GM WORLDWIDE ENGINEERING STANDARDS	**Material Specification**	**GMW16579**

Material and Process Testing Requirements for Press Hardened Steel and Stamping Suppliers

1 Scope

This document describes the minimum process and internal testing requirements for producers of hot stamped parts.

1.1 Material Description. Hot stamping, or press hardening as it is also known, utilizes a steel of high hardenability such as 22MnB5 that is heated to convert the microstructure to austenite followed by stamping in a water cooled die to produce the proper part shape and to simultaneously quench the steel to create a martensite rich microstructure. This process produces parts with varied microstructures consisting of combinations of tempered martensite and non-martensitic transformation products. Parts may also be specified to contain soft zones, which are lower strength than the surrounding metal and may not be fully martensitic in structure.

1.2 Symbols. Not applicable.

1.3 Applicability. Typical parts covered by this specification are those that require extremely high strength and are generally critical to passenger safety. These parts are found throughout the body structure and closures, with typical applications including but not limited to door beams, center pillar reinforcements, floor reinforcements, and upper body roof rails.

2 References

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

2.1 External Standards/Specifications.

AIAG CQI-9	ASTM E140	ISO 1463	ISO 6892
ASTM B487	IATF 16949	ISO 4287	

2.2 GM Standards/Specifications.

GMW3059	GMW3335	GMW14400

2.3 Additional References.

- GM 1927-16b Press Hardened Steel Process Audit
- Statement of Requirements (SOR) Appendix N

3 Requirements

3.1 Requirements on Test Specimens. Not applicable

3.2 Marking. All parts shall be marked as shown in the Statement of Requirements (SOR) Appendix N.

3.3 General Requirements. All sheet metals shall be produced at supplier facilities approved by GM and will be shown as approved to GMW14400. All hot stampings shall be produced at hot stamping supplier facilities approved by GM and will be shown as approved to GMW16579. Approved suppliers are listed in the GM Approved Materials Source List and can be provided by your GM Global Purchasing Supply Chain (GPSC) buyer.

3.3.1 Suppliers of hot stamped parts to GM are required to verify that incoming steels meet all specified material requirements. This shall include, but not be limited to: steel thickness, steel chemistry, coating weight and coating type (for coated products) and any other requirements determined by GM and/or the released part drawing/math

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data. The supplier is responsible to ensure that the steel, the heat treatment, the stamping process, the die cooling, the post form trimming, etc., are capable of producing parts meeting all specified requirements.

3.4 Supplier Audits. Suppliers shall develop a Heat Treatment Assessment Plan consistent with the requirements of Automotive Industry Action Group (AIAG) standard CQI-9 Heat Treat System Assessment Process Table I "Dry Contact Press Hardening". General Motors shall perform assessment audits to ensure suppliers are in conformance to these requirements. Successful completion of the CQI-9 audit and the GM 1927-16b Press Hardened Steel Process Audit is required before a hot stamper can be placed on the GM Approved Source List and supply parts to General Motors. Failure to be in compliance with the CQI-9 Audit standards shall result in removal from the opportunity to bid on future business and may result in the loss of current business.

3.5 Supplier On-Site Testing Requirements. Suppliers providing Press Hardened Steel (PHS) parts to General Motors are required to have on-site testing capability to perform part evaluations to ensure conformance to specification requirements and to monitor quality of parts as they are produced. The laboratory shall have operator(s) that have adequate training to perform such tests and operators shall be available to perform testing consistent with their quality plans during all shifts when parts are being produced. At a minimum, suppliers are required to be able to perform tests 3.5.1 through 3.5.5.

3.5.1 Microstructural Evaluation. Suppliers shall have the proper equipment to section, mount, polish, etch, microscopically examine and photograph samples at a minimum magnification of 500x and resolution > 1 µm with a metallurgical microscope to determine the phases present in test samples.

3.5.2 Hardness Testing. Suppliers shall have the capability to perform Rockwell C hardness testing. Suppliers shall also have the capability to perform Vickers or Knoop micro-hardness testing and provide representative photographs.

3.5.3 Mechanical Properties. Suppliers shall have the capability to perform mechanical property testing with full size and subsize tensile bars following GMW3335 tensile testing requirements.

3.5.4 Thickness Testing. Suppliers shall have the capability to perform thickness testing, including part thickness, coating thickness and thickness of each alloy coating layer (coated parts), including the steel/coating interface layer. Thickness testing shall be performed using a suitable layer thickness gauge, online x-ray gauge, or from a specimen sectioned perpendicular to the panel surface per ASTM B487 or ISO 1463. On uncoated steels, the supplier shall also have the capability to measure decarburization depth.

3.5.5 Surface Texture. Suppliers using aluminum-silicon coated steel shall have the capability to measure surface roughness using a profilometer per ISO 4287.

3.6 Part Verification Requirements. Suppliers shall ensure and verify part conformance to all applicable specification requirements. Testing prior to Non-Saleable, Saleable, and Fully-Approved Production Part Approval Process (PPAP) shall be conducted on the first part of each production run and on a part from approximately the 20th sequential die hit (i.e., steady state part) of every production run until the process is determined to be in control as measured by successful completion of full PPAP. For the purpose of this requirement, a production run shall be defined as a product run, e.g., Mule, Integration Vehicle Engineering Release (IVER), Material Required Date (MRD)1, MRD2, etc., or plant work shift, e.g., 8 h. The supplier shall cut at least six (6) samples from a part, unless otherwise agreed with GM Supplier Quality and Product Engineering, to evaluate all requirements listed in subsequent sections for each sample. The specific test locations shall be established prior to first shipment to GM and chosen from the areas of interest, e.g., hot and cold areas of the part exiting the die as shown through thermal imaging, critical areas identified by Computer Aided Engineering (CAE)/Finite Element Analysis (FEA), or typical areas of concern based on past knowledge. Part geometry shall also be considered so that at least one tensile sample can be extracted.

