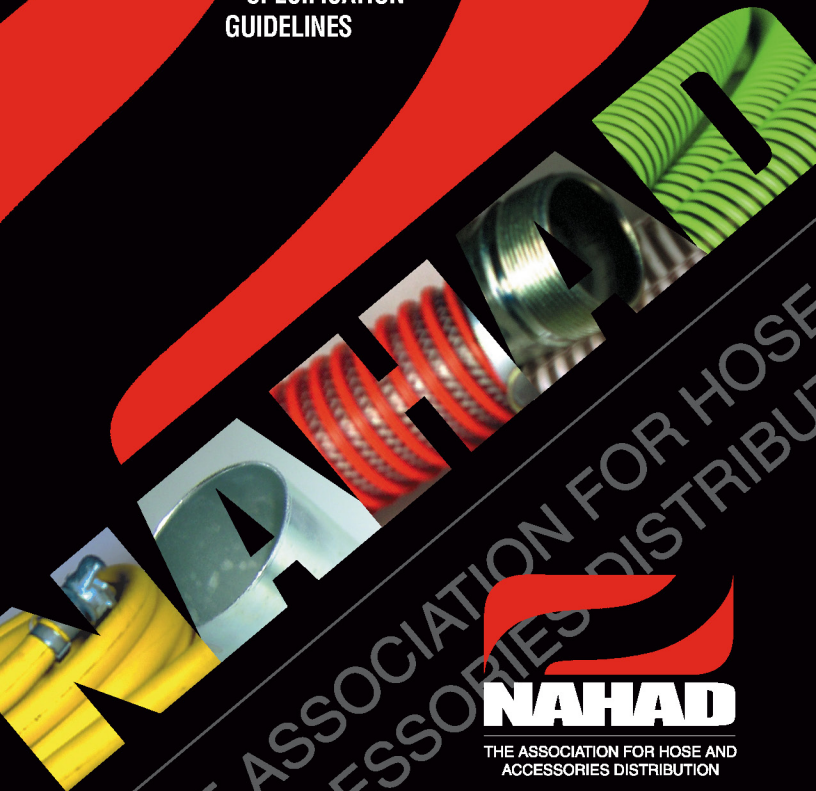


INDUSTRIAL  
HOSE  
ASSEMBLY  
SPECIFICATION  
GUIDELINES



THE ASSOCIATION FOR HOSE AND  
ACCESSORIES DISTRIBUTION



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ACCESSORIES DISTRIBUTION

**NAHAD 500**  
2005

## **IMPORTANT NOTE TO READER:**

**NAHAD - The Association for Hose and Accessories Distribution** - is pleased to provide this *comprehensive set of basic Hose Assembly Specification Guidelines* for customers seeking to acquire fabricated hose assemblies for various industrial applications. The information contained within this document has been developed through the concerted efforts of dozens of member volunteers, association staff and industry leaders, with the common goal of helping to improve the safety, quality and reliability of fabricated hose assemblies.

In addition to this document, NAHAD has produced four other Hose Assembly Specification Guidelines publications, addressing a total of five hose product groups, including: Composite Hose; Corrugated Metal Hose; Hydraulic Hose; Industrial Hose and Fluoropolymer Hose. These five publications are intended to complement existing industry and federal regulations. Aerospace and hydraulic brake hose assemblies are specifically excluded from this and the other four documents.

Hose, hose fittings and hose couplings come in various sizes and designs. Although there are standards published by manufacturers and independent testing organizations, such as ANSI, ASME, ASTM, ASQ, UL, ISO, SAE, RMA and others which relate to hoses and hose fittings, there are no generally recognized standards for hose assemblies. This publication is indebted to these organizations and, in specific cases, refers the reader to designated existing standards and recommendations provided by these other sources in an attempt to encourage the fabrication of safer, higher quality and more reliable hose assemblies.

NAHAD has published these Hose Assembly Specification Guidelines in order to create reference works that compile information of value to NAHAD members, manufacturers and customers in developing hose assemblies that meet specific individual needs. To the extent that each assembly has unique characteristics, it must be custom designed, engineered and tested. Hopefully, these Guidelines will be useful in the process.

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, and the member company volunteers, association staff and industry leaders who participated in the creation of these Guidelines do not assume, and expressly decline and deny, any and all liability for any product failures, damages or injuries that may result in any way from utilization of these Guidelines or products based on these Guidelines.

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105 Eastern Avenue, Suite 104  
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[www.nahad.org](http://www.nahad.org)



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## Section 1 – Scope

This NAHAD Hose Assembly Specification Guideline is intended to complement existing industry standards and federal regulations. This document aids the end user in the selection and recognition of suitable Industrial Hose Assemblies.

This document is not intended to prohibit either supplier or customer from attaching additional requirements for hose (made of rubber unless otherwise specified), couplings or hose assemblies, if necessary, to satisfy the application. It is the responsibility of the fabricator and user to separately qualify these applications and their unique requirements necessary to ensure performance capability.

There are specific applications that require additional design, fabrication installation and maintenance considerations over and above the requirements set forth in these Hose Assembly Guidelines. Please see Section 3.3 of this document for further information.

## Section 2 – Glossary

**abrasion:** external damage to a hose assembly caused by its being rubbed on a foreign object; a wearing away by friction.

**abrasion tester:** a machine for determining the quantity of material worn away by friction under specified conditions.

**absorption:** regarding hose, the process of taking in fluid. Hose materials are often compared with regard to relative rates and total amounts of absorption as they pertain to specific fluids.

**accelerated life test:** a method designed to approximate in a short time the deteriorating effects obtained under normal service conditions.

**acid resistant:** having the ability to withstand the action of identified acids within specified limits of concentration and temperature.

**adapter, adaptor:** 1) fittings of various sizes and materials used to change an end fitting from one type to another type or one size to another. (i.e., a male JIC to male pipe adapter is often attached to a female JIC to create a male end union fitting); 2) the grooved portion of a cam & groove coupling.

**adhesion:** the strength of bond between 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 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.

**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 a hose assembly deflects laterally to one side from its normal position, when this deflection occurs on both sides of the normal hose centerline.

**anchor:** a restraint applied to eliminate motion and restrain 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 deposit protective or cosmetic coatings in a variety of colors on metal, primarily used with aluminum.

**ANSI:** American National Standards Institute.

**anti-static:** see static conductive.

**application working pressure:** unique to customer’s application. See pressure, working.

**application:** the service conditions that determine how a hose assembly will be used.

**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.

**assembly:** a general term referring to any hose coupled with end fittings of any style attached to one or both ends.

**ASTM:** American Society for Testing and Materials.

**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).

**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.

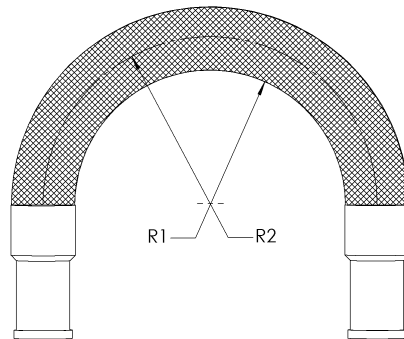
**barbed and ferrule fitting:** a two-piece hose fitting comprised of a barbed insert (nipple), normally with peripheral ridges or backward-slanted barbs, for inserting into a hose and a ferrule, usually crimped or swaged.

**basket weave:** a braid pattern in which the plaits of wire alternately cross over and under two strands (two over-two under).

**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 of the curved portion.



**bend radius, minimum:** the smallest radius at which a hose can be used.

**bend radius, dynamic:** the radius at which constant or continuous flexing occurs.

**bend radius, static:** the smallest fixed radius at which a hose can be subjected.

**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.

**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 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 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.

**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-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 +800°F.

**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.

**C of C:** 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.

**cam & groove:** see fitting/coupling - Cam & Groove.

**capped end:** a hose end covered to protect its internal elements.

**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.

**cemented end:** a hose end sealed with the application of a liquid coating.

**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 friction:** a relative measure of the surface lubricity.

**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 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.

**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.

**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:** chlorinated polyethylene; a rubber elastomer.

**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.

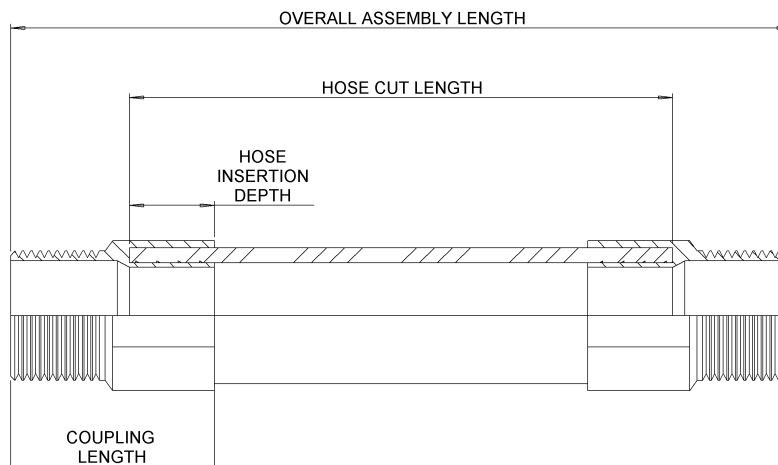
**crimp diameter:** the distance across opposite flats after crimping.

**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.

**CSM:** chlorosulfonated polyethylene.

**cure:** the act of vulcanization. See vulcanization.

**cut off factor:** the hose length to be subtracted from the overall assembly length that allows for the hose coupling end connection extension beyond the end of the hose.



**cut resistant:** having that characteristic of withstanding the cutting action of sharp object.

**cycle-motion:** movement from normal to extreme position and return.

**date code:** any combination of numbers, letters, symbols or other methods used by a manufacturer to identify the time of manufacture of a product.



**deduct length:** the amount of fitting length deducted from a hose to result in the desired finished assembly length.

**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.

**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.

**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 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.

**electrostatic discharge:** the sudden discharge of static electricity from an area of buildup to a grounding point.

**elongation:** the increase in length expressed numerically as a percentage of the initial length.

**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:** Ethylene Propylene Diene Monomer; an elastomer.

**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 weakening or deterioration of a material occurring when a repetitious or continuous application of stress causes strain, which could lead to failure.

**FDA:** United States Food and Drug Administration.

**FEP:** 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 sleeve 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 design featuring a hollow circle or “donut” attached to one end of the fitting barb so that the inner diameter is along the hose axis.
- *Butt Weld Fittings* - a hose fitting designed to be permanently welded to a connecting member such as another pipe or a butt weld flange.
- *Cam & Groove Fittings* - a type of fitting that allows connection and disconnection by means of arm(s) or cam(s) on the female fitting. The seal is accomplished by means of a gasket, available in various materials. These fittings are frequently used on product transfer hose assemblies.
- *Compression Fitting* - a fitting style that seals on a mating tube by compressing an internal ferrule against the tube O.D..
- *Encapsulated Fittings* - a metal fitting of various styles usually encased in a thermoplastic or fluoroplastic material by means of molding or coating. Most often done for sanitary purposes or to eliminate corrosion.
- *Field Attachable Fitting* - a fitting designed to be attached to hose without crimping or swaging. This fitting is not always a Reusable type fitting.
- *Flange Retainer Fittings* - a hose fitting flared to a 90° surface, designed to hold a circular rotating flange, such as a slip-on or lap joint style flange.
- *Flange Style Fittings* - pipe flanges and flanged fitting standards are listed under ANSI B16.5. Flanges are rated for pressure and listed as “American Class 150, 300, 400, 600, 900, 1,500 or 2,500”. Pressure-Temperature ratings can be obtained by consulting the ANSI specification or ASME B16.5 (American Society of Mechanical Engineers). Designs vary by neck and face style, or other dimensional changes based on use. Various finishes or grooves may be applied to the face for sealing on a gasket or

o-ring. Bolt holes and other dimensions are per the ANSI standard.

- *Slip-on Flange* - a flange designed to slip over a flange retainer and float freely in place for bolt alignment. Similar to a lap joint flange except with a very small radius on the face side of the inside diameter to mate with a machined flange retainer. May have a flat or raised face.
- *Lap Joint Flange* - a flange designed to float freely on the flange retainer for bolt alignment. Made with a flat face and having a large radius on the I.D. to mate with a flared pipe style flange retainer.
- *Threaded Flange* - a flange, the inside diameter of which is threaded to attach to a male pipe fitting. A leak proof seal, made with thread sealant, usually does not allow for bolt hole alignment. Inverted Flare Fitting - a fitting consisting of a male or female nut, trapped on a tube by flaring the end of the tube material to either 37° or 45°.
- *JIC Fittings* - joint Industrial Council (no longer in existence). An engineering group that established an industry standard fitting design incorporating a 37° mating surface, male and female styles. These standards now governed by SAE.
- *Lined Fitting* - any fitting of which the wetted surface or entire fitting is covered with a protective material. The covering process may be by spray coating, molding or by inserting hose liner through the I.D. of fitting and anchoring.
- *O-ring Fittings* - a fitting that seals by means of an elastomeric ring of a specified material.
- *Pipe Thread Fittings* -
  - NPT- National Pipe Taper. Pipe thread per ANSI B1.20.1
  - NPTF- National Pipe Tapered for Fuels. Same as above except dry-seal per ANSI B1.20.3
  - NPSH- National Pipe Straight Hose per ANSI B1.20.7
  - NPSM- National Pipe Straight Mechanical. Straight thread per ANSI B1.20.1
  - NPSL- National Pipe Straight Loosefit per ANSI B1.20.1
  - BSPP, BSPT- British Standard Pipe Parallel, British Standard Pipe Taper. BS21.

