GUIDE

For the Fabrication of Corrugated Metal Hose Assemblies

Version 2.1
July, 2015

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Section F1 - Scope

The purpose of this document is to assist sales engineers, fabricating distributors and metal hose assembly shops in the proper methods and techniques for metal hose fabrication. This document supplements the NAHAD *Hose Safety Institute Handbook* © which should be referenced for additional information. This document should be used in conjunction with all applicable federal, state, and local building codes, as well as any applicable industry guides.

This document provides general guidelines and is not intended to provide all information or requirements for the design, engineering, assembly and testing of hose assemblies or for compliance with applicable laws, standards, and regulations. Always refer to and follow the supplier's instructions and warnings.

This document is not intended to prohibit either supplier or customer from specifying additional or different requirements for hose, couplings or hose assemblies, if necessary, to satisfy the specific application. It is the responsibility of the fabricator and user to separately qualify these applications and their unique requirements necessary to ensure performance capability.

This document assumes that all equipment used in the fabrication of the hose assembly has been properly maintained and calibrated on a regular basis.

The user of this document is cautioned that the information contained herein is for general guidance only. The document reflects the most commonly used equipment and procedures to make assemblies**. It does not reflect new developments or products developed for specific applications.**

There are specific applications that require additional design, engineering, fabrication, testing, installation and maintenance considerations over and above the requirements set forth in these Hose Assembly Guidelines. This includes applications where custom design, engineering, fabrication, testing, installation and maintenance are specified or required. Please see Section 2.4 and Appendix G of NAHAD's Hose Safety Institute *Handbook*© for further information.

This document is subject to revision. Users should obtain the latest version.

NOTE: For hose assemblies used to transport chlorine, there are specific requirements set forth in the Chlorine Institute Pamphlet #6 (edition 15), "Piping Systems for Dry Chlorine", Appendix A, Section 9. Please note that Chlorine transfer hose (CTH) must be clearly and permanently marked as per Chlorine Institute Pamphlet #6 (edition 15), Appendix A, Section 9. These permanent markings (e.g. stamping, stenciling or coding) should be utilized throughout the supply chain for purposes of continuous positive identification.

Important Notice About This Document

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Hose, hose fittings and hose couplings come in various sizes and designs. Although there are standards published by manufacturers and independent standards and testing organizations, such as ANSI, ASTM, UL, SAE, ARPM, which relate to hoses and hose fittings, there are no generally recognized standards or guidelines for hose assemblies.

NAHAD, The Association for Hose and Accessories Distribution, has published these Guidelines in order to create a reference work that compiles information of value to NAHAD members, manufacturers and customers in developing hose assemblies that meet specific individual needs. To the extent that a hose assembly has unique characteristics or specific requirements, it must be custom designed, engineered and tested.

The Guidelines incorporate pressure recommendations, corrosion recommendations and temperature recommendations published by hose and coupling manufacturers and others. NAHAD has not independently tested or verified these recommendations and specifically disclaims all liability, direct or indirect, for these recommendations.

In making this document available, NAHAD is not undertaking to render professional or other services for or on behalf of any person or entity. Anyone using this document should rely on their own judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Any certification or other statement of compliance with the requirements of this document shall not be attributable to NAHAD and is solely the responsibility of the certifier or the person making the statement.

DISCLAIMER:

In compiling standards and recommendations published by others and in developing these Guidelines, NAHAD has not and will not engage in independent testing or verification of the information provided to it. Users of these Guidelines should not and cannot rely on these Guidelines as a standard, certification or approval of the data published herein. NAHAD does not assume and expressly declines and denies any and all liability for any product failures, damages or injuries that result in any way from utilization of these Guidelines or products based on these Guidelines. The NAHAD Guidelines incorporate pressure recommendations, corrosion recommendations and temperature recommendations published by hose manufacturers. NAHAD has not independently verified these recommendations and specifically disclaims any and all liability, direct or indirect, for any failures, damages or injuries resulting in whole or in part from the failure of any product, including hoses, fittings, and assemblies described in the Guidelines.

Thanks and Recognition

NAHAD wishes to acknowledge the contributions of many organizations which have made this document possible.

History of Changes

1995
NAHAD commits to take on the multi-year challenge of creating a comprehensive set of performance recommendations for the Specification, Design and Fabrication of Industrial, Hydraulic, Fluoropolymer, Corrugated Metal and Composite hose assemblies. Scores of volunteer member engineers are recruited to serve on five different technical teams to draft what will become ***NAHAD's Hose Assembly Guidelines***. The comprehensive 420-page document is produced and presented to the membership at the 2000 Convention in Monterey, CA.

2003
The NAHAD Board appoints a new ***Standards Committee*** to re-craft the Guidelines to be more useful for members and end-users.

2005
Version 1: ***Hose Assembly Specification Guides,*** along with ***Design and Fabrication Guides*** are created for Corrugated Metal, Industrial, Composite, Hydraulic, and Fluoropolymer Hose assemblies. These are made available for purchase and use with customers, for supporting internal training, and for providing guidance for related hose assembly technical and business processes.

2008-9
Custom Hose Guide added 2008
Ducting Guide added 2009

2010-12
NAHAD creates the ***Hose Safety Institute*** to formalize the work of driving safety, quality and reliability of hose assemblies. The Hose Assembly Guidelines are updated and republished as the ***Hose Safety Institute Handbook***.

2013-14
The ***Fabrication Guides*** within the Hose Assembly Guidelines are updated and republished for use by ***Hose Safety Institute*** members only.

Changes: Materials updated and all 7 Specification manuals plus Design Guides for industrial, hydraulic, composite, fluoropolymer and corrugated metal hoses integrated in one master document; Fabrication Guide materials for all five hose groups are all updated.

2015
Updates and reconciliation between the Handbook and the five Fabrication Guides completed; version1.2 of the Handbook created along with version 2.1 of each Fabrication Guide.

Section F2 – Fabrication Methods for Metal Hose

This chapter will discuss the key steps and the proper fabrication techniques for various combinations of hose, coupling and attachment methods referenced in the Hose Safety Institute Handbook. The following attachment methods are detailed in the following pages:

- Direct attachment
- Braid over (neck down)
- Smooth transition – direct attachment
- Smooth transition braid-over (neck down)
- Unbraided – Direct Attachment
- Unbraided – Smooth Transition

Key Steps in the Fabrication Process for Corrugated Metal Hose Assemblies

Select and Inspect Components (see Quality Plan, Section F3)

- proper component selection ensures the right product for the right application; components may look similar, but have been carefully chosen as part of the specification process
- inspect for damage and imperfections
- ensure components match assembly specification (hose type and dimensions, fitting material)

Prepare and cut hose

- identify or choose the proper attachment method (direct attachment, etc.)
- calculate appropriate length
- select the right cutting tool – different hose types may require different cutters to avoid damaging the hose (in all cases, proper personal protection equipment must be used)
- ensure your measurement is calculated with the hose lying perfectly straight and then cut hose squarely; angular cuts can result in poor assembly quality.
- clean all debris from the end of the hose
- different applications require different fabrication procedures to ensure reliability and consistency of hose assembly performance (see Section 3)
- verify selected components meet dimensional requirements; for example, the braid ring must be the appropriate size to match the OD of the hose

Welding procedure

- complete the cap weld by sealing the braid ring, braid and innercore together
- carefully place hose fitting on the end of the hose being sure of proper fitting alignment
- complete the attachment weld by sealing the fitting to the cap weld at the end of the hose

Inspection and testing

- 100% of metal hose assemblies must be leak tested
- ensure hose assembly meets the design requirements
- identify appropriate test for this assembly
- ensure appropriate safety equipment and procedures are followed
- verify assembly functionality meets requirements
- verify any special customer requirements have been met

Cleaning

- various types and degrees of cleaning may be required for certain applications; extends life of the hose, prevents contamination of media, etc.
- identify appropriate cleaning process for assembly
- verify any special customer requirements have been met

Documentation

- documentation enables traceability
- identify any certifications or labels required
- complete internal record keeping requirements

Packaging

- identify any special packaging and marking requirements
- proper packaging and packaging techniques are required to protect hose assembly integrity

Section F3 – Quality Plan

The purpose of this section is to outline a quality plan that helps to support the fabrication of high quality hose assemblies. The assurance of an acceptable hose assembly reaching the customer depends upon the quality of the components and the workmanship of the fabricator.

An effective quality control plan is based on statistical sampling principles. Responsibility for supervising the quality plan must be designated. Corrective action procedures must be formalized to deal with nonconformance.

Sampling Plan

An effective sampling plan is based on the statistical history of a design that demonstrates quality performance and sets confidence levels.

Sampling is performed in an effort to statistically evaluate a product or process against tolerances that are considered acceptable as determined by national standards, customer requirements, etc. This monitoring of product or process with an adequate sampling plan is done in an effort to provide 100% acceptable product to the customer. In an ideal world, if inspection capability is 100% effective, then the only way to assure 100% acceptable product is to inspect everything 100%. Due to practical considerations of time and resources (both manpower and financial), 100% inspection will probably not occur as a standard method of operation.

Many areas or processes may be sampled. These may vary from operation to operation. However, some constants should apply no matter what the operation.

A. Inspection of incoming material - You cannot guarantee the quality of the outgoing product, if the quality of incoming materials has not been verified.

B. In process inspection - This may be as simple as inspection of the first assembly produced. Or it may be quite complicated, such as doing a complete dimensional audit on so many pieces per production run and plotting these results on Statistical Process Control (SPC) charts in order to track trends and potential problems.

C. Final Inspection - This may be relatively simple, such as verifying piece counts before shipping to the customer, or as complicated as checking specific criteria to ensure compliance with the customer's requirements.

Inspection characteristics, the corresponding documentation, and the personnel responsible must be defined, regardless of what is being sampled.

When establishing the frequency of sampling, many factors need to be considered. These include but are not limited to:

1. Cost
2. Complexity of process
3. Application
4. Liability
5. Stability of procedure

If a process is very stable as indicated by past performance, the frequency of sampling can be decreased. There is no specific sampling plan that can be considered best suited to all applications.

Material Receiving Inspection

Couplings

Upon receipt of a shipment of couplings, the assembly fabricator should perform, at minimum, the following inspection steps:

1. Compare the couplings received with the purchase order by making sure part numbers agree between order and packing slip.

2. Check the count between packing slip and actual quantity received.

3. Check the product in the package to make sure it agrees with the part number on the package. Supplier catalogs are a good reference.

4. When possible, leave the couplings in the original container with the original date code. If a coupling problem arises later, all the couplings of that size and date code can be separated out for 100% inspection purposes.

5. At least one coupling from every box should be inspected for dimensions, defective plating, concentricity, snap rings attached to the swivels, any damage from shipping.

Hose

Upon the receipt of a shipment of hose, the assembly fabricator should perform, at a minimum, the following inspection steps:

1. Check product numbers on the packing list with numbers on the packages of the actual merchandise.

2. Check total footage against the packing slip, making sure they agree.

3. Check the product, making sure it agrees with the label on the packaging.

4. Check the hose inside diameter, outside diameter and reinforcement, and verify against the manufacturer's product information.

5. All hose should be visibly inspected for damage due to shipping, kinks, loose cover, bulges, ballooning, cuts, crush, and tears. A certificate of conformance may be requested with the hose, couplings, and attachments.

Section F4 – Hose Measurements & Calculations

Length Tolerances

The OAL of an assembly shall be as requested by the customer with acceptable tolerances as agreed between the customer and provider. Unless otherwise specified, the tolerances shall be as defined in the following Table.

Table – Assembly Overall Length Tolerances

		Overall Length of Assembly					
		0" thru <8"	8" thru <18"	18" thru <3'	3' thru <6'	6' thru <12'	≥12'
Hose I.D.	< 1"	+/- 1/4"	+/- 5/16"	+/- 3/8"	+/- 1/2"	+/- 1"	+/- 1%
	1" thru < 4"	+/- 3/8"	+/- 1/2"	+/- 5/8"	+/- 3/4"	+/- 1 ¼"	+/- 1.5%
	4" thru 12"	+3% -1.5%	+3% -1.5%	+3% -1.5%	+3% -1.5%	+3% -1.5%	+3% -1.5%

Measuring OAL of Hose Assemblies

OAL measurements are normally taken with the assembly in a straight position. For most assemblies, the OAL is measured from the end of one fitting to the end of the other fitting (*see* Figure A). Assemblies with certain types of fittings, however, require different measuring procedures. Fittings with both a sealing seat and a moveable or retractable nut are measured from the sealing seat (*see* Figure B). Elbow fittings are measured as illustrated in Figure C.

Figure A
OAL – End to End

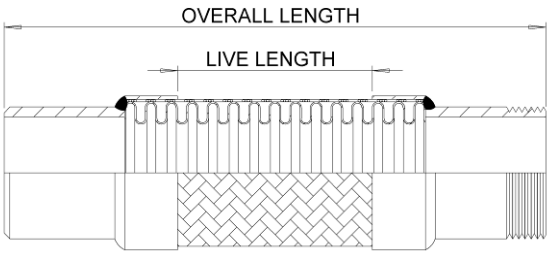


Figure B
OAL – Seat to Seat

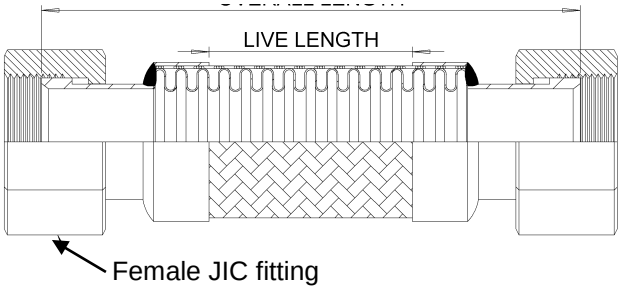
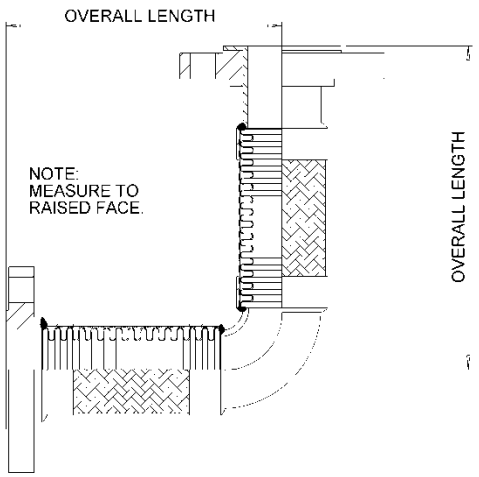


