GUIDE

For the
Fabrication of
Hydraulic Hose Assemblies

Version 2.0
October, 2014
# Table of Contents

Section F1 - Scope ........................................................................................................... 3  
Section F2 - Material Verification, Order Requirements .................................................. 7  
Section F3 - Key Steps in the Fabrication Process – Quality Checklist .......................... 8  
Section F4 – Quality Plan ................................................................................................ 9  
Section F5 - Hose ........................................................................................................... 11  
  F5.1 Calculate Cut Length ............................................................................................. 11  
  F5.2 Cutting .................................................................................................................. 15  
  F5.3 Cleanliness .......................................................................................................... 15  
  F5.4 Skiving or Buffing (As required) .......................................................................... 16  
Section F6 – Fabrication Process .................................................................................... 17  
  F6.1 Coupling Assembly (First End) ........................................................................... 17  
  F6.2 Crimping/Swaging (First end) ............................................................................. 18  
  F6.3 Accessories ......................................................................................................... 20  
  F6.4 Crimping/Swaging (Second end) ......................................................................... 20  
  F6.5 Hose Assembly Orientation for Offset Elbow Fittings ........................................... 21  
Section F7 – Finished Assembly Dimensions ................................................................ 23  
Section F8 – Cleanliness ................................................................................................. 24  
Section F9 – Assembly Testing and Inspection ................................................................. 26  
  F9.1 Testing ................................................................................................................ 26  
  F9.2 Documentation ..................................................................................................... 27  
  F9.3 Final Assembly Inspection .................................................................................... 27  
Section F10 – Identification, Storage, & Packaging ......................................................... 29  
  F10.1 Identification (Labeling and Tagging) ................................................................. 29  
  F10.2 Storage .............................................................................................................. 29  
  F10.3 Packaging ........................................................................................................... 29  
Section F11 – Safety ....................................................................................................... 31  
Section F12 – Thermoplastic Considerations ................................................................ 32  
Appendix A – Definitions ................................................................................................. 33  
Appendix B – Hose end identification/information ............................................................ 52  
Appendix C – Hydraulic Audit List .................................................................................. 68  
Appendix D – Hose Working Pressures ......................................................................... 69  
Appendix E – Conversion Charts ..................................................................................... 71
Section F1 - Scope

This document recommends the methods and requirements necessary for the fabrication and testing of hydraulic hose assemblies and pertains to nominal internal diameters 1/8 inch through 4 inch (3.2 mm through 101.6 mm). Its intended audience is warehouse fabricating personnel. This document will define the best practices and procedures for how to make a hydraulic hose assembly.

It is extremely important that the specific instructions of the hose and coupling manufacturers be followed. The intermixing of hose and couplings from different manufacturers is typically NOT acceptable, so the assembly fabricator should use hose, fittings and assembly equipment as supplied by a single manufacturer, as couplings are engineered to only work with approved hoses and vice-versa. If extenuating circumstances exist requiring that the hose and coupling be supplied by different manufacturers, it is mandatory that the fabricator use crimp specifications and test results to verify the reliability of the hose assembly. In no instance should the information printed in this section supersede a manufacturer's instructions.

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.

For general information and design recommendations not covered in this document, please consult NAHAD’s Hose Safety Institute Handbook©.

Note: Aerospace and hydraulic brake hose assemblies are excluded from the scope of this section.

For fabricators working with hydraulic hose, NAHAD recommends the International Fluid Power Society Fluid Power Connector and Conductor Certification be considered for more in-depth expertise in this area.

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

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.

Because there are many combinations of hose, end connections and attachment methods, the user should not assume that all combinations listed in the guide have been tested for.
acceptability. The information that is provided is based on an environment of +72°F (+22.2°C).

For any assembly instructions related to re-attachable fittings, please consult the manufacturer.

**Thanks and Recognition**

NAHAD wishes to acknowledge the contributions of many organizations which have made this document possible. In particular, the International Fluid Power Society (IFPS) has made significant contributions; many portions of their *Connector and Conductor Study Manual* (rev. 4/1/11) were used by permission in whole, or in part.

**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.
Important Notice About This Document

NAHAD (including its members, officers, directors, volunteers, staff and those participating in its activities) disclaims liability for any personal injury, property or other damage of any nature whatsoever, directly or indirectly resulting from the publication, use of, or reliance on this document or for compliance with the provisions herein. NAHAD makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

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.
Section F2 - Material Verification, Order Requirements

F2.1 Fabrication Order (Work Order)

Whether it is one hose assembly from an over the counter request or a written work order for multiple hose assemblies from an OEM, it is recommended that the components to be assembled be verified against the requirements of the fabrication order.

F2.2 Material Quality

Initial visual inspection of hose assembly components, as well as the completed assembly must be performed.

Hoses and hose ends should be visually inspected for defects. Hose covers and inner tubes should be free from deformities, cuts, etc… Wall thickness should be uniform for all hoses. Hose ends should be free from corrosion and cracks. Swivels should rotate freely. One-piece hose ends should have the nipple centered in the ferrule. Contact the manufacturer if there is any question about the quality of a component.

Documented validation may be required by the customer. It is recommended the assembly fabricator keep inspection records on incoming material, as well as document assembly testing and packaging processes. (See Section F4 – Quality Plan)
Section F3 - Key Steps in the Fabrication Process – Quality Checklist

This section is intended to provide a high level overview of the fabrication process; specific instructions and related details are provided in the following sections.

1. Select and Inspect Components (see section F4 for additional detail)
   - proper component selection helps ensure 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 as these impact assembly quality
   - ensure components match assembly specification (hose type and dimensions, fitting material)

2. Prepare and cut hose (see section F5.2 for additional detail)
   - there are different ways to measure the length of a hose assembly; select the method recommended by the manufacturer
   - 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)
   - hose must be cut squarely; angular cuts can result in poor assembly quality
   - clean all debris from the coupling area as this can impact assembly integrity

3. Coupling procedure
   - different hose constructions require different coupling procedures to ensure reliability and consistency of hose assembly performance
   - verify selected components meet dimensional requirements; for example, the OD of the hose could vary over the course of the assembly length and require component modification
   - Following manufacturer recommendations helps ensure reliability and consistency of assembly performance
   - Attach fitting per manufacturer’s specification

4. Fitting insertion
   - proper fitting insertion plays a key role in fitting retention
   - mark fitting depth on the hose cover
   - lubrication may be required
   - insert fitting to proper insertion depth without damaging the hose

5. Inspection and testing
   - ensure hose assembly meets the design requirements
   - identify appropriate test for this assembly
   - ensure appropriate safety equipment is used and the procedures are carefully followed
   - make sure any special customer requirements have been met

6. Cleaning
   - identify appropriate cleaning process for assembly to meet customer specifications
   - verify any special customer requirements have been met

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

8. Packaging
   - identify any special packaging and marking requirements
   - proper packaging and packaging techniques are required to protect hose assembly
Section F4 – 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 F5 - Hose

F5.1 Calculate Cut Length

The hose cut length for a hose assembly is calculated by subtracting the cut off factor (distance from the top of the ferrule or collar to the end of the fitting) from the actual assembly length required. Typical length tolerance for an assembly is +/- 1% or less. Thus, the tolerance for the hose cut length should be based on the overall assembly length tolerance. Standard overall assembly length tolerances can be found in the tables below, however customer specifications would always take precedence. Hose cut length is important, as it will create most of the variation in the overall assembly length.

When establishing proper hose length, motion absorption, hose length changes due to pressure, as well as hose and machine tolerances must be considered. Typical length tolerances for assemblies are shown in the table below.

Note: SAE is the standards organization which originated in the United States and is predominantly a North American organization while ISO originated in Europe. For hose assembly tolerance length, either standard may be referenced and used unless stated otherwise.

Hose Assembly Length Tolerances (SAE):

<table>
<thead>
<tr>
<th>Assembly Length</th>
<th>Tolerances (mm)</th>
<th>Tolerances (decimal in)</th>
<th>Tolerances (fraction in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up through 12 inches (304.8 mm)</td>
<td>3.2</td>
<td>0.13</td>
<td>1/8</td>
</tr>
<tr>
<td>Over 12 through 18 inches (304.8 through 457.2 mm)</td>
<td>4.8</td>
<td>0.19</td>
<td>3/16</td>
</tr>
<tr>
<td>Over 18 through 36 inches (457.2 through 914.4 mm)</td>
<td>6.4</td>
<td>0.25</td>
<td>1/4</td>
</tr>
<tr>
<td>Over 36 inches (914.4 mm)</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Hose Assembly Length Tolerances (ISO):

<table>
<thead>
<tr>
<th>Assembly Length</th>
<th>Tolerances (mm)</th>
<th>Tolerances (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-16 and smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up through 24.8 inches (630 mm)</td>
<td>-3 to +7</td>
<td>-0.1 to +0.3&quot;</td>
</tr>
<tr>
<td>Over 24.8 through 49.2 inches (630 through 1250 mm)</td>
<td>-4 to +12</td>
<td>-0.2 to +0.5&quot;</td>
</tr>
<tr>
<td>Over 49.2 through 98.4 inches (1250 through 2500 mm)</td>
<td>-6 to +20</td>
<td>-0.2 to +0.8&quot;</td>
</tr>
<tr>
<td>Over 98.4 through 315.0 inches (2500 through 8000 mm)</td>
<td>-0.5% to +1.5%</td>
<td>-0.5% to +1.5%</td>
</tr>
<tr>
<td>Over 315 inches (8000 mm)</td>
<td>-1.0% to +3.0%</td>
<td>-0.5 % to +3.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assembly Length</th>
<th>Tolerances (mm)</th>
<th>Tolerances (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger than -16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up through 24.8 inches (630 mm)</td>
<td>-4 to +12</td>
<td>-0.2 to +0.5&quot;</td>
</tr>
<tr>
<td>Over 24.8 through 49.2 inches (630 through 1250 mm)</td>
<td>-6 to +20</td>
<td>-0.2 to +0.8&quot;</td>
</tr>
<tr>
<td>Over 49.2 through 98.4 inches (1250 through 2500 mm)</td>
<td>-6 to +25</td>
<td>-0.2 to +1.0&quot;</td>
</tr>
<tr>
<td>Over 98.4 through 315.0 inches (2500 through 8000 mm)</td>
<td>-0.5% to +1.5%</td>
<td>-0.5% to +1.5%</td>
</tr>
<tr>
<td>Over 315 inches (8000 mm)</td>
<td>-1.0% to +3.0%</td>
<td>-0.5 % to +3.0%</td>
</tr>
</tbody>
</table>

Certain routing applications call for accurate hose assembly lengths, especially for short assemblies. When couplings are crimped, a growth length must be factored into the overall length. While SAE provides a tolerance range, growth length can vary from different hose constructions and coupling types. The following steps will determine growth length and provide an accurate overall length for a hydraulic assembly.
Length Change Instructions
1. Determine the cut off length for both couplings.
2. Subtract the coupling cut off length from the overall length (OAL) = Cut Length
3. Prior to cutting the hose, measure and mark the cut length from one end of the hose.
4. Insert Coupling A onto hose. From the cut mark, measurement to the end of Coupling A.
5. Crimp Coupling A and measurement of the growth of the coupling.
6. Take the growth length \((x2)\) and subtract from the hose cut mark. This is the new cut mark.
7. Crimp coupling B on other end. Measure the OAL.

