



Painted Plastic Parts Performance 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 covers organic surface coatings on plastic parts and components used for automotive exterior and interior applications on motor vehicles, and also for painted components within the engine compartment.

1.2 Applicability. This specification details the performance requirements for applied paints on plastic parts used for either exterior, interior or engine compartment applications on motor vehicles. This includes the laboratory test requirements for GM Approved Paint on Parts (APOPS), Validation Testing Complete (VTC), Production Part Approval Process (PPAP) approval, processing conditions, and routine quality control for exterior and interior plastic painted automobile components.

1.2.1 APOPS Approval versus PPAP Approval. Refer to Figure 1 "Overall APOPS Process". Prior to producing parts in the production setting, a GM approved substrate and a GM approved paint is specified by GM on part drawings or otherwise to use in making the part. APOPS is intended as detailed review of a new combination of GM approved substrate, GM approved paint, and production paint process for a specific molder/painter. This is accomplished by the GM Materials Engineer with the supplier. An APOPS approval is documented with either:

- i) Entry into either the MATSPC/APOPS database available on GM SupplyPower.
- ii) Entry into the APOPS spreadsheet loaded on GM SupplyPower.
- iii) Approval document from GM to supplier.

Typically, the molder/painter may re-use the APOPS approval for an additional new part that has the same substrate/paint/paint process, however, the GM Materials Engineer may request an APOPS submission or additional testing at their discretion.

For new combinations of substrate/paint/painter, the APOPS data is often used for part (e.g., for exterior parts) or all (e.g., interior parts) of the PPAP submission. In all cases, the APOPS approval documentation is required with the PPAP package. Reference PPAP Checklist, Table A14.

1.2.2 Raw Material Approvals. This specification applies only to substrate and paint related materials that have been qualified and approved to the appropriate GM specifications.

1.2.2.1 Substrates. The substrate must be approved to the appropriate GM material specification. For previously unpainted substrates, substrate paintability may be demonstrated per GMW16172 (plaques or parts), or via APOPS testing to the appropriate table:

- Table A1 for exterior applications (including weathering of parts per Table A1).
- Table A3 for engine compartment applications.
- Table A4 for interior trim applications (including paint over chrome).

1.2.2.2 Paints. Paints shall be approved to the appropriate GM specification. For exterior topcoat applications, GMW3005 requirements must be met for approval to the appropriate, e.g., 998XXX paint specification. GM9620M must be met for all new paint colors when applicable, as specified. For interior paints, the requirements of the applicable GMWXXXX paint specification must be met.

1.2.2.2.1 Paints Without GM Approval. In situations or regions where the paint approval process is new, GMW14797 requirements can be followed for APOPS testing on the part, and then the approval for the paint must be completed. The GM engineer shall work with the paint supplier to fulfill the requirements of GMW3005 for exterior topcoats, GMW17105 for primers for plastics, and the applicable GMWXXXX for interior paints. The paint would then be approved by GM Engineering and listed in MATSPC under the appropriate GM 998XXX

or GMWXXXXX specification. Additionally, in the APOPS approval for the part, it must be noted that the GM paint approval is in progress, and estimated date of completion must be included.

2 References

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

2.1 External Standards/Specifications.

ASTM D3763	ISO 105-A02	ISO 6603-2	SAE J1976
ISO/IEC 17025	ISO 2808	ISO 20433	SAE J2527
ISO/TS 16949			

2.2 GM Standards/Specifications.

9984808	9984905	GMW14445	GMW15919
9984810	B 040 0540	GMW14698	GMW16133
9984815	GM4389M	GMW14700	GMW16172
9984818	GM9233P	GMW14701	GMW16745
9984824	GM9620M	GMW14704	GMW16746
9984836	GMW3005	GMW14729	GMW17105
9984861	GMW3059	GMW14829	GMW17138
9984862	GMW14124	GMW15516	GMW17206
9984901	GMW14333	GMW15520	
9984904	GMW14444	GMW15891	

2.3 Additional References.

Statement of Requirements

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities.