Figure C
OAL – Elbowed Assembly

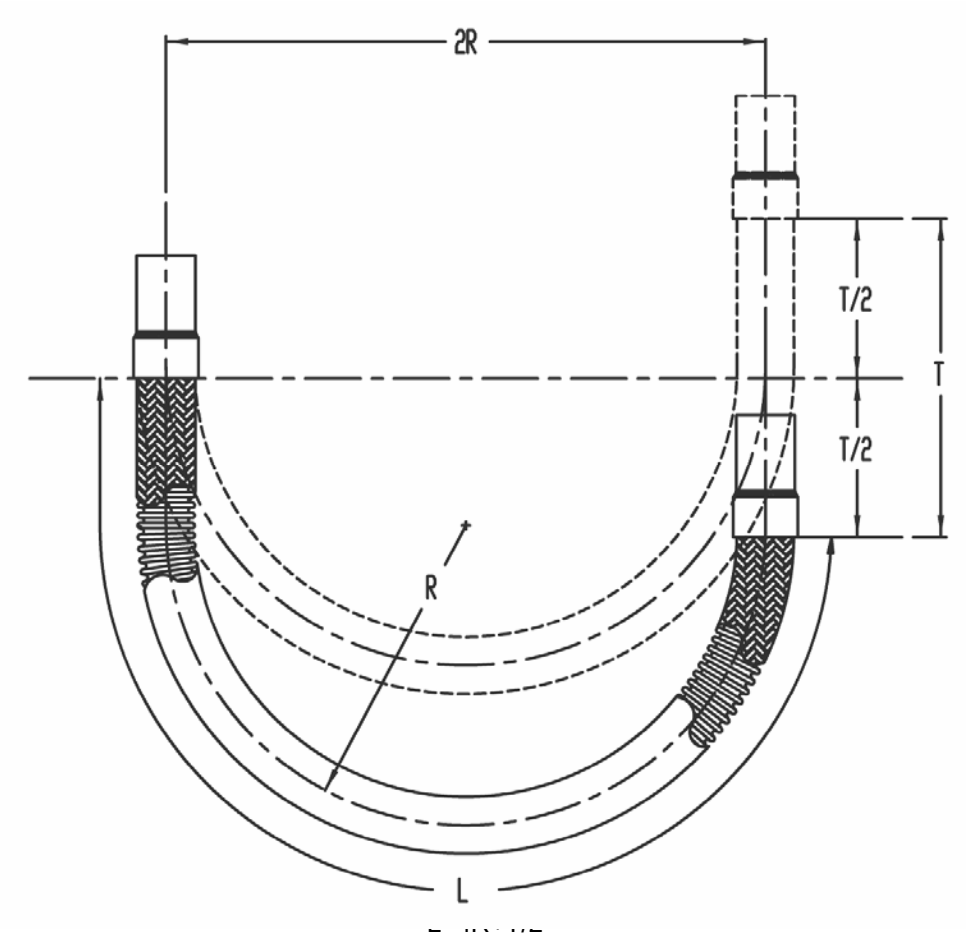


Length Calculations

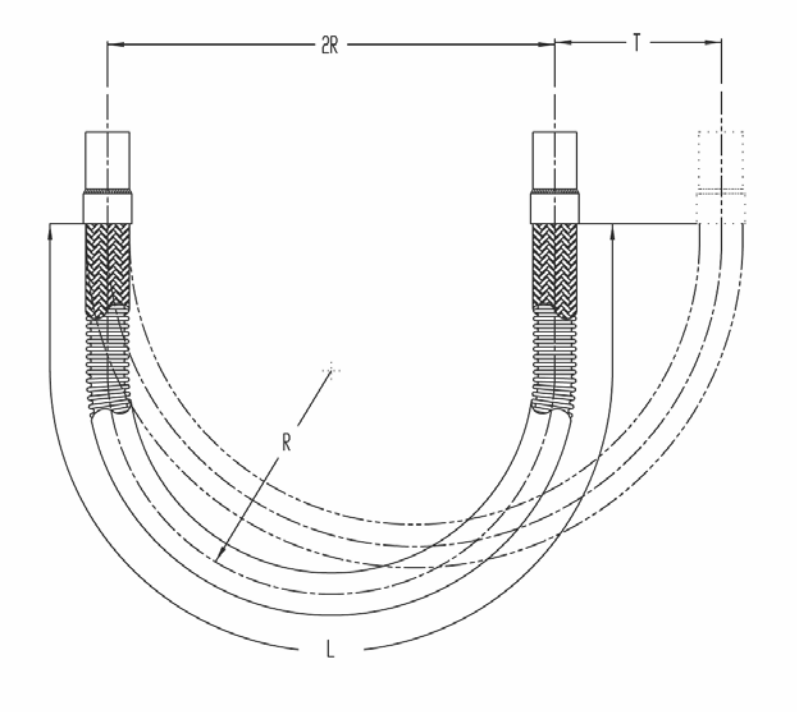
Below are illustrations of some of the most common hose installations. Use the formula to determine the appropriate live length (L) for that assembly. Then confirm that the installed radius (R) of that configuration is greater than the published minimum (dynamic/static) bend radius of the hose selected. Also confirm that the center line of the hose always remains in one (the same) plane. Otherwise, detrimental torsional stresses may be induced on the hose during cycling.

Avoid axial hose compression. This may bulge the braid "off" the hose and ultimately induce squirm and failure. If any of these issues arise, consider adjusting the piping system to facilitate a more appropriate hose installation.

A-Loop

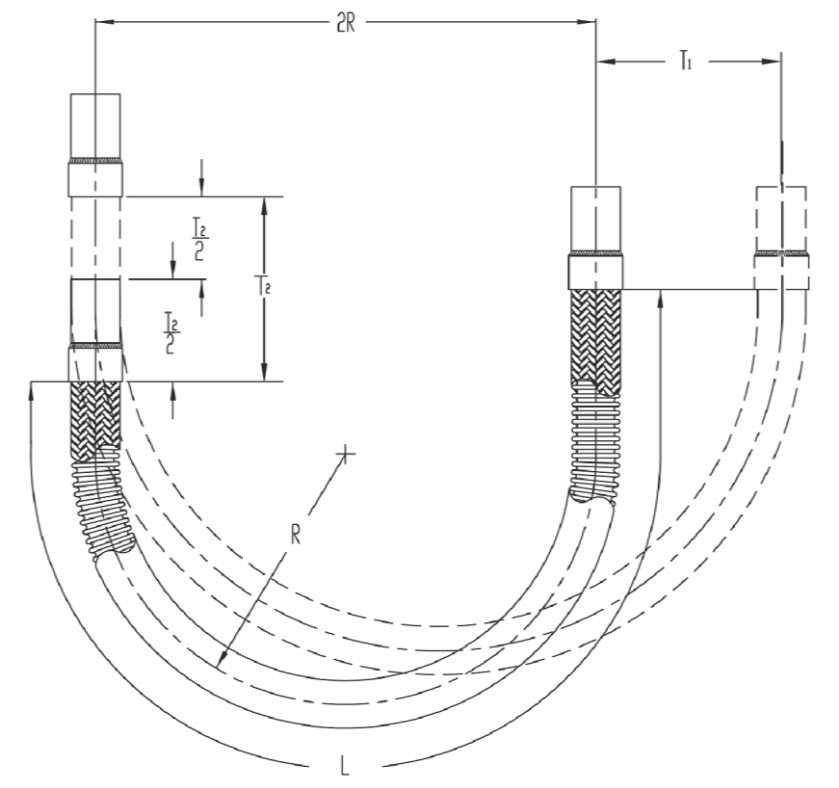


B-Loop



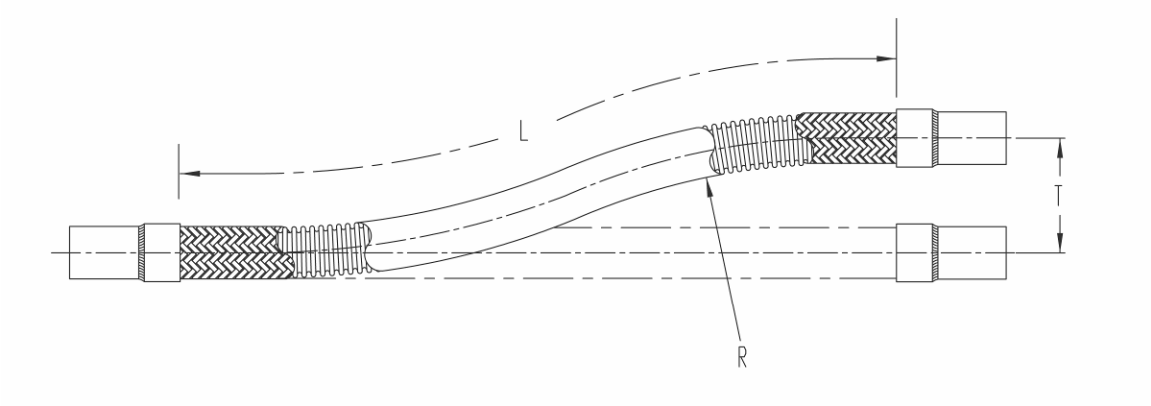
$L=4R+1.57T$

Combination Loop



$L=4R+1.57T_1+(T_2/2)$

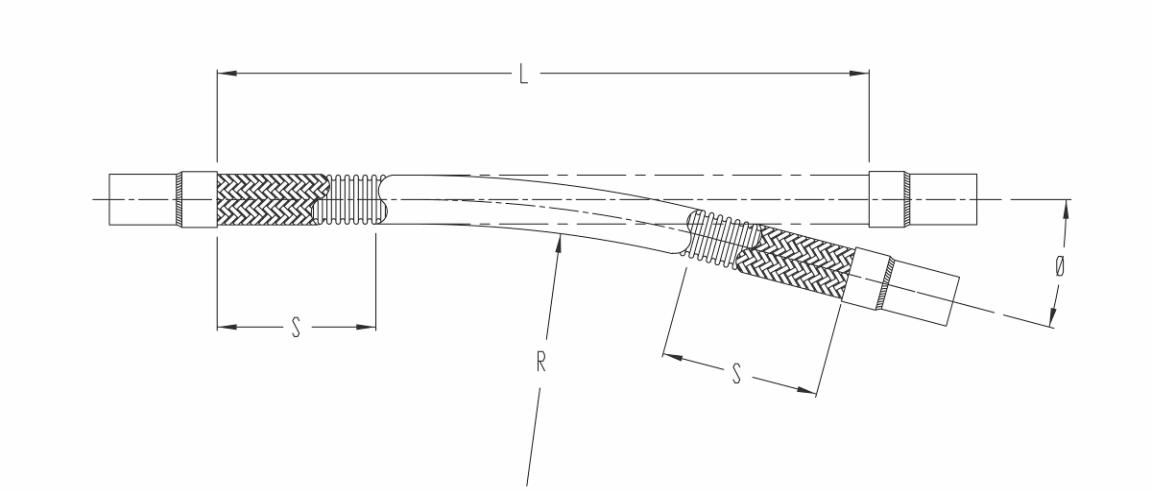
Lateral Offset



$$L = \sqrt{20R \times T}$$

Where: R = published minimum bend radius (inches)
T = offset (inches)

Angular Deflection



L=2S + (Ø/57.3)R

Where: R = published minimum bend radius (inches) S = hose O.D. (inches)
Ø = deflection angle (degrees)

Section F5 – Fabrication Process

Purpose

The purpose of this document is to detail the fabrication and welding procedure for metal hose assemblies regardless of the manufacturer. A Metal Hose Assembly can be fabricated utilizing 4 different component attachment methods. An explanation of each is detailed below.

Component Attachment Methods

F5.1 Direct Attachment Method

1. Determine hose cut length by deducting fitting length from overall length.

If using unbraided hose:

a. Select proper hose, measure, mark and cut to length using vertical band saw, circular chop saw, or equivalent. If burrs or sharp edges exist, remove from both ends of hose with stainless steel wire wheel, grinding wheel, or equivalent.
b. Select the proper braid. Slip the braid onto the hose. Smooth and tighten it down onto the hose.
c. Cut the braid, leaving 3/8” minimum excess braid at each end.

If using tube-type braid retainer rings:

a. Select the proper braid retainer rings. Slip a ring over each hose-end and slide rings flush up to the ends of the hose. If specified or required, crimp braid retainer rings using a swaging machine or equivalent.

If using band-type braid retainer rings:

a. Select the proper band. Wrap band around end of braided hose, overlapping band, with edge of band flush with end of hose. Clamp the band with a hose clamp.

If using braided-hose-on-reel:

a. Select proper braided-hose.
b. Select the proper braid retainer rings.
c. Slide braid retainer rings onto hose, and then cut hose to length using circular chop saw or equivalent.
d. Slide braid retainer rings flush up to the ends of the hose. If specified or required, crimp braid retainer rings using a swaging machine or equivalent.

2. Trim excess braid flush with hose-end using snips.
3. Braid must be tight and all braid wires must end flush with ends of hose.

NOTE: Testing has shown that the braid sleeves must be snug on the hose or the burst value of the hose will be significantly reduced.

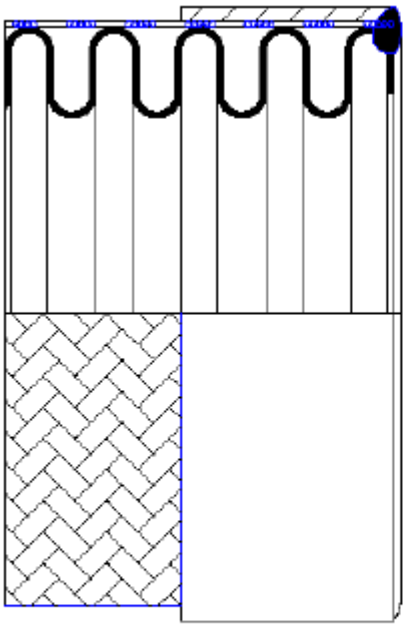
4. Place hose / braid rings in variable speed turntable. Insert proper size purge plug inside the end of the hose being welded. Set purge level. Select filler rod and set amperage to proper levels.

NOTE: It is highly recommended that an inert backup gas, such as Argon, be utilized during the welding process.

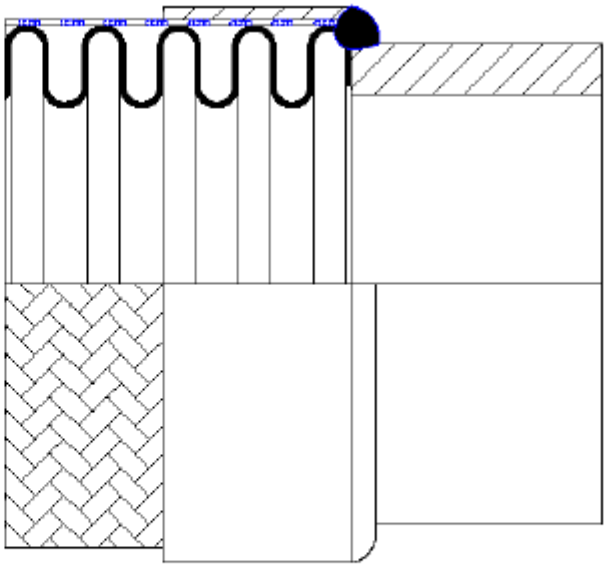
5. Make first pass weld joining hose, braid and retainer ring. Remove hose and repeat at other end. On hoses with a band-type retaining ring, remove hose clamp and weld seam at end of band.

