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| WORLDWIDE ENGINEERING STANDARDS | General Specification | GMW17406 |

# Chrome Plated Plastic Parts Process Requirements

## 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 process requirements for chrome plated plastic parts, known throughout the rest of this specification as the “Process”. The purpose of these requirements is to ensure that the level of final finish and performance on chrome plated plastic parts meets or exceeds the level expected by the vehicle owner. 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 need to be approved by a representative of the Part Supplier and GM’s Bill of Material (BOM) Family Owner (BFO), Global Process Leader (GPL), Materials Engineer (ME) using the Deviation Request Form in Appendix A.

**1.2 Applicability.** Chrome plated plastic parts.

**1.3 Remarks.** This specification is intended to assist supplier quality engineers in evaluating a Part Supplier’s ability to produce chrome plated plastic parts that meet GM’s requirements. Emphasis is placed on the ability to supply a uniform and consistent part. While this specification details the requirements for global qualification, additional information and/or qualification may be requested by GM regional Supplier Quality Engineer (SQE) representatives. Additional data required to be submitted will be determined by the regional SQE representatives. Addressed in this specification are the following

- Raw material/molding preparation/setup.
- Plating line approvals (trim transmittals per GMW16193).
- Rack loading/unloading areas.
- Plating lines.
- Chemicals/Chemical Process controls.
- Plating rack tooling.
- Plating line maintenance.
- Performance testing.
- Deviation process.
- Production Part Approval Process (PPAP), Automotive Industry Action Group (AIAG) PPAP-4 (or equivalent).
- Quality issue response.

**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-11 | AIAG FMEA-4 | AIAG PPAP-4 |

**2.2 GM Standards/Specifications.**

| | | |
|---|---|---|
| GMW3059 | GMW15572 | GMW16882 |
| GMW14668 | GMW15581 | GMW17083 |
| GMW15424 | GMW16193 | GMW17205 |

**2.3 Additional References.**

- Automotive Industry Action Group (AIAG) Special Process Plating System Assessment CQI-11, Failure Mode and Effects Analysis (FMEA) FMEA-4 and Production Part Approval Process (PPAP) PPAP-4 available at Uniform Resource Locator (URL): www.aiag.org.
- Dimensional Control Systems (DCS) File Log from Unigraphics (UG).
- GM1927-16b Chrome Plating Plastic Process Audit spreadsheet available at GM Supply Power at URL https://gmsupplypower.covisint.com/.
- GM Materials Approved Source List.
- Process Control Plan.
- Statement of Requirements (SOR).

## 3 Requirements

**3.1 Molder.**

**3.1.1 Use of Approved Substrate.** The Molder (working with the Part Supplier) shall select an approved substrate. These substrates are approved by GM Materials and listed under the Approved Source List. For Acrylonitrile Butadiene Styrene (ABS), GMW15572 T5 or T6. For ABS/Polycarbonate (PC), GMW15581 T7. This substrate cannot be changed after PPAP approval without approval and revalidation. In certain situations, more than one substrate can be approved during the PPAP approval, but during production this does not mean that both substrates can be used at will and have mixed inventory. The identification of which substrate used shall be identifiable on the finished part. No regrind material shall be used for chrome plated parts

**3.1.2 Melt Flow Monitoring.** The incoming plastic should be monitored for melt flow to understand the impact to the molding process. At minimum, the incoming certification sheet shall be monitored and an independent verification of the melt flow should be checked, recorded and communicated to the molding process department.

**3.1.3 Substrate Stress Test.** Each molded lot shall be inspected for substrate stress, Glacial Acetic for ABS, as required in the GMW14668 (GMW17083). The part shall be compared to a known standard as defined in the development of the molding process, i.e., PPAP. After all development is finished and final PPAP validation collected, a substrate test shall be completed and recorded (part retain and/or photo) for baseline of future product. Any large changes to the molding process or tooling shall require revalidation through the plating process focusing on adhesion related testing.

**3.1.4 Parting Line Prep.** All parts requiring a secondary operation to improve the parting line, i.e., inside door handles, shall follow GMW15424. Supplier shall have approved secondary operation and testing method by the GM SQE, BFO or GPL.

**3.2 Plater.** All plating suppliers (confirmed by the Part Supplier), regardless of tier, shall have GMW16193 approval (with the exception of Code A, Type 3). Approval letters for each matrix shall be completed.

**Note:** The Molder and Plater shall be from the same company or have a defined and approved financial relationship. Any deviations to this process shall be reported to GM and approved by Engineering and Supplier Quality GPL.

**3.2.1 Rack Loading/Unloading Areas.** Dedicated areas for rack loading and unloading shall be maintained and properly labeled. Proper floor space should be given to safely load and unload the parts to the rack and have an organized area to stage the packaging of the molded parts and finished goods. These areas should be clean and have a proper part flow to avoid damage to the parts or safety issues for the operators.