3.1.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.1.3 For APOPS Testing. All APOPS testing shall be performed in an accredited laboratory. Laboratory accreditations to ISO/IEC 17025 are acceptable.

3.1.1.4 For PPAP Testing and VTC Testing. Tests performed outside of GM are to use a lab from an organization that is either third party registered to ISO/TS 16949 or has laboratory accreditations to ISO/IEC 17025.

3.1.1.5 All testing is the responsibility of the GM supplier who applies paint to the parts in question.

3.1.2 Equipment. Not applicable. **3.1.3 Test Vehicle/Test Piece.** Not applicable.

3.1.4 Test Time. Not applicable.

3.1.5 Test Required Information. Not applicable

3.1.6 Personnel/Skills. Add content.

3.2 Preparation.

3.2.1 Bake. All bakes must comply with GM Paint approved bake charts for each specific product. GM Paint approved bake charts are those that have an approval signature of the responsible engineer at the bottom. These bake charts may be obtained from the paint suppliers.

3.2.1.1 For Exterior Grade Parts. All Thermoplastic Polyolefin (TPO) substrates must be processed using any of the following three options:

- **Option 1:** High-bake adhesion promoter + topcoat systems. The adhesion promoter (e.g., 9984808, 9984810, 9984818) is applied wet on wet and co-baked with an approved topcoat high bake system (e.g., 9984836, 9984861, 9984862) in accordance with the GM Paint approved bake chart.

- **Option 2:** Low-bake adhesion promoter + topcoat systems. The adhesion promoter (e.g., 9984905) is applied wet on wet and co-baked with an approved topcoat low bake system (e.g., 9984904, 9984901) in accordance with the GM Paint approved bake chart.
- **Option 3:** Flame treated + topcoat systems, low bake or flame treated + primer + topcoat systems, low bake. Flame treated (GMW16133) and bake with an approved topcoat (e.g., 9984836, 9984861, 9984862, 9984901, 9984904) or with an approved primer (e.g., 9984815, 9984824) plus topcoat (e.g., 9984836, 9984861, 9984862, 9984901, 9984904).

Deviations to any of the preceding must be agreed upon by GM Engineering.

3.2.1.2 Interior paint bake charts are stored in the GM Materials File, MATSPC, or held by the regional Materials Engineer responsible for interior paint raw material approval.

3.2.2 Additional Requirements for Exterior.

3.2.2.1 Reprocessing. Defined as running a previously finished part through the Original Equipment Manufacturer (OEM) process. The reprocessing must agree with the Material Data Sheet and recommendation from the Paint Material Supplier. The following must be followed at a minimum for all part reprocesses.

3.2.2.1.1 All reprocessed parts must meet all the requirements stated in this specification and all other specifications and requirements listed on the engineering drawing.

3.2.2.1.2 Sanding to substrate is not allowed for any substrates except for a sheet molding compound (SMC) and Carbon Fiber. Sanding is allowed on the topcoat system to remove surface imperfections or defects. Documentation of sanding process is required.

3.2.2.1.3 Clearcoat over Clearcoat and Adhesion Promoter over Adhesion Promoter is not permitted. Clearcoat may be applied over clearcoat only on components made with carbon fiber exposed weave.

3.2.2.1.4 Topcoats and color keyed or color specific primers are to be repaired with the same OEM or two-tone color only, specified by the GM color code number, for example WA6502 (i.e., white over white, red over red, etc.)

3.2.2.1.5 The maximum number of reprocess applications is two for primer and two for topcoat as given in Table 1.

For GM Europe and GM Holden, multiple coatings are defined for maximum one single over-painting of the complete paint system. Multiple coatings are not permissible for original equipment parts and parts for after sales service.

Exception: Multiple coatings for original equipment parts are only permissible if the coloring is acceptable. No adverse changes are permissible.

