

GM 1927 10 Fixture Standards For Suppliers of Production Material



GM Confidential



Foreword

The **GM Fixture Standards for Suppliers of Production Material** was developed to establish common GM Supplier PPAP checking fixture standards worldwide. Previously, fixture standards existed at the divisional or unit level only.

In December of 2020 the **GM 1925** GM Fixture Standards for Suppliers of Production Material was changed to **GM 1927 10 GM Fixture Standards for Suppliers of Production Material**.

NOTE: This manual supersedes GM 1925 Fixture Standards 2014

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GM Fixture Standards for Suppliers of Production Material

I. Preface

A. Introduction

In accordance with The Automotive Industry Action Group (AIAG), The Advanced Product Quality Planning (APQP) Manual, and The Production Part Approval Process (PPAP), part suppliers will obtain fixtures (if and when required) to monitor their product as part of their quality plan. GM 1927 Supplier Quality Manual Section 1 Task 11 describes the Gauge development and approval phases.

Production part suppliers shall utilize this manual in addition to their own standards and minimum requirements when quoting, designing, and building fixtures for General Motors purchased parts.

The GM Supplier Quality Engineer reserves the right, with engineering approval, to modify the Gauge standards (including Geometric Dimensioning and Tolerancing and measurement points). The GM Supplier Quality Engineer will obtain direction and approval from GM Dimensional Engineering prior to the modification of these standards. The GM Supplier Quality Engineer is also required to procure the appropriate supporting documentation for these modifications (e.g., ECR's, EWO, marked drawings approved by engineering, etc.).

B. Scope

The **GM 1927 10 Fixture Standards** summarize the *minimum* requirements that apply to all GM suppliers PPAP checking fixtures worldwide. All GM suppliers must ensure that their sub-suppliers are also meeting these minimum requirements.

This manual exists to provide a uniform process for the procurement of PPAP checking fixtures, suppliers shall incorporate these standards into their in-process and / or sub-assembly gaging.

In addition to these standards, the following manuals must be utilized where applicable:

- The GM P.E.D.-114 Checking Fixture/Gauge Standards Manual (tolerances listed in the GM 1927 Supplier Quality Manual supersedes tolerances listed in the P.E.D.-114)

C. Assembly Gauge Definitions

Phase 1 Gauge: Production intent, Gauge with datums and hold downs present. Suitable for use as a holding fixture for scanning or CMM data

generation to support builds through M1 (Minimum required for Pre-production).

Phase 2 Gauge: Production Gauge – Phase 1 Gauge plus all measurement ports, check rails, etc. to support data needs from M2 builds through production and beyond.

Pull Ahead Gauge: A production intent Gauge brought forward in time to support PPO for IVER builds.

II. Part Supplier Responsibilities

- A. When fixtures are required, the part supplier is directly responsible for all elements of the fixture procurement process. In addition, the part supplier shall document all relevant activity. Due to the varying complexity of component parts covered under this document, the supplier must contact the procuring unit to determine the appropriate extent of the GM SQE's involvement.
- B. The Supplier shall ensure that the following apply to all fixtures:
 - 1. They are procured in a timely manner to meet program timing objectives, including IVER and Matching events, where applicable.
 - a. Approximate Timing Checking Fixture Phases once the GD&T drawing is P released by the DRE for GA parts:
 - b. Gauge Concept Timing Review TKO + 4 Weeks
 - c. Gauge Design Timing Review TKO+ 6 Weeks
 - d. Gauge Build Timing Review TKO + 27 Weeks
 - 2. They must agree with functional part usage.
 - 3. They must comply with part Geometric Dimensioning and Tolerancing (GD&T) by honoring the datum scheme.
 - 3.1 **NOTE:** Supplier is responsible for verifying if multiple attaching schemes are required. (Ex. With / without fasteners set-ups for free state checks)
 - 4. They are required to have variable data collection devices for all dimensional critical measurement points (KPC's PQC's DR's). For critical measurement points, the variable data collection device positioning details (SPC ports) must be hard attached to the fixture. The variable data collection devices must be capable of meeting all AIAG Measurement Systems Analysis (MSA) requirements.
 - 5. They must include the ability to discriminate part variation from nominal.

C. In accordance with IATF 16949:2016 International Standard for Automotive Quality Management Systems, the supplier shall establish and maintain documented procedures for measuring equipment control. This documentation should include:

1. Dimensional inspection report. The use of a Coordinate Measuring Machine (CMM) is preferred.
2. Documentation of engineering changes.
3. A Gauge Repeatability and Reproducibility study. (Gauge Repeatability or 1x10 minimum required for Preproduction).
4. A math base UG compatible fixture design.

