

Northwestern | RESEARCH SAFETY

Connecting research device pipe, hose and tubing

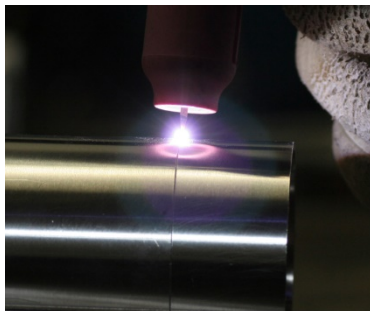
This is an abbreviated job aid. Consult additional resources and experts for design decisions.

1. Selection and installation of high hazard, high pressure or high temperature hose or tubing requires expert level competencies. Only experts can perform and certify high end installations. Some competencies can be acquired through NU Research or Facilities Managementⁱ organized training programs.
2. Consider the worst case pressure, worst case temperature and highest possible concentration of the conveyed material to select correct pipe or tubing material and material grade.
3. More extreme ambient temperatures can be expected in enclosed applications. Thermal cycling of nonmetal hose may affect a positive seal over time.ⁱⁱ
4. Fittings and connections in high vibration areas may result in leaks over time. Install high quality materials and high grade fittings in high vibration areas.
5. In high risk flooding areas or areas that may be directly connected to the NU water supply or process cooling water, consider the installation of a leak sensor and auto shut off valves. Consider a point of use water source as an alternative. Some high hazard gases require the installation of in-line automatic shut off or excess flow control valves.
6. Provide pressure relief to protect the lowest rated pressure system component from rupture. Direct the relief device away from lab users preferably into a dedicated exhaust. Properly designed pressure relief is a must for the conveyance of cryogenic liquids.
7. Coordinate with Facilities Management for installation of sleeves and slots penetrating room walls. Do not drill through walls or run pipes, tubes or hoses through windows or door openings.
8. Affix standardized labels and flow diagrams.ⁱⁱⁱ

Hard wall (rigid) tubing and piping

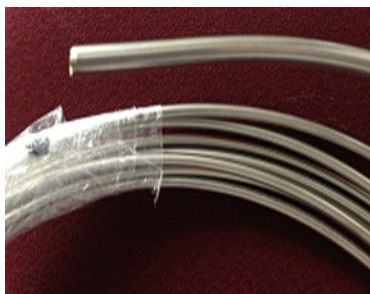
Piping is sized by the nominal inner diameter. Tubing is sized by the outer diameter and never threaded. Use PTFE tape or pipe dope on threaded connections but do not use PTFE tape or pipe dope on any CGA or other compression fittings.

Double walled stainless steel tubing (orbital welded) for high purity gas applications



Orbital welded double-walled stainless steel tubing (Grade 316L) systems are used for highly toxic or corrosive gases in clean room applications. This tubing can only be installed by experts and is helium leak tested before use. Standard laboratory size is 1/2" nominal tube size on the outer pipe and 1/4" nominal tube size on the inside tube. Use a tube minimum pressure rating of 300psig at the range of applied laboratory temperatures.

Stainless steel tubing



Stainless steel tubing, grade 316L, is required for the delivery of hydrogen and toxic gases to research equipment. Use nominal size is 1/4" ID with minimum pressure rating 300psig at the range of applied laboratory temperatures. Connect with Swagelok VCR fittings or similar. Leak check before use.

Copper tubing^{iv}



Standard copper tubing is for water, plumbing and house vacuum applications. For the delivery of flammable gases, inert gases, and compressed air, use Type K and Type L copper tubing (Generally Size: NPS 3/8"). Use 300 psig minimum pressure rating downstream from a pressure regulator.

For the delivery of oxygen or high purity gases use high purity copper type ASTM B88, C 12200 hard drawn copper tube and fittings specialty cleaned for oxygen service^v.

Do not use copper tubing for the delivery of acetylene! Acetylene in contact with copper and lead solder can form explosive compounds.

PVC piping



Use ASTM Schedule 40 or 80 for liquid drains only. Do not use to deliver pressurized gases, air or water.

Can be used for the delivery of low pressure distilled, deionized and purified water.

Fluoro polymer (PTFE) and PFA tubing



Some PTFE tube grades with minimum pressure rating 300psig can be used for the delivery of inert gases, flammable gases, oxidizers, compressed air, lab water, house vacuum systems.

