

# **Tube Fitting Essentials Tech Talk**

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Jeff Allen, Swagelok Essentials Trainer



## Today's tech talk with focus on

**Tube fitting design** and how it relates to performance

**Tube fitting Installation procedures** and how it relates to performance

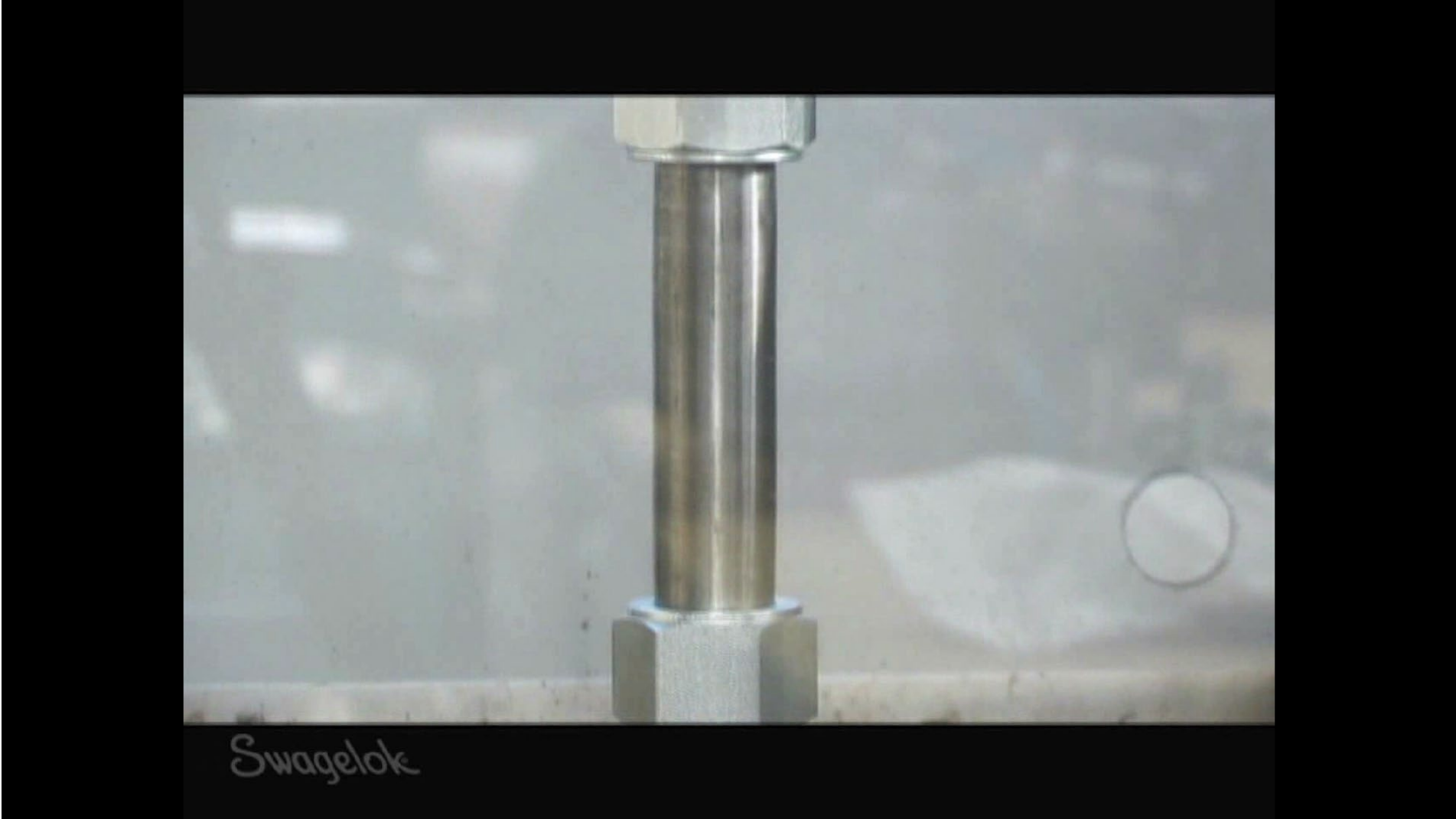
# Performance

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**The action or process of carrying out or accomplishing an action, task or function.**

**In the instrument and process applications performance is measured by following approved procedures of installation, achieving 100% leak free systems with the lowest installed cost.**

# Ultimate Tube Fitting Performance



# Typical industrial tube and pipe components

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Tube Fitting – Ferrule Design

Tube Fitting - Gasket Design

Tube Fitting - O-ring Design

Tube Fitting - Socket And Butt Weld (Manual & Orbital)

Tube Fitting – Vacuum & Sanitary Applications (O-ring & Gasket)

Tube Fitting – Medium And High Pressure Up To 60,000 Psi

Tube Fitting – 37 ½ Degree Flare (Special Tools Needed)

Pipe – 4-bolt Flange (Torque Wrenches Needed)

Pipe – Threaded (Threading Equipment)

Pipe – Socket Weld (Manual & Orbital)

Pipe – Butt Weld (Manual & Orbital)

- Everyone of these components have their own specific assembly procedures to achieve leak free systems.
- What do all these tubing and pipe component connections have in common?

# What do these component have in common?

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- They all have the potential to leak if an approved procedure to assemble is not followed.

Proper procedures may include tubing and pipe preparation (cutting, de-burring, cleaning), component inspection, installation, fire watch, documentation, weld maps, etc. ending with pressure and leak checking to safely install leak free tubing and piping systems.

There is not one specific procedure that fits all tubing and pipe component installations.

# What is the difference between...

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**A Potential Leak**

and

**An Actual leak ?**

**It Depends...**

# It depends on the following

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**Degree of assembly** and the **different applications** where these fittings are used including:

- **Media** – gas or liquid, chemical compatibility

Specific gravity of air = 1, helium = .137

- **Temperature** – 70 F or 350 to 1000 degrees F
- **Pressure** – 10 psig or 2500 psig

Instrument air vs. bottle gas (example nitrogen bottles up to 6000 psi)

- **Vibration**, and thermal and hydraulic shock.
  
- A properly trained installer that follows the manufactures assembly procedures removes the above variables to obtain 100% leak free systems.



# System Applications

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- Always design component material, pressure and temperature ratings for the worst-case conditions.