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**3.2.1.1 Rack Loading Time**. Proper time must be given for each rack. This reduces the chance for damaging or miss-loading parts. Offline loading may be necessary for high volume racks to ensure proper loading time. In other instances, multiple operators can be assigned to each rack to help reduce loading time.

**3.2.1.2 Rack Unloading Time.** Proper time must be given for each rack. This reduces the chance for damaging parts. As stated in 3.2.4, offline unloading may be necessary for high volume racks to ensure proper unloading. In other instances, multiple operators can be assigned to each rack to help reduce unloading time.

**3.2.1.3 Lighting Levels.** Lighting levels should be adequate and consistent from each station of loading area. 1100 lx to 2200 lx (100 foot-candles to 200 foot-candles) are preferred. Each facility shall have internal lighting standards for their part inspection areas to detect molding issues and damaged parts.

**3.2.1.4 Mutilation Control**. Operators shall wear mutilation Personal Protection Equipment (PPE) to protect the parts from damage. Typical examples include, but not limited to, ring guards, belt buckle guards, watch guards, etc. On complex racks and racks with auxiliary anodes, it is a best practice to have removable protection utilized during the loading procedure.

**3.2.1.5 Work Instructions.** All part racks shall have work instructions showing proper loading and/or orientation of part on the rack.

**Note:** There shall be no mixed substrate parts on a single flight bar. If both ABS and PC/ABS are plated on a single line mixing parts are not allowed.

**3.2.2 Plating Lines.** Plating lines shall be automatic and computer controlled. Process time, amperage, temperature and level controls shall be computer controlled or automatic.

**3.2.2.1 Hoist Control.** For all hoist type platers, the motion of the part shall be controlled automatically. Manual operation or timing is not allowed without a detailed deviation. This is required to insure consistent processing.

**3.2.2.2 Amperage Control.** For return type hoist platers, the current delivered to the part shall be controlled and monitored in both amperage and voltage. Recipes shall be determined for each flight bar and these parameters should be monitored and alarmed when a deviation is detected. For return type lines, voltage shall be monitored and alarmed when large variations are detected. All amperage shall be alarmed when ANY loss of current or voltage is detected. This issue shall be captured in a detailed downtime procedure, See 3.2.2.5.

**3.2.2.3 Temperature/Level Control.** All heated baths shall have automatic temperature controllers. The controller shall manage the temperature to remain in a defined range and shall alarm if a deviation occurs. This is not only important for process control, but also to mitigate fire hazards. Bath level should be automatically controlled. This is especially important in process tanks utilizing electric heat to mitigate fire hazards.

**3.2.2.4 Automatic Chemical Replenishment.** Automated feeder pumps shall be used to feedback select consumed chemistries. These pumps shall be frequently calibrated and tested to ensure they are properly feeding the correct amounts of chemicals. Frequent chemical analysis and or hull cells shall also be completed or performed for additional verification of the bath.

**3.2.2.5 Downtime Procedure.** Every plating line shall have a comprehensive downtime procedure with the following features:

- The downtime procedure shall separate downtime events between time interruptions and current interruptions.
- Critical tanks shall be identified and the downtime procedure shall reflect the flowchart of decisions for the parts affected including any parts that hang in the air for an extended time. See Table 1 for an example.
- The downtime procedure shall have a visual representation posted near the line.
- Any parts that have current interruptions in the nickel tanks shall be scrapped. See Table 2 as an example.
- All downtime events shall be recorded and records maintained. The records should include, flight bar, part number, time, date, length of downtime and what was affected (current or motion).
- Any part affected by downtime shall be quarantined or scrapped. An automated system is preferred and if this is not possible then every attempt shall be made to create a robust system to avoid a suspect part from being released.
- The downtime procedure shall state that post downtime checks will verify that all parameters return to pre-downtime settings.
- Training of all employees shall be done and recorded for all production shifts.

**3.2.3 Chemicals and Chemical Controls.**

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**3.2.3.1 Chemicals.** The Plater (confirmed by the Part Supplier), shall use chemicals (pre-plate and electroplating side) from approved global chemical suppliers. Any deviation from this shall needs to be approved by GM Materials Engineering and the GM SQE/GPL. See the deviation form in Appendix A. If any chemicals are changed after approval process or PPAP of parts, the Plater shall contact GM Materials and GM SQE/GPL for approval and testing required. Any changes to the chemicals manufacturer shall need revalidation to the properties that are affected, e.g., a pre-plate chemical change revalidation will focus on the adhesion properties before and after the change.

**3.2.3.1.1 Chemical Analysis.** The Plater (confirmed by the Part Supplier), shall conduct chemical analysis on key parameters on frequent a basis. See Automotive Industry Action Group (AIAG) CQI-11 for parameters for minimum analysis requirements for each process bath. This analysis is to be documented and recorded and run charts are to be developed to show that the Process is in control. Frequencies of analysis can be negotiated to the GM SQE based on the history of the run charts and control of the concentrations.