The supplier shall maintain the change columns of both the fixture design and the fixture. The change column shall reflect the latest production design level whether the fixture has been affected or not.

The supplier is expected to resolve design problems in a timely manner. The design and construction source are responsible for immediate notification that a problem exists. Any revision that changes the original fixture cost must be approved by GM Purchasing.

III. Design Concept

- A. Prior to starting a fixture design, a preliminary design concept meeting shall be held. The input to this meeting is either the GD&T from the eSOR, or pre-release version of the GD&T. Core members expected to participate include the following: the GM Supplier Quality Engineer, the supplier's Engineer and the fixture design/construction source representative, GM Design Release Engineer (DRE), Dimensional Systems Engineer (DSE), and Supplier Quality Gauge Process Specialist upon request by the SQE. Other GM team members that should be included are; the Matching Engineer, BIW Quality Lead or designate, and the GM manufacturing plant representative if applicable.
- B. The design concept shall consist of an electronic sketch and or a written description of the fixture with sufficient detail in order that the fixture design process can proceed. The design concept should not be as detailed as a complete design, but it should include the following information:
1. The part position in relationship to the fixture base. In body position is standard. However, other orientations may be appropriate to maximize part/fixture usage with the approval of the GM Supplier Quality Engineer. 90-degree increments are recommended. However, it may deviate based on measurement accessibility. Design must include ability check to all requirements including back side requirements.
 2. A datum strategy which represents the specified Geometric Dimensioning and Tolerancing which may require multiple attaching schemes. Any auxiliary surface datums that are identified as qualified datums shall be retractable to allow inspection.

3. Details and devices for supporting the part (risers, datums targets).
4. Proposed clamping techniques must be identified as defined within the GD&T. (Measuring with or without clips, clamps, unclamped, etc.)
5. Details and devices for inspection of features such as:
 - Measurement points
 - Feature lines
 - Functional holes
 - Historic (lessons learned) areas of high process variability
 - For attribute check details on interior and exterior trim parts, the use of scribe lines or tolerance bands (check rails) are an acceptable method for part evaluation.
6. Acceptable construction materials based on fixture usage and environment to ensure functionality, repeatability, and reproducibility throughout the length of the part program.
7. Mating or adjacent part representations or features where applicable, duplication of mating part at nominal (e.g. Dupes).

C. Selection of Build Materials

When selecting build materials for fixture/Gauge checking surfaces, the Supplier should consider:

- Cost
- Durability requirements based on fixture use and conditions
- Construction methods
- Shape and area of checking surface on fixtures
- Environmental conditions
- Weight limitations of apply-type checking fixtures
- Robustness to maintain Dimensional Integrity during machining and the life cycle of the program.

Unless the Supplier Quality Engineer instructs otherwise, the design source will adhere to the following material requirements:

- Use steel or aluminum for risers, support members and brackets of N/C machined fixtures and checking details, this decision should in part, be based on the following factors: vehicle volumes, material cost, structural requirements, weight, ability to machine and corrosion resistance.
- Base setup pad requirements, flatness .01mm per 100mm square, maximum. NOT TO EXCEED +/- .13mm over all flatness.
- Use lightweight materials for hand apply fixtures
- All material must have the Supplier Quality Engineer's approval
- Avoid the use of wood as raw material to build any part of the checking fixture.

- D. Operator ergonomics, part loading and unloading, and accessibility for CMM inspection and Statistical Process Control (SPC), Product Quality Characteristic (PQC) data collection should be considered in the Design Concept.
- E. The X Y Z location(s) on product features where variable data will be collected to monitor critical measurement points shall be reviewed and approved by the GM Supplier Quality Engineer.

IV. Concept Approval

Concept Approval is required. (Use GM 1927 29 Gauge Concept, Design and Build Approval Workbook) The part supplier shall obtain Concept Approval from the GM Supplier Quality Engineer, the GM Design Release Engineer, Gauge Specialist and the GM Dimensional System Engineer prior to initiating the fixture design process.

Any change which may occur during the fixture procurement process that has significant impact on the original concept must be reviewed with the GM Supplier Quality Engineer.

