GM	WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW14600

High Pressure Power Steering Hose Assembly

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 defines the material and construction requirements for coupled high pressure power steering hose assemblies.

1.2 Applicability. This standard is applicable to all high pressure power steering hoses assemblies**.**

2 References

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

2.1 External Standards/Specifications.

ASTM D380	ASTM D471	ISO 48
ASTM D395	ASTM D865	ISO 188
ASTM D412	ISO 36	ISO 1431-1
ASTM D413	ISO 37	ISO 1817

2.2 GM Standards/Specifications.

9985010	B 040 2012	GMW3286	GMW14872
9986153	GMW3059	GMW14264	GMW15272

2.3 Additional References.

- 9274926 – GM Part Number.
- Component Technical Specification (CTS).
- Subsystem Technical Specification (SSTS).
- TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

3 Test Preparation and Evaluation

3.1 Resources.

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

3.1.2 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.

3.1.3 Facilities. Facilities shall conform to the relevant test procedures.

3.1.4 Equipment. Equipment shall conform to the relevant test procedures.

3.1.5 Test Vehicle/Test Piece. Not applicable.

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3.1.6 Test Time. Shall conform to the relevant test procedures.

3.1.7 Test Required Information. Conforming to the relevant test procedures.

3.1.8 Personnel/Skills. Conform to GM Supplier Quality and/or laboratory certification requirements. Technician training records must be available upon request.

3.2 Preparation. Not applicable.

3.3 Conditions. The minimum time between vulcanization and testing of elastomers shall be 72 h.

3.3.1 Environmental Conditions. The test pieces shall be maintained at a temperature of 23 °C ± 5 °C for at least 8 h prior to test and shall be free from strain during this period. Ambient temperature test conditions shall be held to 23 °C ± 5 °C. All other temperatures shall be held to ± 3 °C and all pressures to 0 kPa + 690 kPa unless otherwise noted.

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.

3.4 Instructions. Not applicable.

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.

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 the product/process, and to apply for a new release.

If not 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 Test Results. With reference to this standard, the test results shall be presented in a test report.

4 Requirements and Procedure

4.1 Material Description. Hose assemblies for different applications are differentiated by "Type" designations based on the proposed application's pressure ranges and permitted volumetric hose expansion and by "Class" designations based on the heat resistance of the hose materials as specified by the permissible continuous and excursion temperatures of exposure. Refer to Table 1 and Table 2 for values of "Type" and "Class".

If no **"Type"** or **"Class"** is specified in the relevant Subsystem Technical Specification (SSTS) or Component Technical Specification (CTS), it shall be assumed to be Type A1.

4.1.1 Hose Construction.

4.1.1.1 Inner Tube. The inner tube of the hose shall consist of Hydrogenated Nitrile Butadiene Rubber (HNBR), Chlorosulfonated Polyethylene (CSM), Chlorinated Polyethylene (CM) rubber, a blend of CSM and CM, or other suitable elastomer. The inner tube must be a smooth seamless construction which will resist deterioration by action of GM approved mineral oil based power steering fluid, part numbers 9986153 (Dexron® VI) and 9985010, in a temperature environment from -40 °C with maximum continuous temperature limit of +125 °C and maximum excursion operating temperatures of 150 °C as defined in Table 2.

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Table 1: Hose Type (Expansion Rate and Operating Pressure)

Type	R_{exp}	P_{max} (MPa)
A	Low	12.8
B	High	12.8

R_{exp} = Expansion Rate
P_{max} = Maximum Operating Pressure

Table 2: Hose Classes (Temperature Conditions)

Class	Maximum Inside Temperature	Maximum Outside Temperature
1	+125 °C Continuous +135 °C Excursion +150 °C Extreme	+125 °C Continuous +135 °C Excursion +150 °C Extreme
2	+125 °C Continuous +150 °C Excursion +160 °C Extreme	+125 °C Continuous +150 °C Excursion +160 °C Extreme

4.1.1.2 Reinforcement. The reinforcement for the hose shall consist of two (2) layers of braided Polyamide (PA 6.6) yarn. Alternative reinforcement yarn materials may be permitted after review by GM Materials Engineering.

4.1.1.3 Cover. The cover of the hose shall consist of a layer of CSM or CM rubber or a blend of these materials.

4.1.1.4 Construction. All hoses shall be free from splices, porous areas, weak sections, bubbles, non-fills, foreign material, or any other defects that may affect serviceability.

4.1.1.5 Dimensions and Tolerances. Hoses designed to this specification shall nominally be 10 mm (0.39 in) inside diameter and conform to the tolerances shown in Table 3. All hoses furnished to this standard shall record wall gauge variation of no greater than 0.40 mm. Alternative inside diameter hose sizes may be considered after review by GM Materials Engineering.