6. Reposition hose in turntable and place end fitting on first pass weld. Tack weld fitting in place. Fitting must be centered and straight on hose. Rotate turntable 180 degrees. Select proper filler rod and amperage and weld fitting in place. There must be fusion between the first and second welds. Do not burn through fitting wall. Repeat on other end, and air cool welds.

Welds should have a good consistent appearance.



DIRECT FITTING ATTACHMENT
STEP ONE



DIRECT FITTING ATTACHMENT
STEP TWO

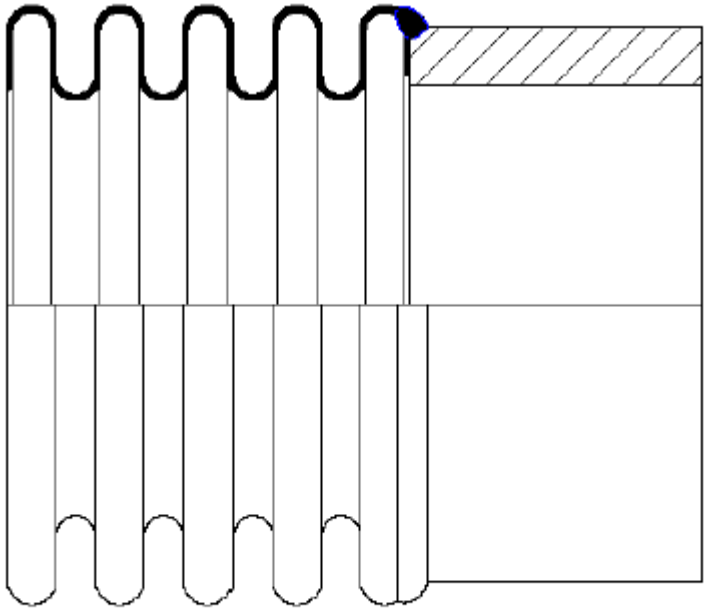
F5.2 Braid-Over (Neck Down) Attachment Method

1. Determine hose cut length by deducting fitting length from overall length. Select proper hose, measure, mark and cut to length using vertical band saw, circular chop saw, or equivalent. If burrs or sharp edges exist, remove from both ends of hose with stainless steel wire wheel or equivalent.

2. Place hose / fittings in variable speed turntable. Insert proper size purge plug inside the end of the hose being welded. Set purge level. Select filler rod and set amperage to proper levels.

NOTE: It is highly recommended that an inert backup gas, such as Argon, be utilized during the welding process.

3. Make first pass weld joining hose and fitting. Remove hose and repeat at other end.



BRAID OVER CONSTRUCTION
STEP ONE

Welds should have a good consistent appearance.

4. Slip the braid over hose, leaving at least 3/8” excess braid past end of fitting at each end. Smooth and tighten the braid down onto the hose.

If using tube-type braid retainer rings:

a. Select the proper braid retainer rings. Slip a ring over each fitting end and slide rings up to the hose-ends. If specified or required, crimp braid retainer rings using a swaging machine or equivalent.

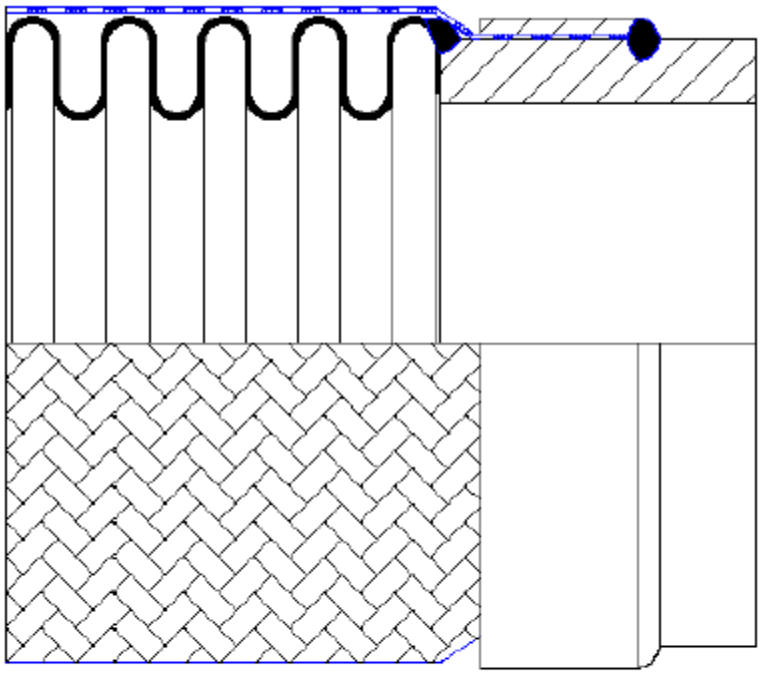
If using band-type braid retainer rings:

a. Select the proper band. Wrap band around the fitting, overlapping band, with edge of band flush with end of hose. Clamp the band with a hose clamp.

5. Trim excess braid flush with braid ring using a small circular saw with a bevel edge (no teeth) blade, or something equivalent.

6. Braid must be tight and all braid wires must end flush with ends of braid ring.

7. Make final pass weld joining braid, retaining ring and fitting. On hoses with a band-type retaining ring, remove hose clamp and weld seam at end of band. Remove hose and repeat at other end.



BRAID OVER CONSTRUCTION
STEP TWO

F5.3 Smooth Transition – Direct Attachment Method

1. Determine hose cut length by deducting fitting length from overall length.

If using unbraided hose:

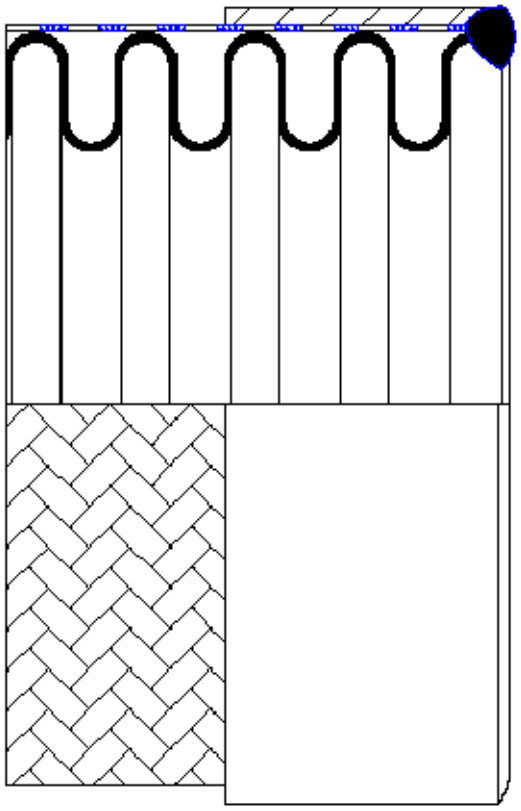
   a. Select proper hose, measure, mark and cut to length using vertical band saw, circular chop saw, or equivalent.
   b. Sand both ends of the hose back to the crest of the first corrugation.
   c. Select the proper braid. Slip the braid onto the hose. Smooth and tighten it down onto the hose.
   d. Cut the braid, leaving 3/8" minimum excess braid at each end.
   e. If using tube-type braid retainer rings:
      i. Select the proper braid retainer rings. Slip a ring over each hose-end and slide rings flush up to the ends of the hose. If specified or required, crimp braid retainer rings using a swaging machine or equivalent.
   f. If using band-type braid retainer rings:
      i. Select the proper band. Wrap band around end of braided hose, overlapping band, with edge of band flush with end of hose. Clamp the band with a hose clamp.

If using braided-hose-on-reel:

   a. Select proper braided-hose.
   b. Select the proper braid retainer rings.
   c. Slide braid retainer rings onto hose, and then cut hose to length using circular chop saw or equivalent.
   d. Sand the ends of the hose back to the crest of the first corrugations.
   e. Slide braid retainer rings flush up to the ends of the hose. If specified or required, crimp braid retainer rings using a swaging machine or equivalent.

2. Trim excess braid flush with hose-end using snips.

3. Braid must be tight and all braid wires must end flush with ends of hose.



SMOOTH TRANSITION
DIRECT ATTACHMENT
STEP ONE

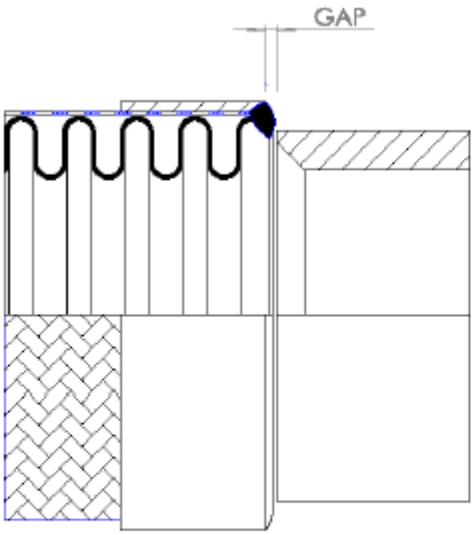
NOTE: Testing has shown that the braid sleeves must be snug on the hose or the burst value of the hose will be significantly reduced.

4. Place hose / braid rings in variable speed turntable. Insert proper size purge plug inside the end of the hose being welded. Set purge level. Select filler rod and set amperage to proper levels.

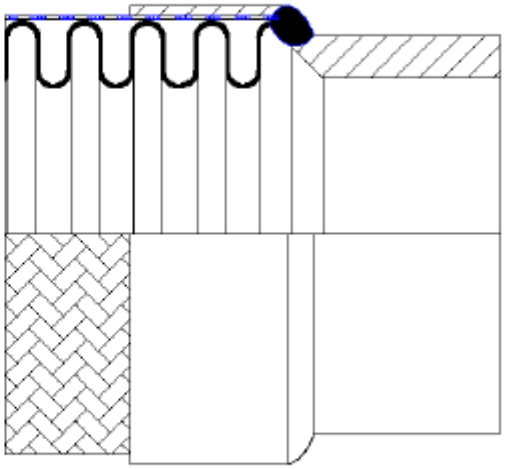
NOTE: It is highly recommended that an inert backup gas, such as Argon, be utilized during the welding process.

5. Make first pass weld joining hose, braid and retainer ring. Remove hose and repeat at other end. On hoses with a band-type retaining ring, remove hose clamp and weld seam at end of band.
6. Reposition hose in turntable and place end fitting on first pass weld, maintaining a gap of approximately 1/16". Tack weld fitting in place. Fitting must be centered and straight on hose. Rotate turntable 180 degrees. Select proper filler rod and amperage and weld fitting in place. There must be fusion between the first and second welds. Do not burn through fitting wall. Repeat on other end, and air cool welds.

Welds should have a good consistent appearance.



SMOOTH TRANSITION
DIRECT ATTACHMENT
FITTING PREPERATION

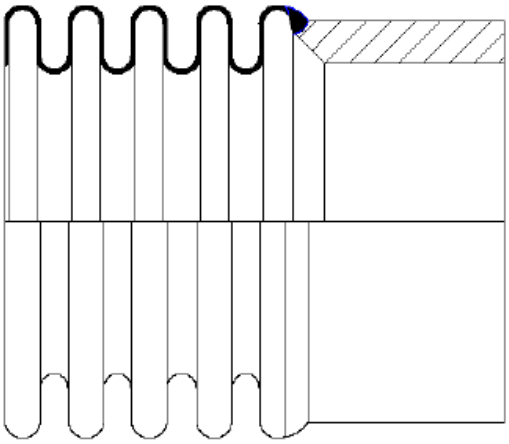


SMOOTH TRANSITION
DIRECT ATTACHMENT
STEP 2

F5.4 Smooth Transition Braid-Over (Neck Down) Attachment Method

1. Determine hose cut length by deducting fitting length from overall length. Select proper hose, measure, mark and cut to length using vertical band saw, circular chop saw, or equivalent.

2. Sand both ends of the hose back to the crest of the first corrugation.



SMOOTH TRANSITION
BRAID OVER
STEP ONE

3. Place hose / fittings in variable speed turntable. Insert proper size purge plug inside the end of the hose being welded. Set purge level. Select filler rod and set amperage to proper levels.

NOTE: It is highly recommended that an inert backup gas, such as Argon, be utilized during the welding process.

4. Make first pass weld joining hose and fitting. Remove hose and repeat at other end.

Welds should have a good consistent appearance.

5. Slip the braid over hose, leaving at least 3/8" excess braid past end of fitting at each end. Smooth and tighten the braid down onto the hose.

If using tube-type braid retainer rings:

a. Select the proper braid retainer rings. Slip a ring over each fitting end and slide rings up to the hose-ends. If specified or required, crimp braid retainer rings using a swaging machine or equivalent.

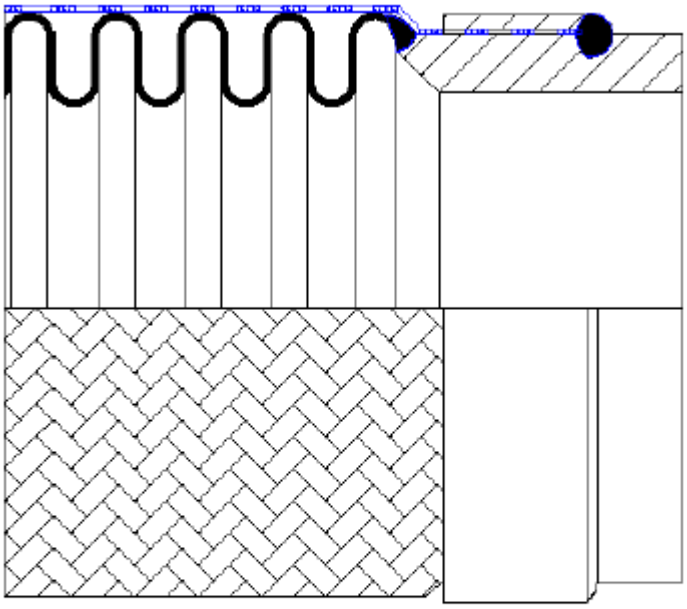
If using band-type braid retainer rings:

a. Select the proper band. Wrap band around the fitting, overlapping band, with edge of band flush with end of hose. Clamp the band with a hose clamp.

6. Trim excess braid flush with braid ring using a small circular saw with a bevel edge (no teeth) blade, or something equivalent.

