



QUALITY METALCRAFT INC.

PRODUCTION

GAGE STANDARDS MANUAL

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PREFACE

- The purpose of this manual is to provide adequate information for all Quality Metalcraft subcontractors relative to gage design, gage construction and gage acceptance criteria.
- This manual's function is to distribute technical information as well as supplemental information contained in the purchase order.
- In addition, it should not be misconstrued as a means of relieving the subcontractor of any responsibility of producing a quality gage.
- As revisions are made to this manual, copies will be updated and sent to all subcontractors.

SUBCONTRACTOR RESPONSIBILITY

1. All gages shall be quoted, designed and constructed to meet or exceed all of the requirements and standards contained in this manual, unless superseded by final customer standard.
2. The subcontractor has the final responsibility for producing a gage that will check the part within 10% of part tolerances. Gage repeatability and reproducibility shall conform to AIAG Measurement System Analysis (4th Edition) long format, 2 operators minimum, 2 trial minimum, and should be less than 10% R&R (full tolerance) using the drawing tolerance for the characteristic. Any deviation is to be addressed by the potential gage sources in their quotation. Gage R&R's above 10% (full tolerance) shall not be considered, unless current technologies do not permit feasibility, or the cost exceeds the benefits. Acceptance of RFQ's exceeding 10% R&R (full tolerance) shall be at the discretion of QMC.
3. Accuracy verification of gage feature locations shall be performed using tooling balls, pins, blocks or some other clearly identified zone on the base.
4. Alignment locating pins should be removable without disassembling the gage. Exceptions must be agreed upon by the QMC Engineer and documented on the Gage Design / Verification Checklist.
5. Bilateral tolerances shall apply to all feeler surfaces with a bilateral print tolerance. The maximum tolerance of all gage features shall not exceed 10% of the part tolerance. Exceptions must be noted in the quotation and be agreed upon by the QMC Quality Engineer and documented on the Gage Design / Verification Checklist. In no case shall the tolerances applied allow an out of tolerance part feature to be measured within tolerance. The applied tolerances shall not negatively affect production because it uses excessive part tolerance.
6. All gage designs are the property of Quality Metalcraft and should not (in total or in part) be given to another company or duplicated without the written approval of the QMC Quality and Engineering departments.
7. The subcontractor is responsible for the regular submission of a progress report on new gage builds to the QMC Program Manager and QMC Quality Engineer.
8. Any changes in the cost of a gage, requested by the subcontractor, shall be communicated in writing immediately to the appropriate program manager with a copy of the request being sent to the cost estimating and purchasing departments.

9. Any request for information pertaining to a gage being built for Quality Metalcraft, shall be directed to the Quality Manager and responsible Quality Engineer.
10. The subcontractor shall adhere to the dates on the purchase order. In the event the assigned dates cannot be met, the subcontractor is responsible for submitting a request in writing to the Program Manager and Quality Engineer.
11. Costs incurred by Quality Metalcraft for receipt of fixtures beyond the date specified on the purchase order as well as additional inspection costs for the validation of corrected nonconformance features may be debited.

DESIGN REVIEW

1. Upon receipt of authorization to build the gage, the subcontractor shall submit a 3D gage concept to the Quality Engineer for concept approval.
2. The Program Manager will provide the final print and any specific customer requirements to the subcontractor.
3. The Quality Metalcraft Quality Engineer and Quality Manager will review the Gage Design and Verification Checklist and provide the supplier any necessary feedback.
4. Subcontractor must submit a 3D gage concept along with detail and assembly drawing for review by the Quality Engineer for final design approval.