- *Quick Connect Fitting* - 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.

**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.

**flow rate:** a volume of media being conveyed in a given time period.

**fluid:** a gas or liquid medium.

**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.

**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.

**hand built hose:** a hose made by hand on a mandrel, reinforced by textile or wire or combination of both.

**hardness:** resistance to indentation. See durometer hardness.

**heat resistance:** the property or ability to resist the deteriorating effects of elevated temperatures.

**heat-shrink sleeving:** tubular thermoplastic sleeve used for chafe protection or identification. The sleeve is slipped over the hose and shrunk down by the application of heat to fit tightly on the hose.

**helical wire armor/spring guard:** an abrasion resistance device.

**helical:** used to describe a type of corrugated hose having one continuous convolution resembling a screw thread.

**helix:** a shape formed by spiraling a wire or other reinforcement around the cylindrical body of a hose; typically used in suction hose.

**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.

**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.

**hydrostatic testing:** the use of liquid pressure 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.

**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.

**indentation:** 1) the extent of deformation by the indenter point of any one of a number of standard hardness testing instruments; 2) a recess in the surface of a hose.

**innercore:** the innermost layer of a hose; the hose material in contact with the medium.

**insert:** optional term for nipple. See nipple.

**interlocked hose:** formed from profiled strip and wound into flexible metal tubing with no subsequent welding, brazing, or soldering; may be made pressure-tight by winding in strands of packing.

**interlocking clamp:** a clamp which engages the fitting in a manner which prevents the clamp from sliding off the fitting, typically a bolt or U-bolt style with interlocking fingers which engage an interlock ring on the fitting.

**interlocking ferrule:** a ferrule, which physically attaches to the fitting preventing

the ferrule from sliding off the fitting.

**interstice:** a small opening, such as between fibers in a cord or threads in a woven or braided fabric.

**IPT:** iron pipe threads; a reference to NPT or NPTF.

**ISO:** International Organization for Standardization.

**jacket:** a seamless tubular braided or woven ply generally on the outside of a hose.

**JIC:** see fitting/coupling-JIC.

**kinking:** a temporary or permanent distortion of the hose induced by bending beyond the minimum bend radius.

**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.

**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.

**mean diameter:** the midpoint between the inside diameter and the outside diameter of a corrugated/convoluted hose.

**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.

**misalignment:** a condition where two parts do not meet true.

**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.

**Neoprene®:** a registered trademark of DuPont.

**nipple:** the internal member or portion of a hose fitting.

**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-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.

**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-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

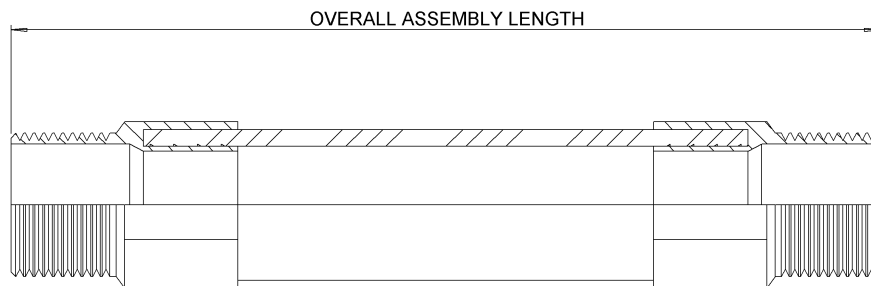
contact with the product being cured.

**operating conditions:** the pressure, temperature, motion, and environment to which a hose assembly is subjected.

**o-ring fitting:** see fitting/coupling, O-Ring.

**OS & D hose:** the abbreviation for oil suction and discharge hose.

**overall length (OAL):** the total length of a hose assembly, which consists of the free hose length plus the length of the coupling(s).



**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).

**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 (service test):** a test in which the product is used under actual service conditions.

**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.

**Pharmacopeia Class VI:** a standard for sanitary fittings, designating the form, fit,

function and finish.

**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.

**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.

**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.

**plating:** a material, usually metal, applied to another metal by electroplating, for the purpose of reducing corrosion; typically a more noble metal such as zinc is applied to steel.

**ply:** an individual layer in hose construction.

**pneumatic testing:** the use of compressed air to test a hose or hose assembly for leakage, twisting, and/or hose change-in-length. NOTE: Use of high pressure air is extremely hazardous.

**polymer:** a macromolecular material formed by the chemical combination of monomers, having either the same or different chemical compositions.

**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.

**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 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, 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.

**propane:** see LPG, LP Gas.

**psi:** pounds per square inch.

**pull off force:** the force required to pull the hose from its attachment not generated by the internal pressure.

**PVC:** polyvinyl chloride. A low cost thermoplastic material typically used in the manufacture of industrial hoses.

**PVDF:** 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.

**reusable fitting/coupling:** see fitting/coupling, reusable.

**RMA:** The Rubber Manufacturers Association, Inc.

**SAE:** Society of Automotive Engineers.

**safety factor:** see design factor.

**sampling:** a process of selecting a portion of a quantity for testing or inspection, selected without regard to quality.

**Santoprene®:** a registered trademark of Monsanto.

**scale:** the oxide in a hose assembly brought about by surface conditions or welding.

**serrations:** bumps, barbs, corrugations, or other features that increase the holding power of the device.

**service temperature:** see working temperature.

**shank:** that portion of a fitting, which is inserted into the bore of a hose.

**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:** a metal cylinder, which is not physically attached to the fitting, for the purpose of forcing the hose into the serrations of the fitting.

**smooth bore:** a term used to describe the type of innercore in a hose.

**socket:** the external member or portion of a hose fitting, commonly used in describing screw-together reusable fittings.

**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.

**spiral:** a method of applying reinforcement 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.

**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 bonding:** use of a grounded conductive material 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 wire:** wire incorporated in a hose to conduct static electricity.

**stem:** see nipple.

**stress corrosion:** a form of corrosion in metal.

**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.

**tape wrapped convoluted:** a type of flexible hose incorporating layers of tape to form helical ridges and grooves.

**tear resistance:** the property of a rubber tube or cover of a hose to resist tearing forces.

**tube:** the innermost continuous all-rubber or plastic element of a hose.

**tube fitting:** see fitting/coupling-Tube.

**tubing:** a non-reinforced, homogeneous conduit, generally of circular cross-section.

**twist:** (1) the turns about the axis, per unit of length, of a fiber, roving yarn, cord, etc. Twist is usually expressed as turns per inch; (2) the turn about the axis of a hose subjected to internal pressure.

**unsintered:** material that has not undergone primary heat processing.

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

**velocity resonance:** vibration due to the buffeting of a high velocity gas or liquid flow.

**vibration:** amplitude motion occurring at a given frequency.



**viscosity:** the resistance of a material to flow.

**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.

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

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

**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. The preceding Glossary of Terms, as utilized in the hose industry, includes some definitions from The Hose Handbook, published by the Rubber Manufacturers Association.

## Section 3 – Application Requirements – STAMPED

### 3.1 Purpose

The purpose of this section is to provide a simple to use guide to assist in determining the correct hose, coupling and attachment method that will satisfy the customer's needs. Please note that Section 3.3 addresses Critical Applications which may require special attention.

### 3.2 General

The guide uses the STAMPED process. STAMPED is an acronym and stands for the 7 major information areas required to provide a quality hose assembly for the customer, as follows:

**S** stands for **SIZE**; I.D., O.D. and length

**T** stands for **TEMPERATURE** of the material conveyed and environmental

**A** stands for the **APPLICATION**, the conditions of use

**M** stands for the **MATERIAL** being conveyed, type and concentration

**P** stands for the **PRESSURE** to which the assembly will be exposed

**E** stands for **ENDS**; style, type, orientation, attachment methods, etc.

**D** stands for **DELIVERY**; testing, quality, packaging, and delivery requirements

### 3.3 Critical Applications

There are specific applications that require additional design, fabrication installation and maintenance considerations over and above the requirements set forth in these Hose Assembly Guidelines. The following is a non-inclusive list.

#### 3.3.1 Chlorine

For hose assemblies used to transport chlorine, there are specific requirements set forth in the Chlorine Institute Pamphlet #6 (edition 15), "Piping Systems for Dry Chlorine", Appendix A, Section 9. Please note that Chlorine transfer hose (CTH) must be clearly and permanently marked as per Chlorine Institute Pamphlet #6 (edition 15), Appendix A, Section 9. These permanent markings

(e.g. stamping, stenciling or coding) should be utilized throughout the supply chain for purposes of continuous positive identification.

### **3.3.2 Anhydrous Ammonia**

### **3.3.3 Aircraft Fueling**

### **3.3.4 Welding Hose**

### **3.3.5 LP Gas**

## **3.4 Directions**

Using the form:

1. Inform the customer you will be using an application format called STAMPED.
2. Ask your customer the pertinent questions outlined on the form, in sequence.
3. After completing the form, ask your customer to confirm their answers as you repeat them, in sequence.
4. Provide the completed format to your assembly area or order entry as required.

The following list of special considerations may help to clarify application parameters:

1. Abrasion
2. Electrical conductivity
3. Environment
4. Flammability
5. Flow rate
6. Fluid velocity
7. Movement (type, distance, frequency)
8. Ozone
9. Permeation (vapor conveying hose)
10. Routing
11. Salt water
12. Static electricity
13. Ultraviolet light
14. Vibration (frequency rate – Hz, amplitude – "G" load)

(See **STAMPED** Form on next page)

**Customer Information:**

Company: \_\_\_\_\_

Fax: \_\_\_\_\_

Contact: \_\_\_\_\_

E-mail: \_\_\_\_\_

Address: \_\_\_\_\_

P.O.#: \_\_\_\_\_

Phone: \_\_\_\_\_

Terms: \_\_\_\_\_

Size	I.D.	O.D.	Overall Length	Tolerance

Temperature	Materials Conveyed		Environmental Temperature	
	Min.	Max	Min	Max
	°F/°C	°F/°C	°F/°C	°F/°C

Application	Type:
-------------	-------

Material/ Media	Material Conveyed			
	Internal Media		External Environment	

Pressure	Max Working Pressure	Spikes	Vacuum
	PSI/kPa	PSI/kPa	Inches of Hg/kPa

Ends	End	Style/ Material	Size	Threads/Bolts Hole Alignment	Orientation	Attachment Methods	Capped
	1						Y N
	2						Y N

Delivery	Quantity Required:		Date Required:
	Package Type:		
	Pick Up Date:		Ship Via:
	Testing Required:	Y   N	Type:
	Certification Required:	Y   N	Type:

**Special Requirements:**

## **Section 4 – Industrial Hose**

### **4.1 Scope**

The sections pertaining to industrial hose assemblies has been compiled to provide authoritative information on assembly applications; hose, coupling and attachment selection. This information is intended to help those that are responsible for selecting the components.

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. The user is encouraged to contact a NAHAD Listed Distributor in order to obtain the latest information.

***Note:***

Because there are many combinations of hose, coupling 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). The reader is cautioned to contact a NAHAD Listed Distributor when dealing with temperature extremes.

## 4.2 Selection Chart - The Attachment Method based on Fitting Type and Hose Type

Hose Type	Fitting Type						Cast Shank- Pin Lug Water Hose Cplg, Suction Cplg, Shank Cplg
		Cam and Groove	Universal-Chicago, Crowsfoot, Claw	Machined-Short Shank	Machined-Medium Shank	Machined Long Shank	
Air Hose		NOT TO BE USED	Crimped Ferrule/Sleeve Interlocking Clamp Preformed Clamp	Crimped Ferrule/Sleeve Pinched Clamp Preformed Clamp	Crimped Ferrule/Sleeve Pinch Clamp Preformed Clamp Band & Buckle	Pinch Clamp Preformed Clamp Band & Buckle	Not Recommended
Asphalt							
Chemical – Plastic Lined		Crimped Ferrule/Sleeve Preformed Clamp Band & Buckle Swaged Ferrule		NOT TO BE USED	Preformed Clamp Band & Buckle	Preformed Clamp Band & Buckle	
Chemical – Rubber Lined		Crimped Ferrule/Sleeve Preformed Clamp Band & Buckle Swaged Ferrule			Preformed Clamp Band & Buckle	Preformed Clamp Band & Buckle	
Food Handling-Regulated							
Food Handling – Non-Regulated		Crimped Ferrule/Sleeve Preformed Clamp Band & Buckle Swaged Ferrule			Bolt Clamp Preformed Clamp Band & Buckle	Bolt Clamp Preformed Clamp Band & Buckle	Bolt Clamp Preformed Clamp Band & Buckle
Lay Flat		Crimped Ferrule/Sleeve Preformed Clamp Band & Buckle			Preformed Clamp Band & Buckle	Preformed Clamp Band & Buckle	Preformed Clamp Band & Buckle

Fitting Type							
		Cam and Groove	Universal-Chicago, Crowsfoot, Claw	Machined-Short Shank	Machined-Medium Shank	Machined Long Shank	Cast Shank- Pin Lug Water Hose Cplg, Suction Cplg, Shank Cplg
	Material Handling- Bulk Transfer	Crimped Ferrule/Sleeve Preformed Clamp Band & Buckle Swaged Ferrule			Bolt Clamp Preformed Clamp Band & Buckle	Bolt Clamp Preformed Clamp Band & Buckle	Bolt Clamp Preformed Clamp Band & Buckle
	Material Handling - Cement						
	Petroleum						
	Fuel Oil	Crimped Ferrule/Sleeve					
	Petroleum Drop	Preformed Clamp			Preformed Clamp	Preformed Clamp	
	Petroleum Vapor Recovery	Band & Buckle			Band & Buckle	Band & Buckle	
	Petroleum Discharge	Swaged Ferrule					
	Petroleum Suction & Discharge						
	Push On						
	Sandblast						
	Steam	NOT TO BE USED	NOT TO BE USED				
	Water/ Multipurpose	Crimped Ferrule/Sleeve Preformed Clamp Band & Buckle Swaged Ferrule	Inter-locking Clamp Preformed Clamp	Crimp Ferrule/Sleeve Pinch Clamp Preformed Clamp	Bolt Clamp Pinch Clamp Preformed Clamp	Bolt Clamp Pinch Clamp Preformed Clamp	Bolt Clamp Pinch Clamp Preformed Clamp