7. Braid must be tight and all braid wires must end flush with ends of braid ring.

8. Make final pass weld joining braid, retaining ring and fitting. On hoses with a band-type retaining ring, remove hose clamp and weld seam at end of band. Remove hose and repeat at other end.



SMOOTH TRANSITION
BRAID OVER
STEP TWO

F5.5 Unbraided – Direct Attachment Method

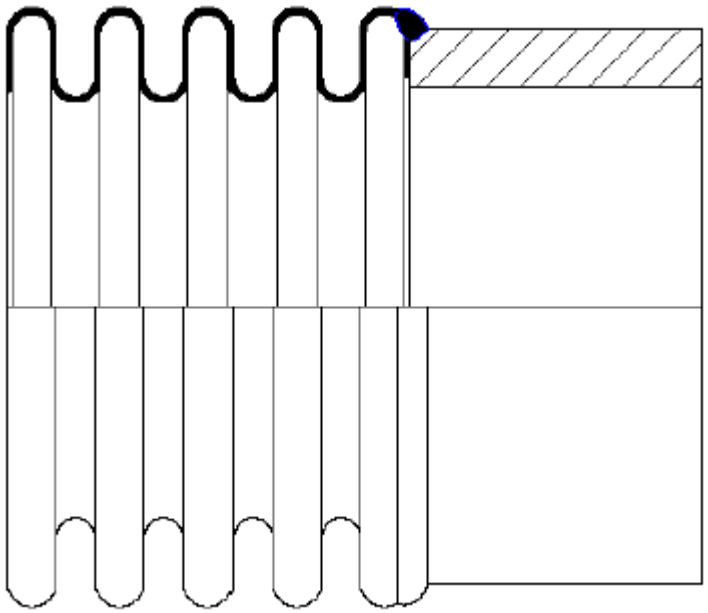
Step one is the same process for unbraided as it is for braid-over construction Step 1.

1. Determine hose cut length by deducting fitting length from overall length. Select proper hose, measure, mark and cut to length using vertical band saw, circular chop saw, or equivalent. If burrs or sharp edges exist, remove from both ends of hose with stainless steel wire wheel or equivalent.

2. Place hose / fittings in variable speed turntable. Insert proper size purge plug inside the end of the hose being welded. Set purge level. Select filler rod and set amperage to proper levels.

NOTE: It is highly recommended that an inert backup gas, such as Argon, be utilized during the welding process.

3. Make first pass weld joining hose and fitting. Remove hose and repeat at other end.

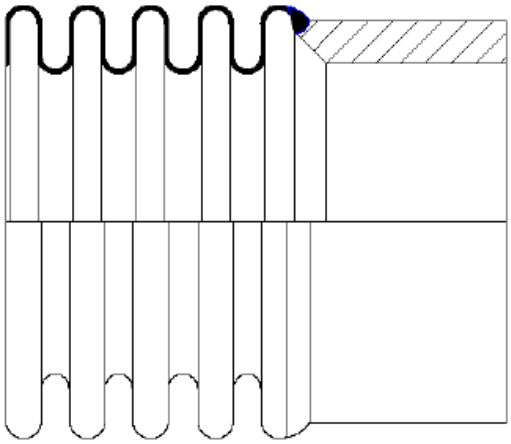


Welds should have a good consistent appearance.

F5.6 Unbraided – Smooth Transition Attachment Method

1. Determine hose cut length by deducting fitting length from overall length. Select proper hose, measure, mark and cut to length using vertical band saw, circular chop saw, or equivalent.

2. Sand both ends of the hose back to the crest of the first corrugation.



3. Place hose / fittings in variable speed turntable. Insert proper size purge plug inside the end of the hose being welded. Set purge level. Select filler rod and set amperage to proper levels.

NOTE: It is highly recommended that an inert backup gas, such as Argon, be utilized during the welding process.

Section F6 - Supplementary Procedures

F6.1 Welding Stainless Steel Hose to Copper Fittings

Weld base pass of the stainless steel hose and braid using the correct filler material. The base weld must be wire brushed before welding the copper fitting to the hose. Welding the copper fitting to the hose will require additional heat (amperage) because the copper is a good conductor of heat. When one first starts to weld the copper fitting to the stainless steel hose, the torch must be positioned to allow most of the heat to go towards the copper fitting.

F6.2 Procedure for Welding Monel Hose

Monel will weld similar to stainless steel but cleanliness is very important. If during assembly and welding the hoses are allowed to come in contact with dirt, dust or metal grindings, the hoses will leak at pressure test.

NOTE: Extra care must be taken when welding Monel hose and braid, that the area is kept clean.

NOTE: 1.) When welding Monel - all parts must be cleaned prior to welding.

2.) When welding ss hose to copper fittings, ss welds must be wire brushed before welding copper fittings.

NOTE: For hose assemblies used to transport chlorine, there are specific requirements set forth in the Chlorine Institute Pamphlet #6 (edition 15), “Piping Systems for Dry Chlorine”, Appendix A, Section 9. Please note that Chlorine transfer hose (CTH) must be clearly and permanently marked as per Chlorine Institute Pamphlet #6 (edition 15), Appendix A, Section 9. These permanent markings (e.g. stamping, stenciling or coding) should be utilized throughout the supply chain for purposes of continuous positive identification.

FILLER MATERIAL CHART

BASE METAL MATERIAL	FITTING MATERIAL	PROCESS	FILLER MATERIAL
CARBON STEEL HOSE AND BRAID	300 SERIES STAINLESS STEEL FERRULES	GTAW / GMAW FILL WELD	AWS ER-308, ER-308L, ER-312
CARBON STEEL HOSE BRAID AND FERRULES	CARBON STEEL END FITTINGS	GTAW / GMAW ATTACHMENT WELD	AWS ER-308, ER-308L, ER-312
T304 HOSE BRAID AND FERRULES	CARBON STEEL OR 300 SERIES END FITTINGS	GTAW / GMAW ALL WELDS	AWS ER-308, ER-308L, ER-312
CARBON STEEL TUBE OR PIPE	CARBON STEEL END FITTINGS	GTAW / GMAW	AWS ER-70S-* (MILD STEEL ROD)
T304L HOSE , T304 OR T321 BRAID AND FERRULES	CARBON STEEL OR 300 SERIES END FITTINGS	GTAW / GMAW	AWS ER-308L
ALL T316L AND T316Ti	T316 OR T316L FITTINGS	GTAW / GMAW	AWS ER-316L
ALL T321	T321 FITTINGS	GTAW / GMAW	AWS ER-347
MONEL 400	MONEL 400	GTAW	AWS ERNiCu-7 (MONEL 60)
INCONEL 600	INCONELS, MONEL 400, CARBON AND STAINLESS STEELS	GTAW	AWS ERNi-1 (ALLOY 61)
INCONEL 625	INCONELS, MONEL 400, CARBON AND STAINLESS STEELS	GTAW	AWS ERNiCrMo-3 (ALLOY 82), ERNiCr-6 (ALLOY 90)
BRONZE HOSE AND BRAID	BRONZE OR COPPER FITTINGS	GTAW / TORCH	AWS A5.27 CLASS RBCuZn-C, A5.8 CLASS RBCuP-2 OR Sil-Phos AND SWEAT JOINTS, INSTALLER CAN OVERHEAT AND DAMAGE JOINTS
BRASS	BRASS OR COPPER	TORCH	AWS BAg1-3 (SILVER BRAZING ALLOY) MINIMUM OF 25% SILVER IS RECOMMENDED

NOTES:

1.) WHEN WELDING MONEL - ALL PARS MUST BE CLEANED PRIOR TO WELDING.

2.) WHEN WELDING SS HOSE TO COPPER FITTINGS, SS WELDS MUST BE WIRE BRUSHED BEFORE WELDING COPPER FITTINGS.

F6.3 Special Fabrication of hose assemblies with various accessories & attachments

- Jacketed hose
- Lined hose
- Heat traced
- Armor guard

Please see manufacturer for information and/or instructions.

Section F7 – Assembly Inspection & Testing

Every metal hose assembly must be visually inspected as well as, at the very least, leak tested. The following testing methods may or may not be required. Refer to the customer requirements and or the appropriate assembly data sheets for the recommended inspection and testing and needed.

F7.1 Visual Inspection

Every assembly must be visually inspected to verifying the following:

- Assembly Length and construction are as requested by the customer.
- All components are properly aligned.
- There are no obvious signs of defects.
- All weld joints are smooth and free from visual discontinuities.
- The assembly is clean and cosmetically acceptable.

F7.2 Leak Testing

Pneumatic Testing – All testing shall be performed in accordance with customer drawings or requirements. Where testing requirements are not specified, all assemblies are to be leak tested with nitrogen, helium or dry air under water for a minimum of 20 seconds. Any bubbles observed will be cause for rejection. When testing, care should be exercised to remove all entrapped air residing under the braid during the test so as not to confuse it with any actual leak.

NOTE: To guard against corrosion, the chloride content of the water in the test tank used for testing austenitic stainless steel should be controlled to less than 50 ppm (Parts per Million).

NOTE: Any pressure test, regardless of test pressure, can be a very dangerous test due to the compressibility of the gas resulting in an explosive reaction should the assembly fail. This must be performed by trained personnel using proven procedures with appropriate equipment.

PNEUMATIC TEST PRESSURES

UNBRAIDED ASSEMBLIES	
NOMINAL ID	TEST PRESSURE (PSIG)
1/4" thru < 3/4 "	25
3/4" thru < 1 1/4"	10
1 1/4" thru < 4"	5
4" thru < 6"	3
> 6"	2
BRAIDED ASSEMBLIES	
NOMINAL ID	TEST PRESSURE (PSIG)
1/4" thru 4"	75
> 4" thru 6"	50
> 6"	15

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 and maintained for a sufficient length of time to permit a visual examination. The minimum testing time should be one (1) minute. Any evidence of leakage or permanent deformation is cause for rejection.

Since the hydrostatic test is performed at considerably higher pressures, it not only tests for leakage, but also confirms the structural integrity of the assembly. The following procedure details the minimum for a general hydrostatic test:

1. Connect assembly to test pump in a straight fashion, assuring a leak tight connection.

2. An outlet valve should be applied to the hose end of the assembly that opposes the test pump end of the assembly. Unless otherwise specified, the test media should be water.

3. Fill the hose with water while the outlet end is raised and the valve slightly opened to bleed all air from the system.

4. Use the outlet valve to bleed all air remaining in the hose. When all of the air has been expelled, close the valve and lower the end.

5. Gradually raise the pressure to the desired test pressure, hold the pressure for the time dictated, but not less than 1 minute. Watch for visual indications of permanent deformation and leakage.

6. 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 alcohol if all of the water must be removed.

NOTE: Follow manufacturer's recommendations regarding appropriate test pressures.

NOTE: To guard against corrosion, the chloride content of the water in the test tank used for testing austenitic stainless steel should be controlled to less than 50 ppm (parts per million).

NOTE: Any pressure test, regardless of test pressure, can be a very dangerous test due to the compressibility of the gas resulting in an explosive reaction should the assembly fail. This must be performed by trained personnel using proven procedures with appropriate equipment.

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.

Cleaning for Oxygen

Oxygen can spontaneously ignite and explode in the presence of hydrocarbons or if solid particles are caught in its flow. Methods and parameters for both oxygen cleaning and cleanliness testing can be referenced in the Compressed Gas Association publication, "Cleaning Equipment for Oxygen Service", CGA G-4.1. Breathable oxygen applications require special consideration. Consult the customer for appropriate requirements.

Additional Leakage Tests

Consult the fabricator for other testing methods. These may include, but are not limited to, the following: Pressure Decay, Vacuum Decay, Mass Flow, and Dye Penetrant Leak Test. Special equipment and skilled operators are required for these types of tests.

WARNINGWARNING**WARNING**WARNING**WARNING**

Wherever particular skills are required, only specially trained persons should engage in those applications or testing procedures. Failure to do so may result in damage to the hose assembly or to other personal property and, more importantly, may also result in serious bodily injury.

Hoses must be properly cleaned prior to inspection and testing. This will prevent unexpected reactions between conveyants and the test media. 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. Also make sure that the hose is sufficiently shielded during pressure testing to stop a coupling in case of a coupling blow-off.

Any failure during testing is likely to be of an explosive nature!

Section F8 – Assembly Cleaning and Packaging

Each assembly shall be supplied to the customer free of water and debris. Air may be blown through the assembly to remove loose particles. Some applications have more stringent levels of cleanliness that may require special cleaning procedures. Consult provider for other cleaning options.

When cleaning with compressed air, special care (such as eye protection) should be taken.

Hose assemblies shall be packaged in such a manner to prevent damage during shipping and handling. The assembly should be packed while it is clean and dry in a way to prevent internal contamination. The assembly should not be coiled tighter than its specified dynamic minimum bend radius. All containers, boxes, banding and pallets shall be of sufficient size and strength to withstand the abuses of normal handling and transit.

Section F9 – Assembly Documentation and Certifications

Documentation – Customers may require documentation stating that the hose assembly meets specific criteria. There are several common types of documentation outlined below. In addition to the specific requirements, each document should contain the following information:

- Customers name, address, and purchase order number
- Suppliers name and address
- Complete description of the hose assembly including type of hose, ID, length, fittings and accessories
- Date
- Suppliers authorized signature

Certificate of Conformance (C of C) – A C of C is a statement by the supplier that the hose assembly or its fabrication method conforms to specific standards or documents. In additions to the information listed in section F7, paragraph 1, a C of C should also:

- Identify the standard or document to which the C of C is being supplied
- Contain a statement by the supplier that the assembly conforms to the specified standard or document.

Test Report – A test report is issued at a customer's request to document that the assembly has passed a specific test. In addition to the information listed in section F9, paragraph 1, a test report should also:

- Identify the test to which the assembly was tested giving a detailed explanation of the test and testing procedure
- Contain a statement by the supplier that the assembly has been tested and passed the test.

Material Test Report – A material test report shows that the material for which the report was requested meets the customers' specifications. Typically, MTR's are copies of the raw material MTR's that were supplied to the assembly provider by their raw materials vendor.

Positive Material Identification – For positive material identification, the provider validates the material by performing a nondestructive test using an X-Ray Fluorescence alloy analyzer and provides the results to the customer.

Third Party Certification – When required by the customer, an independent third party shall inspect and or test the assembly and certify that it conforms to the customer's specifications. In addition to the information listed in section F9, paragraph 1, a third party certification should also:

- Identify the standard or document to which the certification is being supplied
- Contain a statement by the third party that the assembly conforms to the specified standard or document

Section F10 – Safety

Safety is a critical factor in any hose assembly fabrication process, or in any shop. Recommendations for specific safety processes and/or equipment are provided in many of the chapters of this document. In addition, it is important to consider:

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

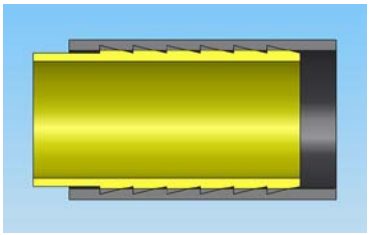
Appendix A: Definitions

The following Terms, as utilized in the hose industry, include some definitions from The Hose Handbook, published by the Rubber Manufacturers Association.