Example
OAL = 18"

Cut-off length for Coupling A = 1.5"
Cut-off length for Coupling B = 1.5"
Cut off length = 3"

Hose Cut length = 15"
OAL – coupling cut off length = cut length
18' – 3" = 15"

Prior to cutting hose, measure and mark 15" from the end of the hose.

Insert Coupling A and prior to crimping, measure the from the cut mark to end of coupling.
Note pre-crimp measurement, 16-1/2".

Crimp Coupling A, measure from cut mark to end of crimped coupling, 16 -5/8"

The Growth Length is the difference between the crimped and pre-crimp coupling measurement.
Crimped Coupling A measurement = 16 -5/8"
Pre Crimp Coupling A measurement = 16 -1/2"
Growth Length for Coupling A = 1/8"
Growth length for Coupling A & B = ¼"
Subtract ¼” from the cut mark and cut hose.

Insert Coupling B and measure from end of Coupling A.

Crimp Coupling B on other end. Measure the OAL.
Measuring Hose to determine hose cut-off length: With some assemblies, the length must be within tight tolerances for proper installation. This is especially true for short high pressure hose assemblies.

**Note:** Before cutting the hose, make sure you understand the difference between “cut hose length” and “assembly overall length” (OAL)

The hose cut length for a hose assembly is calculated by subtracting the cut-off factor (distance from the bottom of the ferrule or collar to the end of the fitting, dimension “C” below). Typical length tolerance: Up to and including 12": +/- .13 in (3.2 mm), over 12” and up to 18": +/- .19 in (4.8 mm), over 18” and up to 36”: +/- .25 in (6.4 mm), over 36”: +/- 1% of length.

Unless otherwise specified by the customer, the assembly’s overall length is measured from the extreme end of one fitting to the extreme end of the other; except for the O-ring face seal fittings which shall be measured from the sealing face. Where elbow fittings are used, the measurement shall be to the centerline of the sealing surface of the elbow end. For examples please see the illustrations below.
For male thread fittings (Fig. a), the cut-off is measured from the locking collar to the end of the threads (C) as shown.

For straight female fittings (Fig. b & c), the cut-off is measured from the locking collar to either the end of the nut or seat depending on whether the nut can be pulled back exposing the seating surface as shown.

All cut-off values are identified in the fitting tables found in the manufacturer's catalog.

F5.2 Cutting

Wire reinforced hydraulic hose should be cut with either a circular steel cutting wheel or a circular abrasive cutoff wheel. The preferred choice would be the steel wheel with a cooling agent. Overheating the hose, as it is cut, can cause deformation of the hose creating difficulty when assembling the hose fittings. For textile-reinforced hose, a guillotine style cutter may be used. Regardless of the cutting method used, the cut should always be perpendicular to the axis of the hose. Angled cuts will increase the likelihood that the hose end cannot be fully inserted into the hose.

Caution: When cutting hose always wear safety glasses and avoid loose fitting clothing. Hearing protection is also strongly recommended.

F5.3 Cleanliness

Contaminated oil will reduce the service life of hydraulic systems. Therefore, hose cleanliness is an important part of the fabrication of a hydraulic hose assembly. If contamination is left in the hose after cutting, it is very likely that these particles will work their way into the hydraulic system. Always clean the hose after cutting.

If a guillotine cutter was used with textile hose, it is unlikely that any particles were generated from the cutting process. However, it is possible that contaminants still exist. If a circular saw with an abrasive cutoff wheel is used, a significant amount of rubber and steel is forced into the end of the hose. At a minimum, run a brush into at least the first 6” (152.4 mm) of both ends of the hose, and blow out with shop air. Hose cut on an air or water cooled cutter may only require blowing out after cutting. It is important to clear away any debris, which could become trapped between the nipple and inner tube. This could cause damage to the inner tube.

Improved methods are available to clean the hose. They include the use of cleaning projectiles and flushing of the assembly. Some customers may require additional cleaning after assembly of the hose ends. Check customer requirements to ensure that all assembly cleanliness requirements are met.
F5.4 Skiving or Buffing (As required)

Some component manufacturers design the fitting in a manner that skiving or buffing is required. Typical equipment used to skive or buff hoses are abrasive wheels and knife-type cutting equipment, which cut or peel the cover (or inner tube) from the hose. Some of these processes require a mandrel to support the hose. This helps maintain a uniform skived/buffed length around the circumference of the hose and help prevent damage during the operation.

Skiving

Skiving is the process of removing the portion of hose cover that lies directly under the coupling collar or ferrule. This allows the metal fitting shell to be coupled directly onto the hose reinforcement. Some fitting designs also may require a section of the tube to be removed before coupling.

Use caution not to damage, burn, or disturb the hose reinforcement. Burned wire will appear blue. Disturbed reinforcement is defined as fibers/wire, which are no longer in their manufactured spiral or braided pattern. Review the hose and coupling manufacturer’s recommendations (internal external skive lengths, etc…) prior to performing this operation. Skive lengths which are too short can prevent the hose end from functioning properly while ones that are too long can leave reinforcement exposed to environmental damage.

Always blow or vacuum off the rubber particles created from this process.

Buffing

Buffing is also a process of removing rubber cover from the hose. Unlike skiving, the rubber would not be removed to the reinforcement, but to a specified diameter. This process could apply to either wire or textile reinforced hose. Typically, buffing should not expose the hose reinforcement. Review the hose and coupling manufacturer’s recommendations for both buffing length and diameter prior to the operation.

Always blow or vacuum off the rubber particles created from this process.

Caution

Use caution during the skiving and buffing process when using a centralized collection unit because heat buildup in rubber dust can cause combustion.
Section F6 – Fabrication Process

F6.1 Coupling Assembly (First End)

Insertion Depth

To determine the insertion depth of a hose coupling, first measure the distance from the bottom of the fitting to the end of the ferrule where the hose is to be inserted. Mark a line on the hose cover at the distance from the end of the hose that equals the insertion depth. This becomes a visual check to determine if the hose was fully bottomed in the fitting. Most hose and fitting suppliers provide information, which allows the calculation of correct insertion depth. See figure below.

Lubrication (As Needed)

It is sometimes difficult to insert a fitting into hydraulic hose. When this occurs, it is recommended that SAE 10 W oil or another compatible lubricant be used to lubricate the hose. Insure that the lubricant is compatible with both the hose and all other hydraulic system components.

Never dip the end of the hose into a container of oil or use a squirt can. Instead, put a thick sponge or other soft material in the bottom of a small tray (anything large enough to handle all sizes of hose in the work area). Before inserting the coupling into the hose, push approximately 1/2” (13 mm) of the end of the hose into the sponge in the tray of lubricant.

Verification of Full Fitting Insertion

Measuring and marking is the appropriate way of verifying the full insertion of the fitting; simply “feeling” it has been completely inserted is not sufficient. After lubricating the hose, grip firmly and push into the fitting. Fittings with an elbow configuration should point toward the curvature of the hose, unless otherwise specified. If the insertion mark was applied correctly, you should now be able to determine if the coupling has been completely inserted. The depth mark should be aligned with the end of the ferrule.
F6.2 Crimping/Swaging (First end)

Special Tools Required:
Crimping equipment and appropriate dies

Fabrication Procedures:

1. Per Section 3 Fabrication Preparation Procedures, determine the required cut length of the hose. Cut the hose square, and ensure hose is clean of any residue, oil, dirt, etc. from cutting or storage.
2. If applicable, pull out grounding wire sufficiently to bend wire inside of hose, extending wire at least 1/2" (12.7 mm).
3. Measure the outer diameter of the hose with an O.D. tape; alternatively, determine the average wall thickness (times two) plus nominal I.D.
4. Based on the hose outer diameter, select the proper ferrule, see manufacturer for recommendations. CAUTION: some hydraulic crimp ferrules have very aggressive serrations which can damage fabric reinforcement.
5. Slide the ferrule over the end of the hose; note: ignore this if using a one piece fitting.
6. Lubrication should only be used if necessary. If a lubricant must be used to aid full insertion, it is suggested to use water or a slightly soapy water solution. Be sure whatever is used is compatible with the assembly components and application.
7. Insert the stem into the hose squarely without causing damage to the tube. Mark a line on the hose cover using a marking pen at the distance from the end of the hose that equals the length of the ferrule. This becomes a visual check to determine if the hose is fully bottomed into the fitting.
8. Select the desired crimp OD using manufacturer’s recommendations.
9. Based on #8, select the proper die set using the crimp machine manufacturer’s recommendations.
10. Place the hose assembly in the die opening.
11. Jog the crimp dies to the closed position until they just contact the ferrule. Be sure the ferrule and crimp dies are lined up properly to achieve the desired crimp length.
12. Crimp to the desired diameter.
13. Retract the dies and remove the hose assembly.
14. Measure the crimp diameter across the flats to ensure it meets manufacturer’s specifications.
15. Repeat steps 1 through 15 for the other end.
16. Check for electrical continuity if required.

