



Laminated Vibration Damping Steel Patch (LVDSP) Blanks

1 Scope

1.1 Material Description. The material defined by this specification is a laminated vibration damping steel patch (LVDSP) blank consisting of either two (2) similar or dissimilar metal sheets of the same or different thickness separated by, and bonded by, a viscoelastic core. The patch blanks shall be applied on interior surfaces, however exposure to corrosive environments may exist at pierced/trimmed hole locations. The engineering drawing will specify dimensions, tolerances, sheet steels, and coatings required. Only unexposed (U) applications have been approved for LVDSP applications. LVDSP will have approximately the same density as homogenous or monolithic steel sheets. The elastic modulus, however is variable depending upon such factors as deformation rate, temperature, and vibrational frequency. The stiffness of the main panel will not be significantly affected by the addition of the patch. For analysis purposes, the stiffness of a stamping from LVDSP should be taken as that of the monolithic main panel.

1.1.1 Laminate Core. The core shall consist of a viscoelastic resin that exhibits adequate bonding, temperature stability, strength, and plasticity to provide the required damping and manufacturing performance of the composite. A Material Safety Data Sheet (MSDS) shall be provided along with information on potential toxicity and odor emissions through the resistance welding temperature ranges.

1.1.2 Laminate Steel Skins. Most applications are specified as cold rolled low carbon sheet steels per GMW2, but others may be considered with approval from Materials Engineering. Additional development may be required. Both the main steel blank and steel skins may be specified as uncoated or double-sided galvanized per GMW8 or GMW11, with approval from GM Materials Engineering.

1.1.3 Material Identification. This specification shall be included in the engineering drawing material callout and the related manufacturing documents (i.e., the Manufacturing Engineering Metal Part Specification (MPS) Sheet).

1.2 Symbols. Not applicable.

1.3 Applicability. LVDSP is to be used in applications intended for noise and vibration harshness (NVH) reduction on the vehicles. For example, a dash panel could be optimized for NVH reduction with laminated patches after engineering design, manufacturing, and performance validation.

2 References

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

2.1 External Standards/Specifications.

ASTM D1002	ASTM D1876	ISO 4587	SAE J1637
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2.2 GM Standards/Specifications.

GMW2	GMW3032	GMW3286	GMW14270
GMW8	GMW3059	GMW14057	GMW16823
GMW11	GMW3224	GMW14124	

2.3 Additional References.

- Manufacturing Engineering (ME) Lastenheft
- GM-North America Plant Requirements for Coils and Blanks (NACB)

3 Requirements

3.1 Requirements on Test Specimens. See 3.2.3, Mechanical Requirements.

3.2 Requirements on Delivery.

3.2.1 LVDSP Subassembly. To improve subassembly formability, the applied patches may be spot welded to the main blank. The spot welds shall meet the requirements of GMW14057, unless deviations are shown to improve formability during blank development. The quantity, location, and any changes to the requirements of these welds shall be agreed upon by GM Engineering and the supplier. Spot welds, following the part forming process, shall no longer be deemed structural and may no longer meet GMW14057 requirements.

3.2.2 Chemical Requirements. Chemistry of the base metal shall meet the requirements specified in the base metal specification.

3.2.3 Mechanical Requirements.

3.2.3.1 Sheet Metal. GM approved sheet metal substrates shall be used in the LVDSP blank subassembly. Mechanical properties of the monolithic sheet steels comprising the LVDSP blank subassembly shall meet the requirements specified in the base metal specification. Current applications are limited to GMW2 (CR2, CR3, or CR4) and GMW3032 (CR180B2) substrates. Any other substrates shall be approved by Materials Engineering.

3.2.3.2 Laminate Properties. The damping performance of the laminated steel composite, the tensile shear strength requirements, and the tensile peel strength requirements below, shall be met before and after the following environmental exposures.

- **Exposure 1:** 60 minutes at 190 °C.
- **Exposure 2:** 1500 h at 105 °C.
- **Exposure 3:** 240 h neutral salt spray per GMW3286.
- **Exposure 4:** 200 h at room temperature in a GM-approved lubricant or mill oil.
- **Exposure 5:** 13 cycles of GMW14124 Cycle K.

3.2.3.2.1 Damping Performance. Damping performance shall be determined by measuring the damping properties of LVDSP using the test procedure SAE J1637 with the modifications per 3.2.3.2.1.1 through 3.2.3.2.1.4.

3.2.3.2.1.1 The width of the specimen shall be from 17 mm to 25 mm. The length of the specimen shall be no less than 150 mm with the option to adjust upward in length to reach the desired frequencies, 100 Hz to 1000 Hz.

3.2.3.2.1.2 The damping performance of the LVDSP will change with temperature. The supplier shall provide data showing variation of composite loss factor with temperature and frequency within the design range of use. The design range of use shall be ± 10 °C of the expected operating temperature. Measurements of the composite loss factor shall be made at 4 °C increments over the entire design range.

3.2.3.2.1.3 The damping performance of the LVDSP expressed in terms of the composite loss factor over the range of frequencies and temperatures required must meet the minimum of 0.1 before and after the non-sequential environmental exposures detailed in 3.2.3.2.

