



Process Requirements for Steel Stamping Suppliers

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard describes the minimum process requirements for steel stampings and stamping suppliers, known throughout the rest of this specification as the "Process". The purpose of these requirements is to ensure the final stamping parameters meet the overall performance requirements as it relates to fit, form and function. This standard applies to finished parts produced by both GM Suppliers and internal GM facilities, known throughout the rest of this specification as the "Part Supplier". Any deviations from this specification will require approval, and applicable signatures on the Action Plan PPAP Worksheet available from GM Supply Power at Uniform Resource Locator (URL): <https://gmsupplypower.covisint.com/web/portal/home> under Collaborate and Document Library.

1.2 Applicability. Steel Stampings.

Note: For Press Hardened Steel (PHS) steel requirements refer to GMW14400. For PHS process Requirements refer to GMW16579. For stampings manufactured with dual phase steel refer to SAE 2015-01-0529 Paper, Case Studies of Edge Fracture of Dual Phase Steel Stampings available from URL: <http://www.sae.org/>.

1.3 Remarks. This specification is intended to evaluate a Part Suppliers ability to produce steel stampings that meet GM quality requirements. Emphasis is placed on the ability to supply a uniform and consistent part. While this specification details the requirements for global qualification of the component process, additional information and/or qualification submissions may be requested by the GM regional Supplier Quality Engineer (SQE) representatives. Addressed in this specification are the following:

- Forming Simulation Analysis for complex and/or suspect stampings.
- Forming Limit Diagram (FLD) verification.
- Material incoming inspection including verification of mechanical properties, steel chemistry, coating weight and coated type (for coated steel).
- Lubrication Requirements. See 9981881.
- Process controls, including Tool Setup Documentation (Die Setup Check Sheet), Total Run Analysis (TRA), and Active Inspection Process.
- Deviation to process.
- Production Part Approval Process (PPAP), Automotive Industry Action Group (AIAG) PPAP-4 (or equivalent).
- Quality issue response, i.e., Problem Resolution Report (PRR), Problem Resolution and Tracking System (PRTS), General Procedure Number 5 (GP-05), Read Across, 5 Phase, Eight Diamond (8D).

1.4 Requirement Wording Conventions. Within this specification the following conventions are applied:

- The word "shall" states a binding requirement which verifiable proof shall be provided to GM within 24 h upon request.
- The word "should" denotes a preference or desired conformance.

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2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

AIAG CQI-16	AIAG FMEA-4	ASME Y14.5	SAE 2015-01-0529
AIAG CQI-19	AIAG PPAP-4	IATF 16949	

2.2 GM Standards/Specifications.

9981881	GMW3032	GMW14400	GMW16812
GMW2	GMW3059	GMW15745	GMW16823
GMW8	GMW3335	GMW16546	GMW17205
GMW11	GMW3399	GMW16579	
GMW3011	GMW14019	GMW16656	

2.3 Additional References.

- AIAG Failure Mode and Effects Analysis, IATF 16949 Guidance Manual (AIAG CQI-16), AIAG CQI-19 Sub-Tier Supplier Management Process Guideline and Production Part Approval Process, available at URL: <http://www.aiag.org/>
- Autoform forming analysis tool, available at URL: <http://www.autoform.com/en/>
- Case Studies of Edge Fracture of Dual Phase Steel Stampings SAE 2015-01-0529 Paper, available from URL: <http://www.sae.org/>
- Global Quality Management System Requirements available at URL: <https://gmweb.gm.com/quality/oq/QR/Lists/Quality%20Requirements/Global%20Quality%20Manual.aspx>
- GM Built-in Quality Supply (BIQS) based Audit Process, available from GM Supply Power at URL: <https://gmsupplypower.covisint.com/web/portal/home> under Collaborate, Document Library, Supplier Quality folder
- GP-12 Early Production Containment (GM 1927-33 GP-12 Audit), GM10067 Global Matching Part Submission, GM 1925 Fixture Standards, Action Plan PPAP Worksheet, and GM 1927-16b Stamping Process Audit, available from GM Supply Power at URL: <https://gmsupplypower.covisint.com/web/portal/home> under Collaborate, Document Library.
- Math Drawing Files
- Pam Stamp forming analysis tool, available at URL: <http://www.esi-group.com>
- Statement of Requirements (SOR) Appendices B, N and W

3 Requirements

3.1 Use of Approved Material. The Part Supplier shall use an approved material which meets the standards of the approved/released GM Material Specification identified for the part on the released math data and/or drawing. Steel related specifications are GMW2, GMW3032, GMW3335, GMW3399, GMW16579 and GMW16823. Coating related specifications are GMW8, GMW11, and GMW3011. Lubricant related specifications are GMW14019, GMW16546 and GMW16656.

