NAHAD
HOSE SAFETY INSTITUTE
Safety, Quality & Reliability

Guide:
Understanding Hose Assembly Testing Requirements

NAHAD
THE ASSOCIATION FOR HOSE AND ACCESSORIES DISTRIBUTION

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Understanding Hose Assembly Testing Requirements
Available Tests and What They Mean

This document provides a comprehensive view of common tests available for assembly testing, how the test is performed, what it tells you, and common forms used to detail the specific assembly components tested, outcomes, and recommendations.

Safe, reliable hose assemblies require appropriate testing based on NAHAD's Hose Assembly Guidelines. Different types of tests are available to assure assembly integrity; your Hose Safety Institute distributor will select the appropriate test(s) depending on intended application, assembly components, and related factors.

Below are a series of important notes for consideration and relative to the information found in this Guide:

HSI Best Practice: For assembly testing, the rating of the component with the lowest rated working pressure determines the working pressure of the assembly.

System Pressure: A proper hose selection is made when the published maximum working pressure of the hose and fittings is equal to or greater than the maximum system pressure.

The maximum working pressure of a hose assembly is the lower of the respective published maximum working pressures of the hose and the fittings used. Surge pressures or peak transient pressures in the system must be below the published maximum working pressure for the hose. Surge pressures and peak pressures are usually determined by using sensitive electrical instrumentation that measures and indicates pressures at millisecond intervals. Mechanical pressure gauges indicate only average pressures and cannot be used to determine surge pressures or peak transient pressures. Published burst pressure ratings for hose is for manufacturing test purposes only and is no indication that the product can be used in applications at the burst pressure or otherwise above the published maximum recommended working pressure.

Visual Inspection: None of the tests mentioned in this Guide should be performed without a proper visual inspection of the hose assembly to confirm it is free of defects.

Conditions for Testing: Hose assembly testing is normally conducted at normal ambient room temperature. In-service temperatures need to be specified prior to testing. In-service temperatures can have a major impact on hose life and potential failures.

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This Guide was developed by members of the Hose Safety Institute©, a program of NAHAD, The Association for Hose and Accessories Distribution. The Institute provides a powerful forum for distributors, manufacturers, suppliers, end-users, and industry organizations to support and promote hose assembly safety, quality, and reliability, across all markets and industries by establishing guidelines and best practices for hose assembly.

Safety: The #1 Consideration

Safety is a critical factor in any hose assembly fabrication process, or in any shop. Always wear safety glasses, gloves, and protective clothing to protect from leaks or high-pressure spray. Also, use shields to protect people in the work area in the event of a hose burst, spray, or coupling blow-off.

It is recommended to never stand in front of, over, or behind the ends of a hose assembly during pressure testing.

All hydrostatic testing should be conducted with liquid media. Pneumatic testing with gasses such as air or nitrogen is prohibited. The energy stored when pressure testing with gasses creates a very dangerous system, where product failure may cause injury or death. High-pressure pneumatic testing offers benefits for metal hose as long as the assembly is properly restrained and may be considered as long as the appropriate safety measures are taken.

Safety Procedures

- Appropriate signage posted in the shop
- Company safety plan which should include:
  - Overall philosophy
  - Audit process and timing
  - Incident reports
  - Drug and alcohol policy
  - Proper storage of chemicals and other hazardous materials along with appropriate documentation

Personal Protection Equipment (PPE)

- Steel-toed shoes
- Safety glasses
- Ear plugs
- Avoiding loose-fitting jewelry/clothing that can get caught in machinery
- Gloves
- Seatbelts on forklifts

Types of Tests

Proof testing refers to testing that "proves" the finished hose assembly meets the pressure rating required by the application for which it will be used, and that the end fittings have been correctly fitted and the assembly is leak free.

Burst testing refers to a destructive test that determines at what pressure the assembly fails, and whether the finished assembly meets appropriate design factors.

Electrical continuity refers to testing the assembly to determine if there is a grounding path between end fittings.