3.6.1 Part Thickness. Thickness shall be evaluated in flat areas as well as in radii and draw areas. Formability analysis and corresponding thinning maps shall be used to select the suspected worse-case locations. No more than 17% thinning is allowed in any area of the part unless approved by GM Engineering.

3.6.2 Hardness. Hardness shall be evaluated at all six test locations and shall meet the property requirements as shown in Table A3 "Hot-Stamped/Die-Quenched Product Mechanical Requirements" of GMW14400. If the hardness is converted from one scale to another, the conversions in ASTM E140 shall be used.

3.6.3 Mechanical Properties. The mechanical properties of the part shall be evaluated by machined tensile bars taken from flat sections of the part. The method used to cut and prepare tensile specimens for evaluation shall be appropriate for the ultra-high strength of the material. Any metallic pre-coatings such as aluminum-silicon (AS), zinc (HDG), galvanneal (HDA) or zinc/nickel (EG Zn-Ni) shall be left on the sample for testing and

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determination of thickness. In the case where part size and/or shape are not conducive for the removal of conventional tensile bar sized samples, sub-size tensile bars shall be used as described in ISO 6892.

3.6.4 Coating Thickness. Mounted samples shall be used to evaluate the cross sectional thickness of coated parts after heat treatment. This analysis shall include measurement of the total thickness of the coating as well as of the interdiffusion layer between the coating and the steel as defined by Figure A1 "Representative Cross Sections of AS60G60G Coating in Heat-Treated Components Illustrating Coating Interdiffusion Layer Measurement" of GMW14400. Optical photomicrographs of the coating and the transition layer shall be taken at 500x and 1000x. The magnification and a transition layer reference line shall be included on all photos taken at 500x to show the thickness measurement of the interdiffusion layer. If parts are cleaned (mechanically or media blasted) to remove the oxide coating, coating thickness shall be measured after the oxide removal operation.

3.6.5 Coating Analysis. Suppliers shall verify, through microscopic evaluation, that the manufacturing process is capable of producing parts free of surface discontinuities in the coating and surface of the steel that could negatively affect part performance such as, but not limited to; liquid metal embrittlement (LME), coating cracks as defined in 3.2.11 "Coating Quality" of GMW14400, loss of coating adhesion, etc. An example of LME is shown in Appendix A, Figure A1.

3.6.6 Surface Texture. Suppliers shall verify, through profilometer readings, conformance to requirements set forth in 3.3.3.1 "Surface Texture" of GMW14400.

3.6.7 Surface Decarburization. Suppliers shall verify, through microscopic evaluation, that the decarburization depth does not exceed that defined in 3.3.5 "Uncoated PHS: Surface Decarburization" of GMW14400.

3.6.8 Bend Test. Bend testing is required for steel supplier qualification and initial part production verification by saleable PPAP. Samples shall be removed from finished parts using laser or water jet cutting. If a suitable size sample for bend testing cannot be removed from the part, flat samples from the production material may be heat treated and die quenched in the production representative process according to the supplier's process control plan, or waived by engineering. Refer to bend test requirements in 3.2.4 "Bend Test Requirements" of GMW14400.

3.6.9 Blank Temperature Heat-up Profile. As part of the Production Part Approval Process (PPAP) of coated components, blank temperature studies must be conducted to verify that blank heating rate in the applicable temperature range approaching the coating liquidus temperature does not exceed the critical rate to induce coating liquefaction (approximately 12 °C/s). This study must be performed on each furnace as defined in AIAG CQI-9.

3.7 Sample Report. The supplier shall compile the information gathered from 3.6 for review by GM Supplier Quality. The report shall be compiled following the same order of testing detailed in 3.6. Each page shall be numbered and the title of each page shall use the appropriate paragraph number and heading. The report shall include tables that summarize the compiled data and any appropriate photomicrographs. A standardized template is available for PPAP submission; contact GM Supplier Quality or GM Materials Engineering.

After process control has been achieved, testing frequency shall follow requirements set forth in AIAG CQI-9, Process Table I "Dry Contact Press Hardening". In addition, tensile, hardness, and surface texture testing shall be completed on a lot control basis at lot start-up, lot end, and with a minimum frequency of no less than once per shift during the run.

3.8 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to obtain a GM-approved International Material Data System (IMDS) submission.

3.9 Additional Requirements.

3.9.1 Quality Requirements. The supplier shall have quality system procedures compliant with IATF 16949 or as required by the GM Global Purchasing and Supply Chain (GPSC) department demonstrating that the product will conform to all specification requirements. The data required to be submitted for this specification for each shipment will be determined by the GM region which the material is used. A supplier providing parts to this specification shall develop and maintain an appropriate quality control plan, approved by a local Supplier Quality or Materials Engineer. This plan shall include how finish part performance will be monitored, including test methods, test locations, the frequency of testing.

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