**Example:** My regulated system pressure rating is only 150 psi, but I am using a nitrogen bottle at 2200 psi – what happens downstream of the regulator if my regulator fails open? All components downstream of the regulator must be rated to the max pressure or install relief valves.

- I have selected my tubing to a specific pressure rating, but my system is at an elevated temperatures about 600 degrees F, should I be concerned?

**Example:** At elevated temperatures, the maximum pressure rating is lower. For stainless steel, if the pressure rating is 1000 psi, at 600 degrees F you must de-rate it by .85% or the new rating is now 850 psi.

- Other considerations: media compatibility, flow, code and company and federal specifications. **Example:** ball valve versus needle valves.

# Why is training important? (Eliminates leaks)

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- **Clean Air Act of 1990** – Driving force to check and repair leaks
- 189 toxic air pollutant emissions must be reduced
  - **System leaks are unsafe and costly**
- **Oil leaks**: slip hazard, hazardous waste to dispose of, may contaminate your product.
- **Steam leaks**: burn hazard, loss of transfer heat, wasted energy to produce, sets up corrosion.
- **Air leaks**: wasted energy to produce, false reading on controllers and control valves.

**Bottom line: Safety & Energy conservation**

# Common causes of fitting failures

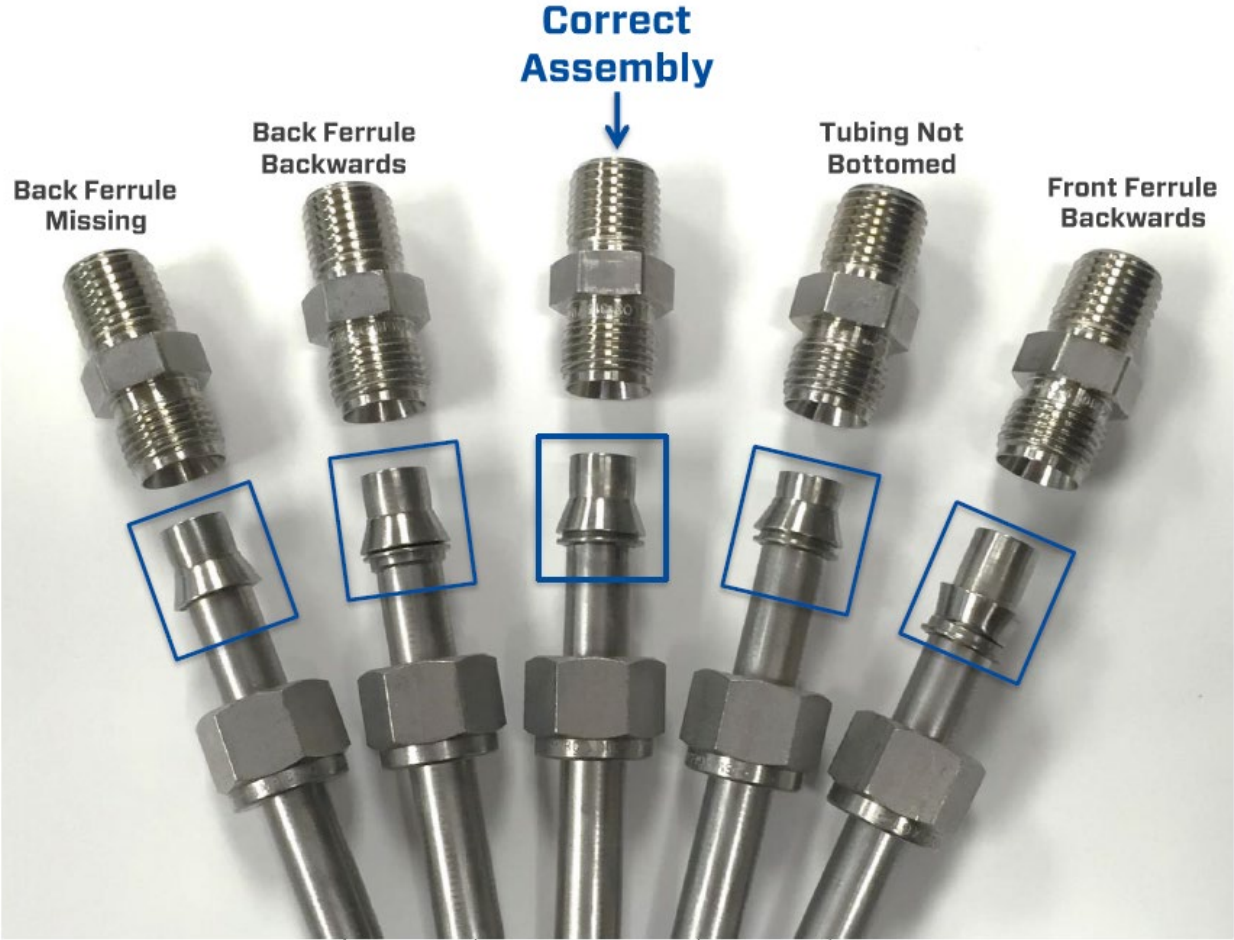
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- Under tightened (55%)
- Over tightened
- Tubing not bottomed out in fitting
- Ferrules installed backwards
- Ferrule missing
- Cross threaded
- Improper tubing
- Damaged tubing



In our tube fitting training course, we have observed thousands of instrument and mechanical installers how they assemble tube fittings, prior to training. We noticed about **55%** of these assemblies were under tightened. Most of them told us they tighten by **FEEL**, if it feels tight stop tightening (especially on stainless steel).