Test	What It Tells You	Comments
Hydrostatic Proof Pressure Test	Pressure integrity of the hose assembly; appropriate component selection; can be used to measure elongation or length changes under pressure	Proper test pressures are crucial so as to avoid damaging the hose
Hydrostatic Burst Pressure Test	At what pressure the hose will burst	Destructive test; typically done by the hose manufacturer to verify hose design
Leak test	Tests for leak paths in the assembly	Typically uses air or helium under water
Helium Mass Spectrometer Test	Evaluates leakage, but not strength of the assembly	For critical applications; special equipment and specialized expertise are required; typically for metal hose
Electrical Continuity Test	Is the hose assembly grounded from one end to the other	Measured by a calibrated multi-meter
Electrically Dissipative Test	Checks whether electrostatic dissipation occurs	Refers to hose characteristics; Done during hose development by the manufacturer
Vacuum Test	Integrity of the hose under a vacuum	Can be destructive; typically conducted by the manufacturer
Impulse test	Integrity of the hose when subjected to continuous pressure spikes	Typically conducted by the manufacturer
Elongation Test	% change in hose length	Typically tested to industry specifications

How They're Done

Hydrostatic Proof Pressure Test

For assembly testing, **the rating of the component with the lowest rated working pressure determines the working pressure of the assembly**. There shall be no indication of failure or leakage.

Hose Type	What pressure	How long
Industrial	Minimum 1 ½ times working pressure for assemblies unless otherwise required by the customer or designated hose specification*	5 minutes
Hydraulic	2 times working pressure**	30-60 seconds
Composite	1 ½ times working pressure**	1-4" nominal bore: 5 minutes >4" nominal bore: 30 minutes
Fluoropolymer	1 ½ times working pressure**	1 minute
Corrugated Metal	Contact the manufacturer for maximum test pressure for each hose	Contact the manufacturer

**Certain specifications may require used hose assemblies to be tested at working pressure*
***unless otherwise required by the customer*

A hydrostatic pressure test requires either a hand pump, a power driven hydraulic pump, or an accumulator system. Connect the hose assembly to the test pump in a straight fashion, assuring a leak tight connection. It is recommended that the hose assembly be secured in an encapsulated tank if possible for short lengths that will withstand the pressure, or sufficient restraints to prevent "whipping" if a failure occurs. The hose ends need to be restrained. The hose must be free to move slightly when pressure is applied.

Test pressure is determined by the assembly component with the lowest pressure rating. Unless otherwise stated by the end user, the test medium should be water.

The following testing procedure is recommended:

1. Lay the hose out straight whenever practical, slightly elevating one end to ensure trapped air is expelled, allowing space for elongation under pressure, preferably on supports to allow free movement under pressure.
2. Blank off one end of the assembly.
3. Completely fill the hose with water; take particular care to ensure that all trapped air is released from the hose. A bleed valve is typically used to release trapped air in a pressurized assembly. This is very important as a safety measure because expansion of air compressed in the hose, when suddenly released by bursting or other failure might result in a serious accident.
4. For reference, mark a line behind the coupling, which is at the end of the ferrule, clamp, band, etc.
5. Gradually raise the pressure to the desired pressure rating. Hold the pressure for the time dictated by hose type and conduct a visual inspection. As the pressure is raised, watch for visual indications of permanent deformation, leakage, and coupling slippage. If any of these are noted, it is cause for rejection. After the test is complete, relieve the test pressure before disconnecting the hose assembly from the test equipment and drain the water from the hose. The hose may be flushed with a drying agent to customer specifications.
    - For industrial hose and depending on coupling design, a minimal amount of hose coupling slippage may be acceptable if the hose does not show any leakage at any time during the test; a second test is recommended in that case to confirm assembly integrity. Contact the manufacturer with any concerns. NO slippage is allowed for hydraulic hoses.
6. When tested in accordance with the above, the assembly under test should be totally leak free for the duration of the test; leakage is defined as a continuous stream of water droplets emitted from a single or multiple locations.

Hydrostatic Burst Pressure Test

Hose assemblies on which the end fittings have been attached less than 30 days may be subjected to a hydrostatic burst pressure test. Increase the pressure at a steady, constant rate until the hose bursts, within a period of not less than 15 seconds. There shall be no leakage, or indication of failure below the specified minimum burst pressure. Note: Attempting to reach burst pressure in a large diameter hose in 60 seconds or less creates potential safety issues with the process.

Due to the cutting and injection hazard of high-pressure testing, personnel should be shielded from the assembly during testing.

Leakage Test

After hose assembly, each hose assembly shall be subject to a leakage test protocol, which should include visual inspection of the assembly as well. Testing may either be based on a sampling, or every assembly, depending on the criticality of the application. Note: for corrugated metal hose, testing for each hose assembly is required; a leak test ensures that both the hose and the attachment welds are leak free, while a visual inspection can detect other physical defects (broken wires, damage, etc.) The test protocol must evaluate leakage, pressure capacity, and motion of the fitting relative to the hose, broken wire and all other permanent damage. The object of the test is to assure a high quality and safe hose assembly.