Table 1: Reprocessing Requirements

Paint Layer	Number of OEM Applications	Maximum Reprocess Applications	Maximum Number of Bakes	Maximum Total Film Build (of Given Paint Layer)
Primer	1	2	3	100 μm (4 mil)
Topcoat	1	2	3	225 μm (9 mil)
Total	2	4	6	325 μm (13 mil)

3.2.2.1.6 A part may see a total of six heat cycles in paint and a total of seven heat cycles including post-cure.

3.2.2.1.7 All film builds must meet the minimum requirements specified on the engineering drawing and the maximum requirements given in Table 2 unless otherwise specified.

Table 2: Maximum Film Builds

Layer	Maximum Film Build
Primer	100 μm (4 mil)
Topcoat	225 μm (9 mil)

3.2.2.2 Spot repair is not a GM approved process for painted parts (except for sheet molding compound (SMC) and Carbon Fiber components).

3.2.2.2.1 Unless otherwise agreed, SMC must be repaired to meet the requirements in GM9233P. The repair process for Carbon Fiber components needs to be reviewed and approved by GM Materials Engineering.

3.2.3 For Interior Reprocessing. Defined as running a previously finished part through the original (OEM) process. The reprocessing must agree with the Material Data Sheet and recommendation from the paint material supplier.

The following must be followed at a minimum for all part reprocesses:

3.2.3.1 The maximum number of reprocess applications is one for primer and one for topcoat.

3.2.3.2 All reprocessed parts must meet all the requirements stated in this specification and all other specifications and requirements listed on the engineering drawing.

3.2.3.3 Sanding to substrate is not allowed. Sanding is allowed on the topcoat system to remove surface imperfections or defects. Documentation of sanding process is required.

3.2.4 For Exterior Components with Paint Over Chrome. Components that are chrome plated and subsequently painted must meet the requirements of GMW17206.

3.2.5 For Interior Components with Paint Over Chrome. Components that are chrome plated and subsequently painted must be painted with a topcoat that is approved to GMW17206 Type 1, and meet the requirements of GMW15516, fogging, oven age at 105 °C, odor, Xenon and sunscreen.

3.3 Conditions.

3.3.1 Environmental Conditions. Not applicable.

3.3.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc. Tests shall be conducted using the latest issue of the test procedures indicated.

Unless otherwise specified, painted samples shall be subjected to the testing after a minimum aging period of 72 h following the baking or drying cycle. A shorter aging period may be used, provided it is recognized that this represents a more severe condition of test and that results obtained at different aging times under 72 h are not a good basis for comparing the relative performance characteristics of paint finishes.

3.4 Instructions. Figure 1 depicts the APOPS approval process. Parts furnished for APOPS approval shall meet the test requirements as shown in the appropriate table for the component application.

3.4.1 Component Testing/APOPS - for Painted Exterior, Painted Interior, and Painted Engine Compartment Components. Component testing is to be performed for the production part per Table A1 for exterior, Table A3 for engine compartment components, and Table A4 for interior trim components (including paint over chrome). This testing is required for APOPS approval. Each molder/painter must have APOPS approval for each combination of substrate/paint/paint process. Once the molder/painter has APOPS approval for a given combination of substrate/paint/paint process, this approval may also be used for other components that use the same combination of substrate/paint/paint process. If any changes are made in the substrate, paint, or paint process, APOPS testing on components must be repeated and reviewed with the appropriate GM Engineer. Additionally, VTC test requirements and PPAP test requirements must be completed for each unique part.

Note: The APOPS process is not applicable for skinned polyurethane parts. See 4.2.3 on PPAP requirements.

3.4.1.1 All specimens for testing must be obtained from parts that have been molded, painted and processed using the same equipment, tools, materials, processing conditions and manufacturing locations that will be used to manufacture production parts for vehicle assembly. If production part has a grained surface, then parts tested for APOPS must also be grained. If regrind is allowed, all specimens for testing must be obtained from production parts that are made from the maximum allowable regrind as stated on the drawing.

3.4.1.2 Each test must be completed on a minimum of three samples, each obtained from separate parts (except fascias, SMC body panels, and Carbon Fiber components - see 3.4.1.3).