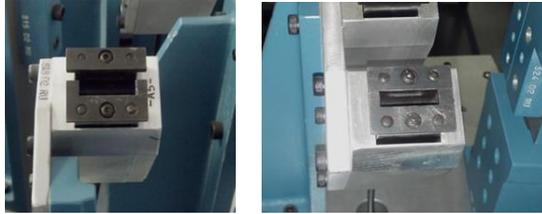
V. Design Requirements

The checking fixtures used to check the fit, form, and function of the part to the vehicle will be designed in a cooperative effort among the GM Supplier Quality Engineer, the supplier, the GM Design Release Engineer, Gauge Specialist and the GM Dimensional System Engineer and will be built through the supplier.

- A. The Design source shall refer to the concept sketch, the GD&T, the written description, and the measurement points provided (as well as) the customer's Technical Review as the controlling expression of the design. If any of this information was not supplied in the applicable SOR (CG4338 GM 1927 03 SQ SOR, Part specific SOR, etc) or at the Technical Review, it is the supplier's responsibility to obtain from the GM Design Release Engineer the information necessary to satisfy all support program deliverables.
- B. For mechanically attached parts the Gauge must check:
 - 1. In respect to inspection of part warpage, refer to GD&T for part measurement requirement, (includes free state, etc.)
 - 2. All Part of Assembly (POA) fastener locations with and without fasteners (approved by the GM Supplier Quality and Design Release Engineer)
 - 3. Profile / contour
 - 4. Part size
 - 5. Fixture must have the capability to measure flushness with/ without restraint and with fasteners (if required review GD&T to see how part is to be checked), by installing the part into the fixture. The fixture shall also contain release mechanisms by which to remove the part. No clamping pressure is permissible on A-surface(s) during part check with fasteners.

All metal clip attachments to be built with dual acting Jaw Mechanisms (where required and possible).

For checking without clips (e.g. doghouse attachments), clamping to be accomplished by hook/swing in clamp to clip attachment.



Dual acting Jaw Mechanisms



Hook/swing in clamp to clip attachment

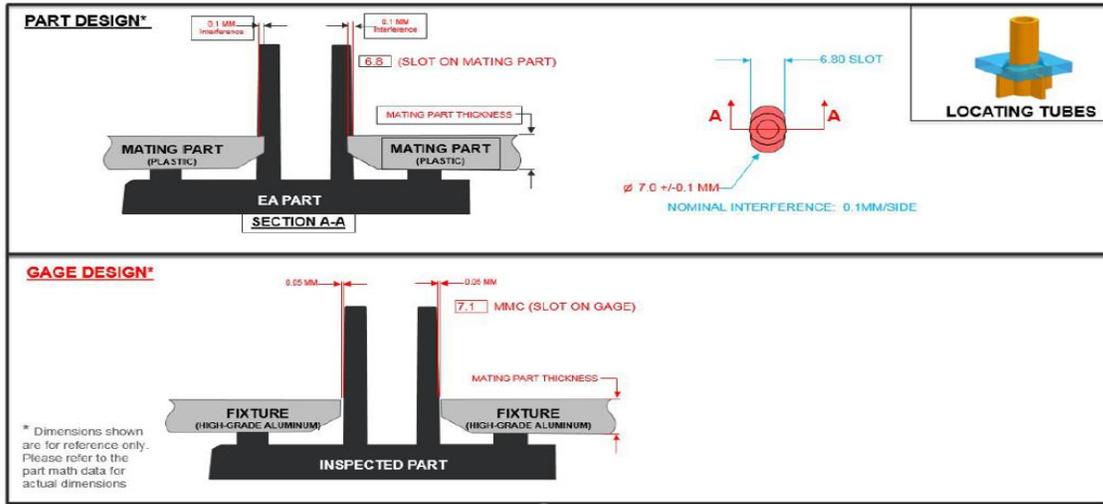
6. The fixture must be able to measure gap and flush at locations defined within the GD&T.
7. All flush and feeler rails to be designed to be 6mm offset for smaller parts less off set, E.G. parts with 0.5 or less tolerance> Provided CMM access is still attainable.
All flush and feeler callouts to be stamped and colored accordingly directly into rails.
Start and stop of flush and feeler pin zones to be clearly identified at checking edge rail.
8. All free state net datums to be retractable /removable. All free state net datums not to include clamps.
9. All door trim assemblies to follow GD&T requirements within the drawing. Requirements shown with/without clips. See Part / Commodity specific CG4214 GM 1927 03a Supplier Quality Door Trim, IP & Floor Console Statement of Requirements and Part GD&T.