	Fitting Type						
		Interlocking Swage/Crimp	Ground Joint	Sanitary	Sandblast	Push On	Internal Expansion Short Brass Cplg
Hose Type	Air Hose	Crimp Ferrule/Sleeve Swaged Ferrule	Interlocking Clamp				
	Asphalt	Interlocking Clamp					
	Chemical – Plastic Lined	Crimp Ferrule/Sleeve					
	Chemical – Rubber Lined	Crimp Ferrule/Sleeve Swaged Ferrule				Internal Expansion	
	Food Handling – Regulated			Internal Expansion		Internal Expansion	
	Food Handling – Non-Regulated	Crimp Ferrule/Sleeve Swaged Ferrule				Internal Expansion	
	Lay Flat						
	Material Handling – Bulk Transfer	Crimp Ferrule/Sleeve Swaged Ferrule					
	Material Handling – Cement	Crimp Ferrule/Sleeve Swaged Ferrule	Interlocking Clamp			Internal Expansion	
	Petroleum Fuel oil						
	Petroleum Drop						
	Petroleum Vapor Recovery	Crimp Ferrule/Sleeve Swaged Ferrule				Internal Expansion	Internally Expanded Short Brass
	Petroleum Discharge						
	Petroleum Suction & Discharge						
	Push On					None Required	
	Sandblast				None Required		
	Steam		Interlocking Clamp				
	Water/ Multipurpose	Crimp Ferrule/Sleeve Swaged Ferrule	Interlocking Clamp				Internally Expanded Short Brass



## 4.3 Hose Data Sheets

### 4.3.1 Air Hose

#### ***General Uses:***

There are typically three categories of air hose: oil resistant, non-oil resistant, and non-conductive. The lower pressure hoses are generally used for applications such as air guns, service stations, industrial air lines in plants, and many other air services. High pressure air hoses which are considered to be hoses with working pressures above 300 psi (2069 kPa) are generally used in construction and mining where large volumes of air service are required. The non-conductive air hose is specifically made to meet one megohm resistance per inch when 1000 volts DC is applied.

#### ***Limitations:***

Hoses that are non-oil resistant rubber should not be used in an oil environment. The non-conductive hoses have an electrical resistance of one megohm per inch when subjected to 1000 volts DC. Consult hose manufacturer for recommendations. Air hoses with a helical wire will reduce the working pressure of the assembly, consult manufacturer for assembly recommendations.

#### ***Warnings:***

Do not use non-oil resistant hoses in an oil environment. Non-conductive hoses should be used in high voltage areas. Use extreme caution with high pressure air applications.

Refer to Selection Chart for fitting and attachment recommendations.

### 4.3.2 Asphalt and Hot Tar Hose

#### ***General Uses:***

This hose is designed for the bulk transfer and delivery of hot petroleum products, such as tar, asphalt, and oil. This hose is generally designed for suction and discharge. Consult hose manufacturer for vacuum rating.

#### ***Limitations:***

Generally, the hoses are recommended for a maximum of +350° (+176.66°C) service. Consult hose manufacturer for specific temperature ratings.

***Warnings:***

Consult the hose, coupling, and/or attachment manufacturer if the application temperature is above +350°F (+176.66°C).

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.3 Chemical Hose – Plastic Lined**

***General Uses:***

This section covers Chemical hoses manufactured from plastic liners such as Cross-Linked Polyethylene (XLPE) or Ultra-High Molecular Weight Polyethylene (UHMWPE). Chemical hose should be inspected, tested and maintained per the guidelines of RMA/IP-11-7.

***Limitations:***

The hose and couplings selected for use must be compatible with the chemical(s) to be conveyed under the stated service conditions. Refer to RMA Hose Handbook, Chapter 8, “Chemical Recommendations”, for general information and/or consult with your hose and coupling suppliers for specific product recommendations.

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.4 Chemical Hose – Rubber Lined**

***General Uses:***

This section covers Chemical hoses manufactured from various types of thermoset rubber polymers such as Natural Rubber (NR), Chlorosulfonated Polyethylene Rubber (CSM), and Fluorocarbon Rubber (FKM). Chemical hose should be inspected, tested and maintained per the guidelines of RMA/IP-11-7.

***Limitations:***

The hose and couplings selected for use must be compatible with the chemical(s) to be conveyed under the stated service conditions. Refer to RMA Hose Handbook - Chapter 8 - Chemical Recommendations for general information and/or consult with your hose and coupling suppliers for specific product recommendations.

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.5 Food Handling Hose, Regulated**

##### ***General Uses:***

These requirements cover hose assemblies designed to convey food products – dry foods, liquid foods and fatty foods. The governing specifications are controlled by the FDA, 3A, NSF, and USDA. This application covers sizes up to and including nominal inside diameter of 6 inches (152.4 mm). There are four classes of hose in the 3A standard. These include:

- Class 1 – +300°F (+148.8°C)
- Class 2 – +250°F (+121.11°C)
- Class 3 – +120°F (+48.88°C)
- Class 4 – +100°F (+37.77°C)

This standard would also encompass hose assemblies addressed by other agencies such as NSF, which cover hot food oil hose that is used at +300°F (+148.88°C) and intermittent to +350°F (+176.66°C).

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.6 Food Handling Hose – Non-regulated**

##### ***General Uses:***

These requirements cover hose assemblies designed to convey food products – dry foods, liquid foods and fatty foods. This application covers sizes up to and including nominal inside diameter 6 inches (152.4 mm).

##### ***Limitations:***

The type of food hose is dependent upon the application. Contact the hose supplier to determine the type of hose needed for the application.

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.7 Lay Flat Hose**

##### ***General Uses:***

This section covers General Purpose Lay Flat hose, i.e. hose that when empty, may be rolled onto itself, providing a neat compact package. Hoses of this type may be manufactured using various types of thermoplastics and or thermoset rubber polymers that provide some minor degree of oil resistance. However, they are not intended for use as a fuel

delivery hose. Polymers that may be used are, but not limited to, Polyvinyl Chloride, Natural Rubber, (NR), Styrene Butadiene Rubber, (SBR), Acrylonitrile Butadiene Rubber, (NBR), or Ethylene Propylene Diene Monomer, (EPDM), alone or in combination. Hoses of this type normally consist of a tube, a layer of reinforcement, and a cover.

Hoses of this type are normally used as discharge hoses in construction, agriculture, mining and marine industries. It is used to transport water or water based material from point of supply to point of discharge. This includes but not limited to, sump or bilge drainage, stock pond water, flood drainage, process water, etc.

***Limitations:***

Lay Flat hoses must not be connected to the suction side of a pump system. General Purpose Lay Flat hoses are NOT intended to be used to transport water intended for human consumption, nor should they be used to transport steam or super hot water, such as a condensate collection line, above +140°F (+60°C). GP Lay Flat hoses should not be used to transport oil or solvent-based liquids and should not be used to transport materials at temperatures below -20°F (-28.88)°C.

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.8 Material Handling Hose – Bulk Transfer**

***General Uses:***

This section covers hoses intended to convey products such as dust, limestone, wood chips, ores, coal, sand, gravel, grains, ground slate, asphalt roofing chips, metal shavings, flour, fish or shells, and/or slurries by means of suction, gravity feed, or pneumatic conveyance. Most products contain a means for static charge dissipation by incorporating a ground wire(s) in the hose wall and/or the use of a static-conducting black rubber in the tube.

***Limitations:***

The hose and couplings selected for use must be compatible with the product(s) to be conveyed under the stated service conditions. For example, use a black static conductive SBR tube for extremely abrasive materials. Use a black static conductive CR tube for oil and abrasion resistance, and a white Food Grade CR tube for conveyance of oily foods. The thickness of the tubes may vary from 1/16 inch (3.17 mm) to 1/2 inch (12.7 mm) depending on the severity of wear and service life expected.

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.9 Material Handling Hose – High Pressure Cement Handling**

##### ***General Uses:***

This Hose is intended for use in plaster, grout, shotcrete and cement applications, handling a multitude of materials being pumped to concrete structures, tunnel faces, swimming pools, etc. at pressures from 700 to 1000 psi (4826 kPa to 6890 kPa). For use as a flexible connection between pumping equipment and hard piping or as discharge hose on the delivery end of high pressure concrete pumps

##### ***Limitations:***

Typical operating temperature is –25°F (–32°C) to +150°F (65°C) in sizes 1 to 6 inches (25.4 to 152.4 mm).

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.10 Petroleum – Fuel Oil Hose**

##### ***General Uses:***

This hose should be used for transfer of fuel oil and other petroleum based products in home delivery, commercial and industrial service.

##### ***Limitations:***

This hose is designed for fuel oil service. If the hose is used for transferring non-petroleum based materials, then consult the hose manufacturer for chemical compatibility of the transferred material with the hose tube.

Hose usually ranges in inside diameters of 1 to 1½ inches (25.4 mm to 38.1 mm). The normal application temperature range is -20°F (-29°C) to +180°F (+82°C).

Hose is NOT to be used in a vacuum application.

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.11 Petroleum Drop Hose**

##### ***General Uses:***

This hose should be used for transfer of gasoline and other petroleum based products under pressure, gravity flow or suction.

***Limitations:***

This hose is designed for petroleum based products. If the hose is used for transferring non-petroleum based materials, then consult the hose manufacturer for chemical compatibility of the transferred material with the hose tube.

Hose is usually designed for a maximum of 150 psi (1034.24 kPa) working pressure. Hose can be used in a vacuum if the hose is constructed with a helical wire or reinforcement that will support a vacuum.

Hose usually ranges in inside diameters of 1 to 6 inches (25.4 mm to 152.4 mm). The normal application temperature range is -20°F to +180°F (-29°C to +82°C).

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.12 Petroleum Vapor Recovery Hose**

***General Uses:***

This hose is used for recovering gasoline vapors in tank truck loading at bulk terminals and in tank truck unloading at service stations.

***Limitations:***

This hose is designed for petroleum based products. If the hose is used for transferring non-petroleum based materials, then consult the hose manufacturer for chemical compatibility of the transferred material with the hose tube.

Hose usually ranges in inside diameters of 2 to 4 inches (50.8 mm to 101.6 mm). The normal application temperature range is -20°F (-29°C) to +180°F (+82°C).

***Warnings:***

Hose is for VAPOR RECOVERY ONLY!

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.13 Petroleum Discharge Hose**

***General Uses:***

This hose should be used for transfer of gasoline and other petroleum based products under pressure or gravity flow.

***Limitations:***

This hose is designed for petroleum based products. If the hose is used for transferring non-petroleum based materials, then consult the hose manufacturer for chemical compatibility of the transferred material with the hose tube.

Hose is usually designed for a maximum of 150 psi (1034.24 kPa) working pressure. Hose should NOT be used in a vacuum application.

Hose usually ranges in inside diameters of 1 to 6 inches (25.4 to 152.4 mm). The normal application temperature range is -20°F (-29°C) to +180°F (+82°C).

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.14 Petroleum Suction and Discharge Hose**

***General Uses:***

This hose should be used for transfer of gasoline and other petroleum based products under pressure, gravity flow or suction.

***Limitations:***

This hose is designed for petroleum based products. If the hose is used for transferring non-petroleum based materials, then consult the hose manufacturer for chemical compatibility of the transferred material with the hose tube.

Hose is usually designed for a maximum of 150 psi (1034.24 kPa) working pressure.

Hose can be used in a vacuum application, if the hose is constructed with a helical wire or reinforcement that will support a vacuum.

Hose usually ranges in inside diameters of 1 to 6 inches (25.4 to 152.4 mm). The normal application temperature range is -20°F (-29°C) to +180°F (+82 °C).

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.15 Push On Hose**

##### ***General Uses:***

These hoses are typically used for air tools, to convey water, mild chemicals, and various petroleum products. These hoses are generally used for air applications up to a maximum of 350 psi (2413.25 kPa). The size range is typically ¼ inch (6.35 mm) to 1 inch (25.4 mm).

##### ***Limitations:***

These hoses are used with push on couplings. Service temperature range is normally -40°F (4°C) to +212°F (+100°C), but check with the hose manufacturer for temperatures above +120°F (+49°C) and compatibility with various chemicals.

##### ***Warnings:***

Due to the risk of tube damage, external clamp should never be used in combination with push on style fittings.

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.16 Sandblast Hose**

##### ***General Uses:***

This hose is designed for sandblasting of metal castings, steel, stone, and cement - wherever abrasive materials are carried at a high velocity.

##### ***Limitations:***

Hose is designed with materials that do not have a high temperature rating. The usual temperature range is -40°F (4.0°C) to +160°F (+71.1°C). This hose requires special couplings for the application.

##### ***Warnings:***

This hose requires special couplings for the application. Sandblasting hoses do not have a long service life due to extreme application. Hoses should be inspected periodically to insure integrity of the assembly.

Refer to Selection Chart for fitting and attachment recommendations.