3.4.1.3 For fascia systems, SMC body panels, and carbon fiber components, triplicate samples need not be obtained from three separate parts due to the size and cost of the parts. In this case, three samples may be taken from different locations on the same part. See Figure 2 for example of testing locations. Since parts vary in design, see responsible GM Materials Engineer if assistance is needed in choosing the locations.

3.4.1.4 For Exterior, testing shall be performed in two colors: White and Light Metallic for original non-repaired parts. If the color palette contains a Tricoat (such as Bright White Diamond), that color must be tested in addition

to the two standard colors. If the two standard colors are not contained in the color palette, the GM Materials Engineer may approve substitutions.

3.4.1.4.1 Testing to Table A1 must also be performed on a reprocessed part in White only. For General Motors North America (GMNA), test on a part that has seen two primer reproprocesses and two topcoat reproprocesses. (Example: primer-bake, topcoat-bake, primer-bake, topcoat-bake, primer-bake, topcoat-bake - six paint layers). For General Motors Europe (GME) and General Motors Holden (GMH), only one primer reproprocess and one topcoat reproprocess is to be tested (primer-bake, topcoat-bake, primer-bake, topcoat-bake - four paint layers). If white is not contained in the color palette, use the color with the highest film build.

3.4.1.5 For Interior, testing shall be performed in each production color for the application.

3.4.1.6 All bakes are to be those of the production system and must fall within the GM Paint approved bake charts for each layer.

3.4.1.7 All coating thicknesses must be in accordance to material requirements as specified on the part drawing notes or in the math file. All coating thicknesses must be measured and reported.

3.4.1.8 Exterior parts which are source primed and subsequently top coated at assembly plants, shall be capable of accepting the topcoat paint system and meeting the requirements specified with both prime only and with both topcoat and prime. See responsible GM Materials Engineer to confirm test requirements for APOPS on primed parts and to determine the number of parts to be top coated and to coordinate the top coating of the parts in the assembly plant.

3.4.1.9 When this testing is completed, the tested specimens cut from the parts and test report will be reviewed by the responsible GM Materials Engineer and entered into the APOPS database.

Note: Full APOPS approval may be given at this time depending on test results.

3.5 Data. Not applicable.

3.6 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Suitable precautions should be taken to ensure that applicable safe limits are not exceeded when conducting test procedures, processes and/or handling the materials required by this specification.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to other product/process, and to apply for a new release.

Unless otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.7.1 Changes in Processing. After the initial APOPS has been established, any change in processing parameters as recorded on Table A5 or A6, Paint Processing Data Form, requires evaluation with the responsible GM Materials Engineer. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release and/or APOPS approval.

3.7.2 Test Results. Test reports shall be written per the Requirements for Test Report in ISO/IEC 17025. Additionally, a test report that contains all of the requirements listed in 3.7.2.1 through 3.7.2.17 shall be submitted to the GM Materials Engineer (reference Table A13, APOPS Checklist). Electronic APOPS forms can be found through GM SupplyPower.

3.7.2.1 Table A12A or A12B, APOPS Request Form.

3.7.2.2 A copy of the Registration or Scope of Accreditation for each test facility that provided data.

3.7.2.3 Table A5 or A6, Paint Processing Data Form completed and signed by paint facility management. Enlarge as required or download form from GM Supply Power.

3.7.2.4 Table A7, A8 or A9, GM APOPS Test Data Form completed (Table A7 for Exterior, Table A8 for Interior or Table A9 for Underhood.) Enlarge as required or download form from GM SupplyPower. A subset of the tests on this form may be used to report VTC and/or PPAP data.

3.7.2.5 Copy of material requirements as listed in part drawing notes from the latest print or math file.

3.7.2.6 Signed documentation of the percent regrind on parts tested.

3.7.2.7 Datapaq or equivalent indicating part surface temperature versus time for all paint bakes including post-cure.

3.7.2.8 Schematic indicating the location of part where Film Build was taken. This includes reprocessed parts.

3.7.2.9 Paint film thickness per ISO 2808 on each part that is used to cut test specimens. Measure a minimum of four areas on each part; report each measurement. More than four areas may be required due to part design. See the responsible Materials Engineer for a definition of the number and placement of the areas required. Report the thickness of each paint layer (i.e., primer, topcoat).