C Elastic Averaging checking fixture guidelines

1. Locating Tubes

- a. The receiving slot size in the gauge equals the maximum material condition size of the EA tube on the part being inspected (It does not mimic the mating part).
- b. The fixture will use a high-grade polished aluminum or steel for strength (less wear) and less friction.
- c. Part will be installed in a single direction.
- d. Clamps required at selected tube interface points.

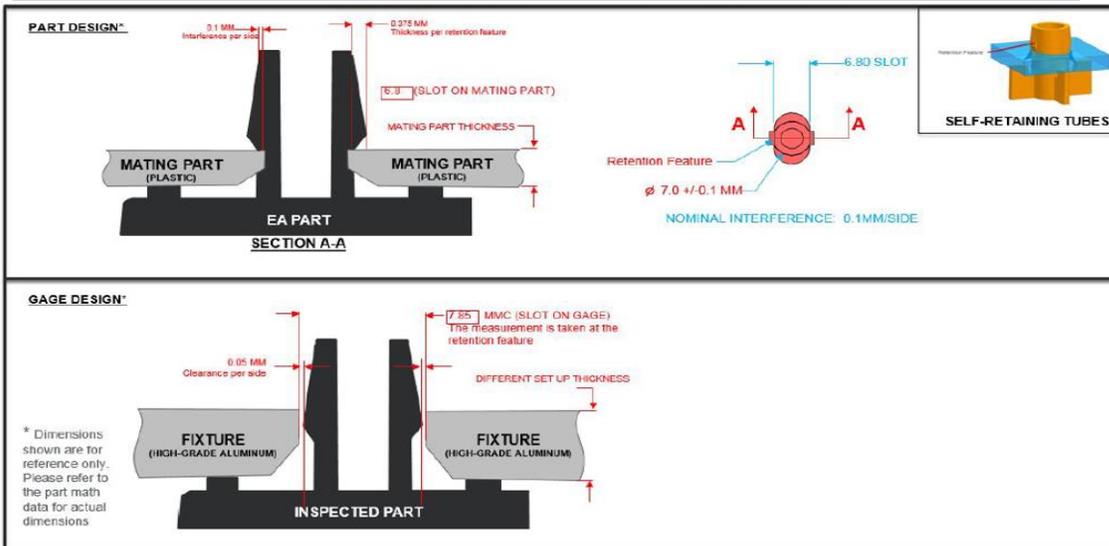
ELASTIC AVERAGING GAGE RECOMMENDATIONS: LOCATING TUBES



2. Self Retaining Tubes

- a. The receiving slot size in the gage equals the maximum material condition size of the EA tube on the part being inspected at the retention feature (It does not mimic the mating part).
- b. The fixture uses a high-grade polished aluminum or steel for strength (less wear) and less friction.
- c. Part is installed in a single direction.
- d. Clamps required at selected tube interface points.

ELASTIC AVERAGING GAGE RECOMMENDATIONS: SELF-RETAINING TUBES – SLOTS IN GAGE

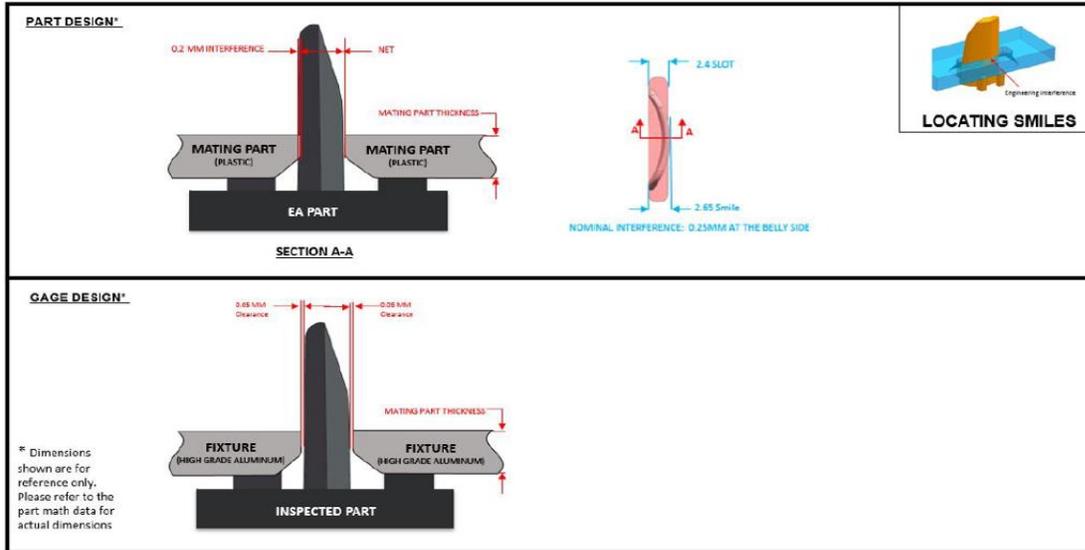


3. Locating Smiles

The receiving slot size in the gage equals the maximum material condition size of the EA tube on the part being inspected at the retention feature (It does not mimic the mating part).