The approved released steel material cannot be changed without GM Design/Release and Validation Engineering approval. The request for material change shall be properly documented through the GM Engineering Work Order (EWO) permanent change process, or the Action Plan for a temporary change. Request for material change via the EWO process must properly be recorded in the Math/Drawing files. Any change to material shall require revalidation of the stamping process. The Part Supplier is to notify the GM SQE of any such revalidation to the stamping process.

3.1.1 The Part Supplier of stamped parts to GM is required to verify that incoming coils/blanks meet all specified material requirements. This shall include, but not be limited to:

- Steel thickness.
- Steel chemistry/mechanical properties.
- Zinc coating weight and coating type (for coated products).

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- Any other requirements determined by GM and/or as noted in the released Math/Drawing files.

3.1.2 The Part Supplier shall verify incoming blanks and/or coils from the steel mill and/or steel processing center meet the respective GMW material specifications. The Part Supplier shall review the respective material certification sheets accompanied with the respective blanks and/or coils and assure certifications sheets comply with the respective GMW material specification as released in math data prior to start of a production run. In the event the certification sheets do not comply with the respective GMW material specification, the Part Supplier shall hold and quarantine blanks and/or coils until material certification can be verified. If verification of material cannot be completed in the Part Suppliers certified test facility, the Part Supplier must use a certified third party test facility. In the event of a material spot buy, the Part Supplier shall adhere to the same certification and quality control processes noted previously for blanks and coils.

3.1.3 When the manufacturing process utilizes a Tailor Welded Blank, the Part Supplier shall assure proper orientation of the blank weld seam and direction of metal offset in blanks and of the final stamped part. Weld seam is verified for location per the released production drawing and/or math data. Process Failure Mode and Effects Analysis (PFMEA), Process Control Plans, Quality Systems, and Die Designs must ensure adequate process and quality controls are in place. The stamping supplier shall implement mechanical error proofing and assure such error proofing is in place and operating correctly prior to the start of a production run. Visual Inspections cannot be the only source of error proofing. The Part Supplier is responsible to ensure the tailor welded blank is fully error proofed through the entire stamping operation. Upon receipt of tools at the home line, the GM SQE will verify the mechanical error proofing detection system is in place and functional. The GM SQE will authorize part manufacturing upon verification at home line.

3.1.4 At minimum, the incoming certification sheet shall be monitored and a verification of the formability analysis should be checked, recorded and communicated to the stamping process department.

3.1.5 Class "A" surfaces (GMW17205), provided by the Part Supplier shall meet the requirements specified in the Sheet Metal Surface Quality Approval in the Global Quality Management System Requirements available at URL: <https://gmweb.gm.com/quality/oq/QR/Lists/Quality%20Requirements/Global%20Quality%20Manual.aspx>. Obtain a copy from the GM SQE.

3.2 Design Failure Mode and Effects Analysis (DFMEA)/Process Failure Mode and Effects Analysis (PFMEA). PFMEA and Control Plan Requirements are as follows:

- The Part Supplier shall use the rankings in AIAG Failure Mode and Effects Analysis (FMEA), available at URL: <http://www.aiag.org>, to determine PFMEA occurrence and detection. See example in Figure A1 in Appendix A. **Note:** This is Table Cr3 in the AIAG FMEA-4.
- PFMEA severity must match DFMEA severity, **including system DFMEA and part-specific DFMEA**. If failure is not listed on the DFMEA, then Part Supplier shall use the AIAG FMEA severity ranking.
- For failure modes with a Severity Ranking of 9 or 10, the corresponding Detection Ranking shall be 3 or lower. **Note:** Detection Rankings of 4 are also acceptable if there is traceability back to the original operation where the failure mode occurs or, there are no manual operations between the detection and the original operation, i.e., automated line. See Table A1 in Appendix A.
- For failure modes with a Severity Ranking of 7 or 8, the corresponding Detection Ranking shall be 4 or lower. See Table A1 in Appendix A.
- The Part Supplier shall ensure that tiered supplier PFMEAs adhere to these severity and detection requirements.
- All rework or repair processes in the Part Supplier manufacturing facility shall be incorporated in the production PFMEA and Control Plan and approved via PPAP. There shall be no rework permitted for failure modes with a 7 through 10 Severity Ranking unless approved in writing by the GM SQE manager or GM SQE manager upper level managers. **Note:** For the purpose of this requirement, "Rework" shall be defined as any work on the product that is outside of the validated or PPAP approved process and/or materials.
- All types of fasteners shall be verified for presence within the assembly process and have a Detection Ranking of 5 or less.
- For failure modes with a Severity Ranking of 9 or 10, the Part Supplier shall institute a Visual Management System that ties PFMEA to Control Plan to Work Cell to Operator Instruction to Verification/Inspection to Inventory control.