GENERAL INFORMATION - PRODUCTION

1. A plaque with the sequence of operations will be permanently attached to the base of the fixture. The sequence of operations must be easily understandable and fully detail the operation of the gage. (I.E. clamping sequence, pin checks, feeler checks, SPC points, etc...)
2. A schematic diagram, corresponding to the sequence of operations plaque, must be attached to the base of the fixture. This diagram should clarify which checking features of the fixture are to be used on which areas of the part. Check fixture to be in body position when feasible.
3. If there is more than one clamp on the fixture, the sequence of clamping must be numbered on the clamps.
4. Surfaces used for flush checking are to be stamped with the word "FLUSH". This must be visible with the part mounted on the fixture. Note: If feasible, a feeler check or scribe line should be used in place of flush checks to enable a more accurate check of the surface in question. All feeler surfaces must be identified with the amount of feeler clearance and an MM symbol. Surfaces and feelers are to be color coded (reference color code chart on page 10). Additional unique colors shall be used for each additional tolerance range. Feelers are to clearly indicate tolerance and be color matched to the corresponding sequence of operations tag.
5. For scribe lines, full trench or groove lines showing complete tolerance band are to be used. This trench shall be colored yellow to make visibility easier. All feeler surfaces must be identified with the amount of feeler clearance and the units (MM). Surfaces and feelers are to be color coded accordingly for tolerances. All corresponding feeler zone locations are to be clearly identified with a permanently impregnated color dot from point to point identifying the specific areas on the fixture.
6. All fixture details must be coated to protect from corrosion using black oxide or other corrosion protection methods approved and documented in the design concept. (This includes nets surfaces, pins, feelers and base mounted blocks and details.)
7. All feeler surfaces must be either hard coated, anodized aluminum or steel.
8. All pins, feelers, holes, probes, etc, must be stamped with the corresponding drawing specification, a corresponding step number in the sequence of operations and schematic sketch. These items must also be permanently attached to the base of the fixture or by other methods approved and documented in the design concept. Color code feelers and surface accordingly. *Reference color code in standard.*

9. The base plate material for the fixture should be based on the mass and part tolerance at the concept design stage. The lightest materials should be used unless accuracy and tolerance become an issue. (e.g. large fixtures should have aluminum bases instead of steel.)
10. Go / No Go pins and details must be base mounted unless part configuration or the accuracy of the fixture dictates otherwise. Pin shall be stamped into the base.
11. When templates are required ¼" stock is recommended.
12. Unless otherwise specified, all pins for locating holes should be positive locating (Conical spring loaded pins or in some cases conical plug gages.)
13. All pins should be slide pins that retract into the fixture unless part configuration dictates otherwise. In these cases plug pins may be required. Stationary pins are not to be used for evaluation of hole locations unless agreed to in the design concept.
14. Body lines are to be scribed at 100mm increments across the check fixture in all directions.
15. Subcontractor must submit an acceptable 3rd party CMM gage layout and a matching numbered print or sketch. Measurement results reported to one decimal beyond the drawing, typically to the nearest .001mm. The print and sketch and the variable data should be easily correlated. This layout should include hand checks for all pins and feelers on the fixture to evaluate for size.
16. When a gage is found to be nonconforming to the Quality Metalcraft Gage Standards, corrections shall be made and the gage returned to QMC within a maximum of 10 working days, but in no case shall this compromise program timing.
17. When more than one area of the part is called out as a primary datum feature, the part must be clamped in each area.
18. Design reviews by Quality Metalcraft do not relieve the gage subcontractor from compliance to this standard.
19. All documents presented by the gage subcontractor to QMC must reference the Customer Part Number, Engineering Level, date and the QMC Job Number.
20. Clamping shall apply loads that are perpendicular to flat surfaces of the part. Swivel clamps will be considered if perpendicular loading is not feasible.
21. Check fixtures exceeding 35 lbs. will have eye-bolts in the base for lifting purposes.

22. Details of a fixture, which locate a datum feature, must also evaluate the true position of that datum feature when applicable. (e.g. One tapered pin for locating the part and a separate round pin for checking true position.)
23. Any deviations to this standard must be identified on the concept approval form with written acceptance by QMC.