#### **4.3.17 Steam Hose**



***General Uses:***

The transport of pressurized saturated steam, pressurized super-heated steam, or pressurized hot water from point of supply to point of use.

***Limitations:***

Steam hoses must not be used for service above their rated working pressures or temperatures. Steam hoses should not be used to transport any material other than those listed in the General Use section above. Steam or hot water contaminated with hydrocarbons or chemicals may shorten service life.

These hoses are NOT intended to connect a steam supply point and a pressurized steam vessel or autoclave.

Refer to Selection Chart for fitting and attachment recommendations.

**4.3.18 Water/Multi-Purpose Hose**

***General Uses:***

There are typically two categories of water hose: multiple purpose, which is oil resistant, and general purpose, which is non-oil resistant.

The lower pressure hoses are generally used to transport water, petroleum based fluids, or water based materials from point of supply to point of use.

High pressure water hoses which are considered to be hoses with working pressures above 300 psi (2069 kPa) are generally used in construction and mining where large volume or high pressure water service is required.

***Limitations:***

Hoses used to transport hot water MUST NOT be used to transport pressurized steam. General and Multiple purpose hoses are NOT intended to transport water for human consumption. Hoses that are constructed of non-oil resistant rubber should not be used in oil environments. Water hoses with a helical wire will reduce the working pressure of the assembly, consult manufacturer for assembly recommendations.

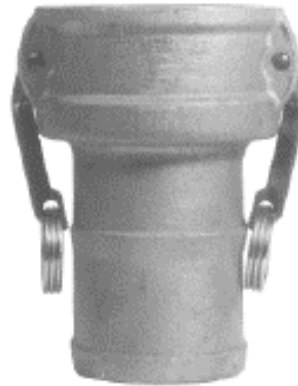
***Warnings:***

Do not use non-oil resistant hoses in an oil environment. Use extreme caution with high pressure water applications.

Refer to Selection Chart for fitting and attachment recommendations.

## 4.4 Fitting Data Sheets

### 4.4.1 Cam and Groove – Metallic Only



Old Designs



New Designs

#### ***General Uses:***

Cam and Groove couplers and adapters are used as a means of coupling hose assemblies to connect hose to hose or hose to pipe manifold for the purpose of transferring liquids or dry bulk products.

Cam and Groove couplings are available in both locking and non-locking designs.

***Limitations:***

Care must be used to select a body material, arm material and gasket material that is compatible with the material being transferred through the coupling. Contact coupler manufacturer for more information. Shanks to old Standard MIL-C-27487 with large serrations are not designed to be attached with a ferrule or sleeve. Damage to the tube can result if they are swaged or crimped. A shank that is specifically designed for swaging or crimping is recommended if the assembly is to be swaged or crimped. For maximum coupling retention, an interlocking collar must be used.

Cam and Groove fittings are interchangeable among manufacturers, with the exception of ½ inch (12.7 mm), 5 inch (127 mm) or 8 inch (203.2 mm), which may not be interchangeable. Contact coupling manufacturer for interchange information.

Pressure ratings of cam and groove fittings vary from manufacturer to manufacturer. Be sure to select a Cam and Groove fitting that will meet the application requirements.

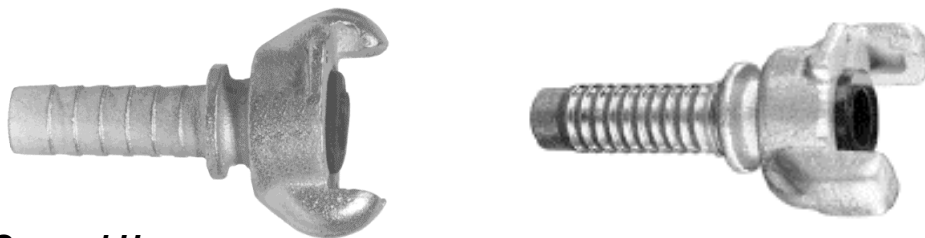
***Warnings:***

Cam and Groove couplings must never be used for steam service.

When replacement of cam arms is necessary, use only original manufacturer's replacement arms.

Refer to Selection Chart for hose and attachment recommendations.

**4.4.2 Universal Coupling (Chicago, Claw, Crowsfoot)**



***General Uses:***

This fitting is designed for air and water service and provides a quick connection between two lengths of hose; or length of hose and a male or female NPT outlet. In sizes ¼ inch (6.35 mm) to 1 inch (25.4 mm), all heads are the same and are interchangeable regardless of the hose shank or NPT thread size. Connections made by pressing the two heads together and applying a quarter-turn. The locking pin is placed in the holes to provide a safe connection.

**Limitations:**

The universal fittings have a maximum pressure rating of 110 psi (758.45 kPa).

**Warnings:**

Safety pins, clips or wires should always be installed in couplings. The universal fitting should never be used for steam service.

Refer to Selection Chart for hose and attachment recommendations.

**4.4.3 Short Shank Machined Fittings**



**General Uses:**

Low-pressure fluid transfer, suction, and discharge. Fitting styles include brass inserts, barbed quick disconnects, single bump nipples and small bore barbed inserts of other metallic materials.

**Limitations:**

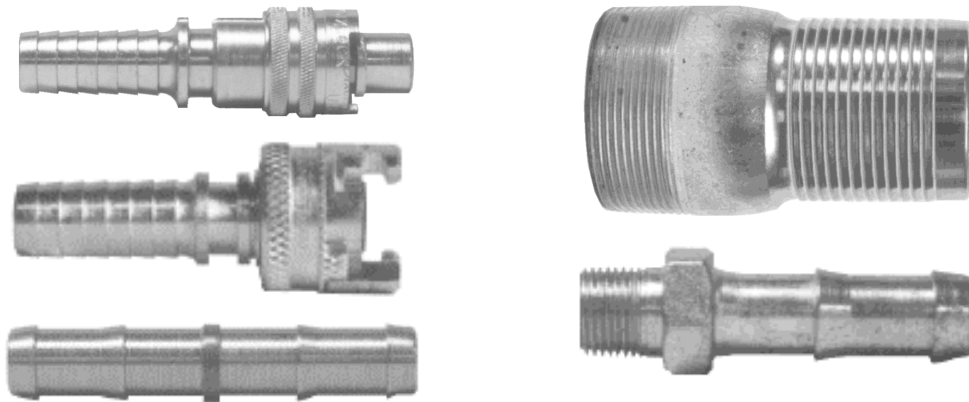
- A. Pressure ratings only apply to non-toxic and non-combustible fluids; careful consideration must be given to dangerous or volatile fluids.  
(Ref. Section 4.7 - Assembly Data Sheets)
- B. Unusual ends other than NPT threaded parts may also effect pressure ratings, consult manufacturers of those connections and/or accessories for pressure ratings.
- C. The following pressure tables apply to fittings made with the outside diameter of the serrations 1/16 inch (1.59 mm) larger than the nominal hose size with a tolerance of  $\pm 1/32$  inch (.79 mm). Minimum shank lengths are as specified in the table. Parts shall have multiple serrations. (Ref. Section 4.7 - Assembly Data Sheets)
- D. The pressure tables also apply to fittings with a single large bump; the bump being 3/32" (2.38 mm) larger than the nominal hose size, with a tolerance of  $\pm 1/32$ " (.79 mm). The area behind the bump shall be sized in diameter to the nominal size of the hose  $\pm 1/32$ " (.79 mm) and shall be wide enough to permit at least a 3/4" (19 mm) wide band clamp. Shank lengths and serration depths as specified in the table do not apply to this style.

- E. Materials used in the manufacture of these fittings shall be pipe or other solid billet. Pipe used shall be intended for pressure applications, shall be hydrostatically tested and certified. Recommended pipe materials include: steel pipe to ASTM A53 or better, stainless pipe to ASTM A312 or better, brass pipe to ASTM B43 or better, and aluminum pipe to ASTM B243 or better.

Nominal Size	Shank Length
1/4" (6.35 mm)	15/16" (23.8 mm)
3/8" (9.53 mm)	15/16" (23.8 mm)
1/2" (12.7 mm)	15/16" (23.8 mm)
5/8" (15.9 mm)	15/16" (23.8 mm)
3/4" (19 mm)	15/16" (23.8 mm)
1" (25.4 mm)	1-1/4" (31.8 mm)

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.4 Medium Shank Machined Fittings



##### **General Uses:**

Low pressure fluid transfer, suction, and discharge. Fitting styles include: combination nipples, double bump (grooved) nipples, menders, turned back nipples and Bowes & Thor style.

##### **Limitations:**

- A. Pressure ratings only apply to non-toxic and non-combustible liquids; careful consideration must be given to dangerous or volatile liquids. (*Ref. Section 4.7 - Assembly Data Sheets*)
- B. Unusual ends other than NPT threaded parts may also effect

pressure ratings, consult manufacturers of those connections and/or accessories for pressure ratings. Other suitable ends include grooved, turned back lapped joint style, British threaded, or other threads.

- C. The pressure tables apply to fittings made with the outside diameter of the serrations 1/32 inch (.79 mm) larger than the nominal hose size with a tolerance of  $\pm 1/32$  inch (.79 mm). Serration tips shall have a radius not exceeding .015 inch (.38 mm). All shanks shall be machined with multiple serrations or grooves. Minimum shank lengths and serration depths are as specified in the table. (*Ref. Section 4.7 - Assembly Data Sheets*)
- D. The pressure tables also apply to fittings with a minimum of 2 large bumps, each bump being 3/32 inch (2.38 mm) larger than the nominal hose size with a tolerance of  $\pm 1/32$  (.79 mm). The areas between the large bumps shall be sized in diameter to the nominal size of the hose  $\pm 1/32$  inch (.79 mm) and shall be wide enough to permit at least a 3/4 inch (19 mm) wide band clamp each. Shank lengths and serration depths as specified in the table do not apply to this style. (*Ref. Section 4.7 - Assembly Data Sheets*)
- E. Materials used in the manufacture of these fittings shall be pipe or other solid billet. Pipe used shall be intended for pressure applications, shall be hydrostatically tested and certified. Recommended pipe materials include: steel pipe to ASTM A53 or better, stainless pipe to ASTM A312 or better, brass pipe to ASTM B43 or better, and aluminum pipe to ASTM B243 or better.

Nominal Size	Shank Length	Depth
1/4" (6.35 mm)	1-3/8" (34.9 mm)	.025" (.64 mm)
3/8" (9.55 mm)	1-3/8" (34.9 mm)	.025" (.64 mm)
1/2" (12.7 mm)	1-3/8" (34.9 mm)	.030" (.64 mm)
5/8" (15.9 mm)	1-3/8" (34.9 mm)	.030" (.64 mm)
3/4" (19 mm)	1-3/8" (34.9 mm)	.030" (.64 mm)
1" (25.4 mm)	1-3/8" (34.9 mm)	.030" (.64 mm)
1-1/4" (31.8 mm)	1-11/16" (42.9 mm)	.035" (.89 mm)
1-1/2" (38.1 mm)	1-11/16" (42.9 mm)	.035" (.89 mm)
2" (50.8 mm)	2-14" (57.2 mm)	.045" (1.1 mm)
2-1/2" (63.8 mm)	2-7/16" (61.9 mm)	.045" (1.1 mm)
3" (76.2 mm)	2-7/8" (73 mm)	.045" (1.1 mm)
4" (102 mm)	3-11/16" (93.7 mm)	.045" (1.1 mm)
5" (127 mm)	4-13/16" (122 mm)	.055" (1.4 mm)
6" (152 mm)	6" (152 mm)	.055" (1.4 mm)
8" (203 mm)	7" (178 mm)	.055" (1.4 mm)

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.5 Long Shank Machined Fittings



##### **General Uses:**

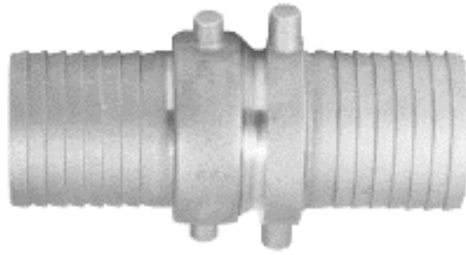
Low pressure fluid transfer, suction, and discharge. Fitting styles include: long shank combination nipples and long shank menders.

##### **Limitations:**

- A. Pressure ratings only apply to non-toxic and non-combustible liquids; careful consideration must be given to dangerous or volatile liquids. *(Ref. Section 4.7 - Assembly Data Sheets)*
- B. Unusual ends other than NPT threaded parts may also effect pressure ratings, consult manufacturers of those connections and/or accessories for pressure ratings. Other suitable ends include grooved, turned back lapped joint style, British threaded, or other threads.
- C. The following pressure tables apply to fittings made with the outside diameter of the serrations 1/32 inch (.79 mm) larger than the nominal hose size with a tolerance of  $\pm 1/32$  inch (.79 mm). Serration tips shall have a radius not exceeding .015 inch (.38 mm). All shanks shall be machined with multiple serrations. Minimum shank lengths and serration depths are as specified in the table. *(Ref. Section 4.7 - Assembly Data Sheets)*
- D. Materials used in the manufacture of these fittings shall be pipe or other solid billet. Pipe used shall be intended for pressure applications, shall be hydrostatically tested and certified. Recommended pipe materials include: steel pipe to ASTM A53 or better, stainless pipe to ASTM A312 or better, brass pipe to ASTM B43 or better, and aluminum pipe to ASTM B243 or better.