# Visual Inspection of Assembled Fittings



***Do not reuse or install the improperly installed connections.***

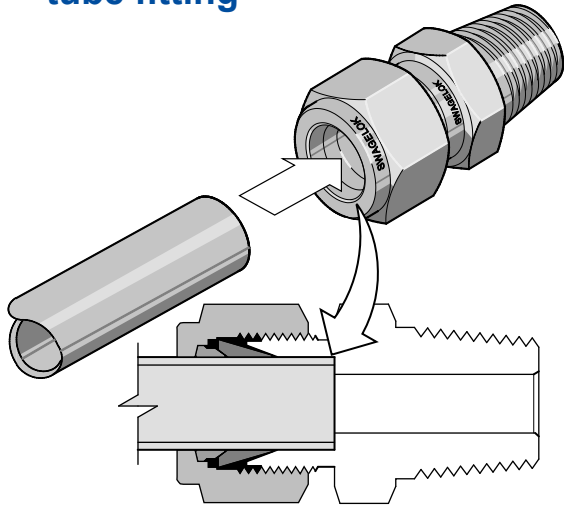
# Visual Inspection



# Manufactures Initial Installation Procedure Manual Installation

1

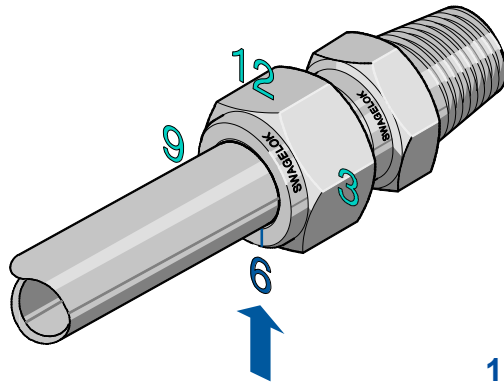
Insert the tubing into the tube fitting



Make sure that the tubing rests firmly on the shoulder of the fitting body and that the nut is finger-tight.

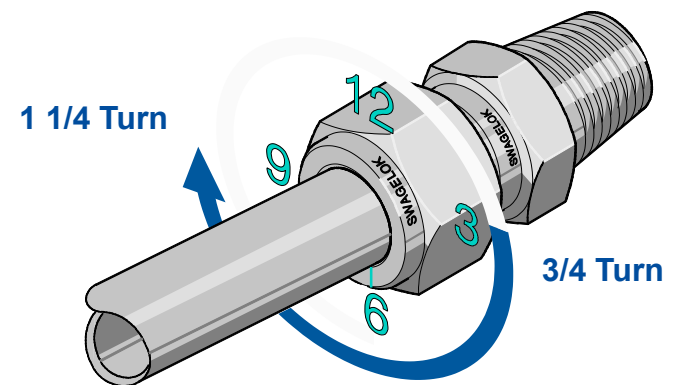
2

Scribe the nut at the 6 o'clock position



3

Hold the fitting body steady and tighten the nut 1 1/4 turns



*For 1/16, 1/8 and 3/16 in., and 2, 3, 4 mm tube fittings, tighten the nut three-quarters turn to the 3 o'clock position.*

# Swagelok fitting procedures

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- For ¼” to 1” tube sizes – **1 ¼ turns from finger tight.**
- For 1/16, 1/8 and 3/16 in., and 2, 3, 4 mm tube fittings, tighten the nut **three-quarters turn** to the 3 o'clock position.
- For sizes over one inch, 1 ¼”, 1 ½” and 2” you must use the **hydraulic swaging tool.**