When leak rates are critical, consult the manufacturer for more sensitive testing methods. These may include but are not limited to the following: Mass Spectrometer Leak Testing, Pressure Decay, Vacuum Decay, Mass Flow, Dye Penetrant, and Nitrogen Leak Test.

Continuity Testing

1. Make sure the hose is fabricated in accordance with HSI procedures and the hose helix or ground wire makes positive contact with the hose fittings. In the case of a wire braided hose a tack or staple may be required to assure the braid is contacting the hose shank.
2. It is recommended that continuity be checked prior to and after hydrostatic testing to assure that wires have not become dislodged during the test.
3. Select the ohm setting on the meter. Be sure to set unit to ohms, not mega ohms.
4. Place the hose ends close enough so that the 2 contacts wires on the meter can reach each end fitting or seat.
5. Hold the meter contacts firmly on each end and read the meter.
6. If the meter reads below the resistance as specified by the manufacturer for that hose group the hose passes the continuity test.

Electrical Resistance Test

Measures the ability of the hose (not the assembly) to conduct electric current. Tests for electrostatic dissipation capability are typically conducted by the hose manufacturer, not by the fabricator in the field. Electrostatic dissipation meets a max resistance per unit length as specified by the manufacturer.

Electrical Continuity Test

Refers to testing the assembly to determine if there is a grounding path between end fittings, which would allow for an electric charge to discharge through the hose to a ground source if necessary. Checking for continuity is done by the use of a calibrated ohm meter or multimeter.

Proof testing for electrical continuity and static dissipation are different and should be conducted according to manufacturer recommendations as necessary for the application.

Note: end to end continuity does not guarantee static dissipation for a hose assembly. Depending on the media being conveyed (for example, powders, solvents, fuels, etc. known as static accumulators), additional steps may need to be taken. Check with the manufacturer for specifics.

Bonding - refers to the continuous connection between the metal end of the hose, the helix wire inside the hose, and (for example) the connection to something like a liquid vacuum truck, providing electrical connections between isolated conductive parts of a system to equalize their electrical potential (voltage). Electrical resistance between two directly bonded connections should not exceed 10 ohms.

Grounding – Refers to the ability of the static charge to trace a path to a grounding point to "mother earth" for dissipation and should be monitored to a level of <1000ohms.

Together, bonding and grounding provide controls to help disperse static electricity, providing electrical connections between isolated conductive parts of a system to equalize their electrical potential (voltage), and to equalize the static charge built up during the vacuum or transfer process.

Acceptable resistance levels may vary depending on hose type and application. In general, acceptable levels are less than 100 ohms, unless otherwise specified by industry standards. Check with manufacturer for acceptable ohm readings.

- Composite hose: <10 ohms
- Textile reinforced fluoropolymer or rubber hose: typically not used when continuity is required unless a helix or static wire is included

Elongation Test

Change in Length Test—measures elongation or contraction of a hose; these tests are normally performed by the manufacturer for new hose and certificates are issued accordingly. Except for Oil Suction & Discharge Hose (Dock Hose) covered by ARPM (RMA IP-8), elongation tests are not typical. The end user would specify the need and frequency of testing.

There are two methods for measuring elongation: one that covers hoses that would fall under the ARPM (RMA) IP-8 and those that fall under SAE requirements or have no specific specs, and that would be SAE J-343.

SAE Test Process:

Measures elongation or contraction of a previously untested, un-aged hose assembly having at least 600 mm length of free hose between hose fittings. Elongation testing is a non-destructive method for determining a hose condition at different pressure ratings.

1. Attach the hose assembly to the pressure source in an unrestricted straight position. If the hose is not straight due to its natural curvature, it may be fastened laterally to achieve a straight position.
2. Pressurize to the specified operating pressure for a period of 30 seconds, then release the pressure.
3. Place accurate reference marks 500 mm apart on the outer cover of the hose, midway between fittings, after allowing the hose assembly to restabilize for a period of 30 seconds following pressure release.
4. Repressurize the hose assembly to the specified operating pressure for a period of 30 seconds.
5. Measure the final length while the hose is pressurized. The final length is the distance between reference marks while the hose is pressurized.

