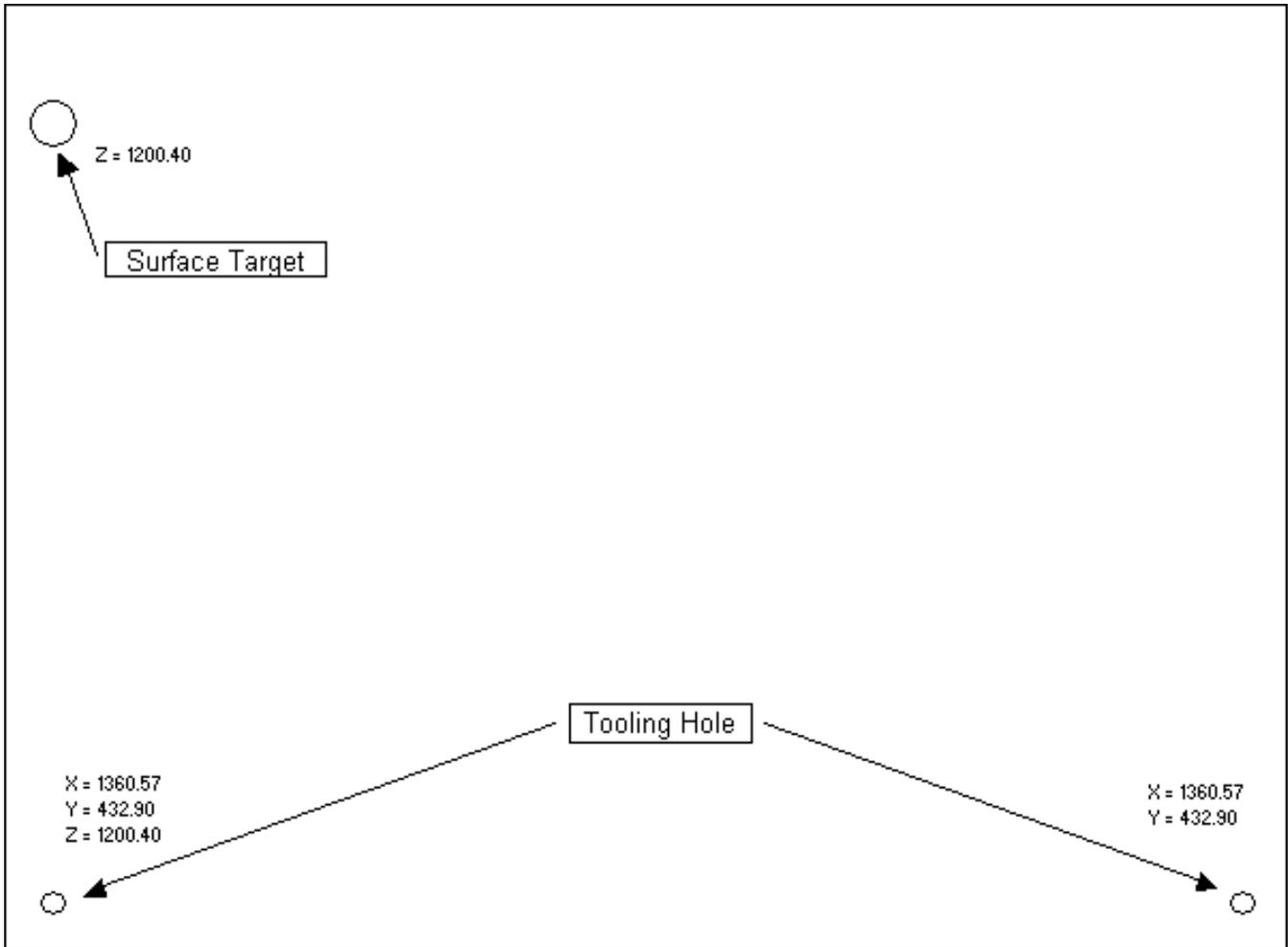
APPENDIX B27. Tooling Hole and Surface Target Labeling

[Return to Design Requirements, Section B. Design, Item #8.](#)

[Return to Build Requirements, Section L. Labeling, Item #3.](#)