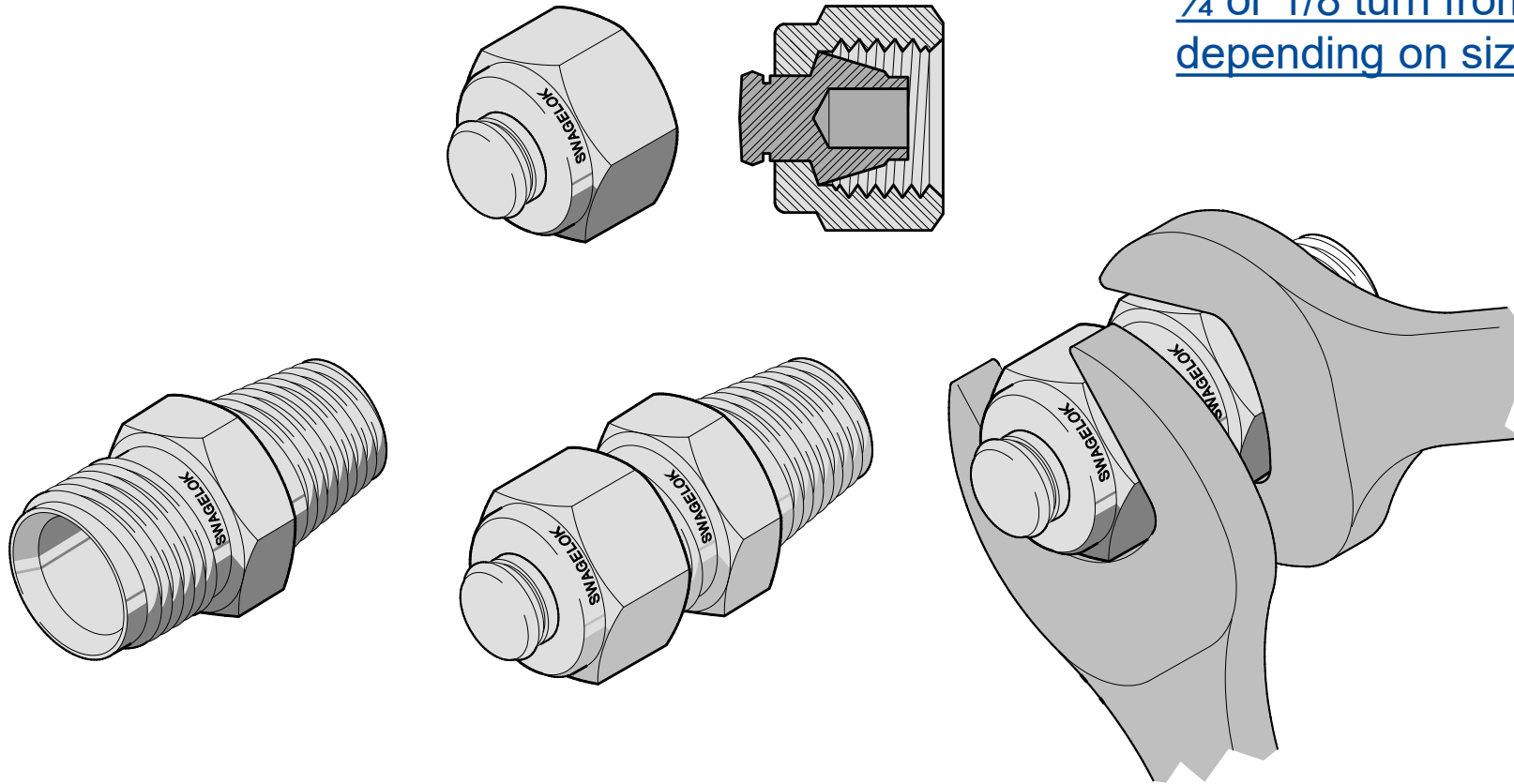


# Other procedures for plugs & port connectors

- Plugs

*Plugs off an unused port*

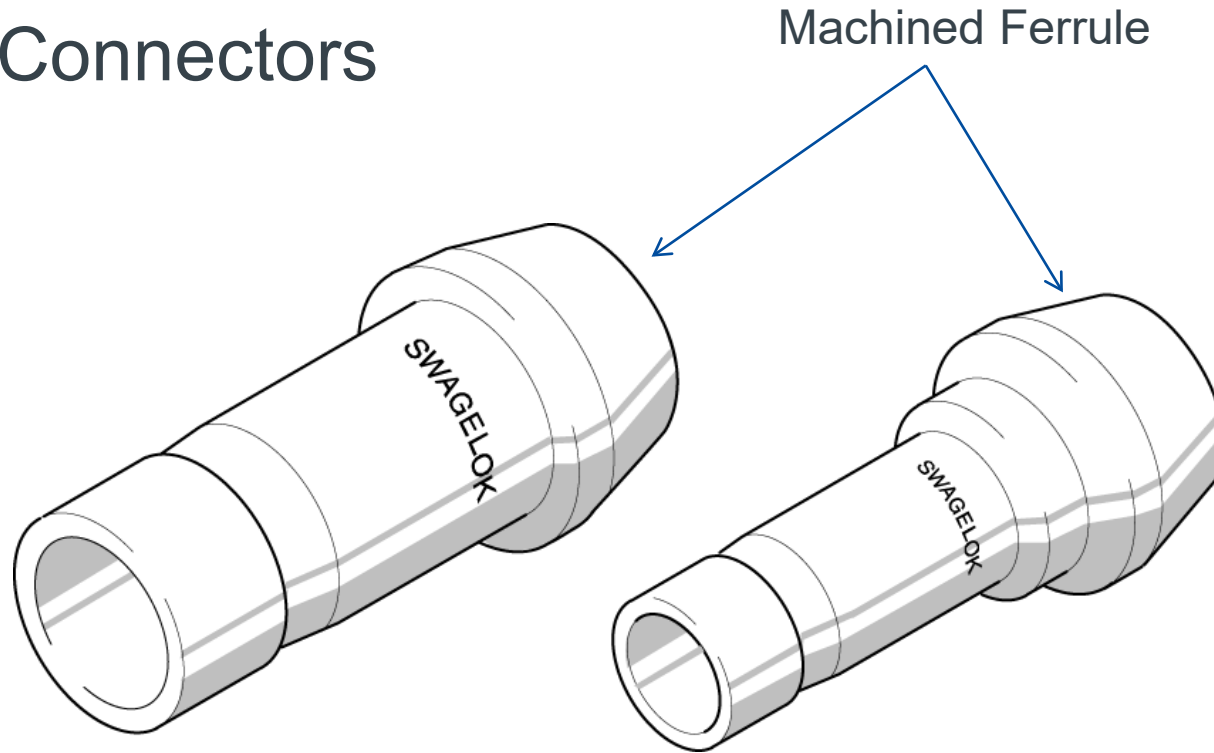
1/4 or 1/8 turn from finger tight depending on size