*To properly measure the crimp diameter:

1. Measure the diameter in the middle of cramped portion of the hose end.
2. Place the caliper in a position to allow a measurement across the pressed (flat) portion of the crimp.
3. Measure halfway between ridges. When using a dial caliper be sure the caliper fingers do not touch the ridges.
4. When measuring small crimp diameters a jaw type micrometer is recommended or a caliper with special pointed tips.
5. Use reference dimension charts provided by the fitting and hose manufacturer.
6. Check the crimp machine periodically for ovality and taper.
Crimp Machines

In order to optimize the crimp performance of the crimp machine, it is important to inspect the crimper periodically for wear and tear. Preventative maintenance is important for all types of machinery. Most crimper designs are designed with components that require interval inspection and changing of wear parts. It is important to contact the crimp machine manufacturer or reference the crimper owner’s manual for further details.

The crimp dies that come into contact with the fittings to be crimped should also be maintained and inspected for wear such as chipping and/or cracks. It is important to keep crimp dies clean and free of debris before and after the crimping process.

A crimp machine that requires hydraulic oil should be inspected at an interval recommended by the manufacturer. Hydraulic oil not changed over a period of time may cause damage to the internal parts of a crimper. Some crimping models may also have an oil filter that will require changing over a recommended interval.

When adding new hydraulic oil, the oil should be filtered through a 20 micron filter or finer to remove excess impurities and minimize build-up of debris in the hydraulic system.

Testing:

Hydrostatic and conductivity testing if required.

Verification of Set Up (Tooling)

The first step in verifying the tooling set up is to review the manufacturers’ recommendations. Read the tooling and/or machine setting specifications and follow the instructions. If instructions are not available, consult your supervisor or contact the manufacturers of the hose, coupling and crimping equipment.

Note: Some crimping/swaging equipment may be generic, but with tooling packages supplied or manufactured by the coupling supplier. In these instances, contact the coupling manufacturer for crimping recommendations.

Verify Crimp Dimensions (First piece only)

Insert the hose and fitting into the crimp machine, and perform the crimping/swaging operation as specified. Remove the crimped/swaged assembly and with the appropriate gauging tools, check the first part for correct crimp/swage diameter and location. If the crimp diameter and location are correct, proceed to the next steps in assembly. It is recommended that a log of these crimp/swage measurements be kept for future reference. This will help with future fabrications and monitor tooling wear.

If there is an error, verify tooling and set up. Make the needed adjustments and proceed. Any crimped/swaged part that cannot be brought within specification must be discarded. Both over-crimping/swaging and under-crimping/swaging can cause an assembly to fail. Crimp/swage diameter and location should be verified each time tooling is changed. This will ensure that the correct tooling and/or machine setting are used.
F6.3 Accessories

External

Some applications require the addition of protective outer sleeving or strain reliefs. If this is a requirement, the most appropriate time to assemble is before the second end fitting is applied. Choose the appropriate product for the specific application. When cutting to length, allow for flexing and bending of the hose.

O-Rings

It is recommended that new o-rings be used when a hose assembly is replaced. This helps prevent additional equipment downtime from occurring from reusing o-rings.

F6.4 Crimping/Swaging (Second end)

At this point, the second end should be ready for assembly and crimping/swaging. Follow instructions above. If the second end fitting is also a bent tube configuration, orientate the fitting before the crimping/swaging operation. After the first part has been examined, and approved, proceed with the balance of the order.
F6.5 Hose Assembly Orientation for Offset Elbow Fittings

Figure 6.1 Offset Angles
How to Measure

As shown in Figure 6.2, with the centerline of the near end as a base reference, angular displacement is measured counterclockwise to the centerline of the far end.

**Figure 6.2 – Near End Reference – Measured Counter-Clockwise**

As shown in Figure 6.3, with the centerline of the far end as a base reference, angular displacement is measured clockwise to the centerline of the near end.

**Figure 6.3 – Far End Reference – Measured Clockwise**

Displacement angle may have any value up to 360 degrees. Please note that making the angle determination in the wrong direction will result in an unacceptable part.

Unless otherwise specified, a tolerance of ±3 degrees is acceptable for assembly lengths up to 610 mm inclusive, and ±5 degrees for assembly lengths over 610 mm.
Section F7 – Finished Assembly Dimensions

Overall Assembly Length

When establishing proper hose length, motion absorption, hose length changes due to pressure, as well as hose and machine tolerances must be considered. Typical length tolerances for assemblies are shown in the table below.

<table>
<thead>
<tr>
<th>Assembly Length</th>
<th>Tolerances (decimal in)</th>
<th>Tolerances (fraction in)</th>
<th>Tolerances (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up through 12 inches (304.8 mm)</td>
<td>0.13</td>
<td>1/8</td>
<td>3.2</td>
</tr>
<tr>
<td>Over 12 through 18 inches (304.8 through 457.2 mm)</td>
<td>0.19</td>
<td>3/16</td>
<td>4.8</td>
</tr>
<tr>
<td>Over 18 through 36 inches (457.2 through 914.4 mm)</td>
<td>0.25</td>
<td>1/4</td>
<td>6.4</td>
</tr>
<tr>
<td>Over 36 inches (914.4 mm)</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Unless otherwise specified by the customer, the assembly’s overall length is measured from the extreme end of one fitting to the extreme end of the other; except for the O-ring face seal fittings which shall be measured from the sealing face. Where elbow fittings are used, the measurement shall be to the centerline of the sealing surface of the elbow end. For examples please see the illustrations below.
Section F8 – Cleanliness

Modern Hydraulics is defined as the use of confined liquid to transmit power, multiply force or produce motion. Clean hydraulic fluid is an integral part of a hydraulic system and contaminated fluid will reduce the service life of hydraulic systems. Therefore hose cleanliness is an important part of the fabrication of a hydraulic hose assembly.

There are 3 methods of specifying cleanliness.

1. Gravimetric analysis (reference ISO 4405)
   ISO 4407 specifies a method to determine fluid contamination by filtering a volume of fluid under vacuum through 1 or 2 filter membranes.

2. Particle counting (reference ISO 4406)
   ISO 4406 specifies a code of 3 scale numbers to measure the particle level in a fluid sample. The scale numbers are as follows:
   - The first scale number represents the number of particles equal or larger to 4 microns per milliliter of fluid.
   - The second scale number represents the number of particles equal or larger to 6 microns per milliliter of fluid.
   - The third scale number represents the number of particles equal or larger to 14 microns per milliliter of fluid.

   The scale code is represented, for example, as 18/16/12. The lower the scale code number, the cleaner the fluid.

3. Maximum particle size (reference ISO 4407)
   ISO 4407 specifies methods to determine contamination levels in a hydraulic system by counting the particles trapped on a membrane filter using an optical microscope. Particles to 2 microns can be counted using this method.

The primary source of contamination in a hose assembly is a result of cutting the hose with both metal and abrasive blades. Therefore it is recommended that the hose be cleaned immediately after cutting and again after the assembly because the secondary source of contamination is the fittings. This insures that all the contamination generated during shop assembly has been removed.

Reason for Cleaning:

The cleaning process ensures that contamination generated during the assembly process has been removed. The primary source of contamination in a hydraulic hose assembly is the result of the cutting process with either a metal blade or abrasive wheel. Therefore it is recommended that the hose be cleaned immediately after the cutting process and always before stem insertion.

The 3 main reasons for cleaning the hose after the cutting process are as follows. 1. Heat from the cutting process causes both rubber and metal particles to become very hot. As the particles cool they may stick or adhere to the tube thus becoming much more difficult to remove. 2. If contaminants are trapped between the O.D. of the stem and the I.D. of the tube they could act as an eventual leak path for hydraulic fluid when the system is under pressure. 3. Stem insertion is much more difficult when trying to push stems over or past the internal contamination. A clean tube is usually smooth and slippery in nature which means stem lubrication may not be necessary.

Stem insertion should be done as cleanly as possible. If lubricants are necessary they should be kept clean and never stored in an open container such as a coffee can. Atmospheric contamination in the shop air will enter the open container and contaminate the lubricant. Never dunk the stem or hose into a
lubricant as this will add contamination back into the cleaned piece of hose. Apply clean lubricants sparingly to the O.D. of the stem only.

During the crimping or swaging process stem deformation occurs to insure the proper coupling retention. The crimping or swaging process may cause metal and plating flash to occur inside the stem. The hose assembly should go through a final cleaning process.

Immediately cap or plug each end of the hose to keep airborne contaminants from entering the clean hose assembly. Caps and plugs will protect the fitting threads and keep the assembly contamination free.

Other sources of contamination include dust, moisture and airborne particles that can enter a completed hose assembly. Customer requirements and the specific application will dictate the required cleanliness level.

**Cleaning Methods:**

**Projectiles:**
The projectile cleaning method requires clean, dry compressed air or an inert gas source such as nitrogen as the propellant. A pneumatic launcher is then used for propelling the projectile through the hose or hose assembly. A virgin polyurethane foam projectile wipes the tube wall clean and pushes contamination out of the assembly.

**Fluid Flushing:**
Clean fluids that are compatible with the hose and tube stock can be flushed through the assembly to remove contamination. A flushing system that provides a high turbulent flow is desirable to make sure that the contamination is removed from the tube wall. The fluid flushing system should have filtration to ensure that the flushing fluids are clean. After flushing the hose assembly will then need to have the flushing fluid removed and the tube should be dry.