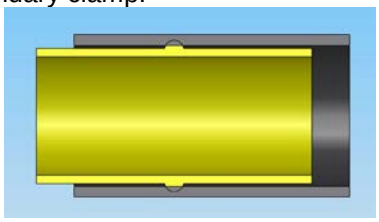
abrasion: external damage to a hose assembly caused by its being rubbed on a foreign object; a wearing away by friction.
abrasion resistance: the ability of the hose to withstand abrasion**. Internal**: the ability of the hose assembly to withstand failure caused by media passing through the hose. **External**: the ability of the hose assembly to withstand abrasion caused by foreign objects rubbing against the cover.
abrasion tester: a machine for determining the quantity of material worn away by friction under specified conditions.
ABS: acrylonitrile butadiene styrene, a common rigid plastic used for injection molding for components such as fittings
absorption: regarding hose, the process of taking in fluid. Hose materials are often compared with regard to relative rates and total amounts of absorption as they pertain to specific fluids.
accelerated life test: a method designed to approximate in a short time the deteriorating effects obtained under normal service conditions.
acid resistant: having the ability to withstand the action of identified acids within specified limits of concentration and temperature.
adapter, adaptor: 1) fittings of various sizes and materials used to change an end fitting from one type to another type or one size to another. (i.e., a male JIC to male pipe adapter is often attached to a female JIC to create a male end union fitting); 2) the grooved portion of a cam & groove coupling.
adhesion: the strength of bond between two adjoining surfaces, i.e., between cured rubber surfaces or between a cured rubber surface and a non-rubber surface.
adhesion failure: (1) the separation of two bonded surfaces at an interface by a force less than specified in a test method; (2) the separation of two adjoining surfaces due to service conditions.
adhesive: a material which, when applied, will cause two surfaces to adhere.
aerostatic testing: see pneumatic testing.
afterglow: in fire resistance testing, the red glow persisting after extinction of the flame.
air flow: the volume of air that can flow through a duct in a given time period (see CFM)
air oven aging: a means of accelerating a change in the physical properties of rubber compounds by exposing them to the action of air at an elevated temperature at atmospheric pressure.
air under water testing: see pneumatic testing.
air velocity: the speed at which air passes through a duct.
Algaflon: registered trademark of Ausimont USA. See PTFE.
ambient temperature: the temperature of the atmosphere or medium surrounding an object under consideration.
ambient/atmospheric conditions: The surrounding conditions, such as temperature, pressure, and corrosion, to which a hose assembly is exposed.
amplitude of vibrations and/or lateral movement: the distance of reciprocating motion of a hose assembly laterally. Half this deflection occurs on each side of the normal hose centerline.
anchor: a restraint applied to eliminate motion and resist forces.
angular displacement: displacement of two parts defined by an angle.
annular: refers to the convolutions on a hose that are a series of complete circles or rings located at right angles to the longitudinal axis of the hose (sometimes referred to as “bellows”).
anodize, anodized: an electrolytic process used to generate controlled oxidation for protective or cosmetic coatings in a variety of colors on metal, primarily used with aluminum.
ANSI: American National Standards Institute.
anti-static: product designed to reduce the build-up of static electricity in the application; not measurable with a standard ohm meter (10 *8 or higher ohms);
see static conductive.
API: American Petroleum Institute
application working pressure: unique to customer’s application. See pressure, working.

application: the service conditions that determine how a hose assembly will be used.
Aramid fibers: a class of heat-resistant and strong synthetic fibers in which the chain molecules are highly oriented along the fiber axis, so the strength of the chemical bond can be exploited.
armor: a protective cover slid over and affixed to a hose assembly; used to prevent over bending or for the purpose of protecting hose from severe external environmental conditions such as hot materials, abrasion or traffic.
ARPM: Association for Rubber Products Manufacturers (was RMA)
ASME B31.1: The ASME (American Society of Mechanical Engineer Standards) B31.1 / B31.3 Power and Process Piping Package prescribes the requirements for components, design, fabrication, assembly, erection, examination, inspection and testing of process and power piping.
assembly: a general term referring to any hose coupled with end fittings of any style attached to one or both ends.
ASTM: American Society for Testing and Materials.
ASTM E162/E662: refers to the spread of the flame/smoke if the product ignites
ASTM E162-06 Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source (Flame Spread)
ASTM E662-06 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials (Smoke Generation)
ASTM E84-08a Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E84: refers to smoke…
attachment: the method of securing an end fitting to a hose (e.g., banding, crimping, swaging, or screw-together-2 piece or 3 piece-style-reusable fittings).
attachment weld: method of attaching a metal fitting to the cap weld of a metal hose.
autoclave: an apparatus using superheated high pressure steam for sterilization, vulcanization and other processes.
axial movement: compression or elongation along the longitudinal axis.

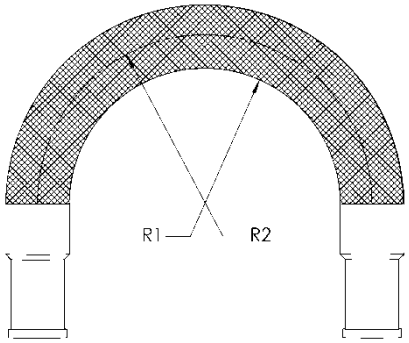
backing: a soft rubber layer between a hose tube and/or cover and carcass to provide adhesion.
band: (1) a metal ring that is welded, shrunk, or cast on the outer surface of a hose nipple or fitting; (2) a thin strip of metal used as a non-bolted clamp. See hose clamp.
barb: the portion of a fitting (coupling) that is inserted into the hose, usually comprised of two or more radial serrations or ridges designed to form a redundant seal between the hose and fitting.



barbed and ferrule fitting: a two-piece hose fitting comprised of a barbed insert (nipple), normally with peripheral ridges or backward-slanted barbs, for inserting into a hose and a ferrule, usually crimped or swaged.
basket weave: a braid pattern in which the plaits of wire alternately cross over and under two strands (two over-two under).
bead: another mechanical feature designed to facilitate a leak free interface between a hose or duct cuff; unlike a barb, they provide significantly lower resistance to removal and are easier to reuse. Not for high pressure applications without a secondary clamp.



beamed braid: braid construction in which the wires in a carrier are parallel.
bench marks: marks of known separation applied to a specimen used to measure strain (elongation of specimen).
bench test: a modified service test in which the service conditions are approximated in the laboratory.
bend radius: the radius of a bent section of hose measured to the innermost surface (R1) of the curved portion. Some manufacturers may measure to the centerline (R2) of the curved portion.



bend radius, minimum: the smallest radius at which a hose can be used without kinking, and while maintaining a circular cross section along the entire hose.
bend radius, dynamic: the smallest radius at which a hose can be used without kinking while constant or continuous flexing occurs.
bend radius, static: the smallest radius at which a hose can be used without kinking while bent or flexed into a fixed position.
bending force: an amount of stress required to induce bending around a specified radius and hence, a measure of stiffness.
bevel seat fitting: see fitting, Bevel Seat.
beverly shear: hand or pneumatically operated, table mounted, metal cutting shear used to cut fluoropolymer hose.
bias angle: the angle at which the reinforcement, either fabric or cord, is applied to the hose relative to the horizontal axis.
bias lap: the area where plies of bias cut reinforcement overlap.
billet: a solid piece of material from which a fitting is manufactured.
bleeding: surface exudation. See bloom.
blister: a raised area on the surface or a separation between layers usually creating a void or air-filled space in a vulcanized article.
bloom: a discoloration or change in appearance of the surface of a rubber product caused by the migration of a liquid or solid to the surface, (e.g. sulfur bloom, wax bloom). Not to be confused with dust on the surface from external sources.
blow molding: process of making corrugated duct using positive pressure in a continuous fashion.
blow out force: the force generated from the internal pressure attempting to push the fitting from the hose.
body wire: normally a round or flat wire helix embedded in the hose wall to increase strength or to resist collapse.
bolt hole circle: a circle on the flange face around which the center of the bolt holes are distributed.
bore: (1) an internal cylindrical passageway, as of a tube, hose or pipe; (2) the internal diameter of a tube, hose, or pipe.
bowl: (1) the exterior shell of an expansion ring type coupling; (2) the larger internal diameter of the internal portion of a ferrule.
braid: the woven portion of a hose used as reinforcement to increase pressure rating and add hoop strength. Various materials such as polyester, cotton or metal wire are used. A hose may have one or more braids, outside or between layers of hose material.
braid angle: the angle developed at the intersection of a braid strand and a line parallel to the axis of a hose.
braid coverage: the relative amount of braid material covering a hose expressed as a percent.

braid makeup: description of braid (i.e., 32-12-.015, T321 SS) where 32 is the number of carriers, 12 is the number of wires on each carrier, .015 is the wire diameter in inches, and T321 SS is the material. (Type 321 Stainless Steel.)
braid sleeve/ring/ferrule: a ring made from tube or metal strip placed over the ends of a braided hose to contain the braid wires for attachment of fitting and ferrule, and to immobilize heat affected corrugations.
braid wear: motion between the braid and corrugated hose, which normally causes wear on the outside diameter of the corrugation and the inside diameter of the braid.
braid window: (see interstice)
braided braid: a braid where the strands of wire on each carrier of the braiding machine are braided together, and then braided in normal fashion.
braided ply: a layer of braided reinforcement.
braid-over-attachment: metal hose attachment method where the braid is pulled over a fitting which has been welded to the inner core and welded directly to the fitting along with a braid sleeve.
braid-over-braid: multiple plies of braid having no separating layers.
brand: a mark or symbol identifying or describing a product and/or manufacturer, that is embossed, inlaid or printed.
brass: a family of copper/zinc alloys.
brazing: a process of joining metals using a non-ferrous filler metal having a melting point that is lower than the "parent metals" to be joined, typically over +800ºF.
breaker layer: (See backing)
bridge clamp: a worm gear clamp capable of bridging over the wire helix in order to create a tight seal; must define whether helix is left or right handed.
bronze: an alloy of copper, tin and zinc.
buffing (sizing): grinding a surface to obtain dimensional conformance or surface uniformity.
bunch braid: braid applied to hose in bundles rather than flat strands (plaits), usually done to achieve high pressure versus hose weight.
burst: a rupture caused by internal pressure; the destructive release of hose pressure.
burst pressure: the pressure at which rupture occurs.
butt weld: process in which the edges or ends of the metal sections are butted together and joined by welding.
butt weld splicing: a method of joining two pieces of corrugated metal hose innercore together to make one piece.

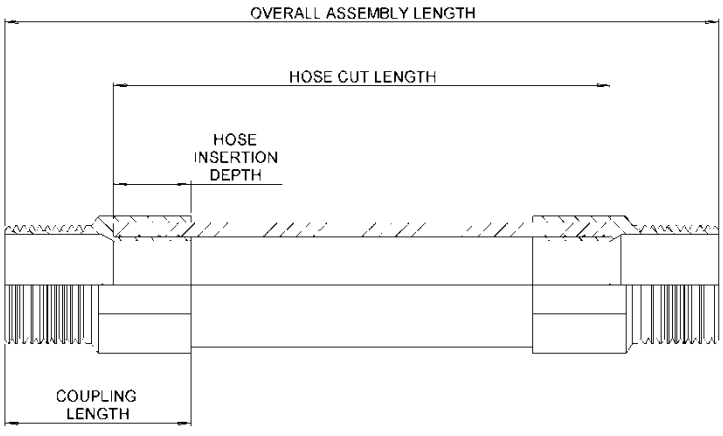
C of C or COC: certificate of conformance or certificate of compliance; a document, typically signed and dated pertaining to a particular lot or purchase order of item(s), which describes any standards, specifications, tests, materials and/or performance attributes to which the referenced item(s) have met or will meet.
calender: a three-roll or four-roll piece of equipment used to produce elastomer plies for a hose at the thickness and width required; also used to skim elastomer onto reinforcing cord or fabric; also used to friction coat (flood) reinforcing fabrics with elastomer.
cam & groove: see fitting/coupling - Cam & Groove.
capped end: a hose end covered to protect its internal elements; usually not pressure-bearing.
CARB: California Air Resources Board
carcass: the fabric, cord and/or metal reinforcing section of a hose as distinguished from the hose tube or cover.
casing: see armor.
cement: unvulcanized raw or compounded rubber in a suitable solvent used as an adhesive or sealant.
cement cover: a braided cover hose without a rubber cover using a liquid adhesive to keep the yarns in place.
cemented end: a hose end sealed with the application of a liquid coating.
certification: see C of C
CFIA: Canadian Food Inspection Agency
CFM: cubic feet per minute
CGA: Can refer to Compressed Gas Association or Canadian Gas Association
chafe sleeve: an outer sleeve providing resistance to chafing and external resistance to damage to

braided hoses, available in wide variety of materials to meet the application requirements (e.g., chafe sleeves include slip-on, heat shrinkable, integrally extruded).
chalking: the formation of a powdery surface condition due to disintegration of surface binder or elastomer by weathering or other destructive environments.
checking: the short, shallow cracks on the surface of a rubber product resulting from damaging action of environmental conditions.
chemical compatibility: the relative degree to which a material may contact another without corrosion, degradation or adverse change of properties.
chemical resistance: the ability of a particular polymer, rubber compound, or metal to exhibit minimal physical and/or chemical property changes when in contact with one or more chemicals for a specified length of time, at specified concentrations, pressure, and temperature.
clamp: see hose clamp.
cloth impression: see fabric impression.
coefficiency of flow: When calculating the measure of the loss of air flow through a duct due to length, bends or any restriction, the coefficiency of flow pertains to the resistance of the duct to pass the volume of air flowing through it. Generally measured in a per foot basis.
coefficient of friction: a relative measure of the surface lubricity.
cohesive failure: A failure of bonded items or the adhesive near (but not at) the surface interface where the adhesive was applied (i.e. the adhesive interface was stronger than the bonded items or the adhesive itself). An example of cohesive failure would be office tape to paper where the adhesive tears off the outermost layer of paper upon removal. Cohesive failures are often a sign of exceeding the capabilities of the materials in practice, particularly when the failure occurs in one of the bonded items rather than the adhesive itself.
cold flex: see low temperature flexibility.
cold flexibility: relative ease of bending while being exposed to specified low temperature.
cold flow: continued deformation under stress. See creep.
collar: 1) the portion of a fitting that is compressed by swaging or crimping to seal the hose onto the fitting barbs and create a permanent attachment; also called a ferrule. (With reusable fittings, the lock and seal are accomplished mechanically by the collar without swaging or crimping); 2) a raised portion on the hose shank which functions as a connection for a ferrule or other locking device or functions as a hose stop.
combustible liquid: a combustible liquid is one having a flash point at or above +100°F (37.8°C).
composite hose: non-vulcanized hose that consists of the following:

- An internal wire helix;
- A multi-ply wall of thermoplastic films and reinforcing fabrics in proportions that give the required physical properties and provide a complete seal. (Note: The film content may be built of tubular films.)
- A cover consisting of fabric with an abrasion resistant polymeric coating;
- An external helix wire.

compound: the mixture of rubber or plastic and other materials, which are combined to give the desired properties when, used in the manufacture of a product.
compression fitting: see fitting/coupling - Compression
compression ratio: a measurement shown in percentages reflecting axial compressibility of a duct
compression set: the deformation which remains in rubber after it has been subjected to and released from a specific compressive stress for a definite period of time at a prescribed temperature. (Compression set measurements are for evaluating creep and stress relaxation properties of rubber.)
concentricity: the uniformity of hose wall thickness as measured in a plane normal to the axis of the hose.
conditioning: the exposure of a specimen under specified conditions, e.g., temperature, humidity, for a specified period of time before testing.
conductive: the ability to transfer electrical potential
configuration: the combination of fittings on a particular assembly.
continuity: the electrical connection of a hose assembly between fittings.
control: a product of known characteristics, which is included in a series of tests to provide a basis for evaluation of other products.

controlled flexing: occurs when the hose is being flexed regularly, as in the case of connections to moving components (e.g., platen presses, thermal growth in pipe work).
convoluted: description of hose or innercore having annular or helical ridges formed to enhance flexibility.
convolution/corrugation: the annular or helical flexing member in corrugated or strip wound hose/corrugation.
convolution count: the number of ridges or corrugations per inch of a hose.
copolymer: a blend of two polymers.
core: the inner portion of a hose, usually referring to the material in contact with the medium.
corrosion: the process of material degradation by chemical or electrochemical means.
corrosion resistance: ability of metal components to resist oxidation.
corrugated cover: a ribbed or grooved exterior.
corrugated hose: hose with a carcass fluted, radially or helically, to enhance its flexibility or reduce its weight.
corrugation: description of a duct having annular ridges formed to enhance flexibility.
coupler: the female portion of the cam & groove connection with the cam arms.
coupling: a frequently used alternative term for fitting.
cover wear: the loss of material during use due to abrasion, cutting or gouging.
cover: the outer component usually intended to protect the carcass of a product.
CPE: ASTM designation for chlorinated polyethylene; a rubber elastomer.
CPMA: Concrete Pumping Manufacturers Association
CR: Chloroprene Rubber; ASTM designation for neoprene; a rubber elastomer.
CRES: refers to corrosion-resistant steel, or stainless steel
cracking: a sharp break or fissure in the surface, generally caused by strain and environmental conditions.
creep: the deformation, in material under stress, which occurs with lapse of time after the immediate deformation.
crimp diameter: the distance across opposite flats after crimping; the external diameter of the collar, ferrule.
crimp/crimping: a fitting attachment method utilizing a number of fingers or dies mounted in a radial configuration. The dies close perpendicular to the hose and fitting axis, compressing the collar, ferrule, or sleeve around the hose.
crimped style: a mechanical lock hose construction whereby the external metal helix acts as a filler and securely crimps the overlapping folds of fabric. No adhesives or glues are required and the style is engineered for higher temperatures and acoustic applications
crush proof: the ability to rebound to 75% of its original ID when crushed all the way closing off the ID; no structural damage such as cracking the helix should be encountered
crush resistance: the force required to crush a hose to 50% of its original diameter; this typically refers to wire supported hose which will not regain its original diameter.
CSM: ASTM designation for chlorosulfonated polyethylene; a rubber elastomer.
cuff: soft wall, wireless, injection molded, or built-in end configurations
cure: the act of vulcanization. See vulcanization.
cut off factor: the hose length to be subtracted from the overall assembly length that allows for the hose coupling end connection extension beyond the end of the hose



cut resistant: having that characteristic of withstanding the cutting action of sharp object.
cycle-motion: movement from normal to extreme position and return.

date code: any combination of numbers, letters, symbols or other methods used by a manufacturer to identify the time of manufacture of a product.
deburr: to remove ragged edges from the inside diameter of a hose end; an important fabrication step for assembling hose of fluoropolymer in order to insure a good seal.
deduct length: the amount of fitting length deducted from a hose to result in the desired finished assembly length. Also see: set back, and cut off factor.
design factor: a ratio used to establish the working pressure of the hose, based on the burst strength of the hose.
design pressure: see application working pressure and pressure, working.
developed length: see overall length.
diamond weave: braid pattern in which the strands alternately cross over one and under one of the strands
(one over-one under); also known as “plain weave.”
die: a tool used to swage or crimp a fitting onto a hose. Swage dies usually consist of two halves machined to a predetermined diameter, designed for a specific hose type and size. A crimp die set is typically six to eight “fingers” designed for infinite diameter settings within a range or preset to a specific diameter for a given hose type and size.
dielectric strength: the relative measure of a material’s ability to resist conducting an electrical charge.
DIN: Deutsches Institut für Normung; DIN, the German Institute for Standardization, is the acknowledged national standards body that represents German interests in European and international standards organizations.
displacement: the amount of motion applied to a hose defined as inches for parallel offset and degrees for angular misalignment.
dog-leg assembly: two hose assemblies joined by a common elbow.
DOT: Department of Transportation.
dry-rot: loss of plasticizer (flexibility) over time, often resulting in cracks or splits in the material
duplex assembly: an assembly consisting of two hose assemblies-one inside the other, and connected at the ends; also known as “jacketed assemblies.”
durometer: an instrument for measuring the hardness of rubber and plastic compounds.
durometer hardness: a numerical value, which indicates the resistance to indentation of the blunt indentor of the durometer.
dye penetrant inspection/test: non-destructive inspection method for detecting surface defects.
dynamic bend radius: see bend radius, dynamic.

eccentric wall: a wall of varying thickness.
eccentricity: the condition resulting from the inside and outside diameters not having a common center. See eccentric wall.
ECTFE: ethylene-chlorotrifluoroethylene.
effective inside diameter: minimum inside diameter of a duct
effective thrust area-hose: cross-sectional area described by the mean diameter of the hose.
effusion: the escape, usually of gases, through a material. See permeation.
elastic limit: the limiting extent to which a body may be deformed and yet return to its original shape after removal of the deforming force.
elastic/intermittent flexure: The smallest radius that a given hose can be bent to without permanent deformation to the metal in its flexing members (convolutions or corrugations).
elastomer: any one of a group of polymeric materials, usually designated thermoset, such as natural rubber, or thermoplastic, which will soften with application of heat.
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)
electrostatic discharge: the sudden discharge of static electricity from an area of buildup to a grounding point; known to cause leak paths.
elongation: the increase in length expressed numerically as a percentage of the initial length.
EN: a document that has been adopted by one of the three recognized European Standardization Organizations: CEN, CENELEC or ETSI. An EN is available, in principle, in the three official languages of CEN (English, French and German).
encapsulated fitting: see fitting/coupling-Encapsulated fittings.
endurance test: a service or laboratory test, conducted to product failure, usually under normal use conditions.
enlarged end: an end having a bore diameter greater than that of the main body of the hose, in order to accommodate a larger fitting.
EPDM: ASTM designation for Ethylene Propylene Diene Monomer; an elastomer.
EVA: Ethylene vinyl acetate
exothermic: releasing heat.
extrude/extruded/extrusion: forced through the shaping die of an extruder; extrusion may have a solid or hollow cross section.

fabric impression: impression formed on the rubber surface during vulcanization by contact with fabric jacket or wrapper.
fabricator: the producer of hose assemblies.
fatigue: the progressive weakening or deterioration of a material occurring with a repetitious or continuous application of stress reducing strength and leading to failure.
FDA: United States Food and Drug Administration.
FEP: ASTM designation for fluorinated ethylene propylene.
ferrule: a metal cylinder placed over a hose end to affix the fitting to the hose. See braid sleeve, interlocking ferrule, and sleeve.

Ferrule

fire sleeve: slip-on or integrally extruded sheath used to retard the effects of fire in certain applications; most often made with silicone and/or ceramic fiber.
fitting/coupling: a device attached to the end of the hose to facilitate connection. The following is only a partial list of types of fittings available:

- *Banjo Fitting* - a through bolted designed featuring a hollow circle or "donut" attached to one end of the fitting barb so that the inner diameter is along the hose axis.
- *Butt Weld Fittings* - a hose fitting designed to be permanently welded to a connecting member such as another pipe or a butt weld flange.
- *Cam & Groove Fittings* - a type of fitting that allows connection and disconnection by means of arm(s) or cam(s) on the female fitting. The seal is accomplished by means of a gasket, available in various materials. These fittings are frequently used on product transfer hose assemblies.
- *Compression Fitting* - a fitting style that seals on a mating tube by compressing an internal ferrule against the tube O.D..
- *Encapsulated Fittings*- a metal fitting of various styles usually encased in a thermoplastic or fluoroplastic material by means of molding or coating. Most often done for sanitary purposes or to eliminate corrosion.
- *Field Attachable Fitting* - a fitting designed to be attached to hose without crimping or swaging. This fitting is not always a Reusable type fitting.
- *Flange Retainer Fittings* - a hose fitting flared to a 90° surface, designed to hold a circular rotating flange, such as a slip-on or lap joint style flange.
- *Flange Style Fittings* - pipe flanges and flanged fitting standards are listed under ANSI B16.5. Flanges

are rated for pressure and listed as “American Class 150, 300, 400, 600, 900, 1,500 or 2,500”. Pressure-Temperature ratings can be obtained by consulting the ANSI specification or ASME B16.5 (American Society of Mechanical Engineers). Designs vary by neck and face style, or other dimensional changes based on use. Various finishes or grooves may be applied to the face for sealing on a gasket or o-ring. Bolt holes and other dimensions are per the ANSI standard.

- *Slip-on Flange* - a flange designed to slip over a flange retainer and float freely in place for bolt alignment. Similar to a lap joint flange except with a very small radius on the face side of the inside diameter to mate with a machined flange retainer. May have a flat or raised face.
- *Lap Joint Flange* - a flange designed to float freely on the flange retainer for bolt alignment. Made with a flat face and having a large radius on the I.D. to mate with a flared pipe style flange retainer.
- *Threaded Flange* - a flange, the inside diameter of which is threaded to attach to a male pipe fitting. A leak proof seal, made with thread sealant, usually does not allow for bolt hole alignment.
- *Inverted Flare Fitting* - a fitting consisting of a male or female nut, trapped on a tube by flaring the end of the tube material to either 37° or 45°.
- *JIC Fittings* - joint Industrial Council (no longer in existence). An engineering group that established an industry standard fitting design incorporating a 37° mating surface, male and female styles. These standards now governed by SAE.
- *Lined Fitting* - any fitting of which the wetted surface or entire fitting is covered with a protective material. The covering process may be by spray coating, molding or by inserting hose liner through the I.D. of fitting and anchoring.
- *O-ring Fittings* - a fitting that seals by means of an elastomeric ring of a specified material.
- *Pipe Thread Fittings* -
    - NPT- National Pipe Taper. Pipe thread per ANSI B1.20.1
    - NPTF- National Pipe Tapered for Fuels. Same as above except dry-seal per ANSI B1.20.3
    - NPSH- National Pipe Straight Hose per ANSI B1.20.7
    - NPSM- National Pipe Straight Mechanical. Straight thread per ANSI B1.20.1
    - NPSL- National Pipe Straight Loosefit per ANSI B1.20.1
    - BSPP, BSPT- British Standard Pipe Parallel, British Standard Pipe Taper. BS21.
- *Quick Connect Fitting* (or quick disconnect) - a fitting designed to quickly connect and disconnect. These fittings come in many styles and types.
- *Reusable Fitting* - a fitting designed to be attached and unattached to a hose, allowing all or most of the fitting to be reused.
- *Sanitary Fittings* - a fitting whose seal is accomplished by means of a round gasket in a groove on the face of the fitting. The design eliminates the need for a male and female, since the fitting mates to itself. A re-attachable clamp is also used for coupling.
- *Bevel Seat* - a type of sanitary fitting incorporating a 45° beveled sealing surface. Used in the food and pharmaceutical industries.
- *Split Flange Fitting* - a fitting consisting of a flange retainer and a flange of two halves. This design allows the flanges to be installed after the retainer has been attached to the hose, making the flange reusable. SAE Code 61 and 62.
- *Tube Fitting* - a hose fitting of which the mating end conforms to a tube diameter. The mate or male end of a compression fitting.
- *2-Bolt Flange Fitting* - an elliptical flange with two bolt holes. Typically used in steam applications such as laundry and tire presses.

flame retardant: Material added to a compound to resist burning
flame spread/propagation: rate at which a flame will proceed along a duct
flammable gases/liquid/media: a flammable gas, including liquefied gas, is one having a closed cup flash point below +100ºF (+37.8ºC) and a vapor pressure greater than 25 psi. (174.2 KPa)
flat spots: flat areas on the surface of cured hose caused by deformation during vulcanization.
flex cracking: a surface cracking induced by repeated bending and straightening.
flex life: the relative ability of an article to withstand bending stresses.
flex life test: a laboratory method used to determine the life of a rubber product when subjected to dynamic bending stresses.
flexing, occasional: when the hose is only required to flex occasionally, such as manual handling
flexing, constant: when the hose is required to flex continuously, usually on moving machinery

flow rate: a volume of media being conveyed in a given time period.
fluid: a gas or liquid medium.
fluid Temperature: The fluid temperature is the temperature of fluid being conveyed inside of the hose during operation.
fluid velocity: the speed of fluid through a cross section expressed in length divided by time.
fluorocarbon: an organic compound containing fluorine directly bonded to carbon. The ability of the carbon atom to form a large variety of structural chains gives rise to many fluorocarbons and fluorocarbon derivatives.
fluoropolymer: a high molecular weight (long chain) chemical containing fluorine as a major element; most common hose types are PTFE, PFA and FEP.
free length: the lineal measurement of hose between fittings or couplings.
frequency: the rate of vibration or flexure in a given time period.

galvanic corrosion: corrosion that occurs on the less noble of two dissimilar metals in direct contact with each other in an electrolyte, such as water, sodium chloride in solution, sulfuric acid, etc.
GPM: gallons per minute.
guide (for piping): a device that supports a pipe radially in all directions, but directs movement.