# Used to couple two Swagelok fittings together

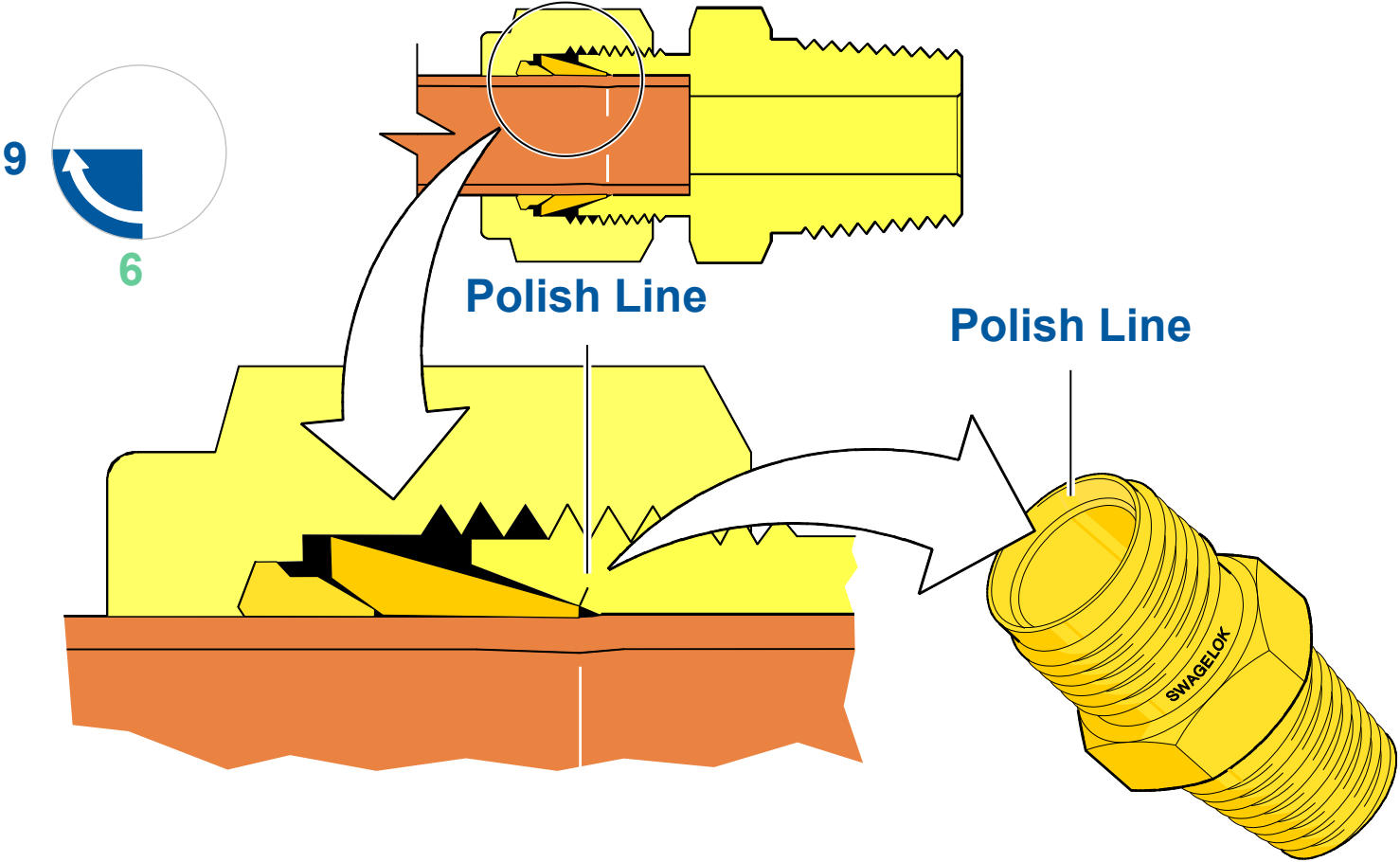
- Port Connectors



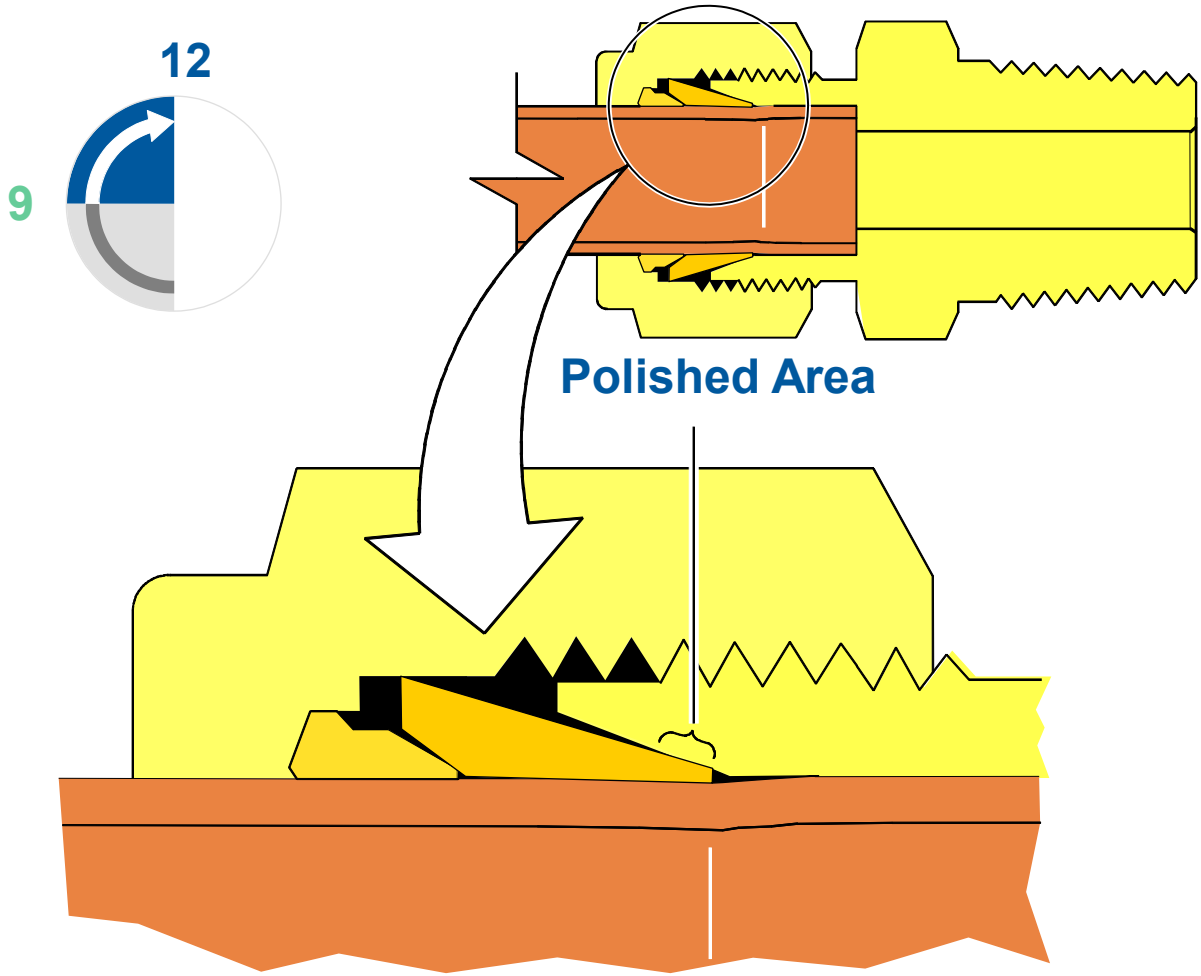
1 1/4 or 3/4 turn from finger tight depending on size