Table 3: Dimensions and Tolerances

Types	Inside Diameter Maximum Tolerance	Wall Thickness Maximum Tolerance
A and C	± 0.35 mm	± 0.35 mm
B and D	± 0.4 mm	± 0.35 mm

4.1.2 Coupling Construction.

4.1.2.1 Coupling Design. The coupling shall be designed, inserted, swaged, or crimped so that no internal tube abrasions, cuts, or flaws shall result under any condition or combination of assembly component dimensioning or tolerancing allowed by supplier production specifications, or under any condition of rubber hose compression allowed by supplier production specifications.

4.1.2.2 Sharp Corners. Sharp corners shall be avoided where the coupling contacts the tube to prevent cutting of the hose when subjected to internal pressure.

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4.1.2.3 Tube Insert. The tube insert must not extend 6 mm past the end of the crimp shell after crimping, unless an extension is required for the tuner cable attachment. The end of the tube insert must be radiused to eliminate burrs or sharp edges which might cause hose damage under conditions of assembly, vibration, or pressure impulse.

4.1.2.4 Coupling Condition. Surface cuts to the rubber, broken braid fibers, or rubber bulges where the hose exits the crimp are not permissible. Witness marks, discoloration, abrasions, small splits in the cover layer not through to the braid fiber, due to the crimp are acceptable when this condition is limited, predictable, controllable, and does not increase the potential for assembly leakage or other malfunction.

4.1.2.5. Tube Collapse. Metal tube insert collapse is not permissible, except when this collapse is limited, predictable, controllable, and does not increase the potential for assembly leakage or other malfunction.

4.1.2.6 Design Restrictions. Grooves, upsets, or serrations, are not permitted on the tube stem outer diameter or on the crimp shell inner diameter, except that these grooves, upsets, or serrations, do not cause hose cutting or other damage under any condition or combination of assembly component dimensioning or tolerancing allowed by supplier production specifications, or under any condition of rubber hose compression allowed by supplier production specifications.

4.1.2.7 Skiving Adhesives. Skiving of the hose is not permissible. Use of adhesives in the crimped joint is not permissible.

4.2 Basic Test Requirements.

4.2.1 Coupled Assembly Required Tests. Coupled power steering hose assemblies shall be tested for conformance as identified in Table 4.

Table 4: Test Table Note 1

Test	Number of Samples	
	Design Validation (DV) Note 2	Process Validation (PV) Note 3
Material Properties to Table 5 (only hose material; no coupled hoses)	6	
Leak Note 4		
Volumetric Expansion Note 5	6	
Tensile Note 6	12	6
Burst Note 6	12	6
Accelerated Impulse Note 6	12	6
Accelerated Impulse/Burst Note 6	12	6
Accelerated Impulse/Ozone Note 2	6	
Cold Temperature Pressure Cycle Test	24	N/A
Cyclical Corrosion Note 5	6	N/A
Salt Spray Note 5	6	6
Overcrimp to 3 Sigma Limits	16	N/A
Overcrimp to Damage Note 7		N/A

Note 1: All hose assemblies shall be tested a minimum of 24 h after coupling.
Note 2: Hose and Crimp Design Validation.
Note 3: Hose and Crimp Process Validation.
Note 4: Performed for all test samples before conducting test procedures listed in Table 6 and Table 7.
Note 5: Six (6) hose assemblies crimped at nominal hose compression shall be tested.
Note 6: Twelve (12) assemblies are to be tested, six (6) at minimum hose compression, and six (6) at maximum hose compression.
Note 7: Quantities are design dependent.
DV: Design Validation.
N/A: Not applicable.
PV: Process Validation.

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4.2.2 Standard Test Samples.

4.2.2.1 Sample for Accelerated Impulse, Burst, and Cold Start Testing. Samples of coupled hose for test to the specification shall have a minimum exposed hose length of 420 mm. Configurations of coupled hose assemblies other than that specified in 4.2.1, may be tested by the supplier for the generation of Engineering Source Approvals for assemblies containing various hose sizes, hose manufacturers, and coupling constructions at the discretion of the GM Materials engineer generating the Engineering Source Approval. Each sample must be tagged with identification of:

- Hose coupling assembly manufacturer.
- GM specification.
- Date of manufacture.

4.2.2.2 Samples for the Remaining Testing. Samples for the remaining testing shall be up to the individual hose assembly manufacturer and is not critical to specify.

4.2.3 Approval Requirements.

4.2.3.1 Information to be reviewed with GM Materials Engineering.

4.2.3.1.1 Blueprints showing the design, dimensions, and tolerances, for all components of the assembly, including allowed eccentricity in the hose, tube insert, and coupling outer diameter. In addition, the range of all hose compressions possible under each condition of dimensional tolerance stack-up.

4.2.3.1.2 Data presented in both tabular and graph form, showing values of hose compression (calculated using both linear and area methods), versus tensile test performance, burst test performance, and fitting insert collapse. The dimensions of the crimped assembly components for each data point need to be listed, as well as the resultant hose compression.