- a. The fixture uses a high-grade polished aluminum or steel for strength (less wear) and less friction.
- b. Part is installed in a single direction.
- c. Clamps required at selected EA smile interface points.

ELASTIC AVERAGING GAGE RECOMMENDATIONS: LOCATING SMILES

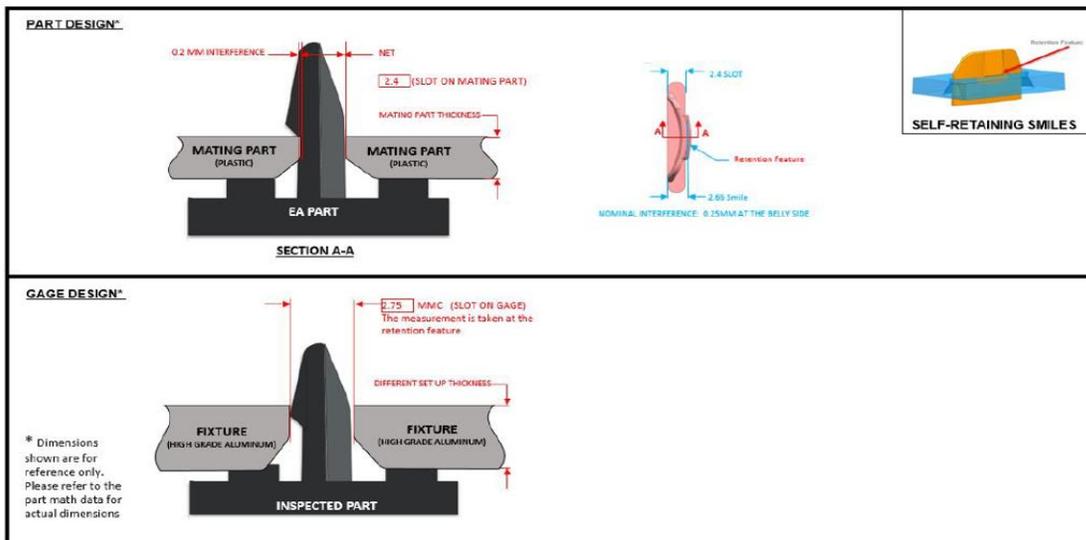


4. Self Retaining Smiles

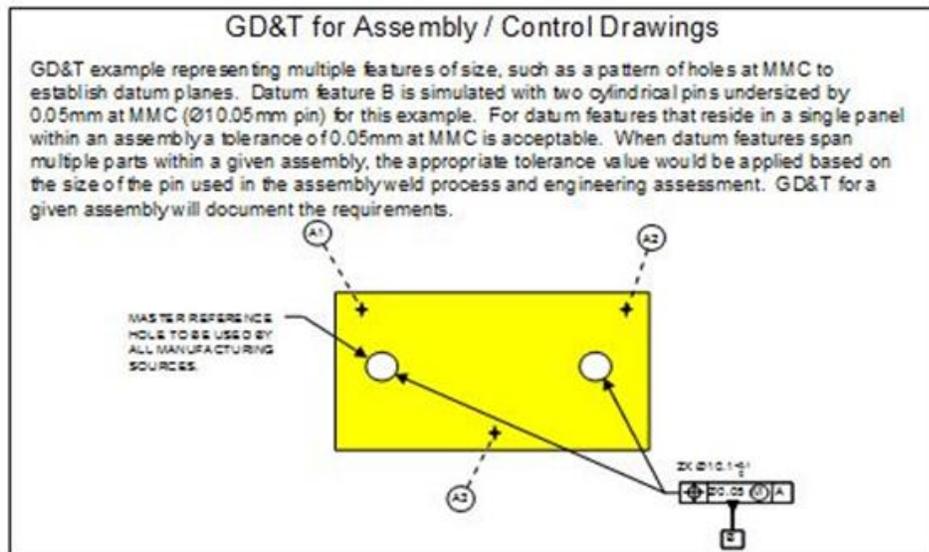
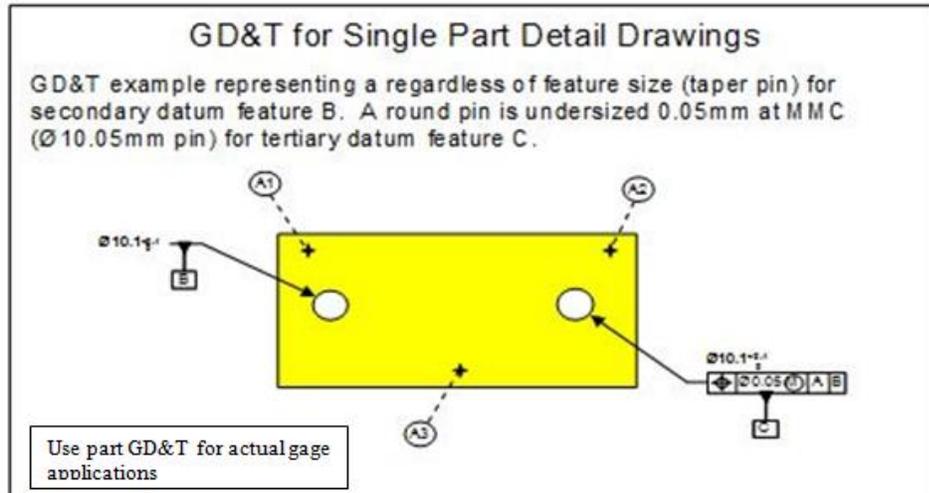
The receiving slot size in the gauge equals the maximum material condition size of the EA tube on the part being inspected at the retention feature (It does not mimic the mating part).

- a. The fixture uses a high-grade polished aluminum or steel for strength (less wear) and less friction.
- b. Part is installed in a single direction.
- c. Clamps required at selected EA smile interface points.

ELASTIC AVERAGING GAGE RECOMMENDATIONS: SELF-RETAINING SMILES – SLOTS IN GAGE



- D. For tape applied parts the Gauge must check:
1. Free State check of contour conformance to surface
 2. Flush / gap fit of part to fixture surface (less than 1 mm is default unless otherwise specified by GD&T)
 3. Part size
 4. Profile / contour
 5. Location of locating features such as pins, slots, holes, etc.
- E. All Check fixture drawings should have the following:
1. Details shall be complete in all views and must be dimensioned to machined surfaces and/or body and/or work lines.
 2. Drawings should include a representation of the part shown in its gaging position.
 3. All section views shall be referenced by section and sheet number corresponding to the call-out on the Gauge design drawing.
 4. The stock list shall include all stock sizes and must identify standard items by supplier name and full catalog number.
 5. All dimensions should be in metric however, the stock list may contain items in Standard English dimensions.