Reference: Color code for feeler tolerances –

	<i>Yellow</i>	<i>+ / - 0.25mm</i>
	<i>Blue</i>	<i>+ / - 0.50mm</i>
	<i>Orange</i>	<i>+ / - 0.75mm</i>
	<i>White</i>	<i>+ / - 1.00mm</i>
	<i>Green</i>	<i>+ / - 1.25mm</i>
	<i>Black</i>	<i>+ / - 1.50mm</i>

GAGE DESIGN / VERIFICATION CHECKLIST INSTRUCTIONS

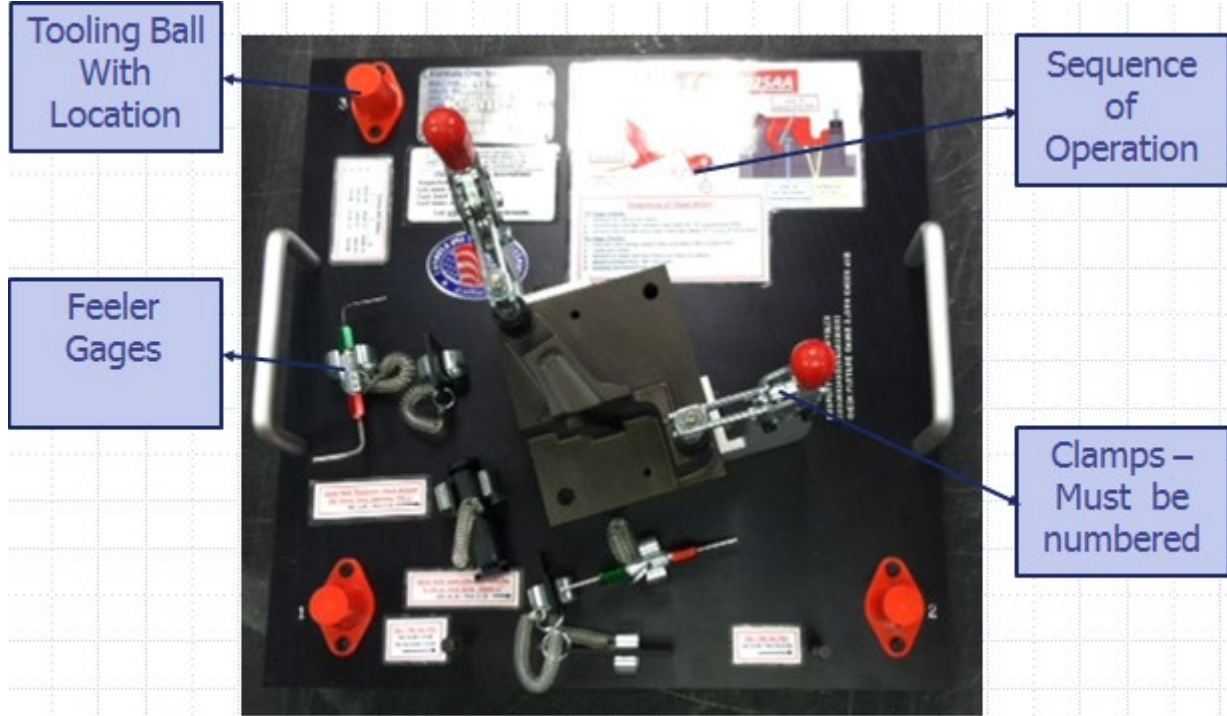
1. Verify that Quality Metalcraft Gage Standards have been provided to the subcontractor
2. Verify build tolerances are on the design. Note – The minimum tolerance to be applied shall not be less than 0.01mm unless required for accuracy and agreed upon and documented on the Gage Design and Verification Checklist.
3. Verify Datum locating pins are removable without disassembling the gage. (If not feasible, note reason on the Gage Design and Verification Checklist.)
4. Verify the identification tag is present, legible and clearly identifies :
 - A. –Customer Part Number
 - B. –Part Name
 - C. –QMC Job Number
 - D. –Print Revision Number
 - E. Supplier Name and Contact Number
 - F. Property of (QMC's Customers Name) – This may be a separate tag or directly on the base in some cases.
 - G. Submit one photo of the complete equipment showing the tag. The tag should be readable with the asset ID information clearly visible upon zoom in by the customer in order to verify that the equipment ID information is correct.
5. Verify that any swing arm templates are functional (when applicable).
6. Verify that lock pins are provided for any swing arm templates.