**Air Blow:**
Clean dry air can be used to blow loose particles of contamination from the hose or hose assembly. Long lengths of hose or hoses with inside diameters of more than a ½” may present a problem when using air only as the cleaning method.

The customer’s cleanliness requirement and the specific application will dictate the required level of cleanliness and cleaning method. The only sure way to know if you are meeting a specific ISO, NAS or SAE cleanliness code is testing.
Section F9 – Assembly Testing and Inspection

F9.1 Testing

When specified by a customer, coupled hose assembly lots should be sampled and tested utilizing an acceptable burst and proof pressure procedure. It is recommended that proof and burst testing be performed in accordance with SAE J517 and SAE J343, as shown below, or an applicable industry standard or customer specification.

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

**Hydrostatic Proof Pressure Test** - This proof test is conducted at twice the working pressure of the hose unless otherwise specified by the customer. The test pressure shall be maintained for a period of not less than 30 seconds or more than 60 seconds. There shall be no indication of failure or leakage. Water is the test medium.

*The following testing procedure is recommended:*

1. Lay the hose out straight whenever practical, slightly elevating one end to ensure trapped air is expelled, allowing space for elongation under pressure, preferably on supports to allow free movement under pressure; take particular care to ensure that all trapped air is released from the hose.
2. For reference, mark a line behind the coupling which is at the end of the ferrule, clamp, band, etc.
3. Then gradually raise the pressure to the desired pressure rating. Hold the pressure for the time dictated by hose type and conduct a visual inspection. As the pressure is raised, watch for visual indications of permanent deformation, leakage, and coupling slippage. If any of these are noted it is cause for rejection. After the test is complete, relieve the test pressure before disconnecting the hose assembly from the test equipment and drain the water from the hose. The hose may be flushed with alcohol if all of the water must be removed.
4. When tested in accordance with the above, the assembly under test should be totally leak free for the duration of the test; leakage is defined as a continuous stream of water droplets emitted from a single or multiple locations.

**Burst Test** - Hose assemblies on which the end fittings have been attached less than 30 days shall be subjected to a hydrostatic pressure increased at a constant rate so as to attain the specified minimum burst pressure within a period of not less than 15 seconds nor more than 30 seconds. There shall be no leakage, hose burst, or indication of failure below the specified minimum burst pressure.

WARNING: Water or another liquid suitable for the hose under test shall be used as the test medium. The use of air or other gaseous materials as testing media should be avoided because of the risk to operators. In special cases where such media are required for the tests, strict safety measures are imperative. Furthermore, it is stressed that when a liquid is used as the test medium, it is essential that all air is expelled from the test piece because of the risk of injury to the operator due to the sudden expansion of trapped air released when the hose bursts.

The hose assemblies to be bench tested must be inspected to ensure conformance to applicable test specifications. It is important to realize that, with the exception of proof test and change in length, all hose assemblies under pressure testing are to be destroyed after the test.

Specific test and performance criteria for evaluating hose assemblies used in hydraulic service are in accordance with requirements for hose in the respective specifications of SAE J517. It is
recommended that every facility making hydraulic hose assemblies have a copy of the SAE HS-150 standards manual. Current issue is on disk and available from SAE Headquarters.

Test methods for threaded hydraulic fluid power connectors shall conform to SAE standard J1644. This is equivalent to ISO 8434-5 with the exception that the SAE standard includes “repeated assembly test” for male flare shaped fittings assembled to tube flare.

The same cautions apply to tube testing as with hose assemblies. Bursts and fine jets can penetrate the skin. Sudden energy release can be very hazardous.

Although proof and burst testing are the most common forms of physical testing, other forms of testing may be required by the end user. This will vary with the application of the assembly.

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!

**Electrical Continuity**

Certain applications may call for Non-Conductive Hydraulic hoses. When conductivity is required in thermoplastic hydraulic hose, different test methods are used, see SAE J343 sections 4.11 & 4.12. These tests are validation tests done in the lab and not normally performed when coupling hose.

**F9.2 Documentation**

If required by the customer, a test certificate may be issued to provide written confirmation that the assembly has been tested, and conforms to certain performance and dimensional criteria. Test results should be maintained and kept on file for five years. Each test certificate should bear a unique number for traceability.

Test certificates may include, but are not limited to the following information:

A. Test Certificate Number
B. Customers Name and Purchase Order Number
C. Suppliers Name and Job Number
D. Hose Serial and/or Batch Number(s)
E. Hose details including length, type of hose and diameter
F. End fitting details with types of ferrules and seals used
G. Test Date
H. Test Pressure Certification
I. Electrical Continuity Conformance
J. Suppliers Authorization Signature
K. Certified Material Test Report
L. Certificate of Conformance

Other types of documentation may be requested by the customer. All certificates and reports required should accompany the shipment, unless otherwise specified.

**F9.3 Final Assembly Inspection**

All sample assemblies should be visually inspected for substandard quality conditions in the hose or
couplings. Visual inspection checkpoints should include but are not limited to the following:

a) Hose Identification – Size and type must correspond to the fabrication order (work order)

b) Coupling Identification - Coupling size, type, and product number must correspond to information on the fabrication order (work order) and specifications. Identified with date code, part number, etc. when required.

c) Inspection Items:
   - Bulge behind the coupling
   - Cocked couplings
   - Cracked couplings
   - Exposed reinforcement
   - Freedom of swivels
   - General appearance of the assembly
   - Internal contaminants
   - Protective caps or plugs
   - Restriction in the tube
   - Rusted couplings

**Dimensional Inspection**

1. **Length** - Measure the length of a coupled assembly laid out on a flat surface. Unless otherwise shown on the fabrication order (work order), hose assembly length includes the couplings. Length tolerances on coupled assemblies.

2. **Crimped Outside Diameter** – With a micrometer or caliper, measure the diameter of the crimped ferrule, in the center between two opposite die faces.

3. **Coupling Orientation** - Coupling orientation should be as specified on customer blueprints or fabrication order (work order). (See Section 6 - Coupling Orientation.)
Section F10 – Identification, Storage, & Packaging

F10.1 Identification (Labeling and Tagging)

Some customers require specific markings be applied to the hose assemblies for identification purposes. Labeling and tagging requirements should be communicated by the end user. These may include but are not limited to:

- Fabrication Date
- Part number(s)
- Assembly description
- Testing information
- Etc…

F10.2 Storage

Proper storage will maximize hose shelf life. SAE J517 recommends that rubber hose may be acceptable for use up to and including 40 quarters from the date of manufacture provided that it is stored properly. When stored properly, thermoplastic and PTFE shelf life is considered to be unlimited.

A. Store components in a cool, dry area. If stored below freezing, pre-warming may be required prior to handling, testing and placing into service.

B. Store components in original date-coded containers.

C. Care should be taken when stacking hose, as its weight can crush hose at the bottom of the stack. The stack could also become unstable, creating a safety hazard.

D. Avoid exposure to direct sunlight, rain, heaters or proximity to electrical equipment

Note: On thermoplastic hose and specifically non-conductive thermoplastic hose it is recommended to keep the hose capped at all times during storage to prevent any moisture from getting into the hose, as this could have an effect on non-conductivity.

F10.3 Packaging

Unless otherwise specified by the customer, packaging should afford adequate protection of both hose and end fittings during shipping. Packaging requirements will vary from handing a completed hose to a customer, to capping, bagging and bar coding. Individual customers will each have different requirements. What they all have in common is adequate protection until usage. Check with your customer for specific details.

Hose assemblies shall be packaged in such a manner to insure that external abuse during shipping and handling does not damage the hose or fittings.

Hose shall be packed in a clean and dry state.

Containers, boxes, banding and pallets shall be of sufficient size and strength to withstand handling and transit without failure.

When packaged, hose assemblies should not be coiled tighter than the specified minimum bend radius. Check customer information for any specific labeling or packaging requirements.
Packaging Options (check with the manufacturer for recommendations)

Coiled
- Protective wrap; palletized
- in crates
- on reels
- poly-bagged in bales

Straight
- Slat packing
- Plastic tubes
- Metal rack (dedicated truck)
- Poly-bagged
- Skids

Packaging and Handling Considerations for Large Diameter Hose and Assemblies

Handling in transit and during installation needs to be considered in order to reduce or eliminate potential damage. Care should be taken not to kink the hose, damage the hose cover, or stress it in ways it wasn't designed to handle. (Any questions should be referred to the manufacturer.) Some considerations include:

- Do not drag the hose over docks or decks, or sharp, abrasive surfaces
- Never lift long length or large bore hose from the middle of its length with the ends hanging down
- Support the hose with wide slings or saddles to limit the curvature of the hose. In order to increase the service life of the hose, NAHAD recommends that proper support be given to the hose during lifting; the use of chains, rope or cable should be avoided.
- Do not kink hose or run over it with equipment

For additional information, see the ARPM manuals for hose maintenance, testing, and inspection.
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
Section F12 – Thermoplastic Considerations

TBD
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, adapter**: 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 E162/E662: refers to the spread of the flame/smoke if the product ignites


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.

![Diagram of Bend Radii](image)

**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.
breaeker 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.

**coefficient of flow:** When calculating the measure of the loss of air flow through a duct due to length, bends or any restriction, the coefficient 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 a 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 indenter 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 necessary 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.

**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 Fitting** - 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 Fitting** - 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 Fitting** - 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 Fitting** - 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

- **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 +100°F (+37.8°C) 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 sleevng: 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 (inH2O): 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.


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”)
**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, polymeric materials and their extracts as described in the US Pharmacopoeia 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 as 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.
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.
TPE: 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 referred 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: 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 hose's 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.
37° Flare (JIC)

The Society of Automotive Engineers (SAE) specifies a 37° angle flare or seat be used with high pressure hydraulic tubing. These are commonly called JIC couplings.

The JIC 37° flare male will mate with a JIC female only. The JIC male has straight threads and a 37° flare seat. The JIC female has straight threads and a 37° flare seat. The seal is made on the 37° flare seat.

Some sizes have the same threads as the SAE 45° flare. Carefully measure the seat angle to differentiate.