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.6 Cast Shank Fittings



**General Uses:**

Low pressure liquid transfer, suction, and discharge. Fitting styles include: shank couplings, suction couplings, pin lug couplings, garden hose couplings, and other shank fittings not meeting the specific requirements of the other categories. This category does not include cam & Groove, ground joint or universal fittings.

**Limitations:**

- A. Pressure ratings only apply to non-toxic and non-combustible liquids; careful consideration must be given to dangerous or volatile liquids. *(Ref. Section 4.7 - Assembly Data Sheets)*
- B. Unusual ends other than NPT, NPSM or NPSH threaded parts may also effect pressure ratings, consult manufacturers of those connections and/or accessories for pressure ratings. This section may also apply to menders or other shank style fittings not meeting the criteria for machined shank fittings as stated in this document.
- C. The following pressure tables apply to fittings made with the outside diameter of the serrations 1/16 inch (1.59 mm) larger than the nominal hose size with a tolerance of  $\pm 1/16$  inch (1.59 mm). Minimum shank lengths are as specified in the table. Parts shall have multiple serrations. *(Ref. Section 4.7 - Assembly Data Sheets)*

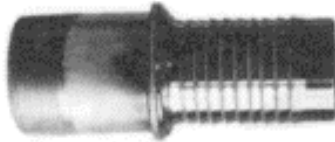


Nominal Size	Shank Length
1/4" (6.35 mm)	1" (25.4 mm)
3/8" (9.35 mm)	1" (25.4 mm)
1/2" (12.7 mm)	1" (25.4 mm)
5/8" (15.9 mm)	1" (25.4 mm)
3/4" (19 mm)	1" (25.4 mm)
1" (25.4 mm)	1-1/4" (31.8 mm)
1-1/4" (31.8 mm)	1-1/4" (31.8 mm)
1-1/2" (38.1 mm)	1-1/2" (38.1 mm)
2" (50.8 mm)	1-1/2" (38.1 mm)
2-1/2" (63.5 mm)	2" (50.8 mm)
3" (76.2 mm)	2" (50.8 mm)
4" (102 mm)	3" (76.2 mm)
5" (127 mm)	3" (76.2 mm)
6" (152 mm)	4" (102 mm)
8" (203 mm)	4" (102 mm)

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.7 Interlocking

##### 4.4.7.1 Interlocking Swaged Stem



##### **General Uses:**

A swaged coupling that provides a connection between coupling and hose allowing for higher-pressure assemblies. These fittings include an interlocking collar that is specifically designed to be used with a ferrule.

##### **Limitation:**

Special swaging equipment is necessary to attach fittings to hose. Refer to Selection Chart for hose and attachment recommendations.

##### 4.4.7.2 Interlocking Crimp Stem



**General Uses:**

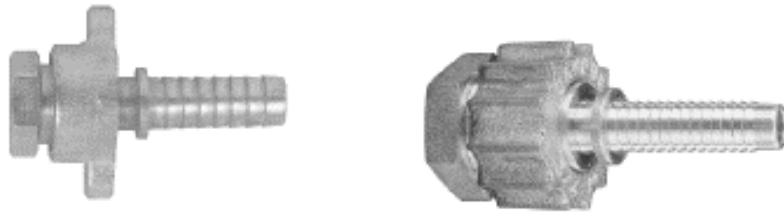
A. crimped coupling that provides a connection between coupling and hose allowing for higher-pressure assemblies. These fittings include an interlocking collar that is specifically designed to be used with a ferrule.

**Limitation:**

Special crimping equipment is necessary to attach fittings to hose.

Refer to Selection Chart for hose and attachment recommendations.

**4.4.8 Ground Joint Fittings**



**General Uses:**

High pressure air, water; steam; other high pressure, elevated temperature applications. Fitting styles include: tapered seat and washer seal ground joints, interlocking male stems, and interlocking hose menders.

**Limitations:**

For ASME B31.1 applications:

- A. Ground joints, malleable or ductile interlocking male stems not to be used for toxic fluids or flammable gases.
- B. Steel interlocking male stems limited to +775°F (+412.8°C). Malleable or ductile ground joints or interlocking male stems limited to 350 psi (2413 kPa) and +450°F (+232.2°C).
- C. Steel or ductile ground joints or interlocking male stems limited to 400°F (204.4°C) for flammable or combustible liquids. Malleable ground joints or interlocking male stems may not be suitable for flammable or combustible fluids.
- D. Further code consultation is recommended.

For ASME B31.3 applications:

- A. Steel ground joints or interlocking male stems are not suitable.
- B. Malleable or ductile ground joints or interlocking male stems limited to -20°F (-8.9°C) to +650°F (+343°C) temperature range.
- C. Malleable ground joints or interlocking male stems not suitable for severe cyclic conditions.
- D. Malleable ground joints or interlocking male stems not suitable for flammable fluid service above +300°F (+148.9°C) or 400 psi. (2758 kPa).
- E. Ground joints or interlocking male stems not suitable for category K fluid service. Category K fluid service is defined by the owner of the piping system as high pressure, typically above 2500 psi (17237 kPa).
- F. Further code consultation is recommended.

For general service applications:

- A. Clamps other than interlocking style may be used; however, pressure and temperature rating charts will not apply. Generally, use of non-interlocking clamps result in similar pressure ratings as other similar shank style fittings.
- B. Use of ground joints or interlocking male stems of unknown or untraceable origin are not recommended for critical applications such as toxic, flammable, combustible fluids, or cyclic conditions involving either temperature or pressure.
- C. The following table shows minimum shank lengths of ground joints or interlocking male stems which the assembly pressure rating tables are based. This table also shows the working pressure of the ground joint or interlocking male stem at a temperature range of -20°F (-28.9°C) to +450°F (+232°C). Materials of manufacture for these tables to be applicable are: steel billet, ductile iron castings to ASTM A395 or malleable iron castings to ASTM A47. Use of materials which can not be certified to these requirements preclude the use of the pressure ratings.

Nominal Size	Shank Length
1/4" (6.35 mm)	1 1/8" (28.6 mm)
3/8" (9.35 mm)	1-1/4" (31.8 mm)
1/2" (12.7 mm)	1-5/8" (41.2mm)
3/4" (19 mm)	2-3/8" (60 mm)
1" (25.4 mm)	2-3/8" (60 mm)
1-1/4" (31.8 mm)	3-1/4" (82.6 mm)
1-1/2" (38.1 mm)	3-3/8" (85.7 mm)
2" (50.8 mm)	3-7/8" (98.4 mm)
2-1/2" (63.5 mm)	4-5/8" (117 mm)
3" (76.2 mm)	5" (127 mm)
4" (102 mm)	5-3/4" (146 mm)
6" (152.4 mm)	6" (152.4 mm)

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.9 Sanitary



##### **General Uses:**

Sanitary stainless steel food grade fittings are designed for various food hose applications, including the processing of wine, beer, juice, vegetables and dairy products.

##### **Limitations:**

Fittings should meet the 3-A Standards for food service if required. Special equipment is required to attach fittings to hose.

The fittings and the ferrules must be from the same manufacturer.

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.10 Sandblast



***General Uses:***

Designed for use on sandblast hose.

***Limitations:***

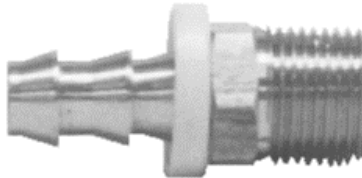
Since these fittings attach to the outside of the hose, they are to be used only with Sand Blast hose. Special care must be taken not to let the screws penetrate the hose tube.

***Warnings:***

These fittings are designed to be used with sandblast hose only.

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.11 Push-on



***General Uses:***

Push-on fittings are specifically designed for push-on style hose. These fittings are commonly used for air, water, petroleum based fluids, etc.

***Limitations:***

Fittings are designed to be used without hose ferrules or clamps.

***Warnings:***

These fittings are designed for Push-on hose only. The barbs of the fitting are larger in diameter and may cut the tube if used on other hoses. Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.12 Internal Expansion Stems



***General Uses:***

An internally expanded coupling provides a permanent connection between coupling and hose where full flow is desired.

***Limitation:***

Special expanding equipment is necessary to attach fittings to hose.

It is important that stems and ferrules come from the same manufacturer, since there is no standardization in the industry.

***Warnings:***

Not intended for Cross-Linked Polyethylene or Ultra High Molecular Weight Polyethylene hoses. Proper ferrule selection is critical for the fabrication of a safe assembly.

These do not include brass short shank (Scovill-style) internal expanded fittings.

Refer to Selection Chart for hose and attachment recommendations.

#### 4.4.13 Internal Expanded Short Brass



**General Uses:**

Brass, internally expanded permanent coupling. Recommended for low-pressure discharge and suction service. Commonly used in the transfer of fuel in industry to homes, airplanes, ships, etc. The working pressure of these fittings varies with the size of the fitting, the size and construction of the hose and the media being conveyed. Consult the Factory for recommendations. *Not intended for air service.*

**Limitations:**

Care must be used to select a body material and gasket material that is compatible with the material being transferred through the coupling.

Special coupling machinery is required to properly install these fittings.

Where the final hose assembly must comply with API 1529 specifications the couplings must be manufactured to comply with API 1529.

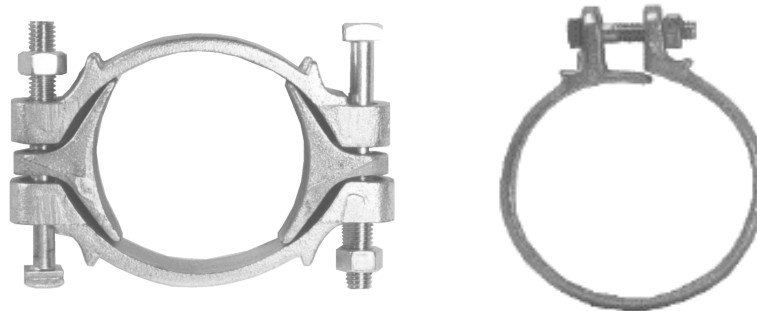
**Warnings:**

Internally expanded brass short couplings are not intended for air service.

Refer to Selection Chart for hose and attachment recommendations.

## 4.5 Attachment Data Sheets

### 4.5.1 Clamp, Bolt



**General Uses:**

These clamps provide a means to secure fittings in heavy or light wall hose. For use with low pressure couplings for suction and discharge service.

## Clamp Recommendations by Hose Size (for combination nipple style shanks)

I.D.	Number of clamps
Below 2" (50.8 mm)	1
2" to 4" (50.8 mm to 101.6 mm)	2
5" to 6" (127 mm to 152.4 mm)	3
8" (203.2) and above	4

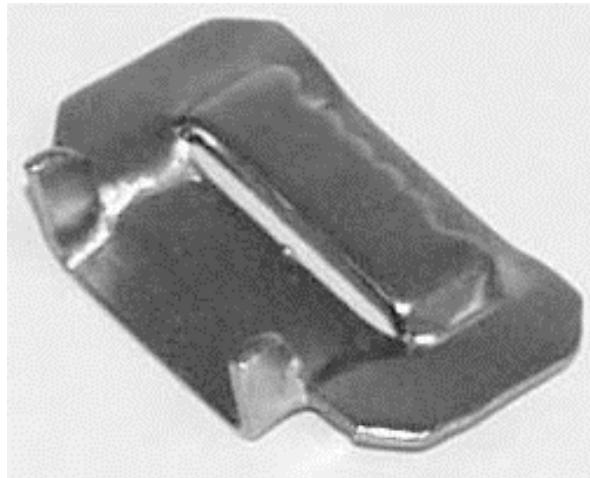
**Limitations:**

Hose outside diameter determines the proper size clamp to use. Single bolt clamps have hose range of 7/8 inch (22.22 mm) to 5-1/4 inches (133.35 mm). Double bolt clamps have hose range of 3-1/2 inches (88.9 mm) to 17-1/2 inches (444.5 mm).

Malleable iron construction restricts use under certain conditions. Check compatibility with media used as well as the environment.

**Warnings:**

Do not use Bolt Clamps on hoses that are constructed with a helix wire. Refer to Selection Chart for hose and fitting recommendations.

**4.5.2 Band & Buckles****General Uses:**

To secure medium and heavy wall hose to grooved or serrated fitting shanks. Band and buckle is applied with manual tools only, and therefore may be too time consuming for high volume production. On the other hand, the band & buckle method gives complete diameter versatility. This versatility makes this attachment method especially suitable for field installation and repairs.



***Limitations:***

Not suited for extreme thin wall and lay flat hose, or very small diameters, due to the possibility of leakage under the buckle.

***Warnings:***

Improperly tightened bands or an insufficient number of bands used per fitting may result in a potentially dangerous hose assembly. A tighter band keeps the fitting more secure, but excess tension could damage the hose.

Refer to Selection Chart for hose and fitting recommendations.

**4.5.3 Crimp and Swage**

**4.5.3.1 Crimped, Ferrule/Sleeve**



Ferrule



Sleeve

***General Uses:***

Crimped Sleeves may be used on virtually any metallic shank fitting that is designed for crimping. These sleeves do not interlock with the fittings.

***Limitations:***

For purposes of this document, Crimped Ferrules are limited to ferrules with a minimum wall of .085" (2.16 mm).

The material of the ferrule/sleeve must be compatible with all materials to which it may be exposed. This includes both the material being transferred as well as external materials.

Proper equipment is required to crimp the ferrule/sleeve onto the

assembly. For maximum coupling retention, the ferrule must lock into the hose shank locking collar.

***Warnings:***

The use of crimped ferrule/sleeve on a cam & groove fitting to old MIL-C-27487 may result in damage to the hose assembly.

Refer to Selection Chart for hose and fitting recommendations.