 6. Stock items (i.e., angle brackets, risers, hinge drops, slides, screws, dowels, etc.) should consist of standard commercially available materials whenever possible.
- F. Datum Hole Locator(s):
1. 2-way gauge pins should be set in the center of the feature, typically a slot, if used. Slides may be allowed for certain components. This should be discussed during the concept/design review.
 2. Recommend datum features of size be Regardless of Feature Size (RFS) or Maximum Material Condition shall be used to positively locate the part as specified in the GD&T. For Hole to Hole applications the best practice is insertable pins (stab pins). If insertable pins cannot be used due to access retractable locating pins should be used. Spring loaded pins are not allowed.
 3. Bodyshop sheet metal drawings affected by Hole-to-Hole:



(For Hole to Hole applications the best practice is insertable pins (Stab pin). Spring loaded pins are not allowed.

- G. Datums that are positioned directly adjacent to a spot-weld, seam weld or parting line shall be brought to the attention of the responsible Design Engineer. If the datum cannot be re-located, clearance shall be provided on the fixture detail to facilitate Gauge R&R.
- H. All details utilized for part inspection including check pin sizes shall be identified on the Gauge design. In addition, all removable and interchangeable details shall be identified including their associated function. The use of color-coding details has proven to be an effective technique in communicating the use of multiple model applications on the same fixture. Interchangeable details require the following:
 1. Hardened steel bushings for bullet-nosed locator pins.
 2. Permanently attached hand knobs.