*Note: Some couplings may have dual machined seats (both 37° and 45° seats).

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1/8</td>
<td>5/16-24</td>
<td>17/64</td>
<td>5/16</td>
</tr>
<tr>
<td>-3</td>
<td>3/16</td>
<td>3/8-24</td>
<td>21/64</td>
<td>3/8</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>7/16-20</td>
<td>25/64</td>
<td>7/16</td>
</tr>
<tr>
<td>-5</td>
<td>5/16</td>
<td>1/2-20</td>
<td>29/64</td>
<td>1/2</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>9/16-18</td>
<td>1/2</td>
<td>9/16</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>3/4-16</td>
<td>11/16</td>
<td>3/4</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>7/8-14</td>
<td>13/16</td>
<td>7/8</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>1-1/16-12</td>
<td>31/32</td>
<td>1-1/16</td>
</tr>
<tr>
<td>-14</td>
<td>7/8</td>
<td>1-3/16-12</td>
<td>1-7/64</td>
<td>1-3/16</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-5/16-12</td>
<td>1-15/64</td>
<td>1-5/16</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>1-5/8-12</td>
<td>1-35/64</td>
<td>1-5/8</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>1-7/8-12</td>
<td>1-51/64</td>
<td>1-7/8</td>
</tr>
<tr>
<td>-32</td>
<td>2</td>
<td>2-1/2-12</td>
<td>2-27/64</td>
<td>2-1/2</td>
</tr>
</tbody>
</table>
SAE (45° Flare)

A term usually applied to fittings having a 45° angle flare or seat. Soft copper tubing is generally used in such applications as it is easily flared to the 45° angle. These are for low pressure applications such as for fuel lines and refrigerant lines.

The SAE 45° flare male will mate with an SAE 45° flare female only. The SAE male has straight threads and a 45° flare seat. The SAE female has straight threads and a 45° flare seat. The seal is made on the 45° flare seat.

Some sizes have the same threads as the SAE 37° flare. Carefully measure the seat angle to differentiate.

*Note: Some couplings may have dual machined seats (both 37° and 45° seats).

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1/8</td>
<td>5/16-24</td>
<td>17/64</td>
<td>5/16</td>
</tr>
<tr>
<td>-3</td>
<td>5/32</td>
<td>3/8-24</td>
<td>21/64</td>
<td>3/8</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>7/16-20</td>
<td>25/64</td>
<td>7/16</td>
</tr>
<tr>
<td>-5</td>
<td>5/16</td>
<td>1/2-20</td>
<td>29/64</td>
<td>1/2</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>5/8-18</td>
<td>9/16</td>
<td>5/8</td>
</tr>
<tr>
<td>-7</td>
<td>7/16</td>
<td>11/16-6</td>
<td>11/16</td>
<td>5/8</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>3/4-16</td>
<td>11/16</td>
<td>3/4</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>7/8-14</td>
<td>13/16</td>
<td>7/8</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>1-1/16-14</td>
<td>63/64</td>
<td>1-1/16</td>
</tr>
<tr>
<td>-14</td>
<td>7/8</td>
<td>1-1/4-12</td>
<td>1-11/64</td>
<td>1-1/4</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-3/8-12</td>
<td>1-19/64</td>
<td>1-3/8</td>
</tr>
</tbody>
</table>
"O" Ring Boss

The O-ring boss male will mate with an O-ring boss female only. The female is generally found on ports. The male has straight threads and an O-ring. The female has straight threads and a sealing face. The seal is made at the O-ring on the male and the sealing face on the female.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1/8</td>
<td>5/16-24</td>
<td>17/64</td>
<td>5/16</td>
</tr>
<tr>
<td>-3</td>
<td>3/16</td>
<td>3/8-24</td>
<td>21/64</td>
<td>3/8</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>7/16-20</td>
<td>25/64</td>
<td>7/16</td>
</tr>
<tr>
<td>-5</td>
<td>5/16</td>
<td>1/2-20</td>
<td>29/64</td>
<td>1/2</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>9/16-18</td>
<td>1/2</td>
<td>9/16</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>3/4-16</td>
<td>11/16</td>
<td>3/4</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>7/8-14</td>
<td>13/16</td>
<td>7/8</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>1-1/16-12</td>
<td>31/32</td>
<td>1-1/16</td>
</tr>
<tr>
<td>-14</td>
<td>7/8</td>
<td>1-3/16-12</td>
<td>1-7/64</td>
<td>1-3/16</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-5/16-12</td>
<td>1-15/64</td>
<td>1-5/16</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>1-5/8-12</td>
<td>1-35/64</td>
<td>1-5/8</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>1-7/8-12</td>
<td>1-51/64</td>
<td>1-7/8</td>
</tr>
<tr>
<td>-32</td>
<td>2</td>
<td>2-1/2-12</td>
<td>2-27/64</td>
<td>2-1/2</td>
</tr>
</tbody>
</table>
"O" Ring Flange -- SAE J518

The SAE Code 61 and Code 62 4-Bolt Split Flange is used worldwide, usually as a connection on pumps and motors. There are three exceptions.

1. The -10 size, which is common outside of North America, is not an SAE Standard size.

2. Caterpillar flanges, which are the same flange O.D. as SAE Code 62, have a thicker flange head ("C" dimension in Table).

3. Poclain flanges, which are completely different from SAE flanges.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-8</td>
<td>1/2</td>
<td>1.188</td>
<td>.688</td>
<td>1.500</td>
<td>.265</td>
<td>1.250</td>
<td>.718</td>
<td>1.594</td>
<td>.305</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>1.345</td>
<td>.265</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>1.500</td>
<td>.875</td>
<td>1.875</td>
<td>.265</td>
<td>1.625</td>
<td>.937</td>
<td>2.000</td>
<td>.345</td>
<td>1.625</td>
<td>.938</td>
<td>2.000</td>
<td>.560</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1.750</td>
<td>1.031</td>
<td>2.062</td>
<td>.315</td>
<td>1.875</td>
<td>1.093</td>
<td>2.250</td>
<td>.375</td>
<td>1.875</td>
<td>1.094</td>
<td>2.250</td>
<td>.560</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>2.000</td>
<td>1.188</td>
<td>2.312</td>
<td>.315</td>
<td>2.125</td>
<td>1.250</td>
<td>2.625</td>
<td>.405</td>
<td>2.125</td>
<td>1.250</td>
<td>2.625</td>
<td>.560</td>
</tr>
<tr>
<td>-40</td>
<td>2-1/2</td>
<td>3.312</td>
<td>2.000</td>
<td>3.500</td>
<td>.375</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-48</td>
<td>3</td>
<td>4.000</td>
<td>2.438</td>
<td>4.188</td>
<td>.375</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-56</td>
<td>3-1/2</td>
<td>4.500</td>
<td>2.750</td>
<td>4.750</td>
<td>.422</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-64</td>
<td>4</td>
<td>5.000</td>
<td>3.062</td>
<td>5.125</td>
<td>.442</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-80</td>
<td>5</td>
<td>6.000</td>
<td>3.625</td>
<td>6.000</td>
<td>.442</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
"O" Ring Face Seal SAE J1453

A seal is made when the O-ring in the male contacts the flat face on the female. Couplings are intended for hydraulic systems where elastomeric seals are acceptable to overcome leakage and leak resistance is crucial. The solid male O-ring face seal fitting will mate with a swivel female O-ring face seal fitting only. An O-ring rests in the O-ring groove in the male.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>1/4</td>
<td>9/16-18</td>
<td>1/2</td>
<td>9/16</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>11/16-16</td>
<td>5/8</td>
<td>11/16</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>13/16-16</td>
<td>3/4</td>
<td>13/16</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>1-14</td>
<td>15/16</td>
<td>1</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>1-3/16-12</td>
<td>1-1/8</td>
<td>1-3/16</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-7/16-12</td>
<td>1-11/32</td>
<td>1-7/16</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>1-11/16-12</td>
<td>1-19/32</td>
<td>1-11/16</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>2-12</td>
<td>1-29/32</td>
<td>2</td>
</tr>
</tbody>
</table>
Pipe Threads

NPTF -- This is a dryseal thread; the National pipe tapered thread for fuels. This is used for both male and female ends. The NPTF male will mate with the NPTF, NPSF, or NPSM female. The NPTF male has tapered threads and a 30° inverted seat. The NPTF female has tapered threads and no seat. The seal takes place by deformation of the threads. The NPSM female has straight threads and a 30° inverted seat. The seal takes place on the 30° seat. The NPTF connector is similar to, but not interchangeable with, the BSPT connector. The thread pitch is different in most sizes. Also, the thread angle is 60° instead of the 55° angle found on BSPT threads.

NPSF – The National pipe straight thread for fuels. This is sometimes used for female ends and properly mates with the NPTF male end. However, the SAE recommends the NPTF thread in preference to the NPSF for female ends.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1/8</td>
<td>27</td>
<td>23/64</td>
<td>13/32</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>18</td>
<td>15/32</td>
<td>35/64</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>18</td>
<td>19/32</td>
<td>43/64</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>14</td>
<td>3/4</td>
<td>27/32</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>14</td>
<td>61/64</td>
<td>1-1/16</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>11-1/2</td>
<td>1-13/64</td>
<td>1-5/16</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>11-1/2</td>
<td>1-17/32</td>
<td>1-43/64</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>11-1/2</td>
<td>1-25/32</td>
<td>1-29/32</td>
</tr>
<tr>
<td>-32</td>
<td>2</td>
<td>11-1/2</td>
<td>2-1/4</td>
<td>2-3/8</td>
</tr>
</tbody>
</table>
DIN 7631 (DIN 60° Cone)

This series combines an internal 60° seat with parallel metric threads. This connection provides a metal-to-metal seal when tightened. This style can be identified by the internal, 60° seat on the male, metric threaded portion.