1/4 or 1/8 turn from finger tight depending on size

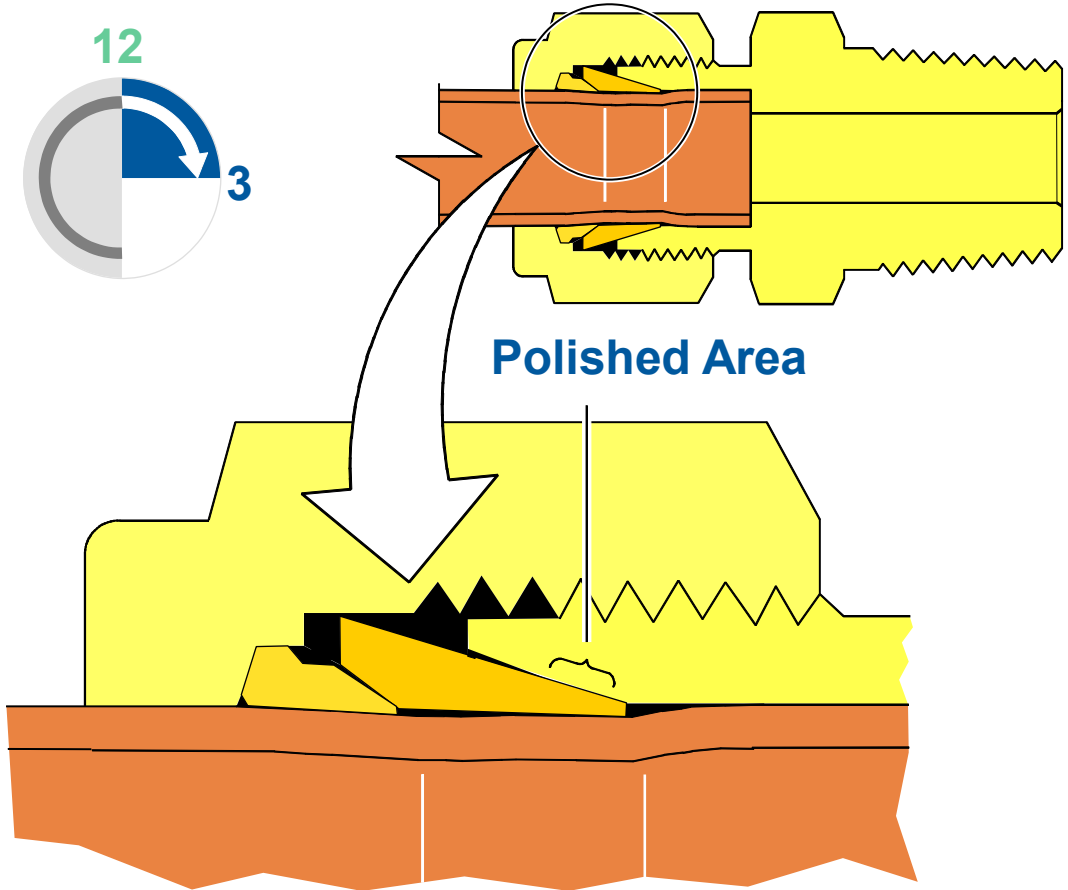
# The Quarter-Turn Demonstration, Brass



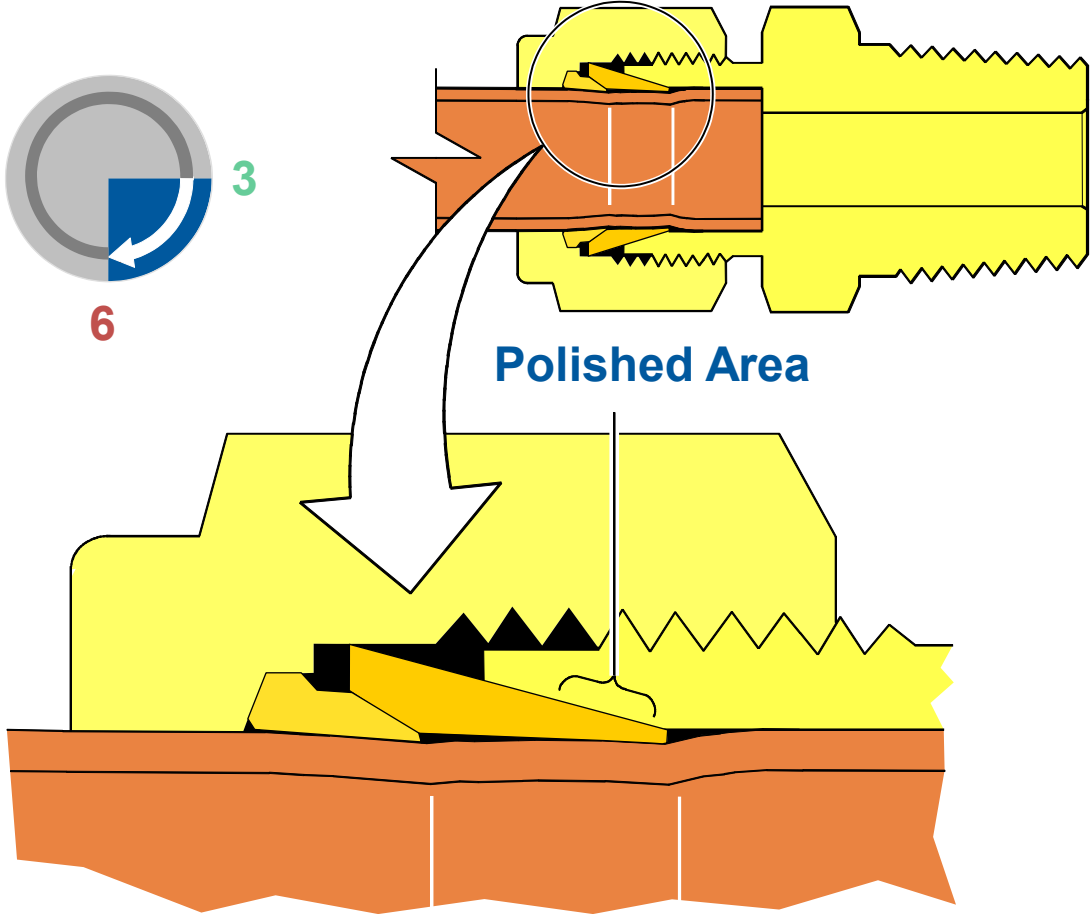
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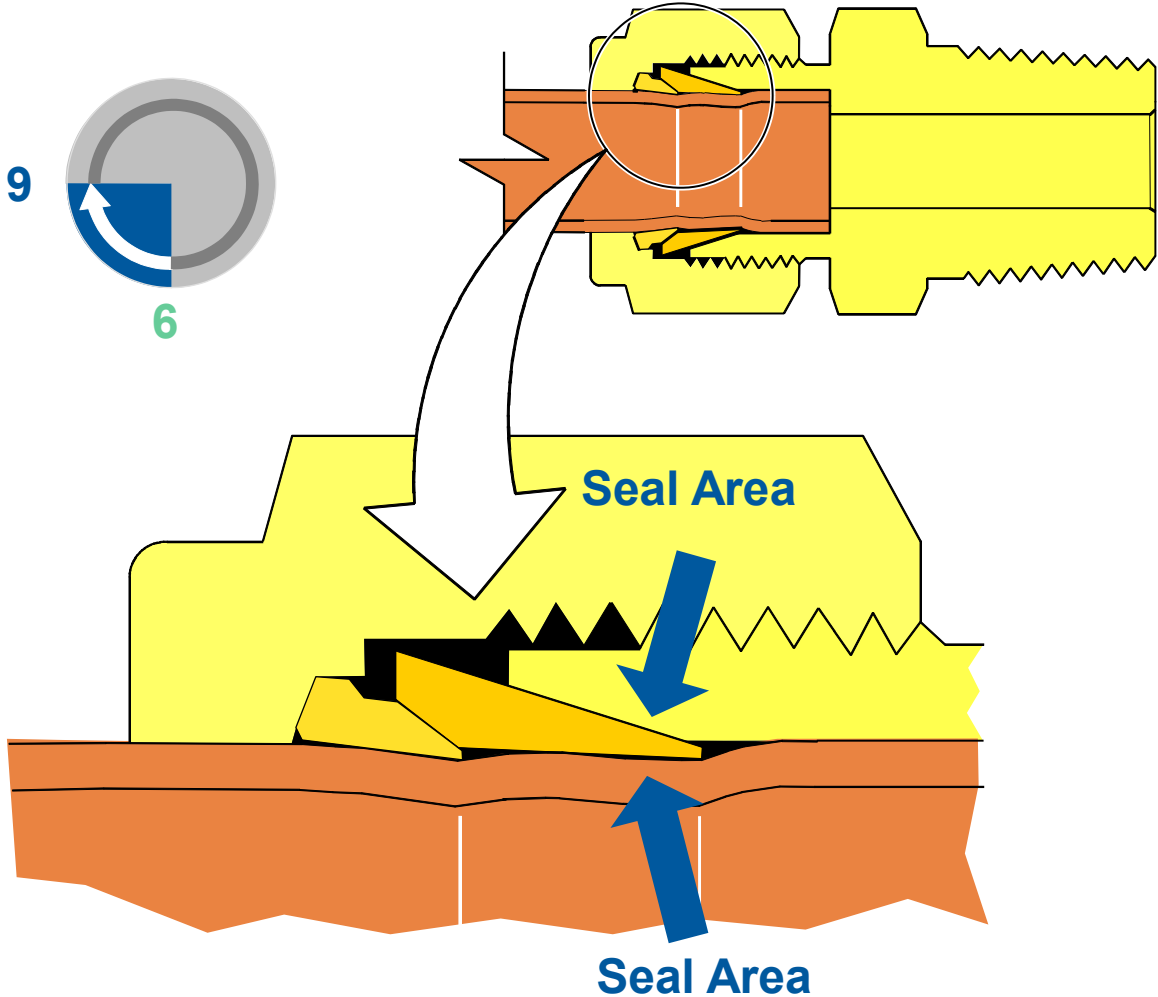
# The Quarter-Turn Demonstration, Brass