**4.5.3.2 Swaged Ferrule**



Ferrule



Sleeve

***General Uses:***

Swaged ferrules are designed to be used with fittings with a collar to provide a high pressure hose assembly where an interlocked connection is required between fitting and ferrule.

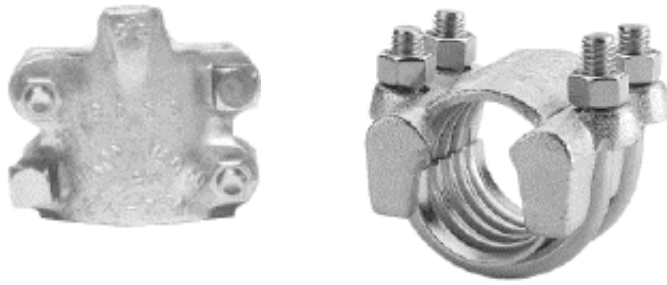
***Limitations:***

For purposes of this document, Swaged Ferrules are limited to ferrules with a minimum wall of .085" (2.16 mm).

Special equipment is required to assemble these ferrules. Proper swage die and ferrule selection are critical for the fabrication of a safe assembly.

Refer to Selection Chart for hose and fitting recommendations.

## Clamp, Interlocking



### ***General Uses:***

High pressure and/or high temperature clamping on ground joint coupling, interlocking male stems and other fittings with an interlocking collar.

### ***Limitations:***

Not recommended for fittings without an interlocking collar. Materials used must meet manufacturer's specifications. Clamp halves or yokes to be from malleable iron to ASTM A47 or ductile iron to ASTM A536 or better, bolts or U-bolts made from carbon steel; all parts zinc plated.

### ***Warnings:***

Re-tightening of clamps may be necessary. Regular inspection of the assembly is recommended. Refer to Selection Chart for hose and fitting recommendations.

## 4.5.5 Internal Expansion Ferrule



### ***General Uses:***

*See Internal Expansion Fitting.*

### ***Limitations:***

Special equipment is required to assemble these ferrules.  
Refer to Selection Chart for hose and fitting recommendations.

#### **4.5.6 Clamp, Pinch**



##### ***General Uses:***

Metal pinch clamps are manufactured in a variety of styles. These styles include: 1-ear, 2-ear and stepless.

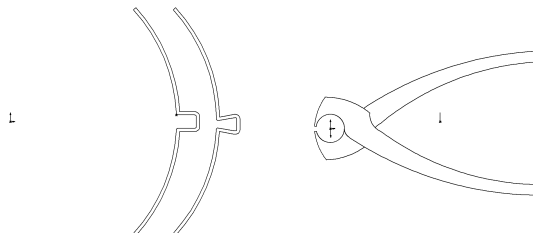
The two-ear clamps discussed in this document are manufactured out of 1008 carbon steel which is zinc plated. Depending upon the size of the clamps, the physical dimensions of these clamps may vary.

This document deals specifically with 2-ear Pinch clamps.

These clamps are used to secure various types of industrial hose to a variety of fittings. They are designed to attach machined or cast barbed fittings to low pressure, small bore soft wall hose.

##### ***Limitations:-***

Pinch clamps should not be used for service on high pressure applications. Proper tools are required for installation and removal of pinch clamps.



##### ***Warnings:***

Sizing of the materials to be clamped is of utmost importance. Proper

sizing is achieved by measuring the outside diameter (OD) of the hose after the appropriate fitting (coupling) is inserted firmly and squarely into the hose.

Refer to Selection Chart for hose and fitting recommendations.

#### **4.5.7 Clamp, Performed**



##### ***General Uses:***

To secure hose to grooved or serrated fitting shanks.

##### ***Limitations:***

Do not use for steam or other applications where clamp re-tightening is required.

##### ***Warnings:***

Improperly tightened clamps or an insufficient number of clamps used per fitting may result in a potentially dangerous hose assembly. A tighter clamp keeps the fitting more secure, but excess tension could damage the hose.

Refer to Selection Chart for hose and fitting recommendations.

#### **4.5.8 Internal Expansion Short Brass/Stainless Ferrule**



##### ***General Uses:***

Brass or Stainless Steel Ferrules are used exclusively on, internally expanded permanent coupling. Recommended for low pressure discharge and suction service. Commonly used in the transfer of fuel in industry such as homes, airplanes, ships, etc. The working pressure of these fittings varies with the size of the fitting, the size and construction of the hose and the media being conveyed. Consult the Factory for recommendations. Not intended for air service.

##### ***Limitations:***

Special equipment is required to assemble these ferrules.

##### ***Warnings:***

These internally expanded short brass or stainless ferrules are not intended for air service. Refer to Selection Chart for hose and fitting recommendations.

### Pressure Ratings Chart

Hose	Fitting	Attachment	1/4"	3/8"	1/2"	5/8"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"	Special Notes
ALL PRESSURE RECOMMENDATIONS ARE "UP TO OR HOSE RATING" WHICH EVER IS LOWER																	
Air (assumed soft wall)	Universal	Crimp		110	110	110	110	110									
Air (assumed soft wall)	Universal	Interlocking		110	110	110	110	110									
Air (assumed soft wall)	Universal	Preformed		110	110	110	110	110									2 bands on 3/4 or larger
Air (assumed soft wall)	Machined, short	Crimp	200	150	150	100	100	100									
Air (assumed soft wall)	Machined, short	Pinch	200	150	150	100	100	100									
Air (assumed soft wall)	Machined, short	Preformed	200	150	150	100	100	100									
Air (assumed soft wall)	Machine, medium	Pinch	300	300	250	200	200	150									2 bands on 1/2 - 1; 1 on 1/4 & 3/8
Air (assumed soft wall)	Machine, medium	Preformed	300	300	250	200	200	150	150	150	125	125	125	125		50	3 bands on 3,4 & 6; 1 on up to 5/8; 2 on rest
Air (assumed soft wall)	Machine, medium	Band/Buckle							225	225	200	200	175	175		75	3 bands on 3,4 & 6; 2 on rest
Air (assumed soft wall)	Machined, long	Pinch	300	300	250	200	200	150									2 bands on 1/2 - 1; 1 on 1/4 & 3/8
Air (assumed soft wall)	Machined, long	Preformed			400	300	300	300	225	225	200	200	175	175		75	5 bands on 3,4 & 6; 4 on 2 & 2 1/2; 3 on rest
Air (assumed soft wall)	Machined, long	Band/Buckle							300	300	250	250	250	200		100	5 bands on 3,4 & 6; 4 on 2 & 2 1/2; 3 on rest
Air	G/J	Interlocking	600	600	600		600	600	600	600	600	450	450	230		230	
Air	Crimp/Swage	Crimp	600	600	600	600	600	600	600	600	600	600	600	500		400	
Air	Crimp/Swage	Swage	600	600	600	600	600	600	600	600	600	600	600	500		400	
Asphalt & Hot Tar	G/J	Interlocking						600	600	600	600	450	450	230			
Chemical Plastic	C&G	Crimp			150		250	250	250	250	250	150	125	100			
Chemical Plastic	C&G	Swage			150		250	250	250	250	250	150	125	100			
Chemical Plastic	C&G	Preformed			125		125	125	125	125	100	75	75	50			
Chemical Plastic	C&G	Band/Buckle							150	150	125	100	75	50			
Chemical Plastic	Crimp/Swage	Crimp			600		600	600	600	400	350	600	300	500		400	
Chemical Plastic	Crimp/Swage	Swage			600		600	600	600	600	600	600	600	500		400	
Chemical Plastic	Machined, medium	Preformed			125		125	125	125	125	100	75	75	50			3 bands on 3 & 4; 2 on rest
Chemical Plastic	Machined, medium	Band/Buckle							150	150	125	100	75	50			3 bands on 3 & 4; 2 on rest
Chemical Plastic	Machined, long	Preformed			150		150	150	150	150	125	100	75	50			5 bands on 3 & 4; 4 on 2 & 2-1/3; 3 on rest

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Hose	Fitting	Attachment	1/4"	3/8"	1/2"	5/8"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"	Special Notes
Chemical Plastic	Machined, long	Band/Buckle							200	175	150	125	100	75			5 bands on 3 & 4; 4 on 2 & 2-1/3; 3 on rest
Chemical Rubber	C&G	Crimp			150		250	250	250	250	250	150	125	100			
Chemical Rubber	C&G	Swage			150		250	250	250	250	250	150	125	100			
Chemical Rubber	C&G	Preformed			150		250	250	250	250	250	150	125	100			
Chemical Rubber	C&G	Band/Buckle							250	250	250	150	125	100			
Chemical Rubber	Crimp/Swage	Crimp			600		600	600	600	400	350	60	300	500		400	
Chemical Rubber	Crimp/Swage	Swage			600		600	600	600	600	600	600	600	500		400	
Chemical Rubber	Machined, medium	Preformed			250		250	250	250	250	200	150	125	100			3 bands on 3 & 4; 2 on rest
Chemical Rubber	Machined, medium	Band/Buckle							300	300	250	175	150	125			3 bands on 3 & 4; 2 on rest
Chemical Rubber	Machined, long	Preformed			300		300	300	300	300	250	175	150	125			5 bands on 3 & 4; 4 on 2 & 2-1/3; 3 on rest
Chemical Rubber	Machined, long	Band/Buckle							375	375	325	250	200	150			5 bands on 3 & 4; 4 on 2 & 2-1/3; 3 on rest
Chemical Rubber	Internal Ex.	Internal Ex.						800	800	800	800	600	600	500		400	
Food Grade Regulated	Sanitary	Internal Ex.						250		250	250	250	250	250			
Food Grade Unregulated	C&G	Crimp			150		250	250	250	250	250	150	125	100		75	
Food Grade Unregulated	C&G	Swage			150		250	250	250	250	250	150	125	100		75	
Food Grade Unregulated	C&G	Preformed			150		250	250	250	250	250	150	125	100		75	
Food Grade Unregulated	C&G	Band/Buckle							250	250	250	150	125	100		75	
Food Grade Unregulated	Machined, medium	Preformed			250		250	250	250	250	200	150	125	100			3 bands on 3 & 4; 2 on rest
Food Grade Unregulated	Machined, medium	Band/Buckle							300	300	250	175	150	125			3 bands on 3 & 4; 2 on rest
Food Grade Unregulated	Crimp/Swage	Crimp			600		600	600	600	400	350	600	300	500		400	
Food Grade Unregulated	Crimp/Swage	Swage			600		600	600	600	600	600	600	600	500		400	
Food Grade Unregulated	Internal Ex.	Internal Ex.						250	800	250	250	250	250	250		400	
Layflat	C&G	Preformed								250	250	150	125	100	75	50	
Layflat	C&G	Crimp								250	250	150	125	100	75	50	
Layflat	Machined, medium	Preformed								250	200	150	125	100	75	50	3 bands on 3,4,5 & 6; 2 on rest
Layflat	Machined, long	Preformed								300	250	175	150	125	100	75	5 bands on 3,4,5 & 6; 3 on 1-1/2; 4 on rest
Layflat	Cast	Preformed								75	75	50	50	50	50	25	3 bands on 3,4,5 & 6; 2 on rest



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Hose	Fitting	Attachment	1/4"	3/8"	1/2"	5/8"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"	Special Notes
Material Handling	C&G	Crimp								250	250	150	125	100	75	75	
Material Handling	C&G	Swage								250	250	150	125	100	75	75	
Material Handling	C&G	Preformed								250	250	150	125	100	75	75	
Material Handling	C&G	Band/Buckle								250	250	150	125	100	75	75	
Material Handling (soft wall only)	Machined, medium	Bolt Clamp								250	200	150	125	100	75	75	
Material Handling	Machined, medium	Preformed								250	200	150	125	100	75	75	3 bands on 3,4,5 & 6; 1 on up to 5/8 2 on rest
Material Handling	Machined, medium	Band/Buckle								300	250	175	150	125	100	100	3 bands on 3,4,5 & 6; 1 on up to 5/8 2 on rest
Material Handling (soft wall only)	Machined, long	Bolt Clamp								300	250	175	150	125	100	75	
Material Handling	Machined, long	Preformed								300	250	175	150	125	100	100	5 bands on 3,4,5 & 6; 4 on 2 & 2-1/2; 3 on rest
Material Handling	Machined, long	Band/Buckle								375	325	250	200	150	125	125	5 bands on 3,4,5 & 6; 4 on 2 & 2-1/2; 3 on rest
Material Handling (soft wall only)	Cast	Bolt Clamp								75	75	50	50	50	50	25	
Material Handling	Cast	Preformed								75	75	50	50	50	50	25	
Material Handling	Cast	Band/Buckle								75	75	50	50	50	50	25	
Material Handling	Crimp/Swage	Crimp								600	600	600	600	500	450	400	
Material Handling	Crimp/Swage	Swage								600	600	600	600	500	450	400	
Material Handling	Internal Ex.	Internal Ex.								800	800	600	600	500		400	
Material Handling - Cement	Crimp/Swage	Crimp						600	600	600	600	600	600	500	450	400	Erosion is possible
Material Handling - Cement	Crimp/Swage	Swage						600	600	600	600	600	600	500	450	400	Erosion is possible
Material Handling - Cement	G/J	Interlocking						600	600	600	600	450	450	230		230	Erosion is possible
Material Handling - Cement	Internal Ex.	Internal Ex.						800	800	800	800	600	600	500		400	Erosion is possible
Petroleum Transfer	C&G	Preformed			150		250	250	250	250	250	150	125	100	75	75	
Petroleum Transfer	C&G	Band/Buckle							250	250	250	150	125	100	75	75	
Petroleum Transfer	C&G	Crimp			150		250	250	250	250	250	150	125	100	75	75	
Petroleum	C&G	Swage			150		250	250	250	250	250	150	125	100	75	75	