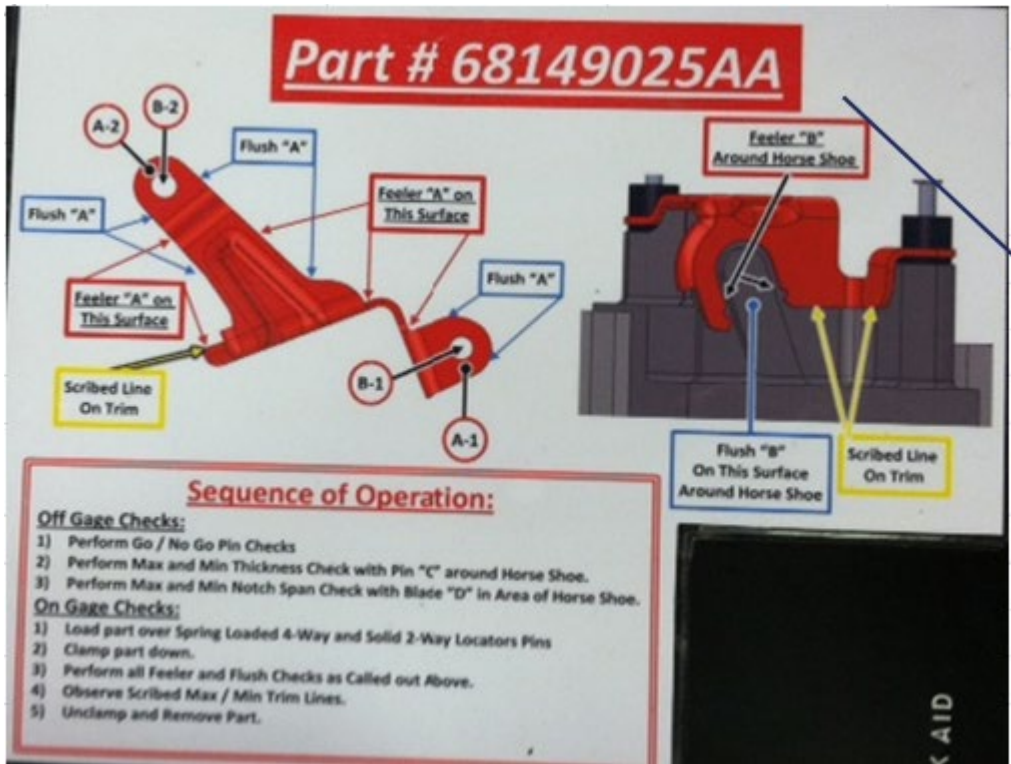
7. Verify that the fixture base has an appropriate sequence of operations plaque. For complex check fixtures the level of detail required will be defined by the responsible quality engineer.
8. Verify that a schematic sketch is attached to the fixture base and correlates with the sequence of operations plaque.
9. Verify that inspection components are correctly identified per this standard, and reference steps in the sequence of operations and schematic sketch.
10. Verify that the flush or sight checks are clearly identified and functional.
11. Verify the feeler check surfaces are properly implemented and identified.
12. Verify that any variable indicator is functional.
13. Verify that a "Gage Master" is available and identified for any variable indicator checks.
14. Verify that any scribe lines along the periphery are clear and properly identified.
15. Verify that all clamps on the fixture are operational and numbered with a clamping sequence if there is more than one clamp on the fixture.
16. Verify that clamp heads move in a line perpendicular to the part surface if they have solid feet, or that they are swing arms with swivel heads. Clamp loads must be applied over net or datum targets or in the center of a singular net/datum area.
17. Verify the size and location of the net surfaces when applicable.
18. Verify that the loading and unloading of parts on the fixture is easy and unobstructed.
19. Verify that all inspection equipment (pins, feelers, indicators, etc..) has secure storage locations on the fixture. Indicators must have calibration records forwarded with the fixture certification to QMC prior to/ or with shipment. Manufactures calibration is sufficient for indicators. Mitutoyo 0.5" indicators are preferred and must have zero blocks mounted to the fixture.
20. Verify that the correct base material has been used as agreed upon in the design concept.
21. Verify that a "Property of Customer" tag has been attached to the fixture base. Submit one photo of the "Property of Customer" ID tag close up, readable, and riveted to the tool.
22. Verify that 10% Gage R&R is feasible.
23. Verify that body lines are clearly identified.