# The Quarter-Turn Demonstration, Brass



# The Quarter-Turn Demonstration, Brass



New fitting  
Never tightened

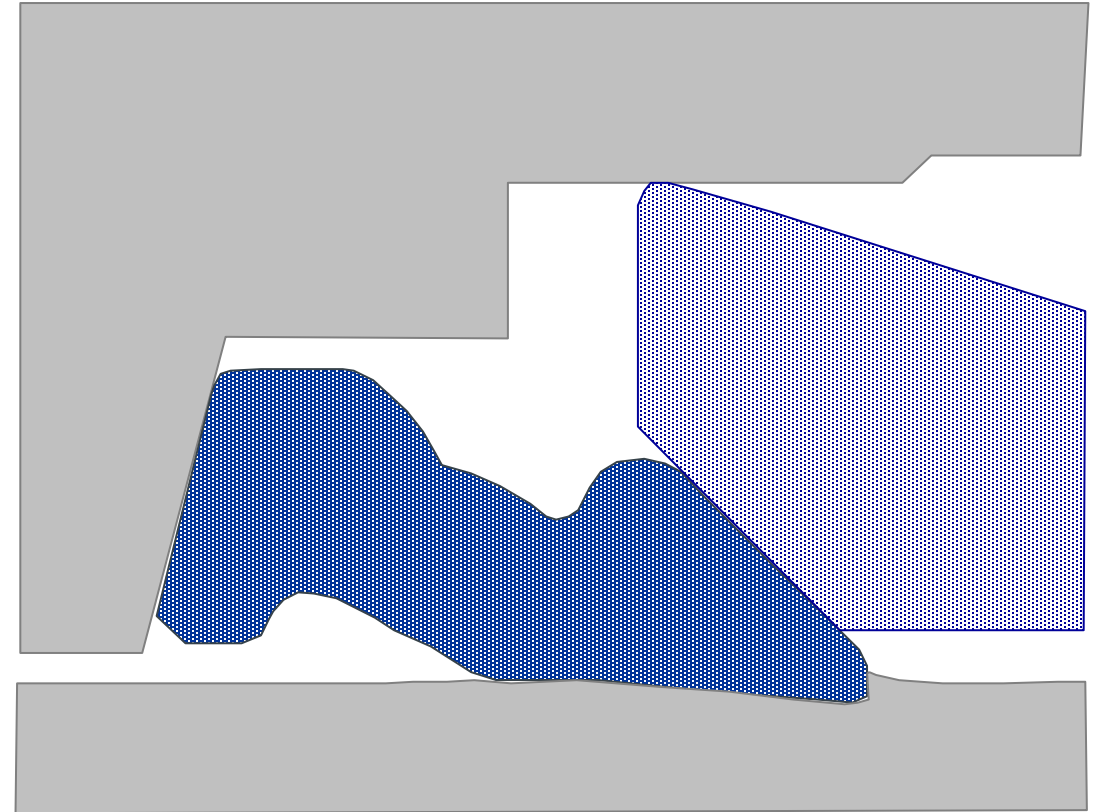


Polished or  
burnished seat after  
tightening 1 ¼ turns

# Enhanced Factors of Performance

## Tube Grip

- Robust grip over a wide range of installations
- Tubing
  - Hardness
  - Wall Thickness
  - Dimensions
  - Material
  - Quality
- Pull-up

