



HNBR-Lined Hydraulic Pressure 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 specification defines the material and construction requirements for coupled hydraulic pressure hose assemblies, to be used as flexible, pulse-attenuating connections between a hydraulic pump and downstream devices such as power steering gear, hydraulic brake booster or active roll control motor. Routings, attachments and other program-specific features are not included in the scope of this specification and require additional validation testing.

1.2 Applicability. This standard is applicable to all high pressure power steering hoses assemblies with Hydrogenated Nitrile Butadiene Rubber (HNBR) lining.

2 References

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

2.1 External Standards/Specifications.

ASTM D380-94	ASTM D471-16a	ISO 37	ISO 1431-1
ASTM D412-16	ASTM D865-11	ISO 48	ISO 1817
ASTM D413-98	ISO 36	ISO 188	

2.2 GM Standards/Specifications.

9985010	9986153	GMW3286	GMW14872
9986117	GMW3059	GMW14264	GMW15272

2.3 Additional References.

- 9274926 – GM Part Number.
- Component Technical Specifications (CTS).
- Vehicle Technical Specifications (VTS).

3 Test Preparation and Evaluation

3.1 Resources.

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

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.

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

3.1.3 Test Vehicle/Test Piece. Not applicable.

3.1.4 Test Time. Shall conform to the relevant test procedures. Test Time will be dependent on specific hose requirements.

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

3.1.6 Personnel/Skills. Conform to GM and/or laboratory 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 $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ 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 $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. All other temperatures shall be held to $\pm 3\text{ }^{\circ}\text{C}$ and all pressures to $-0\text{ kPa} + 690\text{ kPa}$ unless otherwise noted.

3.3.1.1 Deviations from this Standard. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

3.3.2 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 Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

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. Material content description is as described in 4.1.1.

4.1.1 Hose Construction.

4.1.1.1 Inner Tube. The inner tube of the hose shall consist of a tube of hydrogenated nitrile (HNBR) rubber. The inner tube must be a seamless construction, whose surface shall not have surface anomalies which will affect durability or performance and which will resist deterioration by action of General Motors Company approved mineral oil-based power steering fluids as defined in Table 1. Maximum allowable flaw depth in the Inside Diameter (ID) of the tube layer is $15\text{ }\mu\text{m}$, per the test procedure defined in Appendix B. Representative hose samples must be submitted for evaluation of tube ID flaws to the approving GM Materials Engineer.

Table 1: Fluid Compatibility and Operating Conditions

Fluid(s)	R _{exp}	T _{low} (°C)	T _{cont} (°C)	T _{exc} (°C)	P _{max} (MPa)
9985010, 9986117, 9986153	Low	-40	135	150	12.8

Note: C = Celsius, MPa = Megapascals, P_{max} = maximum operating pressure, R_{exp} = expansion rate, T_{cont} = maximum continuous operating temperature, T_{exc} = maximum excursion operating temperature, T_{low} = minimum operating temperature.

4.1.1.2 Reinforcement. The reinforcement for the hose shall consist of two layers of braided Polyamide (PA) 6 yarn or 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 chlorosulfonated polyethylene (CSM) or chlorinated polyethylene (CPE 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 conform to the dimensions and tolerances shown in Table 2. All hoses furnished to this specification shall record wall gauge variation of no more than 0.76 mm.

Table 2: Dimensions and Tolerances

Inside Diameter (millimeters (mm))		Outside Diameter (mm)	
Minimum	Maximum	Minimum	Maximum
9.50	10.20	17.20	18.50

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.

4.1.2.3 Tube Insert. The tube insert must not extend 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 radii used 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 another malfunction.

4.1.2.5 Damage. Damage to hose rubber or reinforcement due to crimping is not permissible, except when this collapse is limited, predictable, controllable, and does not increase the potential for assembly leakage or another malfunction.

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

4.1.2.7 Design Restrictions. Grooves, upsets, or serrations are not permitted on the tube stem outer diameter (OD) or on the crimp shell inner diameter (ID), 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.

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

4.1.2.9 Flow Requirements. The coupling shall be designed for low flow restriction.

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 3.