3. Storage on the fixture base for interchangeable details

- I. To ensure consistent dimensional checking from construction to certification, the design should include documented start points for base alignment on a coordinate measuring device. These points can be tooling balls (preferred), bushings, blocks, or some other clearly identified zones on the base.
- J. The Gauge design shall be such that no detail overhangs the Gauge base when the detail is in any position, e.g. Swing in detail (clamps, SPC, DR, PQC, KPC ports, flush and feeler rails, etc...).
- K. All part information including math data used in the design and required for fixture construction must be identified on the fixture design (including latest revision level and date.)
- L. All changes to the fixture design shall be alpha-numerically indicated in a change notice block. A brief change description referencing the appropriate Engineering Work Order (EWO) or applicable engineering change number should be identified with each change event.
- M. Operator instructions and/or a sequence of operations on the use of the fixture shall be shown on the completed design. The use of multilingual operator instructions must be considered where applicable.
- N. The finished fixture design must be reviewed and approved by the GM Supplier Quality Engineer, the GM Design Release Engineer, Gauge Process Specialist and the GM Dimensional System Engineer.

VI. Build Requirements

- A. All fixtures shall be built to math data and GD&T
- B. All datums, inspection details, clamps, and interchangeable details shall be identified on the fixture in a visible location as shown on the design.
- C. For variable data collection devices, a standard zero block with bushing is to be mounted to the fixture base.
- D. Operator instructions and/or a sequence of operations on the use of the fixture shall be securely affixed to the Gauge.
- E. The use of eye bolts for fixtures over 35 pounds is recommended.
- F. All weldments shall be stress relieved.

- G. All loose and interchangeable details such as hand knobs and check pins, Dial Indicators shall be permanently attached to the fixture. The use of self storing (restrained), tethering devices or recoil type cables is recommended.
- H. The use of shims or shim stock is **not** an acceptable practice in the construction of GM checking fixtures.
- I. When templates are utilized, ¼” stock is an acceptable choice for template construction.
- J. Any steel non-check details susceptible to oxidation should be coated in such a manner as to provide long term protection based on usage, environment, etc. Wipe-on solutions that are removed by normal handling of the details are not recommended.
- K. All check pins shall be manufactured from an acceptable material and hardness to ensure durability and functionality throughout the life of the part program.
- L. Consider a Checking Fixture cover to avoid dust and humidity intrusion is highly recommended for locations where these factors are present.
- M. Fixture Construction Tolerances
1. All fixture details including fixture bases, datums, and inspection details shall be accurately manufactured in order to ensure the accuracy required for product inspection.
 2. General tolerance guidelines are as follows:
 - All datums used to position the part: +/- 0.05 mm.
 - Details used for digital/electronic measuring devices which check part features SPC's +/- 0.05
 - Part representation: +/-0.15
 - Surface contour features (flush checks): +/- 0.15 mm.
 - Trim line features (feeler checks): +/- 0.15 mm.
 - Template checks (profile of part): +/- 0.15 mm.
 - Check Pin Bushing location tolerance: +/- 0.10 mm
- N. An identification tag shall be affixed to each fixture supplied by the fixture source with the following information at a minimum and updated as required (see example below):
- Part Name(s).
 - Program Designation
 - Less Finish Part Number (If Applicable)

- Part Math Data Level
- GD&T Drawing Level
- Final Certificate Date
- “Property of General Motors”

GENERAL MOTORS CORPORATION			
PART NAME			
PROGRAM DESIGNATION			
GM PART NUMBER			
PART MATH DATA LEVEL			
GD&T DRAWING LEVEL			
FINAL CERTIFICATION DATE			
THIS GAGE IS THE PROPERTY OF GENERAL MOTORS			

If the fixture is utilized to inspect additional parts or assemblies, a separate tag containing the drawing numbers, engineering levels, and dates may be required /supplied by the fixture source. All tagging must be multilingual as required.

- O. It is required that the finished fixture build be reviewed and approved by the GM Supplier Quality Engineer, the GM Design Release Engineer, Gauge Process Specialist.

Pre-Production Part Quality Process (PPQP)

Pre-Production Operations (PPO)

Suppliers shall use a holding fixture that meets criteria specified in Checking Fixture Standards and repeatability requirements for repeatability (1x10). Fixture Datums must reflect GD&T callouts. Free state requirements identified in GD&T must be followed.

VII. Certification Requirements

- A. The certification must include (at a minimum) the following: datums, and functional Gauge features such as data collection devices, feeler checks, flush checks, nets, Gauge pins, pin locations, mating part representations, construction balls, etc. The certification must also include certification to multiple locating schemes (e.g., with / without fasteners) per GM requirements.
- B. The construction source shall develop an easily comprehensible X Y Z and vector type CMM certification report. The check sheet should be sufficiently documented to easily relate the check points back to the part drawing. An

example is provided below: All Bushing checks need to be projected to the built-in indicator offset.