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APPENDIX D – REVISION TABLE

Level	Date	Description
Release	03/15/02	a. Release for publication.
001	11/07/02	<ul style="list-style-type: none"> a. Added Partner Gage Supplier signatures to Introduction page. b. Added note to Gage Build Requirements - Section K. Build Tolerance, All tolerances are in millimeters unless otherwise noted. c. Updated Gage Build Requirements - Section K. Build Tolerances to include the Check pin location tolerance. d. Updated Gage Build Requirements - Section K. Build Tolerances to include Go and Nogo pin size tolerances.
002	03/03/04	a. Changed Automotive Systems Group to Automotive Group.
003	05/05/04	<ul style="list-style-type: none"> a. Added reference to Gage Assumption/Gage Cost Model form in General Requirements #1 and #10. b. Added reference to Gage Assumption/Gage Cost Model form in Quotation Requirements #8. c. Added Quotation Requirements #9, referencing customer cost breakdowns using the Gage Assumptions / Gage Cost Model form. d. Revised wording of Gage Design Requirements - Section B. Gage Design #16 for clarification. e. Moved Gage Build Requirements - Section H Clamps #1 to Gage Design Requirements - Section B. Gage Design #23. Also, reworded entry for clarification. f. Revised wording of Gage Build Requirements - Section D. Details #1 for clarification. g. Revised wording of Gage Build Requirements - Section D. Details #4 for clarification. h. Revised wording of Gage Build Requirements - Section D. Details #5 for clarification. i. Revised wording of Gage Build Requirements - Section I Scribe Lines / Tolerance Bands #1 for clarification. j. Revised wording of Gage Build Requirements - Section I Scribe Lines / Tolerance Bands #2 for clarification. k. Revised wording of Gage Build Requirements - Section J SPC Indicators #2 for clarification. l. Changed Gage Build Requirements - Section K SPC Indicators #3 entry from center of indicator travel to approximate center of indicator travel. m. Changed Gage Build Requirements - Section K SPC Indicators #8 reference from tips must be secure to tips must be tightened. n. Revised wording of Gage Build Requirements - Section K SPC Indicators #9 for clarification. o. Revised wording of Gage Build Requirements - Section L Labeling #5 for clarification. p. Revised wording of Gage Build Requirements - Section N Gage Certification #1 for clarification. q. Revised wording of Gage Build Requirements - Section N Gage Certification #2 for clarification. r. Changed Gage Build Requirements - Section N Gage Certification #2 entry from one-direction check like a flush or feeler rail to one-direction check like a net point, flush rail, or feeler rail. s. Changed Gage Build Requirements - Section O Third Party Certification #3 entry by adding up to and including the internal and Third Party recertification. t. Changed Gage Build Requirements - Section P Gage Instructions #2 entry from it must include to they must include. u. Revised wording of Gage Build Requirements - Section Q Function Check #1 for clarification. v. Added Gage Assumption / Gage Cost Model to Appendix A – Documents as Appendix A19.
004	07/25/06	<ul style="list-style-type: none"> a. Changed all references of Gage Buyer to Gage Engineer. b. Corrected the Quotation Requirements #7 entry by changing the 600 in² reference to 400 in². c. Changed Gage Design Requirements - Section B. Gage Design #8 to include Tooling Holes and Surface Target. Added Tooling Holes and Surface Target picture to Appendix B – Diagrams as Appendix B27. d. Added wording to Gage Design Requirements - Section B. Gage Design #19 to include, including details that move (toggle clamps, hinge drops, etc.) e. Changed Gage Build Requirements - Section B. Tooling Balls to include reference to Tooling Holes.