Note: Values of hose compression must be reported both in terms of linear compression and area compression. Refer to Appendix A, Figure A1 for the formula for each calculation.

4.2.3.2 Information to be submitted to GM Materials Engineering.

4.2.3.2.1 The submission of sectioned coupling samples to demonstrate that all of the construction requirements have been met in Section 4.1.1 and Section 4.1.2.

4.2.3.2.2 A description of the statistical process control procedures for the coupling diameter dimensions and the hose compression range.

4.2.3.2.3 The value for hose compression necessary to induce:

- Hose rubber damage (any layer).
- Hose reinforcement damage.

4.2.3.2.4 Copies of test fixture traces, confirming pressure and temperature regiments imposed on the samples during test.

4.2.4 Engineering Approval Factors. Engineering source approvals generated through testing to prove compliance to this specification are specific for combinations of the following factors.

4.2.4.1 Type and Class. Refer to Table 1 and Table 2.

4.2.4.2 Size of hose and coupling components.

4.2.4.3 Hose material and construction.

4.2.4.4 Coupling design.

4.2.4.5 Tube insert material, plating, finish, and hardness.

4.2.4.6 Coupling shell material, plating, finish, and hardness.

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4.2.4.7 Supplier specifications and manufacturing procedures, supplier (both hose and assembly) manufacturing sites.

4.2.4.8 Testing of one (1) construction or assembly can result in Engineering Source Approvals for two (2) crimp designs or materials by placing each design or material variant on one end of the assembly.

4.2.5 Design Level Requirements. All tube/hose assemblies manufactured for testing to this specification for Engineering Source Approval purposes shall be completely representative of production level materials, components, processes, and tooling. The exceptions are those assemblies needing to be specially manufactured under extremes of dimensions and/or tolerancing to meet the test requirements of the specification. Any exceptions to these requirements, or to any criteria referenced in Section 1, Section 3, and Section 4, must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval.

4.2.6 Engineering Source Approval Testing. All testing conducted on assemblies and hoses manufactured with minimum/maximum dimensions, is to be conducted one (1) time only, for the initial Engineering Source Approval. Testing to Cyclical Corrosion Test is to be conducted one (1) time only, for the initial Engineering Source Approval.

4.2.7 Coupling Assembly Required Tests. All test samples must be qualified dimensionally. All data points must be reported. For samples destructively tested, mode of failure must be reported. All test specimens must be retained by the supplier and supplied to the GM Materials Engineer for review, if requested. Where test procedures reference specific minimum test values, those requirements must be met by the -3σ limit of the sample population tested.

4.2.8 Crimp Compression. Test samples throughout this specification will be referred to as minimum hose compression, nominal hose compression, or maximum hose compression samples. The requirements for these conditions are described in Appendix A, Figure A1. If not specified, the test samples shall be of nominal hose compression.

4.3 Deviations from Test Procedure. Elastomer material properties must be measured on samples taken from hose unless appropriate samples cannot be taken from the hose. Samples prepared from slab stock must be documented as such and the cure state of the slab stock must be shown to be equivalent to the cure state of the hose elastomer. Other deviations from the requirements of the test procedures shall have been agreed upon by the GM Materials Engineer generating the Engineering Source Approval. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.4 Material and Performance Requirements. These requirements for testing are specific to this specification for the purpose of hose suppliers to become qualified to supply hose assemblies to GM, and to stay qualified. Sample sizes and preparation are described in Table 4 for design validation testing. For Process Validation and Audit/Inspection testing, the samples are described in Table 4. Samples prepared with nominal crimp compression are to be used in place of the minimum and maximum crimp compression samples. Program specific/vehicle specific hose assembly part numbers do not require retest, if the crimp design, hose design and material content are identical to the standard hose assembly samples qualified to this specification. The pressure hose component technical specification must be referred to for those requirements.

4.4.1 Hose and Crimp Design Validation Testing. Material Properties (material/compound approval) are summarized in Table 5, performance properties (construction approval) in Table 6, corrosion properties in Table 7 and crimping properties in Table 8. For full approval of a hose assembly, compliance to the requirements of Table 5 through Table 8 is needed.

4.4.2 Hose and Crimp Process Validation Testing. If not defined otherwise, the testing should be done for production validation testing per 4.4.2.1 through 4.4.2.2.

4.4.2.1 Material Properties. All tests per Table 5 except Ozone Resistance, Age Resistance (Heat Aging) and Immersion in Fluid for cover and lining.

4.4.2.2 Hose and Crimped Hose Assembly Performance Tests. As indicated in Table 4.

4.4.3 Audit/Inspection Testing (Hose and Crimp Process Validation Audit Testing). If not defined otherwise, the testing should be done for production audit testing per 4.4.3.1 through 4.4.3.2.

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