WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW15947

Catalytic Coating Requirements/Specifications

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 document defines the intended use and requirements for the composition and quality of catalytic coatings used on metallic, cordierite and silicon carbide flow through and filter type substrates.

These parts are used in the General Motors Global Propulsion Systems (GPS) released catalytic converter assembly for application as part of the exhaust after-treatment system.

1.2 Applicability. This document is the GPS engineering specification for catalytic coatings used in GPS released catalytic converter assemblies. Additional GM Purchasing documentation defines commercial terms and conditions, and Platinum Group Metal (PGM) bailment, accounting and audit requirements if applicable.

1.3 Remarks. The catalyst substrate and catalytic coating are integral parts of the catalytic converter assembly. The design and composition of the catalytic coating is the critical emission control component of the catalytic converter assembly. The catalytic coating interacts with the GPS controls and diagnostic systems to provide exhaust after-treatment performance necessary to meet all legislated requirements. This document is managed by the GPS Converter Technical Specialist.

2 References

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

2.1 External Standards/Specifications.

ISO/TS 16949

2.2 GM Standards/Specifications.

GMW3059

2.3 Additional References.

- Catalytic Element Print from the Canner or GM
- GM Global Advance Product Quality Planning (APQP) manual (GM-1927) available from GM SupplyPower at Uniform Resource Locator (URL) https://gmsupplypower.covisint.com/web/portal/home
- GPS Catalytic Converter Assembly Component Technical Specification sent with the electronic Statement of Requirements (eSOR).
- GPS Catalytic Element Component Technical Specification sent with the eSOR
- GP-12 Early Production Containment from GM SupplyPower
- Requirements/Specifications for Visual Appearance of Uncoated and Coated Monolithic Catalysts and Lot Release QC Data Requirements sent with the eSOR

3 Requirements

3.1 System/Subsystem/Component/Part Definition. See Section 1.

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3.1.1 Appearance. Raw and coated substrates must meet Requirements/Specifications for Visual Appearance of Uncoated and Coated Monolithic Catalysts and Lot Release QC Data Requirements sent with the electronic Statement of Requirements (eSOR).

3.1.2 Content. The required compositions of the catalytic coatings covered by this specification are identified in 3.1.2.1 through 3.1.2.1.4.

3.1.2.1 Physical Content.

3.1.2.1.1 Catalytic Coating Specification Document (CCSD). The Supplier shall develop a document or drawing, referred to herein as the CCSD, that provides a complete description of nominal catalytic coating composition and physical layout. For complex multi-layer or zoned catalyst coatings, this description shall define the geometry of all layer/zone structures and their associated compositions.

3.1.2.1.1.1 Production variation of the defined structure and composition of the individual components of the coating shall be developed and documented in the CCSD by the Supplier. This document shall also define how the individual base metal component are arranged in the base metal categories defined in 3.1.2.1.3.

3.1.2.1.1.2 The CCSD shall be approved by the GPS Converter Technical Specialist and kept by the Supplier. The CCSD shall be made available to GM for audit purposes upon request.

3.1.2.1.2 Nominal PGM Content and Allowable Production Variation. All production processes shall be targeted at the nominal PGM content defined by the Catalytic Element Print from the Canner or GM (or Table A1 in Appendix A) for the complete part and each longitudinal zone. All coating processes shall be actively managed such that the variation in coated parts trends toward the nominal content defined by the CCSD for the complete part and each longitudinal zone.

The minimum acceptable individual part and longitudinal zone content for each PGM due to production variation within any lot shall be defined by the Catalytic Element Print from the Canner or GM (or Table A1 in Appendix A) and included in the CCSD. Individual production parts in which either the complete part or any individual longitudinal zone contains less than the specified value of the minimal content of any one or more of the individually specified PGMs shall be removed from the lot and reworked per the GPS Converter Technical Specialist approved rework procedures. **Note:** Reworked parts shall meet all the specifications for content before they will be accepted (3.3.4.2).

3.1.2.1.3 Nominal Washcoat and Base Metal Content and Allowable Production Variation. All production processes shall be targeted at the nominal content defined by the CCSD for the complete part and each longitudinal zone for longitudinally zone coated parts. All coating processes shall be actively managed such that the variation in coated parts trend towards the nominal content defined by the CCSD. Nominal washcoat content and individual base metal contents are defined in the CCSD. The allowable individual part variation for washcoat content and for each base metal component is defined by the Catalytic Element Print from the Canner or GM (or Table A1 in Appendix A) and included in the CCSD in order to protect the Supplier proprietary catalytic coating formulations. The washcoat and base metal components shall be grouped as defined in 3.1.2.1.3.1 through 3.1.2.1.3.7 functional base metal categories. These categories shall be used for reporting purposes as defined in 3.1.2.1.3.1 through 3.1.2.1.3.7.