3.7.2.9.1 For interior and underhood parts, a minimum of three parts in a minimum of three locations per part, dependent upon part size, shall be measured (if not using a shim). Individual measurement locations will be indicated with a schematic, as well as individual readings and the average of the measurements shall be reported. (See Note 3 in Table A3 or Note 7 in Table A4 for details on how to measure film build.)

3.7.2.10 GM9620M film build chart for each coating (if applicable, in accordance with part drawing notes or math file). (Not applicable for Interior coatings.)

3.7.2.11 A GM approved and signed bake chart for each coating.

3.7.2.12 Schematic indicating the location on the part from which the test plaques were obtained. See Figure 2 for example of a fascia schematic.

3.7.2.13 White parts reprocess twice for reprocess validation. (Not applicable for interior coatings.)

3.7.2.14 Signed documentation of the reprocess procedure used by the painted part supplier.

3.7.2.15 Signed documentation of the sanding process procedure used by the painted part supplier.

3.7.2.16 Tested parts for review by the responsible GM Materials Engineer (see Section 3.3).

3.7.2.17 All tested samples shall be retained by the supplier for review by the appropriate GM Materials Engineer at least until APOPS approval is obtained.

4 Requirements and Procedure

4.1 Component Testing/APOPS. (See 3.4.1.) Perform testing on components as indicated in the appropriate table.

4.2 PPAP Testing. Reference Table A14 – PPAP Checklist.

4.2.1 Exterior Components. Perform PPAP testing on all program colors as indicated in Table A1 for components, unless otherwise noted by the GM Materials Engineer (additional testing may be required). A printout of the APOPS approval will be required with the PPAP package. If a new part has the same substrate, paint, paint process, molder and painter as a previous part that is already APOPS approved (i.e., only geometry is unique), then only PPAP and VTC testing per Table A1 is required for PPAP, and a printout of the previous part's APOPS approval will be required with the PPAP package.

4.2.2 Interior Components. Perform testing on all program colors as indicated in Table A4 for components unless otherwise noted by the GM Materials Engineer (additional testing may be required). A printout of the APOPS approval will be required with the PPAP package. If a new part has all the same colors, substrate, paint, paint process, molder and painter as a previous part that is already APOPS approved (i.e., only geometry is unique), then only Table A11 testing is required for PPAP and a printout of the previous part's APOPS approval will be required with the PPAP package. All new colors not previously APOPS reviewed require Table A4.

4.2.3 Polyurethane Skinned Components. Perform testing as indicated in Table A2 for PPAP. APOPS approval does not apply.

4.2.4 Engine Compartment Components. Perform testing on all program colors as indicated in Table A3, unless otherwise noted by the GM Materials Engineer (additional testing may be required). A printout of the APOPS approval will be required with the PPAP package.

4.3 Daily Quality Control Testing. Testing as stated in this specification, at a minimum, is to be followed unless otherwise noted by GM Supplier Quality or in the Statement of Requirements. All tests as listed in Table A10 or

Table A11 must be run every shift on one color that is run for that particular shift. Colors must be randomized. Report the daily test data and date.

A Datapaq or equivalent part temperature chart recorder must be run a minimum of one time per day per oven. To ensure that each oven is consistent from shift to shift, the Datapaq or equivalent charts must be taken on alternating shifts. For example: Monday - Shift 1, Tuesday - Shift 2, Wednesday - Shift 1, etc.

4.4 Weekly Quality Control Testing. Testing as stated in this specification, at a minimum, is to be followed unless otherwise noted by GM Supplier Quality or in the Statement of Requirements. All tests as listed in Tables A11 or A12 must be run once per week on every color run that particular week. Report the weekly test data and date.