24. Verify that fixture was built to customer print and cad data. If only one is to be used it must be specified.

25. Verify that a 3D cad design has been received with the completed fixture.

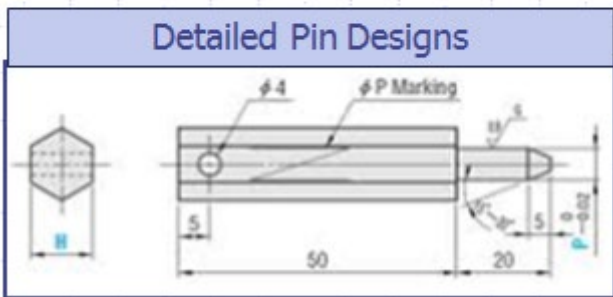
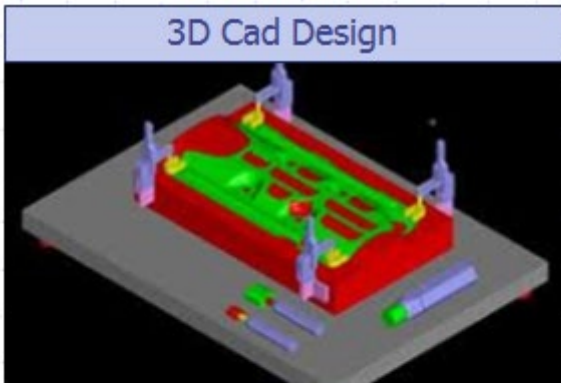
Pictorial References for Examples:



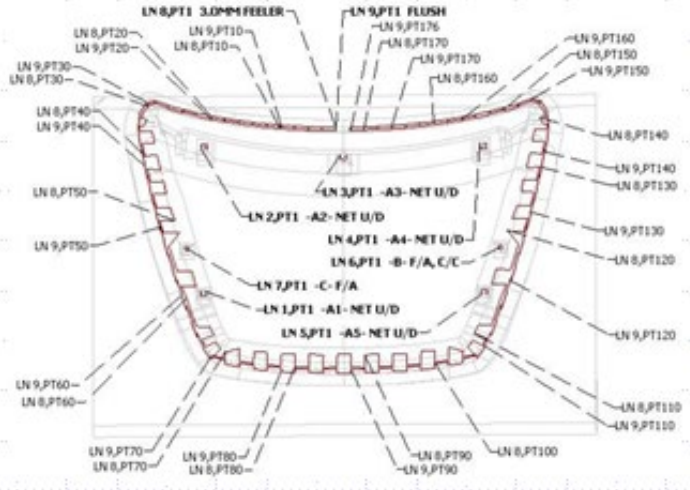


Sequence of Operation is to be detailed enough to insure proper use of gage

Pictorial References for Examples:



Check fixture layout reports to have dimensions listed and have a visual roadmap of the points