X Master	X Check	X Diff.	Y Master	Y Check	Y Diff.	Z Master	Z Check	Z Diff.	Vec.Diff.	Type
Datum A2										
3900.000		3899.942 -0.058	500.000	500.086	0.086	1592.500	1592.500	-0.000	0.1033	SurfRd
Det #5 3MM Flr. Const.										
3910.000		3909.998 -0.002	-207.700	-207.812	-0.112	1605.000	1605.000	-0.000	-0.1119	SurfRd

- C. When a fixture is inspected and found to be dimensionally incorrect or when specifications are not met, the Tier 1 supplier is directly responsible to identify the root cause and implement corrective action.
- D. A new fixture certification is required for any fixture shipped outside of the region from which it was manufactured. This is to verify that no shipping damage has been done to the fixture.
- E. 3rd party certification audit may be requested at the discretion of the GM SQE (If required, it must be requested at the pre-sourcing phase to ensure comparable quotations).

VIII. Gauge Repeatability and Reproducibility Requirements

- A. Supplier shall ensure that Gauge R&R is conducted based on AIAG MSA Manual (latest Edition) and must include all critical measurement points for each locating scheme (e.g., with / without fasteners.).

Guidelines for acceptance of an Average and Range Gauge R&R study re:

- 1. Under 10% error Gauge system acceptable
- 2. 10% to 30% error May be acceptable based on the importance of the application, Gauge revision cost, etc.
- 3. Over 30% error Gauge system needs improvement. Make every effort to identify the problems and have them corrected.

If there is any question regarding whether the percentage of Gauge error listed in item 2 above requires improvement, contact the GM Supplier Quality and Design Engineer for direction.

- B. A Gauge R&R study should be performed after any modifications are made to the fixture which might affect the repeatability and reproducibility performance.

IX. Gauge Final Approval

- A. Supplier is required to contact the GM Supplier Quality Engineer for a completed fixture review prior to Gauge shipment.

- B. Supplier is required to obtain from the GM Supplier Quality Engineer an approved copy of the GM Global Request for Gauge Construction / Design review. Supplier is required to submit / maintain this document with PPAP documentation.
- C. The finished fixture build must be reviewed and approved by the GM Supplier Quality and Design Engineer.

X. Maintenance Requirements

- A. In accordance with IATF 16949:2016 Standard, the supplier must perform regularly scheduled fixture maintenance (based on usage) to retain the measurement capability of the fixture throughout the entire part program.
- B. The part supplier must continually update fixtures to the latest engineering change level on the identification tag, whether the changes affect the fixture or not.

XI. Glossary

Body Position: The positioning of the part in the fixture in the identical orientation the part will have in the final assembled vehicle.

Design Concept: The first level of development in the fixture design process. The purpose of the design concept is to establish and document the requirements of the fixture. This will ensure that the fixture design includes all of the requirements of the part supplier and GM.

Documentation Required (DR): Standard Product Characteristics that are deemed important to part function and Product Engineering will require process capability data documentation. REF capability requirements for PPAP versus production.

EA Elastic Averaging: GM Technology used to design part interfaces with certain degree of controlled interference for plastic parts mainly.

Gauge Certification: The dimensional verification that the fixture details (i.e. datums, SPC details, etc.) have been manufactured to facilitate accurate part measurement

Gauge Design: The final construction drawings that will enable the fixture builder to construct the fixture that is intended for the part supplier...

Gauge Repeatability and Reproducibility (Gauge R&R, GR&R or GRR): A measurement system analysis of the fixture. The analysis is described in the AIAG Measurement Systems Analysis Manual.

CMM Certification Report: Report that shows measured precision requirements that are used to verify that a Gauge /fixture conforms to design and dimensional specifications.

References:

- * IATF 16949:2016 International Standard for Automotive Quality Management Systems
- * AIAG The Advanced Product Quality Planning (APQP) Manual – latest edition
- * AIAG The Production Part Approval Process (PPAP) Manual – latest edition
- * GM 1927 GM Supplier Quality Manual
- * GM 1927 29 Gauge Concept, Design and Build Approval Workbook (Supply Power)

Revision History

Revision	Date	What	Who	Approving Organization
1.0	12/23/2020	Initial release	Carmelo Cupelli	Engineering Supplier Quality