3.1.2.1.3.1 Wet Washcoat Loading (WWCL) or Dry Washcoat Loading (DWCL). Wet or dry washcoat pickup weight (grams (g)/part) for each layer in the formulation necessary to produce a nominal composition part given nominal composition washcoat slurry.

3.1.2.1.3.2 Oxygen Storage Components (OSC). The components contributing to the oxygen storage function of the catalytic coating. These are to be reported individually as OSC1, OSC2, etc.

3.1.2.1.3.3 Hydrocarbon or NOx Storage Components (HSC/NSC). The components contributing to the hydrocarbon storage function of the catalytic coating. These are to be reported individually as HSC1, HSC2, NSC1, NSC2, etc.

3.1.2.1.3.4 Hydrogen Sulfide Suppression Components (HSS). The components contributing to the minimization of hydrogen sulfide production by the catalytic coating. These are to be reported individually as HSS1, HSS2, etc.

3.1.2.1.3.5 Promoters (PMR). The components contributing to the promotion of catalytic activity or stability of the catalytic coating that are not included in the previous categories. Metallic additions to selective catalytic reduction coatings are included within this category. These are to be reported individually as PMR1, PMR2, etc.

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3.1.2.1.3.6 Washcoat Active Ingredient (WAI). The sum of the functional components of the catalytic coating that are not included in the above functional categories. These are to be reported individually as WAI1, WAI2, etc.

3.1.2.1.3.7 Support Components (SUP). The sum of the non-functional components of the catalytic coating that are not included in the above functional categories. These are to be reported individually as SUP1, SUP2, etc.

3.1.2.1.4 Chlorine Content. The allowable chorine content is defined by the Catalytic Element Print from the Canner or GM (or Table A1 in Appendix A). The analytical procedure will be defined and documented per the GM Global Advance Product Quality Planning (APQP) manual (GM-1927) available from GM SupplyPower at Uniform Resource Locator (URL) https://gmsupplypower.covisint.com/web/portal/home. A statement that no chlorine containing salts or other materials are used in the manufacture of the subject catalytic coatings may be an acceptable alternative to the lot analysis requirements for chlorine described in 3.3.4.3.2.

3.1.2.1.5 Restricted and Reportable Chemicals. Catalytic coatings defined in this specification must comply with the requirements listed in GMW3059, **Restricted and Reportable Substances.**

3.1.3 Flow Restriction. The Catalytic Element Supplier shall define a flow restriction specification and methods for testing of coated and non-coated parts that are required to build the catalytic converter assembly. The specification(s) and test methods shall be approved by the GPS Converter Technical Specialist and the appropriate GPS Converter Design Responsible Engineer. The flow restriction of all coated parts shall be monitored on all production lots. Coated part flow restriction data for all production lots shall be reported (3.3.4.3), and this data shall be placed in the Lot File (3.3.4.1).The flow restriction of uncoated parts shall be monitored per the APQP manual prior to production. The permissible restriction range for coated parts will be defined and documented per the APQP manual and will be included on the Catalytic Element Print from the Canner or GM (or Table A1 in Appendix A). The results shall be placed in the Lot File and the Lot In-Process Data File (3.3.4.1).

3.1.4 Post Calcination Cleaning. Loose dirt and debris associated with post calcination mechanical cleaning processes shall be monitored on all production lots. The specifications and test methods shall be approved by the GPS Converter Technical Specialist. The loose dirt and debris shall be included (3.3.2.2).

3.1.5 Particle Size Distribution. The Coating Supplier(s) shall characterize the particle size distribution of each individual coatable washcoat slurry by ninety percent (d90) and fifty percent (d50) values unless otherwise agreed between the Supplier and GM at the technical review and documented in the pre-launch and launch control plans (GP-12 Early Production Containment from GM SupplyPower). **Note:** Ten percent (d10) values may be required.

The targeted nominal d90, d50 and d10 (if required) values as well as the allowable production variation (tolerances) of each production slurry shall be documented in the CCSD. The particle size distribution shall be monitored on all production slurries. The analytical results shall be kept separately from in the Lot File and the Lot In-Process Data File (3.3.4.1) however will be made available to GM for audit purposes upon request.

3.2 Product Characteristics. The catalytic coating is not a serviceable item.

3.3 Design and Construction.

3.3.1 Materials, Processes, and Parts Selection Guidelines. Processes developed to produce and apply the catalytic coating to catalyst substrates shall be defined and documented per the APQP manual and must meet the requirements of ISO/TS 16949.

3.3.2 Design Guidelines and Constraints. Not applicable.

3.3.3 Identification and Markings. Coated parts shall be identified and marked as defined by the applicable Catalytic Element Component Technical Specification.

