Check Fixture/Gage Design and Build Standards

1.0 Purpose:
The purpose of this work instruction is to define how the activity listed is to be performed. For more information refer to the Policy and Procedure Manuals.

2.0 Scope:
The scope of this work instruction is to define the criteria used in the design, build and approval of gauges and fixtures.

3.0 Responsibilities:
Engineering Manager
Program Manager
Quality Engineer
Process Engineer

4.0 Definitions:

1. The following terms are defined to clarify this Fixture/Gage Standard.
   a. Checking Fixture refers to a piece of equipment used to hold a part in a fixed position for CMM Checks or other. It is sometimes referred to as CMM Holding Fixture.
   b. Checking Gage refers to a piece of equipment used as an inspection tool which would help make decision of the quality status of a product.
   c. Modification is defined as any changes made to the Checking Fixture/Gage or its documents due to Camaco Team or OEM directed change, repair or correction. Checking Gauges – Allows for Inspection of parts and collection of attribute & variable data.
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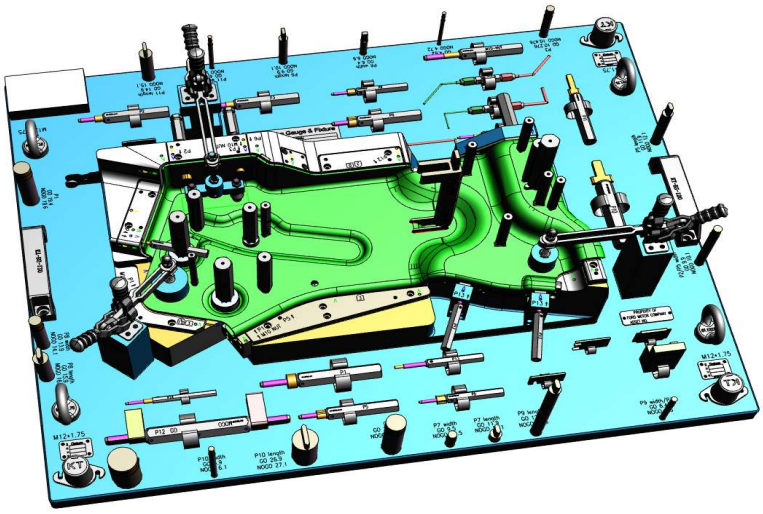
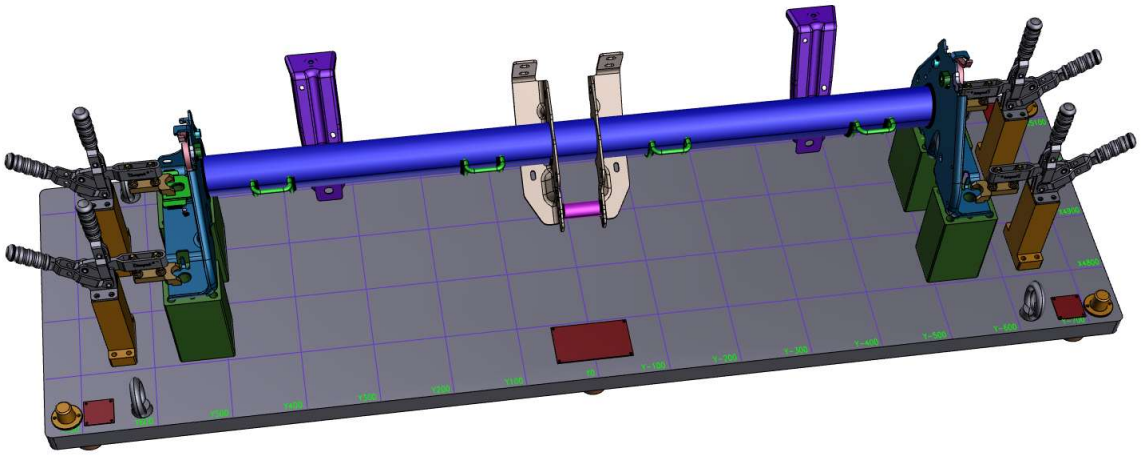


a. Holding Fixtures – Used for CMM poising of parts.