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3.3 Formability/Material Utilization. For designated high-risk parts, the Part Supplier shall submit to the release engineer a formability report which includes:

- Defined forming process.
- Forming Limit Diagram.
- Thinning Plot.
- Draw in diagram.
- Panel break down (binder wrap) 3 mm and 6 mm off bottom visual (simulation).
- Z-Displacement spring back for specific released material.

The formability report shall be submitted prior to initiating die design. See forming analysis tools Autoform, available at URL: <http://www.autoform.com/en/>, Pam Stamp, available at URL: <http://www.esi-group.com/>, or other capable industry approved forming analysis tool. The Part Supplier shall validate formed parts to the forming analysis report.

3.4 Steel Stamping In Process Inspections. Each stamping run shall have Tool Setup Documentation (Die Setup Check Sheet), see example Data Sheet A1 in Appendix A and a Total Run Analysis (TRA) completed with appropriate Part Supplier personnel sign off, see example Data Sheet A2 in Appendix A. The TRA shall be as compared to the GM master approved sample, and shall have:

- Verification of proper hole counts.
- Allowable thinning of material.
- Assurance of no splits.
- No excessive wrinkles.
- Burrs and/or sharp edges must be within industry standards. In the event burrs and/or sharp edges are in excess of the industry standard, the Part Supplier shall review the condition with product engineering to either accept the condition and/or offer a viable solution to improve the condition.

3.4.1 The Part Supplier shall inspect 1st off, last off, and have an in-process frequency inspection (Active Inspection Process). See example Data Sheet A3 in Appendix A. The in-process inspection of parts shall be determined by the Part Supplier and the GM SQE based on volume, rate of production, i.e., Strokes per Minute (SPM) with the intent to avoid large quantity of non-conforming parts. The inspection frequency shall be documented in the Part Supplier process control plan and shall not be altered without GM SQE approval.

3.4.2 Prior to start of system fill, the Part Supplier shall institute a batch and hold strategy and verify parts meet released specifications prior to submitting the batch for approval and release for shipment. The part shall be compared to a known standard as defined in the development of the stamping process, i.e., Material Required Date (MRD) 0, 1, 2, 3, and 4. MRD 4 aligns with AIAG PPAP. After all tooling development is finished and final PPAP validation collected, a GM approved master part sample shall be completed and recorded (part retention) for baseline of future product.

3.4.3 Any changes to the stamping process or tooling shall require revalidation through the entire stamping process, and/or specific operation if deemed applicable by the Part Supplier and GM SQE.

3.5 End of Line Rack/Container Loading Area. A dedicated rack/container shall be maintained and properly labeled. Adequate floor space should be allocated to safely load parts to racks/containers, and have an organized area to stage the packaging of the stamped parts. This area should be clean and have a proper part flow to avoid damage to the parts or safety issues for the operators. Work in Process (WIP) racks/containers shall be identified and properly marked so as not to mistakenly ship WIP containers to GM assembly plants.

3.5.1 Personal Protection Equipment (PPE) Control. Operators shall wear Personal Protection Equipment (PPE) to protect themselves as well as the parts from damage. Typical examples include, but not limited to, ring guards, belt buckle guards, watch guards, safety glasses, Kevlar gloves, sleeve and hearing protection, etc.

3.5.2 Work Instructions. All part loading areas for racks/containers shall have work instructions showing proper loading and/or orientation of part on the rack.