Reinforced flexible tubing or hoses^{vi, vii, viii}

Hydraulic hoses



Hydraulic hose has pliable and steel layers, graded by pressure, temperature, and fluid compatibility. The bend radius of hydraulic hose must be carefully designed. Violating the hose's minimum bend radius will cause failure. Hose failures under pressure can be dangerous. Hydraulic hoses generally have steel fittings swaged onto the ends. Custom designs should only be attempted under expert

supervision.

Braided stainless steel covered tubing



Use for permanent connections to building water and process cooling. Labs are to use stainless steel braided hose when connected to process chilled water rated for 175 psi. Connections are to be threaded.

The minimum pressure rating is 180psig (Safety factor 3:1) to accommodate the normal building water pressure (~60psig) and higher pressure fluctuations due to water hammer.

Reinforced Tygon or vinyl tubing



Acceptable for use with inert gases, compressed air (Safety factor 4:1), and house vacuum. With the correct barb connectors and band clamps can connect pressurized systems up to 150 psig.

Softwall tubing and hoses



Softwall tubing and hoses are generally for inert gases and low pressure water. Do not use in “out-of-sight” applications where the hose is buried, encased or submerged. Use rigid tubing in these applications.

Softwalls have a finite service life and can be expected to fail over time. Most soft wall tubing materials are permeable to gases^{ix} and should not be used in air sensitive applications.

Swagelok or Parker Push on hoses or equivalent^x



At room temperature, acceptable for use with inert gases (some lighter gases may permeate the hose), compressed air (safety factor 4:1), oxidizers, house vacuum systems. Push on hoses can be rated to 350psig when used with the manufacture’s barb connector. Nominal size of 3/8” and smaller diameters require no special tools for assembly.

Flexible plastic tubing

Nylon, PVC, Low Density Poly Ethylene (LDPE), Poly Propylene (PP), silicone, rubber etc. Flexible plastic tubing is generally non-conductive.

This tubing types are used for drain, vent, and general laboratory applications. Standard laboratory sizes are nominal 1/4”, 3/8” and 1/2”. The maximum pressure rating may be as low as 5psig. Do not use for applications where moderate or high pressures can be anticipated.

Polyurethane tubing

Small 1/8” OD tubing is used for compressed air lines that require low flow rates such as most pneumatic valves. Tubing comes in many colors for ease of identification.

Tygon (Nalgene) tubing



Handles a wide variety of flow through laboratory vent gases, oxidizers, and liquids. Useful for applications where system transparency is desired. Only certain Tygon tubing grades can be used in a low pressure system. Use a tube and fitting pressure rating above 60 psi to connect a condenser to a water outlet for example.

Vacuum Hose



Thick wall rubber, vinyl or Tygon tubing. Direct hose connection to a serrated house vacuum nozzle requires an inline liquid trap and [HEPA filter](#).

Vacuum system setup of Schlenk lines and similar systems requires an inline cold trap.

Flexible gas hose

Flexible hose for fuel (red color) and oxygen (green color) delivery to torches must be T-grade. Reinforced flexible Bunsen burner hose designed for direct connection to barbed outlets. Can be obtained from [Research Safety](#)



Couplings, Fittings and Connectors

High pressure metal fittings for specific gas types are standardized by the Compressed Gas Association (CGA). For liquids pressures above 145psi (10 bar) design couplings, fittings and connectors with a safety factor of 4:1.

For water hoses under pressure design with a Safety Factor of 3:1. For flow through water hoses to drain design with a Safety Factor of 2:1.



Example: CPC quick connect for water hose rated for 120 psig.

Resources

[Nalgene Tubing Selection Guide](#) (ThermoFisher)

(Content adapted and revised from a MIT job aid)

ⁱ [FM Design Guidelines and Technical Standards](#)

ⁱⁱ Swagelok, [Hose and Flexible Tubing Manual](#) , (accessed 2018)

ⁱⁱⁱ [ASME A13.1 Scheme for the Identification of Piping Systems](#), 2015

^{iv} [ASME B16-22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings](#)

^v [CGA G-4.1 Cleaning Equipment for Oxygen Service](#), 2009

^{vi} [Hoses Page/Parker](#) (accessed 2018)

^{vii} Thermo-Fisher, [Tubing and Accessories Catalog](#) Excerpt,(accessed 2018)

^{viii} THE GATES SAFETY GUIDE [An inspection and preventive maintenance program for industrial hose](#)

^{ix} [Coleparmer - Tubing-selection-guide](#)

^x [Get a grip! An introduction to hose barbs](#), CPC (Colder Products Company), 2018