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Hose	Fitting	Attachment	1/4"	3/8"	1/2"	5/8"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"	Special Notes
Transfer																	
Petroleum Transfer	Machined, medium	Preformed			125		250	250	250	250	200	150	125	100	75	75	3 bands on 3,4,5 & 6; 1 on up to 5/8; 2 on rest
Petroleum Transfer	Machined, medium	Band/Buckle							300	300	250	175	150	125	100	100	3 bands on 3,4,5 & 6; 1 on up to 5/8; 2 on rest
Petroleum Transfer	Machined, long	Preformed			300		300	300	300	300	250	175	150	125	100	100	5 bands on 3,4,5 & 6; 4 on 2 & 2-1/2; 3 on rest
Petroleum Transfer	Machine, long	Band/Buckle							375	375	325	250	200	150	125	125	5 bands on 3,4,5 & 6; 4 on 2 & 2-1/2; 3 on rest
Petroleum Transfer	Crimp/Swage	Crimp	600	600	600	600	600	600	600	600	600	600	600	500	450	400	
Petroleum Transfer	Crimp Swage	Swage	600	600	600	600	600	600	600	600	600	600	600	500	450	400	
Petroleum Transfer	Internal Ex.	Internal Ex.							800	800	800	600	600	500		400	
Petroleum Transfer	Internal Ex. Short Brass	Internal Ex. Short Brass							300	300	300	300	300	300			
Push On	Push On	N/A			175	175	175	175	150	150	200	300	300				
Sand Blast	Sand Blast	N/A			175	175	175	175	150	150	200	300	300				
Steam	G/J	Interlocking			600		600	600	600	600	600	450	450	230		230	
Water	C&G	Crimp			150		250	250	250	250	250	150	125	100	75	75	
Water	C&G	Swage			150		250	250	250	250	250	150	125	100	75	75	
Water	C&G	Preformed			150		250	250	250	250	250	150	125	100	75	75	
Water	C&G	Band/Buckle							250	250	250	150	125	100	75	75	
Water	Universal	Preformed	110	110	110	110	110	110									
Water	Universal	Interlocking	110	110	110	110	110	110									
Water	Machined, short	Crimp	200	150	150	100	100	100									
Water	Machined, short	Pinch	200	150	150	100	100	100									
Water	Machined, short	Preformed	200	150	150	100	100	100									
Water	Machined, medium	Preformed	300	300	300	300	300	250	250	250	200	150	125	125	75	50	3 bands on 3,4 & 6; 1 on up to 5/8; 2 on rest
Water	Machined, medium	Pinch	300	300	250	200	200	150									
Water	Machined, medium	Bolt Clamp	300	300	300	300	300	250	250	250	200	150	125	100	75	75	
Water	Machined, long	Preformed			400	400	400	300	300	300	250	200	175	175	125	75	5 bands on 3,4 & 6; 4 on 2 & 2-1/2; 3 on rest
Water	Machined, long	Bolt Clamp			400	400	400	300	300	300	250	175	150	125	100	75	
Water	Cast	Bolt Clamp	200	200	150	100	100	100	75	75	75	50	50	50	50	25	
Water	Cast	Preformed	200	200	150	100	100	100	75	75	75	50	50	50	50	25	
Water	Cast	Band/Buckle							75	75	75	50	50	50	50	25	
Water	Crimp/Swage	Crimp	600	600	600	600	600	600	600	600	600	600	600	500		400	
Water	Crimp/Swage	Swage	600	600	600	600	600	600	600	600	600	600	600	500		400	
Water	G/J	Interlocking	600	600	600		600	600	600	600	600	450	450	230		230	

## **Section 5 – Testing Procedures**

### **5.1 Purpose**

The following testing methods may or may not be required. Refer to the customer requirements and/or the appropriate assembly data sheets for recommended testing and documentation needed.

### **5.2 Hydrostatic Proof Pressure Tests**

A proof test is usually conducted at 50% of the minimum burst pressure or twice the working pressure for a new hose assembly and one and a half times the working pressure for used assemblies. The test is usually conducted for a minimum of 5 minutes under pressure.

#### ***Recommended Procedure***

For Industrial hose assemblies, it is strongly recommended to use hydrostatic pressure test methods instead of pneumatic proof testing!

A hydrostatic pressure test requires either a hand pump, a power driven hydraulic pump, or an accumulator system. Connect the hose assembly to the test pump in a straight fashion, assuring a leak tight connection. It is extremely important that fittings, adapters, and any other mating components are rated for the pressure value of the test. It is recommended that the hose assembly be secured in an encapsulated tank that will withstand the pressure, and secure it with steel rods or straps close to each end and at ten-foot intervals along the length of the hose. This will prevent it from “whipping” if a failure occurs. The securing rods or straps must be anchored firmly to the test structure, but should not contact the hose. The hose must be free to move slightly when pressure is applied.

An outlet valve should be applied to the hose end of the assembly that opposes the test pump end of the assembly. Unless otherwise specified by the customer, the test media should be water. Fill the hose with water while the outlet end is raised and the valve slightly opened to bleed all of the air from the system. Use the outlet valve to bleed all air remaining in the hose. When all the air has been expelled, close the outlet valve and lower the raised end.

***\*\*\*This is very important as a safety measure because expansion of air compressed in the hose, when suddenly released by bursting or other failure, might result in a serious accident. \*\*\****

Next for reference, mark a line behind the couplings which is at the end of the ferrule, clamp, band, etc. Then gradually raise the pressure to the desired pressure rating. Hold the pressure at for 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.

**WARNING\*\*WARNING\*\*WARNING\*\*WARNING\*\*WARNING**

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

Hoses must be properly cleaned prior to inspection and testing. This will prevent unexpected reactions between conveyants and the test media. Always wear safety glasses, gloves, and protective clothing to protect from leaks or high pressure spray. Also, use shields to protect people in the work area in the event of a hose burst, spray, or coupling blow-off.

It is recommended to never stand in front of, over, or behind the ends of a hose assembly during pressure testing. Also make sure that the hose is sufficiently shielded during pressure testing to stop a coupling in case of a coupling blow-off.

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

### **5.3 Other Leakage Tests**

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

### **5.4 Electrical Continuity Test**

There are two types of electrical grounding paths for hoses: metallic and non-metallic. Hoses should be tested with a calibrated multi-meter from end fitting to end fitting to determine if the assembly is electrically continuous.

**Note:**

All lengths of Composite Hose that have been fitted with electrically conductive end fittings must be tested.

## **5.5 Electrical Resistance Test - UL330 Testing Method for an Assembly**

The maximum resistance for a hose assembly is determined by the standard that the assembly is made to conform, such as the requirement of 70,000 ohms/ft. per the UL 330 specification.

Hoses that are metallically grounded have a static wire, metal helical wire, or wire braid that is connected to the coupling on each end of the hose. Per the UL 330 specification, the electrical resistance of a metallic grounded hose can be measured with a standard low-voltage ohmmeter. Hoses which have grounding paths that have resistance greater than 1000 ohms require electrical continuity testing to be done with an ohmmeter that has an internal resistance of 100,000 ohms +/- 10 percent, with an open circuit potential of 500 volts, D.C.

Hoses that are non-metallically grounded utilize a conductive material to achieve electrical continuity. These hoses require electrical continuity testing to be completed with an ohmmeter that has an internal resistance of 100,000 ohms +/- 10 percent with an open circuit potential of 500 volts, D.C.

The electrical resistance of the hose is measured from coupling connection to the other end coupling connection while pressurized with air, nitrogen, or kerosene at 75 psig. During the electrical continuity testing, if there is a swivel coupling present, the swivel must be rotated 360 degrees while the ohmmeter leads are attached and the hose is under 75 psig pressure. The highest reading during the test is considered to be the electrical resistance of the hose assembly.

## **5.6 Visual Inspection**

All sample assemblies should be visually inspected for substandard quality conditions in the hose or couplings. Each assembly should be visually inspected for kinks, loose covers, bulges or ballooning, soft spots, cuts, broken wires, or any obvious defect in the hose. The fittings and attachments should be inspected for any type of visible defects that may affect the performance of the assembly.

- A. Visual inspection checkpoints should include but are not limited to the following:
- B. Hose Identification - Size and type must correspond to the fabrication order (work order).
- C. 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.
- D. Inspection Items -
  - Bulge behind the coupling.

- Cocked couplings.
- Cracked couplings.
- Exposed reinforcement.
- Freedom of swivels.
- General appearance of the assembly.
- Hose cover pricked if required.
- Internal contaminants.
- Protective caps or plugs.
- Restrictions in the tube.
- Rusted Couplings.

## **5.7 Calibrations**

Inspection and testing equipment used in the production or testing of coupled hose assemblies should be calibrated at prescribed intervals according to written procedures. All gauging equipment shall be calibrated regularly by means traceable to NIST (National Institute of Standards and Technology). The tag giving date of last calibration, next calibration due date and signature of the inspector shall be attached to the gauge and a record filed for future reference.

## **5.8 Test 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 criteria. If a test certificate is not supplied, test results should be maintained and kept on file for five years.

Each test certificate should bear a unique number for traceability. Test certificates should include the following information as a minimum:

- A. Test Certificate Number
- B. Customers Name and Purchase Order Number
- C. Suppliers Name and Job Number
- D. Hose Serial 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
- I. Electrical Continuity Conformance
- J. Suppliers Authorization Signature

## **5.9 Other Documentation**

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

### **5.9.1 Certificate of Conformance**

When required, a Certificate of Conformance (C of C) shall be supplied with the order, confirming in the form of a text, and without expressed mention of the test results, that the product being supplied meets the requirements of the customers purchase order, as agreed upon order acceptance. The C of C should have the following information, if applicable:

a.	Customer's Name
b.	Customer's Address
c.	Customer's Purchase Order
d.	Customer's Contract Number
e.	Customer's Specification Number
f.	Customer's Drawing Number
g.	Supplier's Name
h.	Supplier's Address
i.	Supplier's Order Number
j.	Supplier's Drawing Number
k.	Quantity
l.	Description
m.	Additional Information
n.	Supplier's Authorized Signature
o.	Date

### **5.9.2 Test Report**

A request for a C of C may require that actual test results be included.

### **5.9.3 Certified Material Test Reports**

When required, a Certified Material Test Report (CMTR) shall be supplied showing the materials meet the requirements of the customer's purchase order. These may be supplied as copies of the raw material CMTR's provided by the materials supplier or on the manufacturer's form providing certified test results.

### **5.9.4 Third Party Certification**

When required by the customer, an authorized inspection party shall inspect and certify that the product being supplied meets the requirements of the customer's purchase order as agreed upon order acceptance. Upon request, copies of these certifications shall be supplied.

## **Section 6 – Quality Plan**

## 6.1 Purpose

The purpose of this section is to outline a quality plan for fabricating 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.

## 6.2 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.

There are many areas or processes that may be sampled. These may vary from operation to operation, but there are some constants that should probably 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. Regardless of what is being sampled, inspection characteristics, the corresponding documentation and the personnel responsible for carrying for inspecting these characteristics, must be defined.
- D. When establishing the frequency of sampling, there are many factors that



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.

## **6.3 Material Receiving Inspection**

### **6.3.1 Couplings**

1. Upon receipt of a shipment of couplings, the assembly fabricator should perform, at minimum, the following inspection steps:
2. Compare the couplings received with the purchase order by making sure part numbers agree between order and packing slip.
3. Check the count between packing slip and actual quantity received.
4. Check the product in the package to make sure it agrees with the part number on the package. Supplier catalogs are a good reference.
5. 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.
6. 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.

### **6.3.2 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.

## **6.4 Storage (Labeling, Environment, Time)**

Proper storage will maximize hose shelf life. All hose should be stored in such a manner to protect them from degrading factors such as humidity, temperature extremes, ozone, sunlight, direct light from fluorescent or mercury lamps, oils, solvents, corrosive liquids, insects, rodents, and any other degrading atmosphere.

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.

### **Note:**

The ideal storage temperature for rubber hose is +50°F to +70°F with the maximum of +100°F. Care should be taken to keep rubber hoses from being stored next to heat sources. Rubber hose should not be stored near electrical equipment that generates ozone. Exposure to high concentrations of ozone will cause damage to the hose.

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

Components should be stored in original date-coded containers. Steps should be made to rotate inventory on a first-in, first-out basis, to insure that the products are exposed to the shortest shelf time possible.

## **Section 7 – Assembly Identification, Cleaning and Packaging**

### **7.1 Purpose**

This section is intended to establish methods and content of applying hose assembly identification markings and identify minimum cleaning and packaging requirements.

### **7.2 Hose Assembly Markings**

### **7.2.1 Method of Marking**

The marking of hose assemblies may be achieved in two ways:

1. Information pre-stamped in legible characters on metal tag or band affixed to the assembly by approved durable method.
2. Information in legible characters stamped directly onto the ferrule or fitting.

## **7.3 Cleaning**

Each assembly shall be supplied to the customer free of water, debris, metal shavings, dirt or any foreign material that may cause problems to the application. Air may be blown through the assembly to remove loose particles. Some customers have stringent cleanliness requirements that may require flushing the assembly. End connection openings should be sealed or capped to assure that cleanliness is maintained.

Consult the customer information for specific cleaning requirements.

## **7.4 Packaging**

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.