6. Complete the determination of the change in length using the following equation:

$$\frac{L_1 - L_o}{L_o} \times 100 = \%\ \text{change}$$

   - L_o is the distance between the reference marks when the hose was not pressurized following the initial pressurization
   - L_1 is the distance between the reference marks under pressure

   The result is the percentage change in length, which will be positive (+) in the case of an increase in length and negative (−) in the case of a decrease in length. ARPM IP-8 testing uses the same process, but the initial pressurization is to 10psi, not the specified operating pressure.

Helium Mass Spectrometer Test

Helium mass spectrometer testing is the most accurate way of evaluating leakage (but not strength). Assemblies designed for critical applications should be leak tested with this method. All tested assemblies shall have a leak rate less than 1×10^{-3} std/cc/sec. Helium mass spectrometer testing to smaller leak rates may be available – consult the assembly fabricator.

Pneumatic Test

Unless otherwise specified, the hose assembly shall be subjected to a pneumatic test at a value defined in the table below. Using a gaseous media, the assembly is immersed in a bath of water for a sufficient length of time to permit visual examination of all fabricated joints. Typical gas testing media are air, nitrogen, and helium. To guard against corrosion, the chloride content of the water used for testing austenitic stainless steel should be controlled to less than 50 ppm (parts per million). Minimum testing time should be twenty (20) seconds. Any evidence of leakage or permanent deformation is cause for rejection.

Minimum Pneumatic Test Pressures

Unbraided Assemblies	
Nominal I.D.	Pressure
1/4" through <3/4"	25 psig
3/4" through <1-1/4"	10 psig
1-1/4" through <4"	5 psig
4" through 6"	3 psig
>6"	2 psig
Braided Assemblies	
Nominal I.D.	Pressure
1/4" through 4"	75 psig
>4" through 6"	50 psig
>6"	15 psig

Helpful Terms:

Electrical Continuity - The ability or power to conduct electricity. Conductivity in a hose can be carried through the helix wire on a suction hose, a wire hose braid in a steam hose or pressure wash hose, an embedded ground wire in a ducting hose, or from the conductive carbon black in the hose tube. Not all black tubes are conductive!

The purpose for checking a hose assembly for continuity is to allow for an electric charge to discharge through the hose to a ground source if necessary. This can be done by the use of a calibrated ohm meter or multimeter.

Electrically Continuous Assembly: refers to the electrical conductivity between coupling ends. To get an "electrically continuous" assembly you need to have the helix or static wires terminated to the couplings; it is measured in Ohms (typically less than 100 ohms). **Note:** an electrically continuous hose is not necessarily a static dissipating hose

Electrically Discontinuous Assembly: refers to the electrical conductivity between coupling ends. To get an "electrically discontinuous" assembly, the wire helix or static wire MUST NOT be terminated to the couplings and the rubber component should have a high electrical resistance; it is measured in thousand of Ohms (electrical resistance typically > 25,000 Ohms)

Electrical Resistance - a material's opposition to the flow of electric current; resistance is measured in ohms.

Electrostatic Discharge: the sudden discharge of static electricity from an area of buildup to a grounding point; is known to cause leak paths.

Elongation: the change in length expressed numerically as a percentage of the initial length.

Non-conductive: the inability to transfer an electrical charge. Non-conductive hoses normally are recommended in applications where the electrical charge is transferred from the OUTSIDE ENVIRONMENT to the hose. Air hoses used around electrical furnaces and multipurpose hoses used in proximity to high voltage power lines should have non-conductive ratings as prescribed by the respective industry. In essence, the hose acts as an insulator protecting the user from EXTERNAL electrical sources. Non-conductive hoses generally are manufactured WITHOUT a metal helix or "bonding" wire. An industry standard for "non-conductive" hose follows the Alcoa specification for potroom air hose which requires a resistance of ONE MEGAOHM PER INCH PER LENGTH OF HOSE.

Static Dissipating Hose (also referred to as semi-conductive hose): Static dissipating hose refers to the electrical properties of the materials making up the hose, usually the tube and/or cover material; it is measured in M-Ohms (million Ohms). It is used in applications where the conveyed material can generate static electricity build- up. Such hoses will dissipate static electricity through the rubber material to the hose ends, provided the correct coupling type is used. **Note: Non-black and many black compounds will not dissipate static electricity.**

Special Notes by Hose Group

Composite Hose:

Hydrostatic Test. Composite hose assemblies with 1 inch to 4 inches (25 mm to 100 mm) nominal bore composite “standard duty” or general-purpose oil and chemical hose should be tested to a minimum of the rated working pressure of the end fittings but must not exceed one and a half times the rated working pressure of the hose for a minimum period of five (5) minutes. Longer test times may be required, consult manufacturer for specific requirements. (Polypropylene, cam and groove, NPT males and flanges do not have the same test criteria.)