**Note:** A staffed wet lab shall be staffed with qualified lab personnel on all shifts (during the operation of the plating line) to support the plating line production.

**3.2.3.1.2 Chemical Filtration.** Proper filtration shall be used on chemical tanks. A filtration maintenance system shall be in place ensuring regular filter changes and control of process. Flow meters and/or pressure gauges shall be used in the Process.

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**Table 1: Example of Equipment Malfunction Decision Matrix**

| Time (minutes) | Equipment Mechanical | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-Plate | | | | Electroplate | | | | | |
| | Etch | | Other Pre-Plate | | Copper | | Nickel | | Chrome | |
| | Process | Drag-out Rinse | Process | Drag-out Rinse | Process | Drag-out Rinse | Process | Drag-out Rinse | Process | Drag-out Rinse |
| 0 to 5 | Test | Test | Test | Test | Test | Test | Test | Test | Test | OK to use |
| 5 to 10 | Scrap | Scrap | Test | Test | Scrap | Scrap | Scrap | Scrap | Scrap | OK to use |
| > 10 | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | OK to use |

**Table 2: Example of Current Interruption Decision Matrix**

| Time (minutes) | Power Failure | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-Plate | | | | Electroplate | | | | | |
| | Etch | | Other Pre-Plate | | Copper | | Nickel | | Chrome | |
| | Process | Drag-out Rinse | Process | Drag-out Rinse | Process | Drag-out Rinse | Process | Drag-out t Rinse | Process | Drag-out Rinse |
| 0 to 5 | Test | Test | Test | Test | Scrap | Test | Scrap | Test | Scrap | OK to use |
| 5 to 10 | Scrap | Scrap | Test | Test | Scrap | Scrap | Scrap | Scrap | Scrap | OK to use |
| > 10 | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | Scrap | OK to use |

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**3.2.3.2 Chemical Process Control.** The Plater (confirmed by the Part Supplier), will outline a detailed flow chart which shows the specific plating process for each GM part. See Figure 1 example Bill of Process (BOP).

**Note:** When changing any chemicals or process, the Plater shall document the date of the change and have a traceable break point that can be identified on the product. Pre-change and post-change data shall be provided.

**3.2.3.2.1 Plastic Pretreat.** The Plater shall define if the pretreat cycle is a standard process or direct metallization. The plastic pretreat shall be in place to sufficiently etch and prepare the substrate to ensure good adhesion and thermal cycle performance. In many cases, processes will differ from ABS and PC substrates. This can be achieved by stronger concentrations of chemicals, higher process temperatures, longer cycle times and/or a combination of any of those variables as follows:

a. **Degreasing/Soap Rinse.** This is optional. Used to remove light dirt, contaminates, finger prints and to break surface tension on parts. Some method of control/replenishment should be defined, i.e., surface tension.

b. **Etch Process.** Follow AIAG CQI-11 Process Table E recommendations. Etch process shall be controlled and a porous pot system shall be utilized and maintained. Frequent analysis shall be done to control the growth of trivalent chrome. Tank should be well vented to ensure no airborne chrome is present in operation to avoid skip plating and operator exposure. Airflow shall be in the direction away from downstream processes. Thorough agitation shall be present by cathode motion and/or agitation system. The tank shall be pumped to storage occasionally (scheduled) and checked for parts or other contaminants. Surface tension shall be monitored to ensure small areas are etched well. Etch bath shall have proper filtration, and a process shall be in place to control contaminants, such as lead chromate, titanium dioxide, organics and iron (along with trivalent chrome growth). The performance of the etch bath should occasionally be checked through etch studies or panels.

c. **Post Etch Rinse.** Follow AIAG CQI-11 Process Table E recommendations. Etch rinsing is used to avoid any skip plating, pitting and bare spots. Proper control and design shall be used in this process. Post etch rinse should be counter-flowing back to the Process tank and proper flow shall be in place to ensure that final rinses are clean. Evaporators or other chrome recovery systems are encouraged. Flight bars shall be immersed or rinsed thoroughly. Spray systems are also encouraged.

d. **Neutralization.** Follow AIAG CQI-11 Process Table E recommendations.

e. **Activator/Activator Pre-Dip.** Follow AIAG CQI-11 Process Table E recommendations.

f. **Accelerator**. Follow AIAG CQI-11 Process Table E recommendations.

g. **Electro-less Copper or Nickel.** Follow AIAG CQI-11 Process Table E recommendations.

h. **Immersion Copper**. Follow AIAG CQI-11 Process Table E recommendations.

i. **Copper Strike.** Follow AIAG CQI-11 Process Table E recommendations.

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