3.3.4 Workmanship. Individual part and production lot acceptance criteria for production parts are specified in 3.3.4.1 through 3.3.4.4.3. Workmanship shall be at the level required to meet the content specifications defined in 3.1.2 and to insure that no latent defects are introduced during coating processes, part handling or delivery of parts to Catalytic Converter Assembly Supplier.

Supplier performance, evaluation and reporting requirements defined and documented per the APQP manual that pertain to workmanship shall be met.

3.3.4.1 Lot File and Lot in-Process Data File. A hard copy Lot File and a digital Lot In-Process Data File shall be prepared for each lot of parts produced. The contents of the Lot File (hard copy production records, traceability

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documentation, batching documentation, etc.) and Lot In-Process Data File are partly specified by this document and partly by the APQP manual process. The Supplier shall be responsible for archiving all Lot Files and all Lot In-Process Data Files until advised by GM that specific files may be deleted. Any Lot File shall be provided on GM request for review/audit at the Suppliers manufacturing location. A digital copy of any Lot In-Process Data File shall be provided on GM request subject to 3.3.4.2.3.

3.3.4.2 Part Acceptance Procedures. The content of each part produced shall be computed from in-process data by procedures defined and documented per the APQP manual. The computed content of each pass/layer shall be traceable to the individual serialized part (3.3.3). Compliance with all of the specifications for content (3.1.2.1.1 through 3.1.2.1.3) shall be determined for each part and only parts which comply with all specifications for content shall be accepted for inclusion in the lot. Parts that do not comply with one or more of the specifications for content may be reworked per the GPS Converter Technical Specialist approved rework procedures. **Note:** Reworked parts must meet all the specifications for content before they can be accepted.

3.3.4.2.1 Statement of Conformity. A statement asserting that all individual PGMs and individual base metal components (not base metal categories) on all parts in the lot are within specifications (3.1.2.1.1) shall be placed in the Lot File.

3.3.4.2.2 Lot In-Process Data File. The Supplier shall create and archive a Lot In-Process Data File (digital storage medium) for each lot produced. This file shall contain all relevant in-process data required to determine the composition (with respect to each PGM and each base metal category) of each part in the lot. A hard copy summary of the contents of the Lot In-Process Data File shall be placed in the Lot File and shall form the basis for lot release control. The contents and format of the Lot In-Process Data File and required summary shall be defined and documented per the APQP manual. A copy of any Lot In-Process Data File shall be made available to GM on request. If the Supplier chooses, the file provided for GM review may be reformatted to contain base metal categories as defined in the CCSD.

3.3.4.3 Early Containment and Lot Quality Control Procedures. The APQP manual defines several production trial milestones. Of particular importance is the Production Part Approval Process (PPAP), the run-at-rate exercise, and production launch. Each of these steps toward regular production requires an associated control plan that details the processes and procedures to be used to demonstrate acceptable performance at each step in the process. The team implementing the requirements of the APQP manual is expected to define a pre-launch control plan, to be used to support PPAP and run-at-rate exercises, and a launch control plan (GP-12) to be used to support the first several production lots. Once stable, acceptable control is demonstrated, the Supplier may exit the launch control plan and follow the agreed regular production control plan. Specific control plans are to be developed based on the Suppliers process that must demonstrate acceptable process control at each step before the next step can be taken. The minimum requirements for these control plans and for regular production are defined in 3.3.4.3.1 through 3.3.4.4.3.

3.3.4.3.1 PPAP, Run-at-Rate, GP-12 and Regular Production PGM, and Washcoat Targeting. All new catalyst part numbers are to be introduced into production targeted at 100% of the nominal PGM, washcoat and base metal loadings defined in the CCSD. The 100% of nominal target shall be maintained during PPAP, run-at-rate and GP-12 Production Launch Control (typically the first ten regular production lots after PPAP). This production target shall remain in effect until a part exits GP-12, and at that point the production target capability for PGM loadings shall be assessed. Based on this assessment, a lower mean production PGM loading target may be mutually agreed by GM and the Supplier, if the capability to do so has been demonstrated during GP-12 Production Launch Control.

The Supplier shall maintain documentation of the production status of all production catalyst part numbers with regard to production PGM, washcoat and base metal loading targets. This documentation will be provided upon request to GPS Engineering and Supplier Quality.

As parts move out of production and into service, the agreed reduced production target for PGM loadings will be maintained for service orders of these parts.

3.3.4.3.2 Composition. The procedures in 3.3.4.3.2.1 and 3.3.4.3.2.2 are to be followed for the first ten lots and each lot thereafter unless otherwise agreed between the Supplier and GM at the technical review and documented in the pre-launch and launch control plans (GP-12).

3.3.4.3.2.1 Non-Metallic Catalyst Composition. For both zoned and non-zoned-coated parts, analysis is required for serialized whole parts for individual PGMs, individual base metal components and chlorine (3.1.2.1.4, if necessary) for samples representing a lot. Analysis of 0.02% of a lot, or three parts (whichever is

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