4.5 Additional Requirements. The preceding requirements must be met at the specified frequencies. Any painted part supplier to GM must keep records of the following activities and be able to provide them for review at any time. No aging period is required for quality control samples. A quality control plan will be developed with every supplier for every part to determine the areas of the part in which the tests need to be performed. All bakes must comply with the GM approved bake charts. Tables A10 and A11 have requirements for each quality control test.

OVERALL APOPS PROCESS

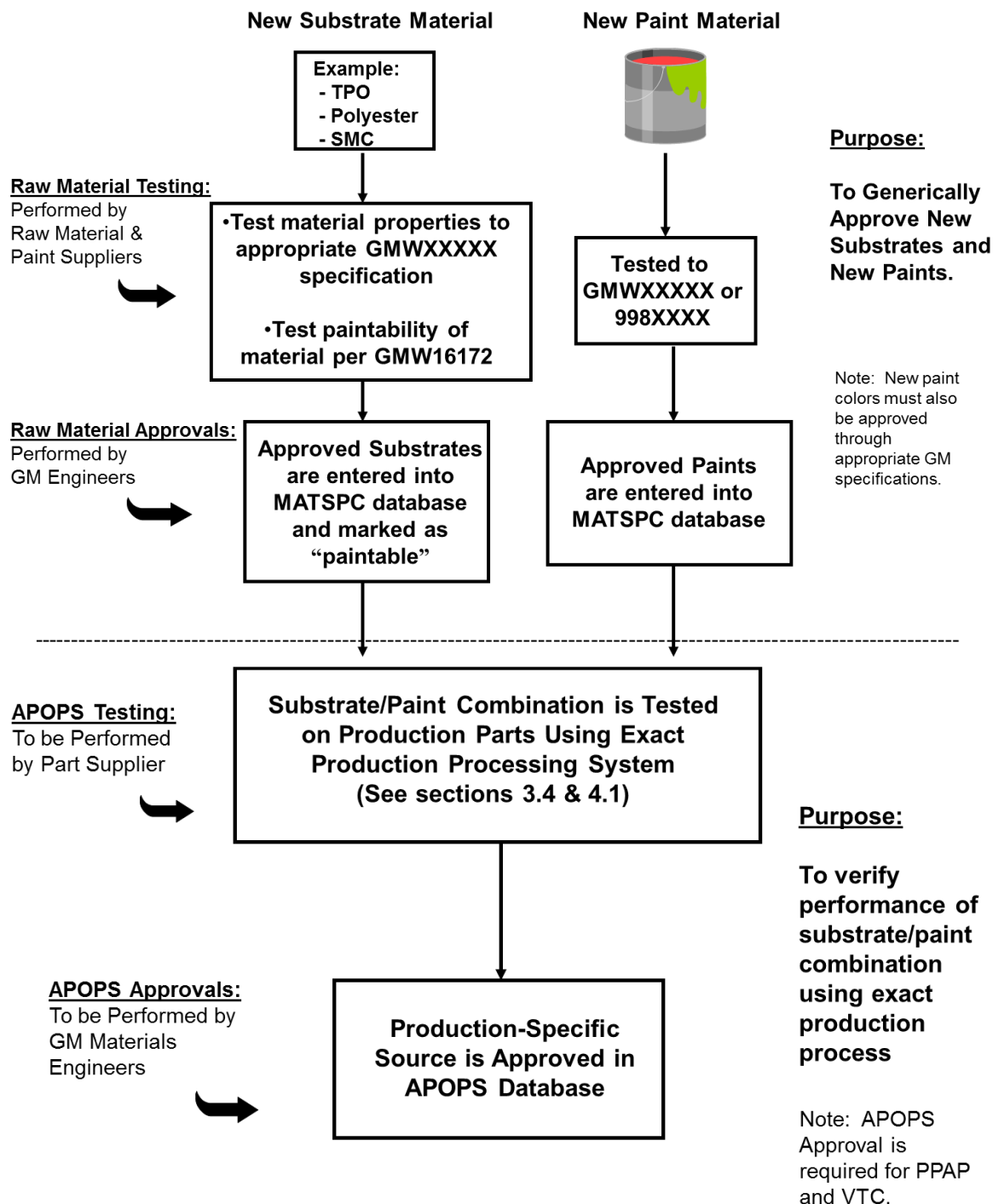


Figure 1: Overall APOPS Process

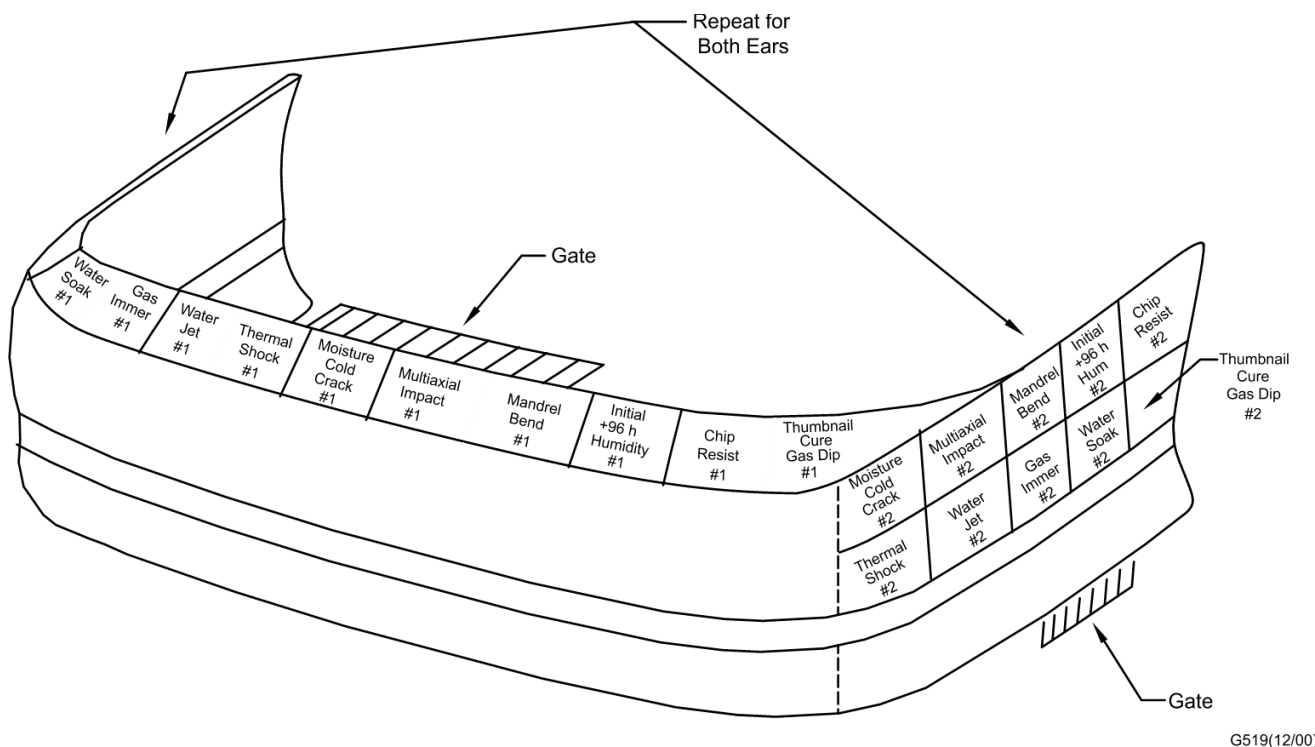
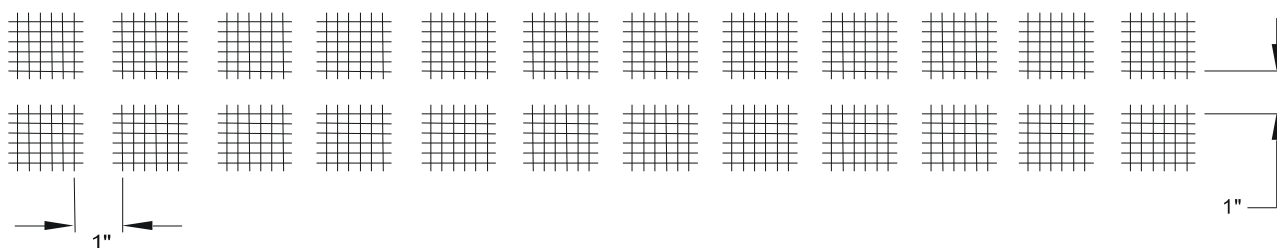