APPENDIX E – REFERENCE LIST

Reference Title	Author / Publisher	Publish
ASME Y14.5-1994 Geometric Dimensioning and Tolerancing	ASME	1/95
CG Model and Fixture Gage Build Standards	CG Model and Fixture	Unknown
Chrysler Truck Platform Interior Systems Dimensional Quality Plan	DaimlerChrysler Corporation – Truck Platform	6/00
Chrysler AME Gage Standards	DaimlerChrysler Corporation	9/98
Chrysler Corporation Checking Fixture Design and Build Standards	DaimlerChrysler Corporation	4/93
Ford Vehicle Operations Final Assembly Engineering Tooling Aids – Design and Build Guidelines	Ford Motor Company	2/97
GM Checking Fixture/Gage Standards (PED:114)	General Motors	10/01
GM Global Checking Fixture Standards	General Motors	9/99
GM Mid/Lux Supplier Development/Quality Part Fixturing Design/Build Standards	General Motors Mid/Lux Division	4/96
ISO Guide 25 Laboratory Certification	ISO / IEC	12/90
ISO / IEC 17025 Laboratory Certification	ISO / IEC	12/90
Jay Enn Gage Build Standards	Jay Enn Corporation	1/97
Johnson Controls Athens Plant General Gage Specifications	Johnson Controls Athens	6/98
Johnson Controls Interiors Special Equipment General Specifications	Johnson Controls Equipment Development Team	5/01
Johnson Controls Interiors Special Equipment General Specifications	Johnson Controls Equipment Development Team	5/01
Johnson Controls Thermobond Headliner Substrate Standards	Johnson Controls Tooling	12/99
Johnson Controls Acousticor Headliner Substrate Standards	Johnson Controls Tooling	10/98
Johnson Controls Honda Business Unit Gage and Fixture Criteria	Johnson Controls Honda BU	4/99
Johnson Controls Injection Mold Standards	Johnson Controls Tooling	1/00
Johnson Controls Integration Center Gage (CMM Fixture) Development Criteria	Johnson Controls Integration Center	3/99
Johnson Controls Lakeshore Gage Standards	Johnson Controls Lakeshore	Unknown
Johnson Controls Reynosa Plant General Gage Specifications	Johnson Controls Reynosa	9/99
Measurement Systems Analysis Reference Manual	Chrysler/Ford/General Motors Supplier Quality Requirements Task Force	6/98
MMMA Checking Fixture Tolerance Standard	Mazda Motors	5/90
MP Components Gage Build Standards	MP Components	1/99
Peterson Jig and Fixture, Inc. Fixture Build Standards	Peterson Jig and Fixture	Unknown
Quality Systems Requirements - QS9000 Manual	Chrysler/Ford/General Motors Supplier Quality Requirements Task Force	3/98
Quality Systems Requirements – Tooling & Equipment Supplement	Chrysler/Ford/General Motors Tooling and Equipment Representatives	6/98
Supplier Quality Assurance Manual for Parts and Components (Section 17 – Checking Fixtures, Gages and Test Equipment)	Toyota Motor Manufacturing North America, Inc.	3/00

APPENDIX F – GLOSSARY OF TERMS

[Return to General Requirements](#)
 [Return to Safety and Ergonomics Requirements](#)
 [Return to Quotation Requirements](#)
[Return to Gage Design Requirements](#)
 [Return to Gage Build Requirements](#)

(Pass cursor over term to read definition.)

2-way locator	4-way locator	90° out of body	180° out of body	A2LA	Accuracy	Analysis of variance (ANOVA)
Anthropometry	Appraiser variation (AV)	ASME Y14.5M-1994	ASME Y14.5.1M-1994	Attribute rail	Attribute study	Base
Bayonet clamp	Bias	Body position	Bullet-nose dowel	Bushing	Calibration	Cartesian coordinate system
Cast aluminum base	Certification	Certification target	Clamp	Clamping direction	Clamp pressure	Concept drawing
Contour template	Coordinate measuring machine	Datum	Datum Axis	Datum feature	Datum point	Datum reference frame
Datum surface	Datum target	Design approval	Detail	Discrimination	Drop template	Equipment variation (EV)
Feeler rail	Fixture	Fixture plank	Flatness	Flush rail	Gage	Gage design
Gage R study	Gage R&R study	Gage instructions	Gaging tolerance	Geometric Dimensioning and Tolerancing	Go/NoGo pin	Hinge drop
IGES	I-J-K check	Inspection	ISO Guide 25	ISO Guide 17025	J corner	Jig feet
Linearity	LMC	Maintainability	Master set block	Mean Time Between Failures	Mean Time Between Maintenance	Mean Time to Repair
Measurement	Measurement system	Measurement system analysis	Measurement system error	Measurement uncertainty	Microslide	MMC
NC machining	Net surface	Out of calibration	Operator's area of movement	Parallax error	Parallelism	Part Alignment
Part orientation	Phase I gage	Phase II gage	Pinch point	Plug gage	Precision	Primary datum
Profile of a line	Profile of a surface	QAF	QS9000	Reliability	Repeatability (EV)	Reproducibility (AV)
Resolution	RFS	Riser	Scribe line	Secondary datum	Set two check one check	Sheet metal Representation
Significant characteristic	Simulated datum	Site check	SPC indicator	SPC port	Squareness	Stability
Stanchion	Start Coordinates	Step gage	Sub-base	TE9000	Tertiary datum	Third party certification
Toggle clamp	Tooling ball	Tooling plate	Total variation	True position	Tulip	Vector check
Virtual condition	Warranty	X-Y-Z coordinate system				