Halar®: Solvay Solexis registered trademark. See ECTFE.
hand built hose: a hose made by hand on a mandrel, reinforced by textile or wire or combination of both; also referred to as Custom Made hose.
hardness: resistance to indentation. See durometer hardness.
Hastelloy ® : registered trademark of Haynes International, Inc. Refers to corrosion-resistant metal alloy.
heat resistance: the property or ability to resist the deteriorating effects of elevated temperatures.
heat sealed: see strip wound**.**
heat-shrink sleeving: tubular thermoplastic sleeve used for chafe protection or identification. The sleeve is slipped over the hose and shrunk down by the application of heat to fit tightly on the hose.
helical wire armor/spring guard: an abrasion resistance device.
helical: used to describe a type of corrugated hose having one continuous convolution resembling a screw thread.
helix: a shape formed by spiraling a wire or other reinforcement around the cylindrical body of a hose; typically used in suction hose.
hertz: unit of frequency defined by the International System of Units as the number of cycles per second of a periodic phenomenon. Symbol: Hz.
Hg: mercury (inches of mercury measurement of vacuum)
higbee: the thread of a hose coupling, the outermost convolution of which has been removed to such an extent that a full cross section of the thread is exposed, this exposed end being beveled to reduce cross threading.
homopolymer: A polymer comprised of a single monomer in a polymerized chain (e.g. polypropylene, PVC)
hoop strength: the relative measure of a hose's resistance to collapse of the diameter perpendicular to the hose axis.
hose: a flexible conduit consisting of a tube, reinforcement, and usually an outer cover.
hose assembly: see assembly.
hose clamp: a device used to hold a hose onto a fitting.
HVAC: heating, ventilation, air conditioning
hydrostatic testing: the use of a pressurized liquid, usually water, to test a hose or hose assembly for leakage, twisting, and/or hose change-in-length.
Hypalon®: a DuPont registered trademark. See CSM.
Hytrel®: a DuPont registered trademark.

IAPMO: International Association of Plumbing and Mechanical Officials
I.D.: the abbreviation for inside diameter.
identification yarn: a yarn of single or multiple colors, usually embedded in the hose wall, used to identify the manufacturer.

impression: a design formed during vulcanization in the surface of a hose by a method of transfer, such as fabric impression or molded impression.
impulse service: an application parameter characterized by continuous cyclical pressure changes from low to high.
impulse: an application of force in a manner to produce sudden strain or motion, such as hydraulic pressure applied in a hose.
inches of mercury (inHg): measure of air pressure or vacuum
inches of water (inH_2O): measure of air pressure or vacuum
indentation: 1) the extent of deformation by the indentor point of any one of a number of standard hardness testing instruments; 2) a recess in the surface of a hose.
innercore: see Core.
insert: optional term for nipple. See nipple.
inside diameter: measurement of the duct from interior wall to interior wall
interlocked hose: formed from profiled strip and wound into flexible metal tubing with no subsequent welding, brazing, or soldering; may be made pressure-tight by winding in strands of packing.
interlocking clamp: a clamp which engages the fitting in a manner which prevents the clamp from sliding off the fitting, typically a bolt or U-bolt style with interlocking fingers which engage an interlock ring on the fitting.
interlocking ferrule: a ferrule, which physically attaches to the fitting preventing the ferrule from sliding off the fitting.
interstice: a small opening, such as between fibers in a cord or threads in a woven or braided fabric.
IPT: iron pipe threads; a reference to NPT or NPTF.
ISO: International Organization for Standardization.

jacket: a seamless tubular braided or woven ply generally on the outside of a hose.
jacketed assembly: see duplex assembly
JIC: see fitting/coupling-JIC.

kinking: a temporary or permanent distortion of the hose induced by bending beyond the minimum bend radius.
Kynar®: Arkema registered trademark. See PVDF.

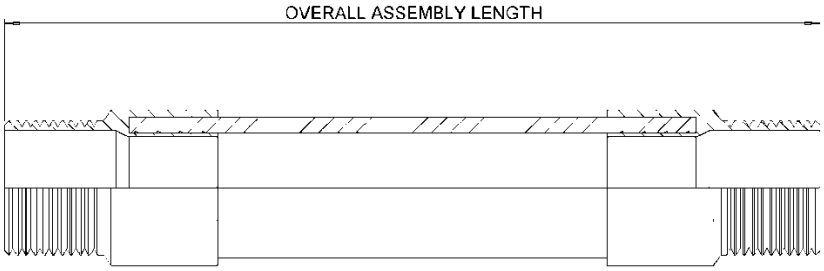
lap seam: a seam made by placing the edge of one piece of material extending flat over the edge of the second piece of material.
lay: 1) the direction of advance of any point in a strand for one complete turn; (2) the amount of advance of any point in a strand for one complete turn. See pitch.
layer: a single thickness of rubber or fabric between adjacent parts.
leaker: 1) a crack or hole in the tube which allows fluids to escape; 2) a hose assembly which allows fluids to escape at the fittings or couplings.
life test: a laboratory procedure used to determine the resistance of a hose to a specific set of destructive forces or conditions. See accelerated life test.
light resistance: the ability to retard the deleterious action of light.
lined bolt holes: the bolt holes, which have been given a protective coating to cover the internal structure.
liner: flexible sleeve used to line the inside diameter of hose when conveying a high velocity media, also prevents erosion.
live length: see free length.
LJF (lap joint flange): see fitting/coupling - Lap Joint Flange
long shank: a shank length greater than the nominal diameter, typically two diameters in length, which allows more than a single clamp.
loop installation: the assembly is installed in a loop or “U” shape, and is most often used when frequent and/or large amounts of motion are involved.
low temperature flexibility: the ability of a hose to be flexed, bent or bowed at low temperatures without loss of serviceability.
LPG, LP Gas: the abbreviation for liquefied petroleum gas.

MAWP: see pressure, maximum allowable working.
mandrel: 1) a form, generally of elongated round section used for size and to support hose during fabrications and/or vulcanization. It may be rigid or flexible; 2) a tapered expanding device, fixed in diameter, which is pulled through a shank of a fitting thus expanding the diameter to exert force on the hose between the shank and ferrule.
mandrel built: a hose fabricated and/or vulcanized on a mandrel.
mandrel, flexible: a long, round, smooth rod capable of being coiled in a small diameter. It is used for support during the manufacture of certain types of hose. (The mandrel is made of rubber or plastic material and may have a core of flexible wire to prevent stretching.)
mandrel, rigid: a non-flexible cylindrical form on which a hose may be manufactured.
manufactured length: length of duct as produced prior to packing
manufacturer's identification: a code symbol used on or in some hose to indicate the manufacturer.
mass flow rate: the mass of fluid per unit of time passing through a given cross-section of a flow passage in a given direction.
material handling hose: hose that is used to transport bulk materials; typical abrasive materials include dry cement, crushed rock, screenings, limestone, grain etc. in dry, slurry (wet) or air suspension. Typical large bore material handling hoses are Sand Suction, Suction &Discharge (S&D), Dredge, Discharge Material Handling, etc. Such applications are found in Mine, Mills, Quarries, Sea Ports, etc.
MAWP: see pressure, maximum allowable working pressure.
maximum intermittent ambient temperature: Hose constructions which use a rubber inner tube and/or cover can have significant change in properties when exposed to extreme heat or cold. This may require some hoses to be rated to a lower operating pressure when exposed to such conditions.
maximum temperature: The maximum temperature is the highest temperature to which the fluid or environment may reach. This temperature is typically short in duration and occurs under extreme operating conditions. The hose selected for an application should be rated at or above the maximum ambient and maximum fluid temperature.
mean diameter: the midpoint between the inside diameter and the outside diameter of a corrugated/convoluted hose. Also used in the calculation of braid strength.
mechanical fitting/reusable fitting: a fitting attached to a hose, which can be disassembled and used again.
media, medium: the substance(s) being conveyed through a system.
mender: a fitting or device used to join two sections of hose.
metal hose: thin wall metal tubing formed into flexible hose with helical or annular ridges and grooves, often braided with stainless steel to increase the operating pressure capability. With fittings welded on, assemblies are used in applications outside temperature range of rubber, thermoplastic and fluoroplastic.
minimum temperature: The minimum temperature is the lowest temperature to which the hose assembly will be exposed. For a hydraulic system, this is based on the minimum ambient temperature. A hose should be rated at or below the minimum ambient temperature to which the assembly may be exposed.
misalignment: a condition where two parts do not meet true.
Monel ®: registered trademark of Special Metals Corporation.
monomer: A basic structural molecule that can link with other monomers into a polymer chain to form unique materials with unique characteristics and properties (e.g. vinyl chloride, various base hydrocarbons).

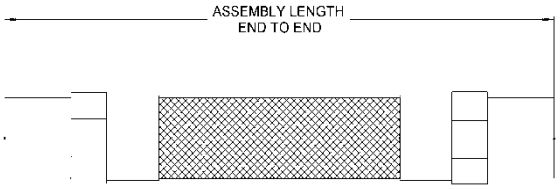
NAHAD: the abbreviation for the Association for Hose and Accessories Distribution.
necking down: a localized decrease in the cross-sectional area of a hose resulting from tension.
negative pressure: vacuum
Neoprene®: a registered trademark of DuPont.
NFPA: National Fluid Power Association
NFPA: National Fire Protection Association
nipple: the internal member or portion of a hose fitting.
NIST: National Institute of Standards and Technology
nitrile rubber (NB/Buna-N): a family of acrylonitrile elastomers used extensively for industrial hose.
nominal: a size indicator for reference only.

nomograph: a chart used to compare hose size to flow rate to recommended velocity.
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.
non-interlocking ferrule: see sleeve.
nozzle end: an end of hose in which both the inside and outside diameters are reduced.
NPT/NPTF: abbreviation for national pipe threads. See fitting/coupling - Pipe Thread Fittings.
NSF: National Sanitation Foundation
nylon: a family of polyamide materials.

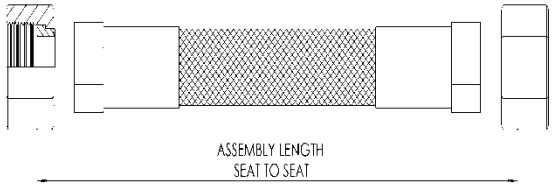
OAL: see overall length
O.D.: the abbreviation for outside diameter.
OE/OEM: original equipment manufacturer.
off-center: see eccentricity.
offset: the perpendicular distance between fitting axes when motion of the assembly occurs and fittings remain parallel.
offset-lateral, parallel: the distance that the ends of a hose assembly are displaced in relation to each other as the result of connecting two misaligned terminations in a system, or intermittent flexure required in a hose application.
oil resistance: the ability of the materials to withstand exposure to oil.
oil swell: the change in volume of a rubber article resulting from contact with oil.
open steam cure: a method of vulcanizing in which steam comes in direct contact with the product being cured.
operating conditions: the pressure, temperature, motion, and environment to which a hose assembly is subjected.
operating pressure (see working pressure)
optimum cure: the state of vulcanization at which a desired rubber compound combination is attained
orientation: the displacement angle of two elbow type couplings in a hose assembly, measured as an off-set value.
orientation index: the ratio of longitudinal to transverse strength in plastic tube extrusions.
o-ring fitting: see fitting/coupling, O-Ring.
OS & D hose: the abbreviation for oil suction and discharge hose.
outgassing: the release of chemicals from the material of the duct over time
outside diameter: measurement of the duct from exterior wall to exterior wall
overall length (OAL): the total length of a hose assembly, which consists of the free hose length plus the length of the coupling(s); need to clearly define whether the basis is overall seat x seat, or end of fitting to end of fitting. (see STAMPED section, "Size")



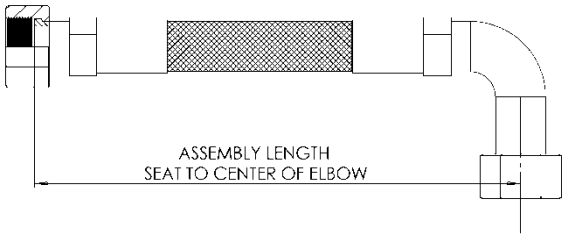
Measurement of Hose Assembly



Measurement of Hose Assembly having an End Connection with a Seating Face



Measurement of Hose Assembly having an Elbow Fitting



oxidation: the reaction of oxygen on a material, usually evidenced by a change in the appearance or feel of the surface or by a change in physical properties.
ozone cracking: the surface cracks, checks or crazing caused by exposure to an atmosphere containing ozone.
ozone resistance: the ability to withstand the deteriorating effects of ozone (generally cracking).

PC: Polycarbonate, a rigid plastic material with excellent impact strength and optically clarity
penetration (weld): the percentage of wall thickness of the two parts to be joined that is fused into the weld pool in making a joint.
performance test (*see* **service test)**
permanent fitting: the type of fitting which, once installed, may not be removed for re-use.
permeation: the process of migration of a substance into and through another, usually the movement of a gas into and through a hose material; the rate of permeation is specific to the substance, temperature, pressure and the material being permeated.
PET: Polyethylene terephthalate, also commonly known as polyester
PFA: Perflouroalkoxy, a fluorocarbon material used for tubes
Pharmacopeia Class VI: a standard for sanitary fittings, designating the form, fit, function and finish. The testing of elastomers, plastics, polymetric materials and their extracts as described in the US Pharmacopia XXII General Chapter 88, designed for evaluating biocompatibility of plastics materials. This *in vivo* testing consists of three tests: systemic, interacutaneous, and implantation. The materials and their extracts are then classified according to the test results as meeting Plastics Class I – Class VI.
pick: the distance across a group of braid wires from a single carrier, measured along the axis of the hose.
pig: a mechanical projectile used for cleaning hose.
pin pricked: perforations through the cover of a hose to vent permeating gases.
pipe spacer: a section of pipe used to facilitate the connection of a fitting to a hose.

pitch: 1) the distance from one point on a helix to the corresponding point on the next turn of the helix, measured parallel to the axis; 2) the distance between the two peaks of adjacent corrugation or convolution.
pitch count: typically measured in turns per inch (tpi)
pitted tube: surface depressions on the inner tube of a hose.
plain ends: fitting ends without threads, groove, or a bevel typically used for welding, as in a flange.
plaits: an individual group of reinforcing braid wires/strands that fill one carrier.
plating: a material, usually metal, applied to another metal by electroplating, for the purpose of reducing corrosion; typically a more noble metal such a zinc is applied to steel.
ply: an individual layer in hose construction, usually a braid or wrap.
pneumatic testing: the use of compressed gas to test a hose or hose assembly for leakage, twisting, and/or hose change-in-length. NOTE: Use of high pressure gas is extremely hazardous.
Polyflon: (trademark) a registered trademark of Daikin USA. See PTFE**.**
polymer: a macromolecular material formed by the chemical combination of monomers, having either the same or different chemical compositions.
Polypropylene (PP), also known as **polypropene**, is a thermoplastic polymer used in a wide variety of applications; it is rugged and unusually resistant to many chemical solvents, bases and acids.
Polyurethane (PU): An organic polymer with a wide range of stiffness, hardness, viscosities and densities, ranging from flexible foams to rigid plastics to wood and floor finishes; see TPU
post-sinter: the technique of re-heating PTFE innercore to process temperature in order to stabilize permeability and reduce orientation index.
preform: the compressed cylinder of PTFE resin that is used to extrude into raw tubing. Also called a billet.
pre-production inspection or test: the examination of samples from a trial run of hose to determine adherence to a given specification, for approval to produce.
preset: the process of pressurizing a hose to set the braid and minimize length change in final product.
pressure: force ÷ unit area. For purposes of this document, refers to PSIG (pounds per square inch gauge).
pressure drop: the measure of pressure reduction or loss over a specific length of hose.
pressure, burst: the pressure at which rupture occurs. See burst.
pressure, deformation: the pressure at which the convolutions of a metal hose become permanently deformed.
pressure, gauge: relative pressure between inside and outside of an assembly.
pressure, maximum allowable working: the maximum pressure at which a hose or hose assembly is designed to be used.
pressure, operating: see pressure, working.
pressure, proof: a onetime test pressure performed by the factory on every new hose prior to shipment, specific to fire hose and mill hose. The proof test pressure shall not be less than two times the specified service test pressure
pressure, proof test: a non-destructive pressure test applied to hose assemblies.
pressure, pulsating: a rapid change in pressure above and below the normal base pressure, usually associated with reciprocating type pumps.
pressure, rated working: see pressure, maximum allowable working.
pressure, service: see working pressure.
pressure, set: the conditioning pressure to align and balance braid.
pressure, shock/spike: the peak value of a sudden increase of pressure in a hydraulic or pneumatic system producing a shock wave.
pressure, working: the maximum pressure to which a hose will be subjected, including the momentary surges in pressure, which can occur during service. Abbreviated as WP.
printed brand: see brand.
profile: used in reference to the contour rolled into strip during the process of manufacturing strip wound hose, or the finished shape of a corrugation/convolution.
proof pressure: see pressure, proof test
propane: see LPG, LP Gas.
psi: pounds per square inch.