<table>
<thead>
<tr>
<th>Metric Thread Size</th>
<th>Female Thread I.D. (mm)</th>
<th>Male Thread O.D. (mm)</th>
<th>Pipe/Tube O.D. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12 x 1.5</td>
<td>10.5</td>
<td>12.0</td>
<td>6</td>
</tr>
<tr>
<td>M14 x 1.5</td>
<td>12.5</td>
<td>14.0</td>
<td>8</td>
</tr>
<tr>
<td>M16 x 1.5</td>
<td>14.5</td>
<td>16.0</td>
<td>10</td>
</tr>
<tr>
<td>M18 x 1.5</td>
<td>16.5</td>
<td>18.0</td>
<td>12</td>
</tr>
<tr>
<td>M22 x 1.5</td>
<td>20.5</td>
<td>22.0</td>
<td>15</td>
</tr>
<tr>
<td>M26 x 1.5</td>
<td>24.5</td>
<td>26.0</td>
<td>18</td>
</tr>
<tr>
<td>M30 x 1.5</td>
<td>28.5</td>
<td>30.0</td>
<td>22</td>
</tr>
<tr>
<td>M38 x 1.5</td>
<td>36.5</td>
<td>38.0</td>
<td>28</td>
</tr>
<tr>
<td>M45 x 1.5</td>
<td>43.5</td>
<td>45.0</td>
<td>35</td>
</tr>
<tr>
<td>M52 x 1.5</td>
<td>50.5</td>
<td>52.0</td>
<td>42</td>
</tr>
</tbody>
</table>

DIN 3902 (DIN 24° Cone Light and Heavy Duty)
This connection style consists of a common male and two female options. The male has a straight metric thread, a 24° included angle, and a recessed counterbore that matches the tube OD used with it. In the first female design, a metal-to-metal seal is accomplished as the female nose and male taper are forced against one another. The other option uses an o-ring on the female tapered nose. This creates an o-ring seal as the connection is tightened. Both a heavy and light-duty series are offered. The series can be determined by measuring the male seat counterbore, which is the approximate female tube outside diameter, and comparing it to the thread size.

<table>
<thead>
<tr>
<th>Metric Thread Size</th>
<th>Female Thread I.D. (mm)</th>
<th>Male Thread O.D. (mm)</th>
<th>Light Duty Pipe/Tube O.D. (mm)</th>
<th>Heavy Duty Pipe/Tube O.D. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12 x 1.5</td>
<td>10.5</td>
<td>12.0</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>M14 x 1.5</td>
<td>12.5</td>
<td>14.0</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>M16 x 1.5</td>
<td>14.5</td>
<td>16.0</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>M18 x 1.5</td>
<td>16.5</td>
<td>18.0</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>M20 x 1.5</td>
<td>18.5</td>
<td>20.0</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>M22 x 1.5</td>
<td>20.5</td>
<td>22.0</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>M24 x 1.5</td>
<td>22.5</td>
<td>24.0</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>M26 x 1.5</td>
<td>24.5</td>
<td>26.0</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>M30 x 2.0</td>
<td>28.0</td>
<td>30.0</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>M36 x 2.0</td>
<td>34.0</td>
<td>36.0</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>M42 x 2.0</td>
<td>40.0</td>
<td>42.0</td>
<td>-</td>
<td>30</td>
</tr>
<tr>
<td>M45 x 2.0</td>
<td>43.0</td>
<td>45.0</td>
<td>35</td>
<td>-</td>
</tr>
<tr>
<td>M52 x 2.0</td>
<td>50.0</td>
<td>52.0</td>
<td>42</td>
<td>38</td>
</tr>
</tbody>
</table>
British Standard Pipe Parallel (BSPP)

The BSPP male has straight threads and a 30° seat. The female has straight threads and a 30° nose. An o-ring design is also available on the nose from some manufacturers. Sealing can either be metal-to-metal or via an o-ring depending on the design. If the female design is used as a port connection, then an o-ring must be utilized on the male similar in design to the o-ring boss.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1/8</td>
<td>1/8-28</td>
<td>11/32</td>
<td>3/8</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>1/4-19</td>
<td>15/32</td>
<td>17/32</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>3/8-19</td>
<td>19/32</td>
<td>21/32</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>1/2-14</td>
<td>3/4</td>
<td>13/16</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>5/8-14</td>
<td>13/16</td>
<td>29/32</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>3/4-14</td>
<td>31/32</td>
<td>1-1/32</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-11</td>
<td>1-7/32</td>
<td>1-11/32</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>1-1/4-11</td>
<td>1-17/32</td>
<td>1-21/32</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>1-1/2-11</td>
<td>1-25/32</td>
<td>1-7/8</td>
</tr>
<tr>
<td>-32</td>
<td>2</td>
<td>2-11</td>
<td>2-7/32</td>
<td>2-11/32</td>
</tr>
</tbody>
</table>
British Flat-Face Seal

A seal is made when the o-ring in the male contacts the flat face on the female. Couplings are intended for hydraulic systems where elastomeric seals are acceptable to overcome leakage and leak resistance in crucial. Although similar in design to the o-ring face seal, they are not interchangeable.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-6</td>
<td>3/8</td>
<td>3/8-19</td>
<td>19/32</td>
<td>21/32</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>1/2-14</td>
<td>3/4</td>
<td>13/16</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>3/4-14</td>
<td>31/32</td>
<td>1-1/32</td>
</tr>
</tbody>
</table>

JIS 30° Inverted Seat (Parallel Pipe and Metric Threads)

The JIS inverted seat connection is available with two different thread styles. The parallel pipe thread design operates similarly to the BSPP connection. However, please consult your hose end supplier for interchangeability recommendations. The metric threaded design is identical to the parallel pipe design except for thread differences.
### Parallel Pipe Threads

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>1/4</td>
<td>1/4-19</td>
<td>15/32</td>
<td>17/32</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>3/8-19</td>
<td>19/32</td>
<td>21/32</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>1/2-14</td>
<td>3/4</td>
<td>13/16</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>3/4-14</td>
<td>31/32</td>
<td>1-1/32</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-11</td>
<td>1-7/32</td>
<td>1-11/32</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>1-1/4-11</td>
<td>1-17/32</td>
<td>1-21/32</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>1-1/2-11</td>
<td>1-25/32</td>
<td>1-7/8</td>
</tr>
<tr>
<td>-32</td>
<td>2</td>
<td>2-11</td>
<td>2-7/32</td>
<td>2-11/32</td>
</tr>
</tbody>
</table>

### Metric Threads

<table>
<thead>
<tr>
<th>Dash Size Equivalent</th>
<th>Nominal Size (mm)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (mm)</th>
<th>Male Thread O.D. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td>6</td>
<td>M14 x 1.5</td>
<td>12.5</td>
<td>14.0</td>
</tr>
<tr>
<td>-6</td>
<td>9</td>
<td>M18 x 1.5</td>
<td>16.5</td>
<td>18.0</td>
</tr>
<tr>
<td>-8</td>
<td>12</td>
<td>M22 x 1.5</td>
<td>20.5</td>
<td>22.0</td>
</tr>
<tr>
<td>-12</td>
<td>19</td>
<td>M30 x 1.5</td>
<td>28.5</td>
<td>30.0</td>
</tr>
<tr>
<td>-16</td>
<td>25</td>
<td>M33 x 1.5</td>
<td>31.5</td>
<td>33.0</td>
</tr>
<tr>
<td>-20</td>
<td>32</td>
<td>M42 x 1.5</td>
<td>40.5</td>
<td>42.0</td>
</tr>
</tbody>
</table>

### British Standard Pipe Tapered (BSPT) / Japanese Tapered Pipe Thread

The BSPT is similar to NPTF, but not interchangeable due to thread differences.
Sealing, like the NPTF, is accomplished on the threads. BSPT is identical and fully interchangeable with Japanese Tapered Pipe Thread.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Nominal Size (in.)</th>
<th>Thread Size</th>
<th>Female Thread I.D. (in.)</th>
<th>Male Thread O.D. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>1/8</td>
<td>1/8-28</td>
<td>11/32</td>
<td>3/8</td>
</tr>
<tr>
<td>-4</td>
<td>1/4</td>
<td>1/4-19</td>
<td>15/32</td>
<td>17/32</td>
</tr>
<tr>
<td>-6</td>
<td>3/8</td>
<td>3/8-19</td>
<td>19/32</td>
<td>21/32</td>
</tr>
<tr>
<td>-8</td>
<td>1/2</td>
<td>1/2-14</td>
<td>3/4</td>
<td>13/16</td>
</tr>
<tr>
<td>-10</td>
<td>5/8</td>
<td>5/8-14</td>
<td>13/16</td>
<td>29/32</td>
</tr>
<tr>
<td>-12</td>
<td>3/4</td>
<td>3/4-14</td>
<td>31/32</td>
<td>1-1/32</td>
</tr>
<tr>
<td>-16</td>
<td>1</td>
<td>1-11</td>
<td>1-7/32</td>
<td>1-11/32</td>
</tr>
<tr>
<td>-20</td>
<td>1-1/4</td>
<td>1-1/4-11</td>
<td>1-17/32</td>
<td>1-21/32</td>
</tr>
<tr>
<td>-24</td>
<td>1-1/2</td>
<td>1-1/2-11</td>
<td>1-25/32</td>
<td>1-7/8</td>
</tr>
<tr>
<td>-32</td>
<td>2</td>
<td>2-11</td>
<td>2-7/32</td>
<td>2-11/32</td>
</tr>
</tbody>
</table>

French GAZ 24° Cone

This end connection is similar to the DIN 24° cone; however, they are not interchangeable. Even though the sealing angles are the same, the threads are different.
### Metric Thread Size

<table>
<thead>
<tr>
<th>Metric Thread Size</th>
<th>Female Thread I.D. (mm)</th>
<th>Male Thread O.D. (mm)</th>
<th>Tube O.D. (mm)</th>
<th>O.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M20 x 1.5</td>
<td>18.5</td>
<td>20.0</td>
<td>13.25</td>
<td>13.5</td>
</tr>
<tr>
<td>M24 x 1.5</td>
<td>22.5</td>
<td>24.0</td>
<td>16.75</td>
<td>16.85</td>
</tr>
<tr>
<td>M30 x 1.5</td>
<td>28.5</td>
<td>30.0</td>
<td>21.25</td>
<td>21.35</td>
</tr>
<tr>
<td>M36 x 1.5</td>
<td>34.5</td>
<td>36.0</td>
<td>26.75</td>
<td>26.95</td>
</tr>
<tr>
<td>M45 x 1.5</td>
<td>43.5</td>
<td>45.0</td>
<td>33.50</td>
<td>33.65</td>
</tr>
<tr>
<td>M52 x 1.5</td>
<td>50.5</td>
<td>52.0</td>
<td>42.25</td>
<td>42.35</td>
</tr>
<tr>
<td>M58 x 2.0</td>
<td>55.0</td>
<td>58.0</td>
<td>48.25</td>
<td>48.35</td>
</tr>
</tbody>
</table>

### French GAZ Poclain 24° Flange

This flange differs from standard SAE flanges in that it has a lip that protrudes from the male flange face with a 24° angle. This lip fits into mating the female flange seat and provides the metal-to-metal seal when the bolts are tightened.
### Nominal Size (in.)