Table 3: Test Table ^{Note 1}

Test	Number of Samples	
	Hose and Crimp Design Validation (DV)	Hose and Crimp Process Validation (PV) ^{Note 2}
Material Properties to Table 4 (only hose material; no coupled hoses)	6	
Leak ^{Note 3}		
Volumetric Expansion	6	
Tensile	12 ^{Note 4}	6
Burst	12 ^{Note 4}	6
Accelerated Impulse	12 ^{Note 4}	6
Accelerated Impulse/Burst	12 ^{Note 4}	6
Accelerated Impulse/Ozone	6	
Cold Temperature Pressure Cycle Test	18 ^{Note 5}	Not applicable
High Temperature Burst	54 ^{Note 6}	Not applicable
Cyclical Corrosion	6	Not applicable
Salt Spray	6	6
Overcrimp to 3 σ Limits	16	Not applicable
Overcrimp to Damage	Design Dependent	Not applicable

Note 1: All hose assemblies shall be tested a minimum of 24 h after coupling.

Note 2: Hose assemblies crimped at nominal hose compression shall be tested.

Note 3: Performed for all test samples before conducting test procedures listed in Table 7 and Table 8.

Note 4: Six (6) at minimum hose compression, and six (6) at maximum hose compression.

Note 5: Six (6) at minimum hose compression, six (6) at nominal hose compression and six (6) at maximum hose compression.

Note 6: Eighteen (18) at minimum hose compression, eighteen (18) at nominal hose compression and eighteen (18) at maximum hose compression.

4.2.2 Test Samples.

4.2.2.1 Standard Test Samples. Samples of coupled hose for test to the specification shall have an exposed hose length of 500 mm $\pm$ 10 mm and a maximum tube length of 100 mm. Samples of coupled hose for test of accelerated impulse and cold temperature impulse shall consist of hose length 502.4 mm (end of crimp to end of crimp) and pipe lengths on each end of 51 mm (including tube nut). Configurations of coupled hose assemblies other than that specified in 4.2.2.1 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.

4.2.3 Approval Requirements. Approval will require the following information to be submitted:

- a. Blueprints showing the design, dimensions and tolerances for all components of the assembly including allowed eccentricity in the hose, tube insert, and coupling OD. In addition, the range of all hose compressions possible under each condition of dimensional tolerance stack-up.
- b. The submission of sectioned coupling samples to demonstrate that all of the construction requirements listed in 4.2.3 have been met.
- c. A description of the statistical process control procedures for the coupling diameter dimensions and the hose compression range.
- d. The value for hose compression necessary to induce:
 1. Hose rubber damage (any layer).
 2. Hose reinforcement damage.
- e. Data presented in both tabular and graph form, showing values of hose compression (calculated using both linear and area methods) vs. 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.
- f. Copies of test fixture traces, confirming pressure and temperature regimens imposed on the samples during test.

Note: Values of hose compression must be reported both in terms of linear compression and area compression (see Appendix A) for the formula for each calculation.

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:

- Type (reference Table 1).
- Size of hose and coupling components.
- Hose material and construction.
- Coupling design.
- Tube insert material, plating, finish and hardness.
- Coupling shell material, plating, finish and hardness.
- Supplier specifications and manufacturing procedures, supplier (both hose and assembly) manufacturing sites.

Testing of one 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 prior to the initiation of the test program.

4.2.6 Engineering Source Approval Testing. All testing conducted on assemblies and hoses manufactured with minimum/maximum dimensions, is to be conducted one 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, 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 4 and Table 5, Construction Properties in Table 6, Performance Properties in Table 7, Corrosion Properties in Table 8, and Crimping Properties in Table 9. For full approval of a hose assembly, compliance to the requirements of Table 4 through Table 9 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 4 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 3.

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.

4.4.3.1 Material Properties. All tests per Table 4 except Ozone Resistance and long term aging and long term immersion tests for cover and lining.

4.4.3.2 Hose and Crimped Hose Assembly Performance Tests. Leak Test, Tensile Test, and Burst Tests per Table 7; Salt Spray Test, per Table 8.

4.4.4 One Hundred Percent (100%) Production Function Tests. The following testing is required for production.

- Air under water, pressure decay, or mass flow leak testing, specific leak test to be used must be referenced in the process control plan for each supplier and approved by GM Supplier Quality Engineering and GM Product Engineering.

4.4.5 Table 4 through Table 9. Other engineering experimental plans are permissible, providing that the approval of the GM Materials Engineer issuing the Engineering Source Approval has been obtained. Any