3.2.3.2.1.4 Conformance to this requirement shall be verified at the time of approval and at the time of the initial production shipment, unless otherwise required by the purchaser.

3.2.3.2.2 Metal Skin to Viscoelastic Core Adhesion (Tensile Shear Strength). The laminated steel composite must have a tensile shear strength of 3 MPa minimum as-received with a 10% maximum strength reduction after each of the non-sequential environmental exposures detailed in 3.2.3.2. Sample preparation per ASTM D1002/ISO 4587 with a 25.4 mm overlap. Conformance to this requirement shall be verified at the time of approval and at the time of the initial production shipment, unless otherwise required by the purchaser.

3.2.3.2.3 Metal Skin to Viscoelastic Core Adhesion (Tensile Peel Strength). The laminated steel composite must have tensile peel strength of 1750 N/m minimum as-received with a 10% maximum strength reduction after each of the non-sequential environmental exposures detailed in 3.2.3.2. Test tensile peel specimens per ASTM D1876. Test specimens shall be 25.4 mm in width. Peel apart 76 mm specimens manually leaving at least 146 mm of material for testing. Place specimens in upper and lower grips securely. After peak load, measure and record average peel load from 19.05 mm to 146 mm of length.

3.3 Additional Requirements.

3.3.1 Formability and Welding. Formability, resistance welding, and projection welds, to the LVDSP are generally considered to be similar to the metal skin substrate specified for each application with regards to processing requirements and finish part quality. Substitutions of monolithic sheets for LVDSP should be

evaluated to verify manufacturing parameters are within accepted norms. These patches shall be designed such that joining other components during assembly will not require weld through the viscoelastic core.

3.3.2 Cleaning and Painting. Parts fabricated with the LVDSP shall be able to be processed through GM paint systems, including all cleaning, phosphate and paint cycles. No degradation or shrinkage of the core material, delaminating of the composite or paint system contamination is allowable. The viscoelastic material shall be fully cured/crosslinked prior to entering the GM manufacturing stream.

3.3.3 General Patch Blank Requirements.

3.3.3.1 Viscoelastic Adhesive Squeeze-Out. Viscoelastic adhesive material squeeze out is not to exceed 3 mm around all weld holes and outside perimeter edges of any patch blank, measured perpendicular to the edge. (Squeeze out inspection is not required after forming).

3.3.4 Material Thickness and Tolerance. The detailed engineering part drawing/electronic math file will specify thickness of each sheet metal skin per GMW3224, the viscoelastic layer thickness must meet the requirements in Table 1. The overall laminate thickness tolerance: (Blank A + viscoelastic core + Blank B) must meet the requirements in Table 2.

Table 1: Visco-Elastic Layer Thickness Range

Laminate Thickness	Visco-Elastic Thickness Range
≤ 1.0 mm	10 microns to 40 microns
> 1.00 mm	10 microns to 50 microns

Table 2: Laminate Thickness and Thickness Tolerances

Laminate Thickness	Laminate Thickness Tolerance
< 1.00 mm	± 0.04 mm
≥ 1.00 mm	± 0.05 mm

3.3.5 Blank Packaging Specification (GM Direct Stamping). Blank packaging is specific to a part and the front of line requirements at the GM stamping plant. Therefore, each part number will have a blank packaging specification that is unique to that part and GM stamping plant. The GM stamping plant that will receive the blanks is responsible to create a blank packaging specification for each part. The blank stack should meet the requirements shown in Figures A1 thru A3 unless otherwise specified. If there is any discrepancy between this document and the blank packaging specification sheet, the blank packaging specification sheet shall be used.

If dimpling is used, the blank packaging specification sheet shall show the type and location of the dimples. Recommended dimple dimensions are provided in Figure A4 and Figure A5. Note that small dimples may be present for de-stacking purposes. These small de-stacking dimples should not be present along the edge to be welded.

Blank packaging shall follow the requirements in the NACB specification for GM-North America unless otherwise specified in this document. If there is any discrepancy between the NACB specification and this document, this document shall be used.

Blank packaging shall follow the requirements in the Lastenheft document for GM-Europe, unless otherwise specified in this document. If there is any discrepancy between the Lastenheft and this document, this document shall be used.

3.3.6 Dimensions and Tolerances of the Blank Stack. The blanks shall be stacked so that each stack is identical in shape with the edges flush. The dimensions and tolerances for the stacks are also outlined in the NACB specification for North America, and the ME Lastenheft document for GME. If there is any discrepancy between the NACB (North America) or between the ME Lastenheft (Europe) and this document, this document shall be used.

3.3.7 Stack Shift, Blank Stagger and Stack Lean Tolerances. Permissible tolerance for these requirements are 6 mm for stack deviation (Figure A1), and ± 3 mm for stack lean (Figure A2).

3.3.8 Flatness of a Stack. The parallelism and flatness tolerance for the stack must fall between two planes parallel to the plane of the pallet. A stack height deflection of ± 25 mm is permitted ($h = \pm 25 \text{ mm}$), as seen in