<table>
<thead>
<tr>
<th>Nominal Size (in.)</th>
<th>A (in.)</th>
<th>B (in.)</th>
<th>C (in.)</th>
<th>D (in.)</th>
<th>E (in.)</th>
<th>F (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1.57</td>
<td>.72</td>
<td>2.20</td>
<td>1.89</td>
<td>.55</td>
<td>.35</td>
</tr>
<tr>
<td>5/8</td>
<td>1.57</td>
<td>.72</td>
<td>2.20</td>
<td>1.89</td>
<td>.55</td>
<td>.35</td>
</tr>
<tr>
<td>3/4</td>
<td>2.00</td>
<td>.94</td>
<td>2.75</td>
<td>2.38</td>
<td>.71</td>
<td>.43</td>
</tr>
</tbody>
</table>

### Metric Standpipe Assembly

A metric standpipe assembly is comprised of three components attached to a male fitting. The components are: a Standpipe tube, Bite Sleeve, and Metric Nut. The nut is placed over the Standpipe, followed by the Bite Sleeve. For DIN light assemblies, a DIN light metric nut is used. For DIN heavy assemblies, a DIN heavy metric nut is used. The Bite Sleeve and Standpipe are selected on the basis of tube O.D. required.
<table>
<thead>
<tr>
<th>Metric Standpipe DIN Tube O.D. (mm)</th>
<th>Bite Sleeve DIN Tube O.D. (mm)</th>
<th>Metric Light Nut Thread</th>
<th>Metric Heavy Nut Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6</td>
<td>M12 x 1.5</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>M14 x 1.5</td>
<td>M16 x 1.5</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>M16 x 1.5</td>
<td>M18 x 1.5</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>M18 x 1.5</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>M22 x 1.5</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>-</td>
<td>M24 x 1.5</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>M26 x 1.5</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>-</td>
<td>M30 x 2.0</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>M30 x 2.0</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>-</td>
<td>M36 x 2.0</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>M36 x 2.0</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>-</td>
<td>M42 x 2.0</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>M45 x 2.0</td>
<td>-</td>
</tr>
<tr>
<td>38</td>
<td>38</td>
<td>-</td>
<td>M52 x 2.0</td>
</tr>
<tr>
<td>42</td>
<td>42</td>
<td>M52 x 2.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Komatsu 30° Flare Parallel Threads

The Komatsu 30° flare is similar to the 37° JIC flare connection except for two things. The seat angle is 30° instead of 37°, and the threads are metric.
### Kobelco Metric Bite Sleeve

![Diagram of a Kobelco Metric Bite Sleeve](image)

These are similar to the German DIN 24° Cone, but the DIN style uses courser threads. Therefore, the Kobelco and DIN connections are not interchangeable.

<table>
<thead>
<tr>
<th>Dash Size</th>
<th>Metric Thread Size</th>
<th>Female Thread I.D. (mm)</th>
<th>Male Thread O.D. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-22</td>
<td>M30 x 1.5</td>
<td>28.0</td>
<td>30.0</td>
</tr>
<tr>
<td>-28</td>
<td>M36 x 1.5</td>
<td>34.0</td>
<td>36.0</td>
</tr>
<tr>
<td>-35</td>
<td>M45 x 1.5</td>
<td>43.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>
## Appendix C – Hydraulic Audit List

### PRODUCT INFORMATION

### INSPECTION AND AUDIT DATA

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>INSPECTION CHARACTERISTIC</th>
<th>METHOD</th>
<th>SPEC</th>
<th>TOL</th>
<th>ACTUAL MEASURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incoming Couplings</td>
<td>Packing List, Labels, Content</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrosion</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Damaged Threads</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swivels Rotate</td>
<td>Hands</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>O-Ring Location &amp; Condition</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incoming Hose</td>
<td>Packing List, Labels, Content</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cover Dirt or Damage</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internal Dirt or Damage</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uniform Wall Thickness</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hose ID</td>
<td>Plug Gage</td>
<td>+/- 0.030”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Braids</td>
<td>Visual</td>
<td>+/- 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hose Cut</td>
<td>Length</td>
<td>Tape</td>
<td>+/- 1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Square</td>
<td>Protractor</td>
<td>+/- 5°</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cut Appearance</td>
<td>Visual</td>
<td>Clean Cut</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Skive or Buff</td>
<td>Wire Color</td>
<td>Visual</td>
<td>Not Blue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reinforcement Layer</td>
<td>Visual</td>
<td>Undisturbed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skive/Buff Length</td>
<td>Tape</td>
<td>+/- 0.030”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skive/Buff OD</td>
<td>Caliper</td>
<td>+/- 0.020”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimp</td>
<td>Stem Insertion Depth</td>
<td>Jig/Mark</td>
<td>Go/No Go</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct Die</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crimp OD</td>
<td>Caliper</td>
<td>+/- 0.010”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orientation</td>
<td>Protractor</td>
<td>+/- 2°</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sleeve/Guard</td>
<td>Fastened Appearance</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
</tr>
<tr>
<td>Final Inspection</td>
<td>Length</td>
<td>Tape</td>
<td>+/- 0.13”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verify Assembly was Cleaned</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caps</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swivels Rotate</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labels and Marking</td>
<td>Visual</td>
<td>Go/No Go</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix D – Hose Working Pressures

<table>
<thead>
<tr>
<th>SAE Hose Spec</th>
<th>ISO Hose Spec</th>
<th>Description</th>
<th>3/16 (-3)</th>
<th>1/4 (-4)</th>
<th>5/16 (-5)</th>
<th>3/8 (-6)</th>
<th>1/2 (-8)</th>
<th>5/8 (-10)</th>
<th>3/4 (-12)</th>
<th>1 (-16)</th>
<th>1 1/4 (-20)</th>
<th>1 1/2 (-24)</th>
<th>2 (-32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100R1</td>
<td>1436 Type 1SN</td>
<td>High Pressure 1 Wire Braid</td>
<td>3630</td>
<td>3260</td>
<td>3120</td>
<td>2610</td>
<td>2320</td>
<td>1890</td>
<td>1520</td>
<td>1280</td>
<td>900</td>
<td>725</td>
<td>600</td>
</tr>
<tr>
<td>100R2</td>
<td>1436 Type 2SN</td>
<td>High Pressure 2 Wire Braid</td>
<td>6020</td>
<td>5800</td>
<td>5080</td>
<td>4790</td>
<td>3990</td>
<td>3630</td>
<td>3120</td>
<td>2390</td>
<td>1800</td>
<td>1300</td>
<td>1150</td>
</tr>
<tr>
<td>100R3</td>
<td>1 Fabric Braid</td>
<td>1500</td>
<td>1250</td>
<td>1200</td>
<td>1125</td>
<td>1000</td>
<td>875</td>
<td>750</td>
<td>565</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R4</td>
<td>Suction</td>
<td>300</td>
<td>250</td>
<td>200</td>
<td>150</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R6</td>
<td>1 Fabric (Braid or Spiral)</td>
<td>500</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>350</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R7</td>
<td>Thermoplastic</td>
<td>3000</td>
<td>2750</td>
<td>2500</td>
<td>2250</td>
<td>2000</td>
<td>1500</td>
<td>1250</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R8</td>
<td>High Pressure Thermoplastic</td>
<td>5000</td>
<td>5000</td>
<td>4000</td>
<td>3500</td>
<td>2750</td>
<td>2250</td>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R9*</td>
<td>4 Wire Spiral</td>
<td>4500</td>
<td>4000</td>
<td>3000</td>
<td>3000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R10*</td>
<td>High Pressure 4 Wire Spiral</td>
<td>10000</td>
<td>8750</td>
<td>7500</td>
<td>6250</td>
<td>5000</td>
<td>4000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R11*</td>
<td>High Pressure 6 Wire Spiral</td>
<td>12500</td>
<td>11250</td>
<td>10000</td>
<td>7500</td>
<td>6250</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R12</td>
<td>4 Wire Spiral</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>3050</td>
<td>2500</td>
<td>2500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R13</td>
<td>5000 PSI Wire Spiral</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R15</td>
<td>6000 PSI Wire Spiral</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R16</td>
<td>Compact Wire Braid</td>
<td>5000</td>
<td>4250</td>
<td>4000</td>
<td>3500</td>
<td>2750</td>
<td>2250</td>
<td>2000</td>
<td>1600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R17</td>
<td>High Pressure Compact Wire Braid</td>
<td>6020</td>
<td>5800</td>
<td>5080</td>
<td>4790</td>
<td>3990</td>
<td>3630</td>
<td>3120</td>
<td>2390</td>
<td>1800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R18</td>
<td>3000 PSI Wire Braid</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100R19</td>
<td>4000 PSI Wire Braid</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The SAE J517 100R9, 100R10 and 100R11 hoses are discontinued per SAE due to lack of demand.