Figure 2: Fascia Example Location



Not more than 1 inch between the last vertical/horizontal line of one cross-hatch block and the first vertical/horizontal line of the next cross-hatch block.

Or

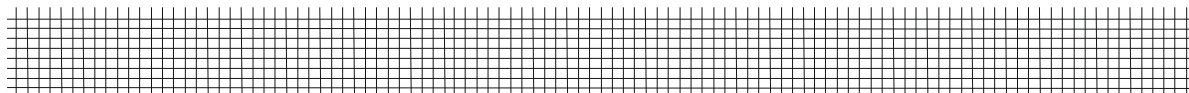


Figure 3: Initial Adhesion Entire Surface Crosshatch (Exterior)

5 Provisions for Shipping

5.1 Source Shipment Responsibility. It will be the responsibility of the supplier to ensure that the material is not exposed to temperatures during shipment which would cause the material to fail to meet any of the requirements of this specification.

6 Rules and Regulations

6.1 Legal Regulations. All materials must satisfy applicable laws, rules, regulations and recommendations valid in the country of usage.

6.2 Language. In the event of conflict between the English and domestic language, the English language shall take precedence.

6.3 Inspection and Rejection. Samples of components or materials released to a GM material specification shall be tested for conformity with the requirements of this material specification and approved by the responsible Engineering department prior to commencement of delivery of bulk supplies.

A new approval must be received for any changes, e.g., properties, manufacturing process, location of manufacture, etc. If not otherwise agreed, all testing and documentation normally required for initial release must be completed.

It is the responsibility of the supplier to inform the customer in a timely manner, without solicitation, and to include documentation of all modifications of materials and/or processes and to apply for a new release.

6.4 Material Safety Data Sheets/Safety Data Sheets (MSDS/SDS). For new product submissions, or when a change in chemical composition of an existing product has occurred, a complete copy of the Material Safety Data Sheet/Safety Data Sheet must be submitted in compliance with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) requirements or other country-specific MSDS/SDS requirements.

6.5 All materials supplied to this standard must comply with the requirements of the International Material Data System (IMDS) and GMW3059, **Restricted and Reportable Substances**.

6.6 Certificate of Analysis. The supplier shall be responsible for submitting a Certificate of Analysis with each batch of material arriving at a plant. This document shall be prepared and provide data in accordance with the requirements detailed in GM4389M.

6.7 Parts for Aftersales Service. Parts for aftersales service shall be primed. Completely coated Parts for aftersales service shall fulfill the requirements to GMW14797.

7 Approved Sources

Materials supplied to this specification must be approved by General Motors.

The appropriate GM Materials Engineering department(s) must confirm material as meeting the requirements of this specification. Any test data sheets of material submitted to General Motors for such confirmation (e.g., during Production Part Approval Process (PPAP)) under this material specification must list all properties and must apply corresponding test methods of this material specification.

8 Notes

8.1 Glossary.

CIELAB (L*a*b* color space): Commission Internationale de l'Eclairage (International Commission on Illumination) representation of colors using the coordinates in a uniform color space consisting of lightness variable L* and chromaticity indices a* and b*.

MATSPC: Global repository of GM approved materials for corresponding GM Engineering Standards.

PGC: Perceived gloss of 2 (Low Gloss) when measured at 60 degrees gloss on flat, ungrained samples.

Reprocessing: Running a previously finished part through the original equipment manufacturer (OEM) process.

8.2 Acronyms, Abbreviations, and Symbols.

#	Number
Adh Pro	Adhesion Promoter
APOPS	Approved Paint on Parts
Conc	Concentration