Composite hose assemblies with 4 inch (100 mm) nominal bore “heavy duty” and 6 inches to10 inches (150 mm to 250 mm) nominal bore composite hose should be tested to a minimum of the rated test pressure of the end fittings, but must not exceed one and a half times the rated working pressure of the hose for a minimum period of 30 minutes and/or regulatory statutory requirements. (Polypropylene, cam and groove, NPT males and flanges do not have the same test criteria.)

Note: Composite hose manufacturers may differentiate the 4-inch (100mm) nominal diameter between “standard duty” and “heavy duty”. It is common practice to suggest that “standard duty” hose is for general purpose in plant applications, whereas the “heavy duty” is used in either more rigorous or marine applications.

Hydraulic Hose:

Coupled hose assembly lots should be sampled and tested utilizing an acceptable burst and proof pressure procedure. It is recommended that proof and burst testing be performed in accordance with SAE J517 and SAE J343, or an applicable industry standard or customer specification.

The SAE J343 standard gives methods for testing and evaluating the performance of the SAE 100R series hydraulic hose and hose assemblies (hose and attached end fittings) used in hydraulic systems.

Fluoropolymer Hose:

All fluoropolymer hose assemblies shall be tested in a condition such that the end fittings and the section of hose immediately behind the fittings is visible. Do not obstruct the access to these areas with any type of optional chafe or fire sleeve that may be required to complete the assembly.

NOTE: Not every fluoropolymer hose is or should be hydrostatically tested; pneumatic testing is perfectly appropriate in certain situations, and in all cases should be conducted under water at a pressure below 500 psi in a closed container. Using a gaseous media, the assembly is immersed in a bath of water for a sufficient length of time to permit visual examination of all fabricated joints. Typical gas testing media are air, nitrogen, and helium.
Ultimately it should be up to the customer to determine what testing is required, but the NAHAD Guidelines provide guidance regarding how those tests are performed. Testing requirements are dictated by both the application and the pressure rating. SAE J517 is the appropriate standard in this case.

Corrugated Metal Hose:

Hydrostatic Test. The hydrostatic test not only tests for leakage, it confirms the assembly’s structural integrity. The assembly shall be pressurized with water to the maximum test pressure of the assembly as determined by the manufacturer and maintained for a sufficient length of time to permit a visual examination. To guard against corrosion, the chloride content of the water used for testing austenitic stainless steel should be controlled to less than 50 ppm (parts per million). The minimum testing time should be 60 seconds. Any evidence of leakage or permanent deformation is cause for rejection.

[SAMPLE - Your Logo Here]

HYDROSTATIC TEST FORM

The following test and sample size was performed with the intent of documenting the structural integrity (by way of a hydrostatic pressure test IAW ASTM D380 if burst testing) of a particular combination of hose, end fitting, and fitting attachment method, which are all clearly defined below. Please note that any changes in components, temperature, media conveyed, operating conditions (see STAMPED) etc. will impact the test results. Therefore, before selecting this hose assembly for use in a system the STAMPED process should be verified.

___Burst Test (ASTM D380) __Proof Test (HSI Best Practices)

Hose Specification:
Manufacturer: _____
Style/Part Number:_____
Hose ID (in.)_____
Assembly Length (in.) _____
Working Pressure _____
Burst Pressure _____

End Fitting #1 Specification:
Manufacturer: _____
Style /Part Number:_____
Attachment Method:_____
Attachment Verification: _____
(Crimp / Swage Diameter, Band Clamp Tension, Bolt Clamp Torque, etc.)

End Fitting #2 Specification:
Manufacturer: _____
Style /Part Number:_____
Attachment Method:_____
Attachment Verification: _____
(Crimp / Swage Diameter, Band Clamp Tension, Bolt Clamp Torque, etc.)

*Test assumes assembly working pressure = working pressure of the lowest rated component

Customer:
Date:
Test Location:
Test Temperature:
Target Test Pressure: *
Is this a Burst Test? Result? (Pressure at burst)
Who performed test:

Test Number	Result
Test 1	
Test 2	
Test 3	
Test 4	
Test 5	
Test 6	
Test 7	
Test 8	
Test 9	
Test 10	