DIM D251= LOCATION OF POINT Ln:9 Pt:52						
AX	NOMINAL	MEAS	+TOL	-TOL	DEV	OUTTOL
X	-308.839	-308.832	0.150	0.150	0.007	0.000 ---#-----
Y	644.185	644.159	0.150	0.150	-0.026	0.000 ---#-----
Z	598.056	598.056	0.150	0.150	0.000	0.000 ---#-----
T	0.000	-0.027	0.150	0.150	-0.027	0.000 ---#-----

DIM D252= LOCATION OF POINT Ln:9 Pt:53						
AX	NOMINAL	MEAS	+TOL	-TOL	DEV	OUTTOL
X	-360.464	-360.448	0.150	0.150	0.016	0.000 ---#-----
Y	629.593	629.537	0.150	0.150	-0.056	0.000 ---#-----
Z	590.026	590.026	0.150	0.150	0.000	0.000 ---#-----
T	0.000	-0.058	0.150	0.150	-0.058	0.000 ---#-----

DIM D253= LOCATION OF POINT Ln:9 Pt:54						
AX	NOMINAL	MEAS	+TOL	-TOL	DEV	OUTTOL
X	-361.376	-361.357	0.150	0.150	0.019	0.000 ---#-----
Y	629.326	629.260	0.150	0.150	-0.066	0.000 ---#-----
Z	607.037	607.037	0.150	0.150	0.000	0.000 ---#-----
T	0.000	-0.069	0.150	0.150	-0.069	0.000 ---#-----

DIM D254= LOCATION OF POINT Ln:9 Pt:55						
AX	NOMINAL	MEAS	+TOL	-TOL	DEV	OUTTOL
X	-409.668	-409.642	0.150	0.150	0.026	0.000 ---#-----
Y	614.826	614.742	0.150	0.150	-0.084	0.000 ---#-----
Z	597.812	597.812	0.150	0.150	0.000	0.000 ---#-----
T	0.000	-0.088	0.150	0.150	-0.088	0.000 ---#-----

DIM D255= LOCATION OF POINT Ln:9 Pt:56						
AX	NOMINAL	MEAS	+TOL	-TOL	DEV	OUTTOL
X	-410.030	-410.022	0.150	0.150	0.008	0.000 ---#-----
Y	614.715	614.690	0.150	0.150	-0.025	0.000 ---#-----
Z	574.733	574.733	0.150	0.150	0.000	0.000 ---#-----
T	0.000	-0.026	0.150	0.150	-0.026	0.000 ---#-----

PROTOTYPE GAGE REQUIREMENTS

Prototype gage requirements will vary from program to program depending on allowed timing and end customer quality requirements. For quoting and manufacturing purposes, 3 grades of gage may be requested of a supplier.

Following is a description of what should be quoted and included for each type of gage:

Grade A

- Grey Wren Board for all major details
- 3mm clear feeler surfaces
- Scribe lines / sight check for all hole locations
- Go/No-Go pins required for hole size
- Go/No Go scribe line or flush check for all trim locations
- Aluminum base with J corners for alignment
- Clamps, clamping sequence, and sequence of operations

Grade B

- Brown Wren Board used for major fixture details
- 3mm clear feeler surfaces
- Sight check for all holes

- Mean scribe line for trim location
- Aluminum base with J Corners for alignment
- Clamps included as necessary

Grade C (lowest cost options for all materials and details)

- 20 Lb. Foam (Lowest cost options available) for major fixture details
- 3mm clear feeler surfaces
- Sight checks for all holes
- Mean scribe line
- No base required
- Clamp necessity will be specified

Prototype Fixture Build Requirements

With Prototype Gages the following assumptions should be used. Any additional requirements will be communicated specifically in the RFQ.

- A. Final 3D designs and detail and assembly drawings do not need to be submitted.
- B. Concept should be approved by appropriate QMC Quality Engineer.
- C. Gage R&R does not need to be submitted
- D. Gage Design Verification Checklist does not apply
- E. As cost and timing are chief concerns on Prototype work, any suggestions for cost decreases or timing improvements from the supply base would be greatly **appreciated**.