5.0 Quotation Requirements:

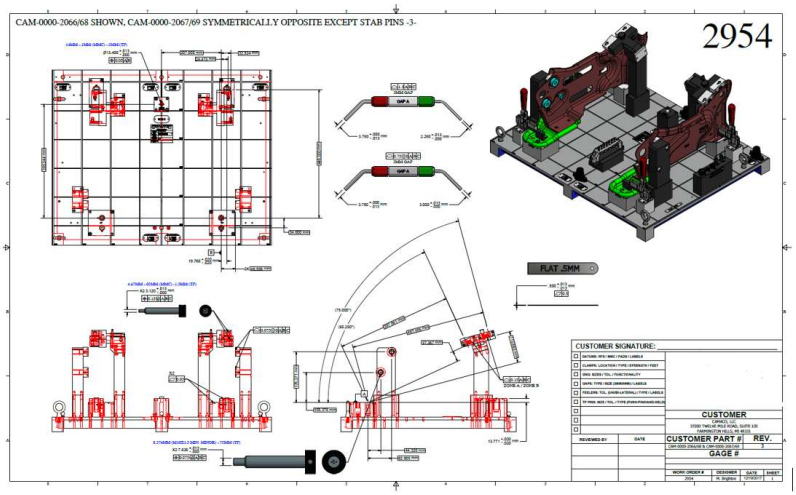
1. Each gauge must be quoted to meet the requirements of the supplied data and part print.

2. The quotation must contain the following information:
   - Part Number
   - Part description
   - Part Engineering Level
   - Detailed description of the gauge requirements.
   - All deviations from the requirements must be specified.
   - Itemized cost
   - Design cost
   - Build cost
   - Third Party Certification required
   - Gage R&R if parts are available
   - Quotation total cost
   - Timeline that meets Camaco Gage Timeline.

Any assumptions and /or exceptions that affect cost and timing must be clearly identified on the quotation.

6.0 Work Instruction:

1. All Gages and Fixtures will require design review and approval prior to fabrication. The required approval is the responsibility of the Camaco Engineering representative. The Fixture/Gage Design and Build Standard shall be used as a basis for all design requirements. Any deviations from the standards shall be communicated and approved by Camaco Engineering in written correspondence.
    a. PRELIMINARY DESIGNS
        i. All items shall be designed to the supplied CAMACO, LLC standards.
        ii. The tooling supplier is required to submit preliminary designs for review by CAMACO, LLC
    b. REVIEW MEETING
        i. When the preliminary designs are completed, a review meeting may be required at CAMACO, LLC or tool vendor, to review designs and Processing.
    c. COMPLETED DESIGNS
        i. CAMACO, LLC. must approve at 100% completed designs before work can begin. However, this approval does not release the vendor from producing a functional gauge or fixture. The gauge or fixture produced must meet the required specifications of the Part Print / CAD data and GR&R.



2. Gage prints and math data approval will require the following:
    a. Adequate dimensioning to allow for accurate reproduction of the gage components.
    b. Critical angles should be referenced to a specific work line, body line or datum.

c. Parts list (Bill of Materials) showing the vendor name and part number of all purchased items included in the design (Clamps, bushings, etc.). When math data, gage prints and certifications are provided, all information shall be delivered to Camaco Engineering via: ftp Upload, CD/DVD or other agreed upon media.

3. All body lines, work lines or datums shown on the part drawing must be shown on the design and identified on the gage.