Figure D-1
### ISO Hose Working Pressures (psi) per hose size

<table>
<thead>
<tr>
<th>ISO ID Size (mm)</th>
<th>5</th>
<th>6.3</th>
<th>8</th>
<th>10</th>
<th>12.5</th>
<th>16</th>
<th>19</th>
<th>25</th>
<th>31.5</th>
<th>38</th>
<th>51</th>
<th>63</th>
<th>76</th>
<th>102</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Spec Dash Size (Inches)</td>
<td>-3</td>
<td>-4</td>
<td>-5</td>
<td>-6</td>
<td>-8</td>
<td>-10</td>
<td>-12</td>
<td>-16</td>
<td>-20</td>
<td>-24</td>
<td>-32</td>
<td>-40</td>
<td>-48</td>
<td>-56</td>
</tr>
<tr>
<td>ISO 18752 Class 35</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>ISO 18752 Class 70</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>ISO 18752 Class 210</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
</tr>
<tr>
<td>ISO 18752 Class 250</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
<td>3625</td>
</tr>
<tr>
<td>ISO 18752 Class 280</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>ISO 18752 Class 350</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
</tr>
<tr>
<td>ISO 18752 Class 420</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
</tr>
<tr>
<td>ISO 18752 Class 560</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
<td>8000</td>
</tr>
<tr>
<td>ISO 1436 1ST/1SN/R1ATS</td>
<td>3625</td>
<td>3250</td>
<td>3100</td>
<td>2600</td>
<td>2300</td>
<td>1900</td>
<td>1500</td>
<td>1250</td>
<td>900</td>
<td>725</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 1436 2ST/2SN/R2ATS</td>
<td>6000</td>
<td>5800</td>
<td>5000</td>
<td>4800</td>
<td>4000</td>
<td>3625</td>
<td>3100</td>
<td>2400</td>
<td>1800</td>
<td>1300</td>
<td>1150</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 11237 1SC</td>
<td>3250</td>
<td>3100</td>
<td>2600</td>
<td>2300</td>
<td>1900</td>
<td>1500</td>
<td>1300</td>
<td>900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 11237 2SC/R16S</td>
<td>5800</td>
<td>5000</td>
<td>4800</td>
<td>4000</td>
<td>3625</td>
<td>3100</td>
<td>2400</td>
<td>1800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 11237 R17</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td>3050</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 11237 R19</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 3862 4SP</td>
<td>6500</td>
<td>6500</td>
<td>6000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 3862 4SH</td>
<td>6000</td>
<td>5500</td>
<td>4700</td>
<td>4200</td>
<td>3625</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 3862 R12</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>4000</td>
<td>3050</td>
<td>2500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 3862 R13</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 3862 R15</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td>6000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### EN Hose Working Pressures (psi)

<table>
<thead>
<tr>
<th>Hose Style</th>
<th>Description</th>
<th>3/16 (-3)</th>
<th>1/4 (-4)</th>
<th>5/16 (-5)</th>
<th>3/8 (-6)</th>
<th>1/2 (-8)</th>
<th>5/8 (-10)</th>
<th>3/4 (-12)</th>
<th>1 (-16)</th>
<th>1-1/4 (-20)</th>
<th>1-1/2 (-24)</th>
<th>2 (-32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ST</td>
<td>1 Wire Braid Standard Cover</td>
<td>3630</td>
<td>3265</td>
<td>3120</td>
<td>2610</td>
<td>2320</td>
<td>1890</td>
<td>1525</td>
<td>1280</td>
<td>915</td>
<td>725</td>
<td>580</td>
</tr>
<tr>
<td>1SN</td>
<td>1 Wire Braid Thin Cover</td>
<td>3630</td>
<td>3265</td>
<td>3120</td>
<td>2610</td>
<td>2320</td>
<td>1890</td>
<td>1525</td>
<td>1280</td>
<td>915</td>
<td>725</td>
<td>580</td>
</tr>
<tr>
<td>2ST</td>
<td>2 Wire Braid Standard Cover</td>
<td>6020</td>
<td>5800</td>
<td>5075</td>
<td>4785</td>
<td>3990</td>
<td>3625</td>
<td>3120</td>
<td>2395</td>
<td>1815</td>
<td>1305</td>
<td>1160</td>
</tr>
<tr>
<td>2SN</td>
<td>2 Wire Braid Thin Cover</td>
<td>6020</td>
<td>5800</td>
<td>5075</td>
<td>4785</td>
<td>3990</td>
<td>3625</td>
<td>3120</td>
<td>2395</td>
<td>1815</td>
<td>1305</td>
<td>1160</td>
</tr>
<tr>
<td>4SP</td>
<td>4 Wire Spiral</td>
<td>6530</td>
<td>6455</td>
<td>6020</td>
<td>5080</td>
<td>5080</td>
<td>4065</td>
<td>3050</td>
<td>2685</td>
<td>2395</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4SH</td>
<td>High Pressure 4 Wire Spiral</td>
<td>6095</td>
<td>5515</td>
<td>4715</td>
<td>4210</td>
<td>3630</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1SC</td>
<td>Compact 1 Wire Braid</td>
<td>3265</td>
<td>3120</td>
<td>2610</td>
<td>2325</td>
<td>1890</td>
<td>1525</td>
<td>1280</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2SC</td>
<td>Compact 2 Wire Braid</td>
<td>5805</td>
<td>5080</td>
<td>4790</td>
<td>3990</td>
<td>3630</td>
<td>3120</td>
<td>2395</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure D-2

Figure D-3

CONFIDENTIAL – NAHAD Hose Safety Institute Member Use Only
Page 70 of 71
### Appendix E – Conversion Charts

<table>
<thead>
<tr>
<th>psi</th>
<th>Atms</th>
<th>inches H2O</th>
<th>inches Hg</th>
<th>mm Hg (Torr)</th>
<th>mbar</th>
<th>Bar</th>
<th>Pa (N/m²)</th>
<th>kPa</th>
<th>MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0681</td>
<td>27.71</td>
<td>2.036</td>
<td>51.715</td>
<td>68.95</td>
<td>0.0689</td>
<td>6895</td>
<td>6.895</td>
<td>0.0069</td>
</tr>
<tr>
<td>14.7</td>
<td>1</td>
<td>407.2</td>
<td>29.92</td>
<td>760</td>
<td>1013</td>
<td>1.013</td>
<td>101,325</td>
<td>101.3</td>
<td>0.1013</td>
</tr>
<tr>
<td>0.0361</td>
<td>0.00246</td>
<td>1</td>
<td>0.0735</td>
<td>1.866</td>
<td>2.488</td>
<td>0.00249</td>
<td>248.8</td>
<td>0.249</td>
<td>0.00025</td>
</tr>
<tr>
<td>0.4912</td>
<td>0.03342</td>
<td>13.61</td>
<td>1</td>
<td>25.4</td>
<td>33.86</td>
<td>0.0339</td>
<td>3386</td>
<td>3.386</td>
<td>0.00339</td>
</tr>
<tr>
<td>0.01934</td>
<td>0.001316</td>
<td>0.536</td>
<td>0.0394</td>
<td>1</td>
<td>1.333</td>
<td>0.001333</td>
<td>133.3</td>
<td>0.1333</td>
<td>0.000133</td>
</tr>
<tr>
<td>0.0145</td>
<td>0.000987</td>
<td>0.4012</td>
<td>0.0295</td>
<td>0.75</td>
<td>1</td>
<td>0.001</td>
<td>100</td>
<td>1</td>
<td>0.001</td>
</tr>
<tr>
<td>14.504</td>
<td>0.987</td>
<td>401.9</td>
<td>29.53</td>
<td>750</td>
<td>1000</td>
<td>1</td>
<td>100,000</td>
<td>100</td>
<td>0.1</td>
</tr>
<tr>
<td>0.000145</td>
<td>0.00001</td>
<td>0.00402</td>
<td>0.000295</td>
<td>0.0075</td>
<td>0.01</td>
<td>0.00001</td>
<td>1</td>
<td>0.001</td>
<td>0.000001</td>
</tr>
<tr>
<td>0.14504</td>
<td>0.00987</td>
<td>401.9</td>
<td>0.295</td>
<td>7.50</td>
<td>10</td>
<td>0.01</td>
<td>1000</td>
<td>1</td>
<td>0.001</td>
</tr>
<tr>
<td>145.04</td>
<td>9.869</td>
<td>401.9</td>
<td>295.3</td>
<td>7500</td>
<td>10,000</td>
<td>10</td>
<td>1,000,000</td>
<td>1000</td>
<td>1</td>
</tr>
</tbody>
</table>

To use this chart:
1. Locate the column with the units you want to convert from.
2. Move DOWN that column until you locate the “1”.
3. Move HORIZONTALLY to the column with the units you want to convert to.
4. MULTIPLY the number in the box by the amount you are changing from to get the converted value.

**Length**
- 1 cm = 0.3937 in = 10 mm = 0.01 m
- 1 m = 3.2808 ft = 1000 m = 100 cm
- 1 in = 2.540 cm = 25.40 mm
- 1 ft = 30.48 cm = 0.3048 m

**Volume**
- 1 L = 0.0353 ft³
- 1 L = 0.2642 gal
- 1 L = 61.025 in³
- 1 L = 0.001 m³
- 1 ft³ = 28.3286 L
- 1 Gal = 0.1336 ft³

**Pressure**
- 1 psi = 0.0681 atm
- 1 psi = 27.71 in H₂O
- 1 psi = 703.8 mm H₂O
- 1 psi = 2.036 in Hg
- 1 psi = 51.715 mm Hg (torr)
- 1 psi = 68.95 mbar
- 1 psi = 0.0689 bar
- 1 psi = 6895 Pa (n/m²)
- 1 psi = 6.895 kPa
- 1 psi = 0.0069 MPa