3.6 Part Supplier Audits. The Part Supplier shall develop a consistent audit with the requirements of AIAG CQI-16, AIAG CQI-19, and IATF 16949 Guidance Manual (AIAG CQI-16) available at URL:

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<http://www.aiag.org/>, GM Built-in Quality Supply (BIQS) based Audit Process, see GM Supply Power at URL: <https://gmsupplypower.covisint.com/web/portal/home> under Collaborate, Document Library tab, Supplier Quality folder, and IATF 16949. The GM SQE shall perform assessment audits to ensure Part Suppliers are in conformance to these requirements. Failure to be in compliance with the audit standards shall result in removal from the opportunity to bid on future business and may result in the loss of current business.

Note: Completion of the GM 1927-16b Stamping Process Audit, available from GM Supply Power at URL: <https://gmsupplypower.covisint.com/web/portal/home>, is required before a stamping supplier can be placed on the GM Approved Source List and supply parts to General Motors. It is also recommended to have the respective GM Design Release Engineer/Designing Engineer (DRE/DE) review the stamping facility prior to sourcing approval.

3.7 Part Verification Requirements. The Part Supplier shall ensure and verify part conformance to all applicable specification requirements. The Part Supplier shall have calibrated/certified checking instruments/equipment on site. The Part Supplier shall notify GM at Strategic Sourcing Process (SSP) the type of equipment (Coordinate Measuring Machine (CMM), Scanning, etc.), the Supplier will utilize for their part verification. Testing on every lot shall be performed until the process is determined to be in control as measured by successful completion of non-saleable part requirements Action Plan and saleable PPAP. For the purpose of this requirement, a lot shall be defined as a shipment, e.g., MRD 1, MRD 2, etc. or plant work shift, e.g., 8 h. In process frequency inspection shall be determined by the Part Supplier and the GM SQE based on manufacturing capability of the part, rate of production, Stroke per Minute, (SPM) with the intent to avoid large quantity of non-conforming parts. Inspection frequency shall be documented in the Part Supplier process control plan and shall not be altered without GM SQE approval. Data taken from testing and inspection frequencies shall be documented and monitored per the agreed upon process control plan.

3.8 Manufacturing Process.

3.8.1 Dies. The Part Supplier is responsible and shall develop control plans for the maintenance of proper stamping dies to meet the quality needs of the material and part being processed. The Supplier shall develop blanking/stamping dies and laser to incorporate the Direction of Blanking/Pierce/Punch/Trim as shown for parts identified in the Electronic Statement of Requirements (eSOR).

3.8.1.1 Die Selection. The Part Supplier shall be responsible to ensure their dies have sufficient tonnage capacity to produce parts meeting all requirements. The Part Supplier shall use industry standard equipment to monitor potential die wear or other tool maintenance needs. Data shall be recorded and compared at least quarterly, unless agreed to otherwise by GM SQE.

3.8.1.2 Die Setup Parameters. The Part Supplier shall measure and record the parameters of the die setup. The stamping process shall be run within pre-established parameters. If nitrogen pressure monitors are not used as part of the stamping manufacturing process, then the Part Supplier shall have (two) bottoming pressure marker in the draw and/or form operation and should be located in the upper die when possible.

Parts produced during periods outside of established control requirements shall be either discarded or quarantined until the parts can be evaluated to ensure conformance to all requirements of the manufacturing process control plan. Once established, the die setup process cannot be altered without designated management authorization within the manufacturing facility, i.e., Manufacturing, Quality, and Production Designated Management Personnel must have final approval and signoff. Production Operators do not have authorization to approve an altered die setup process. Machine controls shall be locked out and access restricted to authorized personnel only.

3.8.1.3 Die Control Plans. The Part Supplier shall develop a control plan, for each stage of the process that meets all part specification requirements. An approved Preventative Maintenance Plan shall be developed and for the specific tool(s).

3.8.2 Post Process. The Part Supplier shall have a method to verify the dimensional tolerances of parts before and after any trimming operations or hole piercing/cutting operations for any secondary processing of the part. The Part Supplier shall design their dimensional measurement strategy to allow for "as needed" dimensional checking of parts at each step of the forming process to enable trouble-shooting and to help understand all sources of dimensional variation. Post stamping rework processes that involve heating, tempering of part, Electrodeposition Coating (ELPO/e-coat), and zinc coating unless specifically required by the part specification and as shown on the engineering drawing and in applicable GM specifications (see 2.1), are prohibited. For Class A panels where post stamping rework is required to eliminate defects; the Part Supplier shall assure any

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