4. Unless otherwise defined, the tolerance allowance for gage and fixture features will be 10% of the print tolerance.

5. General construction will be of Aluminum Wolverine or Equivalent Style Bases, or for smaller gages Aluminum Tooling Plates 1" minimum thickness, unless pre-approved by Camaco. Steel blocks and risers must be Black Oxide, with Allen bolts and dowel pin mountings.

   a. Gage or fixture surfaces that contact the parts surface will be hardened material HRC 50 or higher and designed to be replaceable.
   b. Hot rolled or stress relieved steel is to be used for details.
   c. Hardened tool steel must be used in high wear areas such as:
      i. Feeler check areas and surfaces where feelers are used.
      ii. Slides
      iii. Net pads
      iv. Plug Gages, Go/No Go feelers
      v. Location Pins
      vi. Stab pins must have bushings in base
      vii. All movable locators or pins must be set in bushings.
      viii. Tooling balls or Tooling hole bushings
   d. Aluminum is permitted on:
      i. Various riser or angle plates (must have hardened bushings and hardened wear plates)
      ii. All non-wear surfaces

6. Go/No-Go pins are to be pressed into fixture base and locked with set screws instead of cabled stab pins, wherever practical. Pins must be located in such a manner as to not interfere with other details when checking the part. (Not to increase the size of the base).

7. All pins and gages shall be marked with the size and identified to facilitate gage instructions.

8. All bushings and plug gages must be hardened and ground, and concentric. Pilots and plug gages must be slip fit to bushings within 0.012 (mm).

9. All loose part details will be attached with nylon covered cable, fastened to the fixture base and stored in steel spring clips attached to the base. Carr-Lane type holders are to be used.

10. For SPC data acquisition, the "Mitutoyo" digital indicator is preferred. The indicator should be permanently attached to the fixture.

11. A calibration detail must be furnished with each characteristic requiring variable data (SPC). Any details used for calibration must be affixed to the gage base per #6 of the gage and fixture criteria.

12. All indicators must be set up to nominal print dimensions.

13. Unless otherwise specified: when "4-way" and "2-way" locators are shown on the gage design the details resulting will be tapered, RFS (regardless of feature size).
    a. The "4-way" locator will be a tapered cylindrical concentric pin.
    b. The "2-way" locator will be a tapered spade shaped concentric pin or functional equivalent 2 points of contact 180° apart.
    c. These locators are to be spring loaded in bushing housing were applicable.

14. Three (3) Tooling balls or Tooling holes must be located at a right angle on the gage base and identified with the start coordinates. These features will be used to establish the origin of the fixture for certification and part layout.
    a. Tooling ball size will be 0.500 inches Tooling hole size will be a minimum of 10 millimeters.
    b. Each Tooling ball must have a protective cover. The cover must not interfere with the start coordinate labels.

15. Feeler gages should be standard 3.0 mm distance for parts under 150 mm" and 5 mm for parts over 150 mm. If they cannot be standard, actual distance shall be called out on the feeler gage.

16. General trim tolerance sight check to be trench type, machined to the proper profile width and painted yellow.

17. Approved gage and fixture designs will become the property of Camaco LLC. A true copy of the design will be provided to Camaco LLC by the gage source. *ALL MATH DATA MUST BE PROVIDED IN STEP FORMAT.*

18. Any deviations to these Gage & Fixture criteria require written authorization from Camaco Engineering and Quality personnel. For all "takeover jobs" that include gages, these acceptance criteria will be used at the discretion of the appropriate Quality engineer.

19. Operating gage instructions must be plastic laminated and attached to all check fixtures and gages. The instructions must be concise, simple and logical. Where applicable, details must be color or Alphabetically coded and labeled to show their usage in the operating instructions along with a image of the part pointing out the areas checked as the instructions are followed for the operator to reference. Camaco will provide the gage instruction form.

20. Construction source name tag must be attached to the base.

21. All items will be verified to the datums from the Camaco or OEM provided engineering drawing.

22. Third party certification is required for all dimensional validation. A full and complete dimensional inspection report including linear distance or XYZ locations of all gage fixtures is required. All items will be verified to the datums from the Camaco or OEM provide engineering drawing. All parties utilized for third party layouts must be ISO Guide 25, ISO Guide 17025, A2LA, or SCC Certified or have evidence of assessment by OEM (customer approval).