# **Section 8 – Installation and Handling**

## **8.1 Purpose**

The purpose of this section is to increase awareness on the proper installation and handling of hose assemblies, and to alert fabricators, installers and end-users to the safety hazards in the field.

Hoses and hose assemblies are used interchangeably in this document. Hoses are used to convey fluids, gases and other media. Hose constructions are available in a variety of materials and styles depending on the intended

application.

## **8.2 General**

All hose has a finite life and there are a number of factors, which will reduce its life. The design and use of systems, which contain hoses, require consideration of factors related to specific application requirements.

## **8.3 Safety Considerations**

Below are some potential conditions that can lead to personal injury and property damage. This list is not inclusive. Consider reasonable and feasible means, including those described in this section to reduce the risk of injuries or property damage.

Employers with hose assemblies in fluid systems are encouraged to provide training, including the information in this document, for maintenance personnel and other employees working with and around hoses under pressure.

### **8.3.1 Media Permeation**

Hoses should always be used in well-ventilated areas. Certain media will permeate through hoses that can displace breathable air in confined spaces. Consult the manufacturer if in question.

### **8.3.2 Fluid Injections**

Fine streams of pressurized fluid can penetrate skin and enter a human body. Fluid injection wounds may cause severe tissue damage and loss of limb. Consider the use of guards and shields to reduce the risk of fluid injections.

If a fluid injection occurs, contact a doctor or medical facility at once. Do not delay or treat as a simple cut. Fluid injections are serious injuries and prompt medical treatment is essential. Be sure the doctor knows how to treat this type of injury.

Avoid all contact with escaping fluids. Treat all leaks as though they are pressurized and hot or caustic enough to burn skin.

### **8.3.3 Whipping Hose**

If a pressurized hose or hose fitting comes apart, the loose hose end can flail or whip with great force, and fittings can be thrown off at high speed. This is particularly true in compressible gas or fluid systems. If the risk of hose whipping exists, consider the use of guards and restraints.

### **8.3.4 Fire and Explosions from Conveyed Fluids**

All hydraulic fluids, including many designated as “Fire Resistant”, are flammable (will burn) when exposed to the proper conditions.

Fluids under pressure which escape from system containment, may develop a mist or fine spray that can explode upon contact with a source of ignition (e.g.; open flames, sparks, hot manifolds.) These explosions can be very severe and could cause extensive property damage, serious injury or death. Care should be taken to eliminate all possible ignition sources from contact with escaping fluids, fluid spray or mist, resulting from hydraulic system failures. Select and route hoses to minimize the risk of combustion.

### **8.3.5 Fire and Explosions from Static-Electric Discharge**

Fluid passing through hose can generate static electricity, resulting in static-electric discharge. This may create sparks that can ignite system fluids or gases in the surrounding atmosphere. Use hose rated for static conductivity or a proper grounding device. Consult manufacturer for proper hose and coupling selection.

### **8.3.6 Burns from Conveyed Fluids**

Fluid media conveyed in certain applications may reach temperatures that can burn human skin. If there is risk of burns from escaping fluid, consider guards and shields to prevent injury, particularly in areas normally occupied by operators.

### **8.3.7 Electrical Shock**

Electrocution could occur when a hose assembly conducts electricity to a person. Most hoses are conductive. Many have metal fittings. Even nonconductive hoses can be conduits for electricity if they carry conductive fluids. Certain applications require hose to be nonconductive to prevent electrical current flow. Other applications require the hose to be sufficiently conductive to drain off static electricity. Hose and fittings must be chosen with these needs in mind. Consult manufacturer with any questions.

### **8.3.8 Fluid Controlled Mechanisms**

Mechanisms controlled by fluids in hoses can become hazardous if a hose fails. For example, when a hose bursts, objects supported by the fluid pressure may fall. If mechanisms are controlled by fluid power, use hose with design characteristics sufficient to minimize the potential risks of

property damage or injury.

### **8.3.9 Air and Gaseous Applications**

Consult manufacturer for proper hose and coupling selection. The covers of hose assemblies that are to be used to convey air and other gaseous materials must be pin perforated.

CAUTION: Exercise care not to perforate beyond the cover. These perforations allow gas that has permeated through the inner tube of the hose to escape into the atmosphere. This prevents gases from accumulating and blistering the hose.

### **8.3.10 Hand-held Hydraulic Operated Tools**

Extreme care is necessary when connecting hand-held or portable hydraulic powered tools to a hydraulic power source with a hose assembly.

- A. Always use a strain reliever at both ends of the hose assembly to prevent excessive bending, kinking and stress at the coupling to hose interface.
- B. Never use the hose assembly as a means to carry, pull, lift or transport the hydraulic tool or power unit.
- C. Exposed hose near the operator should be covered with a fluid deflection apparatus such as nylon sleeving, for protection against injection injuries should a hose rupture occur.
- D. Operators should be protected with the proper safety equipment such as face masks, leather gloves and safety clothing as dictated by the job, fluid and tools being used.
- E. If the connecting hose assembly could be subjected to external forces that may inflict damage, an appropriate guard should be used.

## **8.4 Hose Installation and Replacement**

The following practices shall be used when installing hose assemblies in new systems or replacing hose assemblies in existing systems.

### **8.4.1 Pre-Installation Inspection**

Before installing hose assemblies, the following shall be examined:

- A. Hose length and routing for compliance with original design.
- B. Correct style, size, length, and visible non-conformity of assembly.

- C. Fitting seats for burrs, nicks or other damage.
- D. Kinked, crushed, flattened, or twisted hose.

#### **8.4.2 Handling During Installation**

Handle hose with care during installation; bending beyond the minimum bend radius will reduce hose life. Sharp bends at the hose to fitting juncture should be avoided.

#### **8.4.3 Torque**

Hose assemblies shall not be installed or operated in a twisted or torqued condition. Swivel fittings or a lay line may be used to aid in torque-free installation.

#### **8.4.4 Hose Routing**

When planning the hose routing use the following practices for optimum performance and more consistent and predictable service life.

Routing at less than minimum bend radius, will reduce the service life of the hose. Use the static or dynamic minimum bend radius according to service conditions. Sharp bends at the hose to fitting juncture should be avoided

Hose assemblies subject to movement while operating should be installed in such a way that flexing occurs in the same plane.

#### **8.4.5 Securement and Protection**

Necessary restraints and protective devices shall be installed. Such devices shall not create additional stress or wear points.

#### **8.4.6 System Checkouts**

In some liquid systems, it may be necessary to eliminate all entrapped air after completing the installation. Follow manufactures' instructions to test the system for possible malfunctions and leaks.

To avoid injury during system checkouts, do not touch any part of the hose assembly when checking for leaks and stay out of potentially hazardous areas while testing hose systems. (See Safety Considerations)

### **8.5 Maintenance Inspection**

A hose and fitting maintenance program can reduce equipment down time and maintain peak operating performance.

### **8.5.1 Inspection Frequency**

The nature and severity of the application, past history and manufacturer's recommendations shall be evaluated to determine the frequency of the visual inspections and functional tests. However, in the absence of this information, we recommend a visual inspection be conducted before each shift or at least once a day.

To avoid injury during system checkouts, do not touch any part of the hose assembly when checking for leaks and stay out of potentially hazardous areas while testing hose systems. (See Safety Considerations)

### **8.5.2 Visual Inspections**

The hose and fittings shall be visually inspected for:

- A. Leaks at the hose fittings or in the hose.
- B. Damaged, abraded, or corroded braid; or broken braid wires.
- C. Cracked, damaged, or badly corroded fittings.
- D. Other signs of significant deterioration.

If any of these conditions exist, the hose assemblies shall be evaluated for replacement.

### **8.5.3 Visual Inspections for All Other Components**

Hose and fittings shall be visually inspected for:

- A. Leaking ports.
- B. Damaged or missing hose clamps, guards, or shields.
- C. Excessive dirt and debris around hose.
- D. System fluid.
- E. Level, type, contamination, condition, and air entrapment or blockage. If any of these conditions are found, appropriate action shall be taken.

### **8.5.4 Functional Tests**

Functional tests shall be conducted to determine if systems with hose are leak-free and operating properly. Such tests should be conducted in accordance with the manufacturers' recommendations.

## **APPENDIX A – Pressure Conversion Chart**



psi	Atms	inches H <sub>2</sub> O	inches Hg	mm Hg (Torr)	mbar	Bar	Pa (N/m <sup>2</sup> )	kPa	MPa
1	0.0681	27.71	2.036	51.715	68.95	0.0689	6895	6.895	0.0069
14.7	1	407.2	29.92	760	1013	1.013	101,325	101.3	0.1013
0.0361	0.00246	1	0.0735	1.866	2.488	0.00249	248.8	0.249	0.00025
0.4912	0.03342	13.61	1	25.4	33.86	0.0339	3386	3.386	0.00339
0.01934	0.001316	0.536	0.0394	1	1.333	0.001333	133.3	0.1333	0.000133
0.0145	0.000987	0.4012	0.0295	0.75	1	0.001	100	0.1	0.0001
14.504	0.987	401.9	29.53	750	1000	1	100,000	100	0.1
0.000145	0.00001	0.00402	0.000295	0.0075	0.01	0.00001	1	0.001	0.000001
0.14504	0.00987	401.9	0.295	7.50	10	0.01	1000	1	0.001
145.04	9.869	401.9	295.3	7500	10,000	10	1,000,000	1000	1

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 mm = 100 cm  
 1 in = 2.540 cm = 25.40 mm  
 1 ft = 30.48 cm = 0.3048 m

#### Volume

1 L = 0.0353 ft<sup>3</sup>  
 1 L = 0.2642 gal  
 1 L = 61.025 in<sup>3</sup>  
 1 L = 0.001 m<sup>3</sup>  
 1 ft<sup>3</sup> = 28.3286 L  
 1 Gal = 0.1336 ft<sup>3</sup>

#### Pressure

1 psi = 0.0681 atm  
 1 psi = 27.71 in H<sub>2</sub>O  
 1 psi = 703.8 mm H<sub>2</sub>O  
 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/m<sup>2</sup>)  
 1 psi = 6.895 kPa  
 1 psi = 0.0069 MPa

## **APPENDIX B – References**

### **ANSI**

American National Standards Institute  
Attn: Customer Service  
25 West 43<sup>rd</sup> Street  
New York, NY 10036  
Phone: (212) 642-4900  
Fax: (212) 398-0023  
E-mail: [info@ansi.org](mailto:info@ansi.org)  
Internet: <http://www.ansi.org>

### **ASME**

American Society for Mechanical Engineers  
22 Law Drive  
Box 2900  
Fairfield, NJ 07007-2900  
Phone: (800) 843-2763; (973) 882-1167  
Fax: (973) 882-1717; (973) 882-5155  
E-mail: [infocentral@asme.org](mailto:infocentral@asme.org)  
Internet: <http://www.asme.org>

### **ASQ**

American Society for Quality  
600 North Plankinton Avenue  
Milwaukee, WI 53203  
Phone: (800) 248-1946  
Fax: (414) 272-1734  
E-mail: [help@asq.org](mailto:help@asq.org)  
Internet: <http://www.asq.org>

### **ASTM International**

100 Barr Harbor Drive  
West Conshohocken, PA 19428-2959  
Phone: (610) 832-9585  
Fax: (610) 832-9555  
E-mail: [service@astm.org](mailto:service@astm.org)  
Internet: <http://www.astm.org>

### **Document Center, Inc.**

111 Industrial Road, Suite 9  
Belmont, CA 94002  
Phone: (650) 591-7600  
Fax: (650) 591-7617  
E-mail: [mailto:info@document-center.com](mailto:mailto:info@document-center.com)  
Internet: <http://www.document-center.com/>

**Global Engineering Documents**

15 Inverness Way East  
Englewood, CO 80112  
Phone: (800) 854-7179; (303) 397-7956  
Fax: (303) 397-2740  
Email: [global@ihs.com](mailto:global@ihs.com)  
Internet: <http://www.ihs.com>

**Government Printing Office**

732 North Capitol St. NW  
Washington, DC 20401  
Phone: (202) 512-0000  
Email: [webteam@gpo.gov](mailto:webteam@gpo.gov)  
Internet: <http://www.gpo.gov>

**ISO**

International Organization for Standardization (ISO)  
1, rue de Varembé, Case postale 56  
CH-1211 Geneva 20, Switzerland  
Phone: +41 22 749 01 11  
Fax: +41 22 733 34 30  
Internet: <http://www.iso.org>

**NAHAD**

The Association for Hose and Accessories Distribution  
105 Eastern Ave. Suite 104  
Annapolis, MD 21403-3300  
Phone: (410) 263-1014  
Fax: (410) 263-1659  
E-mail: [nahad@nahad.org](mailto:nahad@nahad.org)  
Internet: <http://www.nahad.org>

**RMA**

Rubber Manufacturers Association c/o The Mail Room  
P.O. Box 3147  
Medina, OH 44258-3147  
Phone: (800) 325-5095; (330) 723-2978  
Fax: (330) 725-0576  
E-mail: [info@rma.org](mailto:info@rma.org)  
Internet: <http://www.rma.org>

**SAE**

Society of Automotive Engineers  
400 Commonwealth Drive  
Warrendale, PA 15096-0001  
Phone: (877) 606-7323;  
Fax: (724) 776-0790  
Email: [customerservice@sae.org](mailto:customerservice@sae.org)  
Internet: <http://www.sae.org>

**UL**

Underwriters Laboratory  
333 Pfingsten Road  
Northbrook, IL 60062-2096 USA  
Telephone: (847) 272-8800  
Fax: (847) 272-8129

**NOTES:**

[illegible]