PTFE: polytetrafluoroethylene, a high molecular weight fluoroplastic polymer with carbon atoms shielded by fluorie atoms having very strong inter-atomic bonds, giving it chemical inertness.
pull off force: the force required to pull the hose from its attachment not generated by the internal pressure.
pulled-down tube: see loose tube, delamination or tube separation.
pulsation: the rapid cyclic fluctuations in pressure
PVC: ASTM designation for polyvinyl chloride. A low cost thermoplastic material typically used in the manufacture of industrial hoses.
PVDF: ASTM designation for polyvinylidene fluoride.

quality conformance inspection or test: the examination of samples from a production run of hose to determine adherence to given specifications, for acceptance of that production.

RAC: Rubber Association of Canada.
random motion: the uncontrolled motion of a metal hose, such as occurs in manual handling.
reinforcement: the strengthening members, consisting of either fabric, cord, and/or metal, of a hose. See ply.
relaxed length: length of stretched out duct after compression packing
reusable fitting/coupling: see fitting/coupling, reusable.
RMA: The Rubber Manufacturers Association, Inc.
ROHS: Reduction of Hazardous Substances (standard) The RoHS acronym references the Restriction of Hazardous Substances Directive 2002/95/EC. It is a directive of the European Union which took effect on 1 July 2006. It prohibits the use of six banned substances: lead, mercury, cadmium, hexavalent chromium, poly-brominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE), in the manufacture of Electronics and Electrical Equipment. May be required for products shipped to Europe or otherwise specified by the customer.
Ref: www.rohs.eu.
rough bore: a hose whose interior is not smooth, usually manufactured with a corrugated construction.

SAE: Society of Automotive Engineers.
safety factor: see design factor.
sampling: a process of selecting a portion of a quantity for testing or inspection.
Santoprene®: a registered trademark of Exxon Mobil.
SBR: ASTM designation for Styrene-butadiene; a rubber elastomer.
scale: the oxide in a hose assembly brought about by surface conditions or welding.
self-extinguishing: property of material to extinguish a flame once started
serrations: bumps, barbs, corrugations, or other features that increase the holding power of the device.
service temperature: see working temperature.
service test: a test in which the product is used under actual service conditions.
service test pressure: a hydrostatic test usually for fire and mill hose rated at 10% greater than the operating pressure at which the hose is expected to be used; branded on the hose at the conclusion of the test.
set back: see cut off factor.
shank: that portion of a fitting, which is inserted into the bore of a hose. See nipple.
shelf/storage life: the period of time prior to use during which a product retains its intended performance capability.
shell: see ferrule.
shock load: a stress created by a sudden force.
short shank: shank length, approximately equal to the nominal diameter, but long enough to allow a single clamp at minimum.
simulated service test: see bench test.
skive: the removal of a short length of cover and/or tube to permit the attachment of a fitting directly over the hose reinforcement.

sleeve: (1) a metal cylinder, which is not physically attached to the fitting, for the purpose of forcing the hose into the serrations of the fitting.
(2) see jacket.

Sleeve

smoke generation: a measure of the quantity and content of smoke when the material is burning
smooth bore: a term used to describe the type of innercore in a hose other than convoluted.
smooth transition attachment: special fabrication technique used for metal hose.
socket: the external member or portion of a hose fitting, commonly used in describing screw-together reusable fittings.
soft cuff: a duct end in which the rigid reinforcement of the body, usually wire, is omitted **soft end:** a hose end in which the rigid reinforcement of the body, usually wire, is omitted.
specification: a document setting forth pertinent details of a product.
spikes: (see surge)
spiral: a method of applying reinforcement helically in which there is not interlacing between individual strands of the reinforcement.
spiral angle: the angle developed by the intersection of the helical strand and a line parallel to the axis of a hose. See braid angle.
splice: a method of joining two sections of hose.
splicer: a fitting or device used to join two sections of hose.
spring guard: a helically wound component applied internally or externally to a hose assembly, used for strain relief, abrasion resistance, collapse resistance.
square cut: a straight cut perpendicular to the hose axis
squirm: a form of failure where the hose is deformed into an “S” or “U” bend, as the result of excessive internal pressure being applied to unbraided corrugated hose while its ends are restrained or in a braided corrugated hose which has been axially compressed.
standard: a document, or an object for physical comparison, for defining product characteristics, products, or processes, prepared by a consensus of a properly constituted group of those substantially affected and having the qualifications to prepare the standard for use.
static bend radius: the centerline radius to which a hose is bent in a stationary installation.
static bonding: use of a grounded conductive material on the ID of a hose between fittings to eliminate static electrical charges.
static conductive: having the capability of furnishing a path for a flow of static electricity.
static discharge: see electrostatic discharge.
static dissipating hose (also referred to as semi-conductive hose): Static dissipating hose refers to the electrical properties of the rubber 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 rubber compounds will not dissipate static electricity. Only black compounds formulated with high carbon black content will dissipate static electricity.
static installations: when the flexible hose is used to connect pipe-work out of alignment and remain in a static position
static wire: wire incorporated in a hose to conduct static electricity.
stem: see nipple.
stress corrosion: a form of corrosion in metal accelerated by loading.
stretch hose: duct that is self-retracting that can be stretched to a multiple of its original length
stretch ratio: percentage of stretch allowed; rated for a certain load
strip wound: see interlocked hose.
surge (spike): a rapid and transient rise in pressure.
swage: the method of fitting attachment that incorporates a set of die halves designed to progressively reduce the collar or ferrule diameter to the required finish dimension by mechanically forcing the fitting into the mating die.
swelling: an increase in volume or linear dimension of a specimen immersed in liquid or exposed to a vapor.

taber: a type of abrasion tester, used to evaluate abrasion resistance of materials
tape wrapped convoluted: a type of flexible hose incorporating layers of tape to form helical ridges and grooves.
tapered end: a reduction built in on one or both ends of a rubber hose to simulate a nozzle.
tear resistance: the property of a rubber tube or cover of a hose to resist tearing forces.
Teflon (trademark): a registered trademark of E.I. DuPont. See PTFE, FEP, and PFA.
tensile strength: a measurement of a material's ability to resist tearing; the maximum tensile stress applied while stretching a specimen to rupture.
TFE: polytetrafluoroethylene. See PTFE
thermoplastic: A polymer that softens and becomes a liquid at elevated temperatures.
Thermoplastic Polyurethane (TPU): Polyurethanes that are formulated to be processed via melt extrusion for profile extrusions and injection molding; typically considered highly abrasive resistant and flexible for ducting; can refer to both polyether based or polyester based material.
thermoset: polymer that irreversibly cures at elevated temperatures (vulcanizes).
thread: a helical or spiral ridge on a nut or screw
tig weld/GTAW: the gas tungsten arc welding process sometimes refered to a "shielded arc" or "heliarc"
tolerance: The upper and lower limits between which a dimension must be held; the permissible limit of variation in a physical dimension.
TPE: Thermoplastic elastomer, also commonly referred to a thermoplastic rubber (TPR). A class of materials that demonstrate both plastic and elastomeric properties than can be extruded and injection molded.
TPI: turns per inch of helix**;** see pitch count
TPR: Thermoplastic rubber
TPU: Thermoplastic polyurethane
TPV: Thermoplastic vulcanizate, a compound where a rubber component vulcanizes during the melt extrusion process, becoming partially thermoset to give rubber-like properties.
traveling loop, Class A Loop: an application wherein the radius remains constant and one end of the hose ends parallel to the other end.
traveling loop, Class A Loop: a condition wherein a hose is installed in a U shaped configuration and the ends move perpendicular to each other so as to enlarge or decrease the width of the loop.
tube: the innermost continuous all-rubber or plastic element of a hose.
tube fitting: see fitting/coupling-Tube.
tubing: a non-reinforced, homogeneous conduit, generally of circular cross-section.
twist: (1) the turns about the axis, per unit of length, of a fiber, roving yarn, cord, etc. Twist is usually expressed as turns per inch; (2) the turn about the axis of a hose subjected to internal pressure, the direction defined as Z or S.

unsintered: material that has not undergone primary heat processing. (Post sintered: material that has undergone primary heat processing.)
UL: Underwriters Laboratories
UL181: Specifies requirements that apply to materials for the fabrication of air duct and air connector systems for use in accordance with the Standards of the National Fire Protection Association for the Installation of Air-Conditioning and Ventilating Systems, NFPA No. 90A, and the Installation of Warn Air Heating and Air-Conditioning Systems, NFPA No 90B. The 181 Standard for Factory-Made Air Ducts and Air Connector, defines two categories of flexible "ducts". The UL listed Air Duct must pass all of the tests in the UL 181 Standard. Air Ducts are labeled with a square or rectangular shaped label showing their respective listing. There is no limitation on the length of runs when using **UL Listed Air Ducts**. (Class 1 Air Ducts). The **UL Listed Air Connector** must pass only a limited number of the UL 181 tests, and is labeled with a round shaped label which states "for installation in lengths not over 14 feet". Class 0 air ducts and air connectors have surface burning characteristics of zero. Class 1 air ducts have a flame spread index of not over 25 without evidence of continued progressive combustion and a smoke-developed index of not over 50.
UL94: The UL94 standard is a test specification for evaluating flammability of plastic materials used in devices and appliances. All tests are performed on a uniform test specimen of the component material(s)

of a specified thickness (usually 3.0mm when rated by the raw materials manufacturer). Application of these standards at the product level must consider application, wall thickness and component materials to determine acceptability at the finished product level. Note: contact your UL representative for further clarification.

UL94HB:HORIZONTAL BURN: Horizontal flammability (UL94 HB) – The material (or product) under test positioned in a horizontal orientation has a burning rate of:

- <75mm per minute for thicknesses less than 3.0mm or <40mm per minute for thicknesses between 3.0mm and 13mm
- Or it ceases to burn in less than 100mm regardless of wall thickness and burn rate

UL94V: Vertical flammability (UL94 V and VTM) – The material (or product) under test positioned in a vertical orientation must self-extinguish as follows:

- V-0 and VTM-0 – Must self-extinguish within 10 seconds after flame is removed with no flaming particles or smoldering drips
- V-1 and VTM-1 – Must self-extinguish within 30 seconds after flame is removed with no flaming particles or smoldering drips
- V-2 and VTM-2 – Must self-extinguish within 30 seconds after flame is removed; flaming particles and smoldering drips are acceptable; V and VTM (Very Thin Material) test procedures are similar except for the test sample preparation

USP: United States Pharmacopia

UV resistance: Ability to withstand decay due to the damaging effect of the ultraviolet rays of the sun.

U.S.C.G.: United States Coast Guard

USDA: United States Department of Agriculture

vacuum formed convoluted: smooth bore hose that is made flexible by the formation of ridges and grooves during a process that utilizes heat and vacuum to mechanically form convolutions.

vacuum formed corrugated: process of making corrugated duct using die blocks, positive pressure and vacuum in a continuous fashion

vacuum resistance: the measure of a hoses ability to resist negative gauge pressure.

velocity: the speed (e.g., feet/second) at which the medium flows through the hose

velocity resonance: vibration due to the elastic response of a high velocity gas or liquid flow.

vibration: amplitude motion occurring at a given frequency.

viscosity: the resistance of a material to flow.

Viton®: brand of synthetic rubber and fluoropolymer elastomer commonly used in O-rings and other molded or extruded goods. The name is a registered trademark of DuPont Performance Elastomers L.L.C..

volume change: a change in dimensions of a specimen due to exposure to a liquid or vapor.

volume swell: see swelling.

volumetric expansion: the volume increase of hose when subjected to internal pressure.

vulcanization: a process during which a rubber compound, through a change in its chemical structure, improves or extends elastic properties over a greater range of temperature.

warp: (1) the lengthwise yarns in a woven fabric or in a woven hose jacket, (2) the deviation from a straight line of a hose while subjected to internal pressure

water resistant: having the ability to withstand the deteriorating effect of water.

wear strip: added external material designed to increase the external resistance to abrasion

weathering: the surface deterioration of a hose cover during outdoor exposure, as shown by checking, cracking, crazing and chalking.

web: unreinforced section of the duct between the helix (wall) typically found in plastic ducts.

WEEE: Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC is often used in conjunction with RoHS. It sets collection, recycling and recovery targets for electrical goods.

weft: a term used for filling in a fabric. See filling.

WG: water gauge, or inches of water measurement

wire gauge: diameter of the helical wire

wire reinforced: a hose containing wires to give added strength, increased dimensional stability; crush resistance. See reinforcement.

working pressure: see Pressure, Working
working temperature: the temperature range of the application, may include the temperature of the fluid conveyed or the environmental conditions the assembly is exposed to in use.
WP: the abbreviation for working pressure.
wrapped cure: a vulcanizing process using a tensioned wrapper (usually of fabric) to apply external pressure.