23. A copy of the drawing and CMM inspection report to which the gage or fixture was inspected must accompany the gage and an electronic copy provided to the Camaco corporate office.

24. All Paperwork/Results must be presented in English, failure to do so will result in the rejection of payment.

25. The supplier is responsible for acceptable repeatability and reproducibility studies. If the supplier is not able to perform these studies, they will be done at a Camaco plant facility. The supplier is still responsible to conform to the AIAG Measurement Systems Analysis guidelines for GR&R unless waived in writing by the Camaco plant Q.A. department. If the Camaco facility must perform corrective action to the gage, the supplier is responsible for those costs.

26. All fixtures must pass the complete certification requirement before acceptance. Gage acceptance will be based on dimensional evaluation to the part print and Part Cad Data as well as GR&R.

27. All items are to be delivered directly to the user Camaco plant facility.

28. All checking Fixtures and Gages must be approved prior to their use in the tool shop or Camaco plant facility.

8.0 Terms & Conditions

1. Payment terms to selected Suppliers are "to be determined." Net 47 are the preferred terms.

2. No payment will be paid for changes to and specification found in attachments to the purchase order unless agreed to by CAMACO, LLC Engineering. and communicated to the supplier via written amendment or revision to the purchase order.

3. Engineering change costs will be negotiated where appropriate. The supplier will inform CAMACO, LLC. on any schedule impact arising as a result of changes.

4. The supplier will provide a complete cost analysis of any changes arising as a result of engineering changes.

5. The supplier must breakout timing for Design Time and Build Time.

6. A 5% of sales price penalty will be charged per week for every week the equipment is late, day into week constitutes a full week penalty.

7. All quotes are FOB CAMACO, LLC.

8. No payments will be made without approval from the Camaco Engineering group.

9. All taxes must be noted separately.

10. Responsibility for physical changes to check fixtures belongs to the Engineering Department.

11. Responsibility for changes to check fixtures instructions belongs to the user plant Quality Department.

12. Training for changes to check fixtures belongs to the user plant Quality Department.

8.0 Safety & Environmental Information:

1. The Fixture/Gage Supplier must take all necessary steps to avoid safety incidents on the Fixture or Checking Gage. The following safety requirement is the minimum safety expectation of Camaco Fixture or Checking Gage Suppliers. If there is any deviation from this minimum safety requirement it is the responsibility of the Supplier to consult Camaco Representative for written approval.
    a. The entire gage must be free of burrs and sharp edges.
    b. No pinch points allowed. Use Clamps with no pinch points.
    c. Toggle Clamps and hinged drops must have mechanisms installed that prevent free falling onto the operator. Examples of such mechanisms are handle stops, toggle clamp lockout and hinge drop lockout.
    d. All gages that weigh more than 25 lbs. must have lift handles provided, all gages over 75 lbs. must have 4 threaded holes for eye bolts provided on the base for safe handling.
    e. The Supplier must ensure that any removable detail does not exceed 40 lbs.
    f. Other than the checking fixture/gage feet, no items are to protrude from the base of the checking fixture/gage.

9.0 Associated Documents:

1. Camaco Fixture/Gage instructions F-0010-65
2. Gage Check fixture buyoff sheet QA-170

Check Fixture/Gage Design and Build Standards

REVISION HISTORY:	**Fixture/Gage Design and Build Standards**
Revision Date	**Description of Change**
9/14/2017	Updated for Camaco LLC.
9/21/17	Updated tooling ball/hole positioning requirements.
8/7/2019	Details must be Alphabetically coded Net 47 are the preferred terms
05/03/21	Added # 15 3.0 mm distance for parts under 150 mm and 5 mm for parts over 150 mm