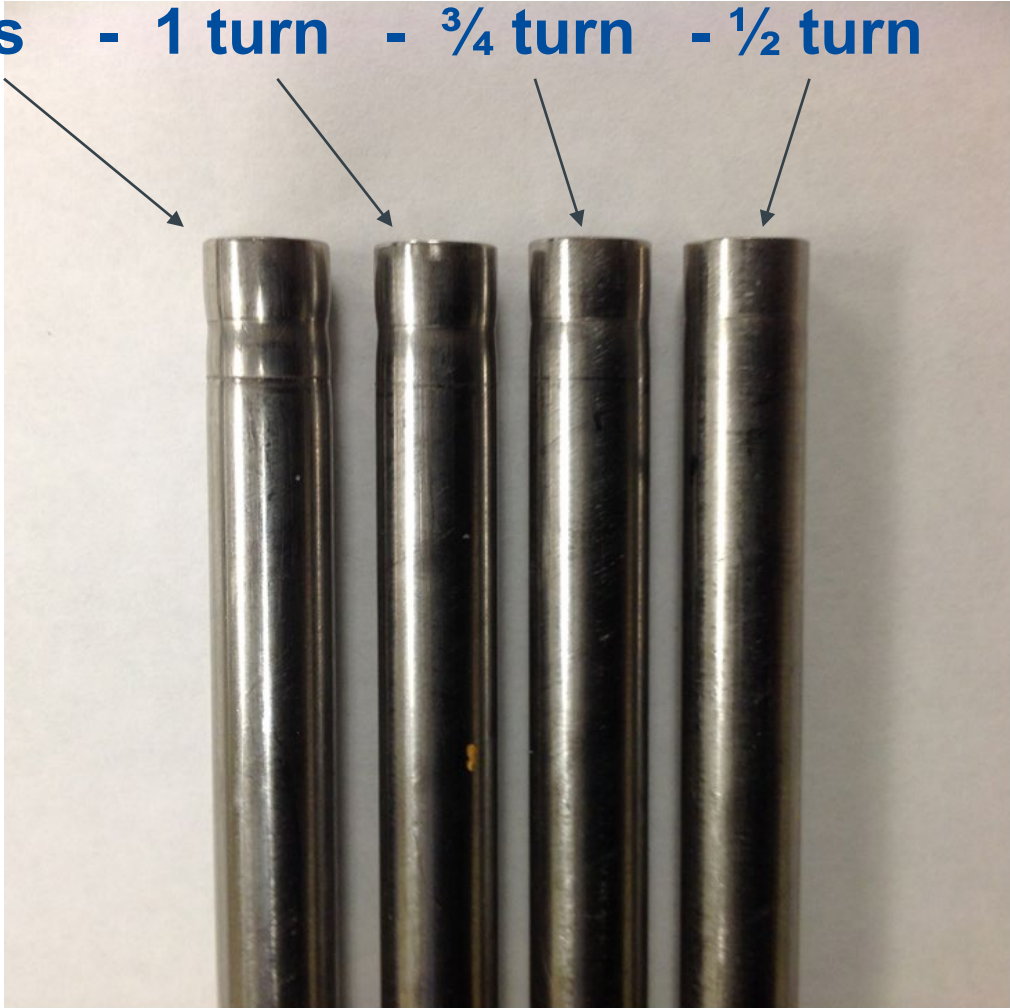


Swagelok Tube Fitting



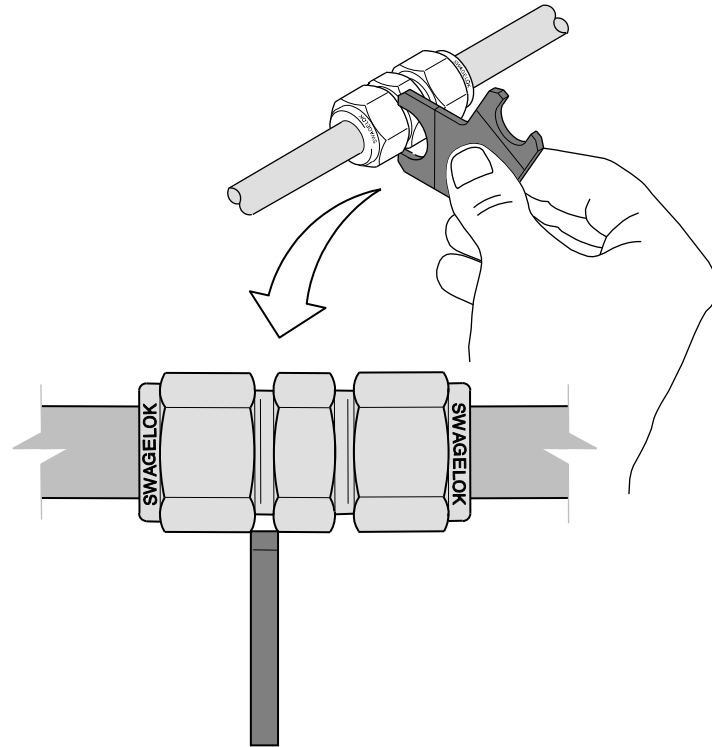
# Quarter Turn Pull Up

1 ¼ turns - 1 turn - ¾ turn - ½ turn

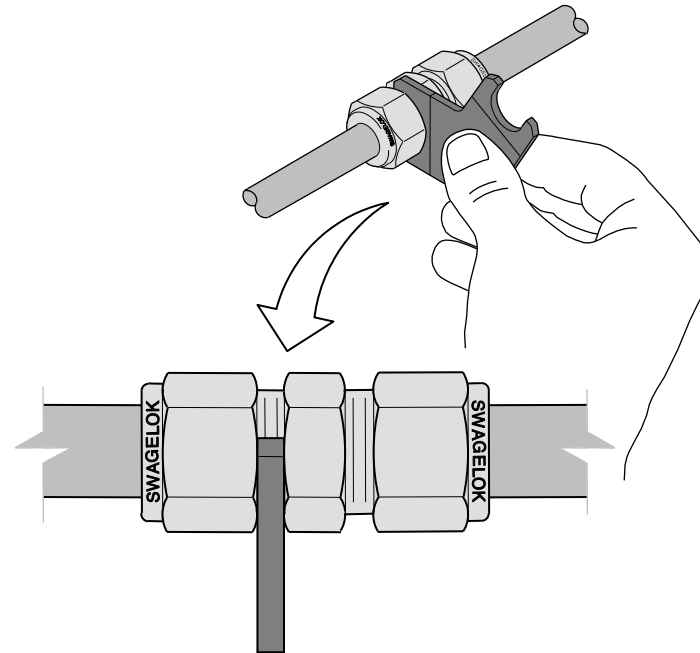


# Gap Inspection Gauge

- A Visual tool to prevent under tightening of fittings.



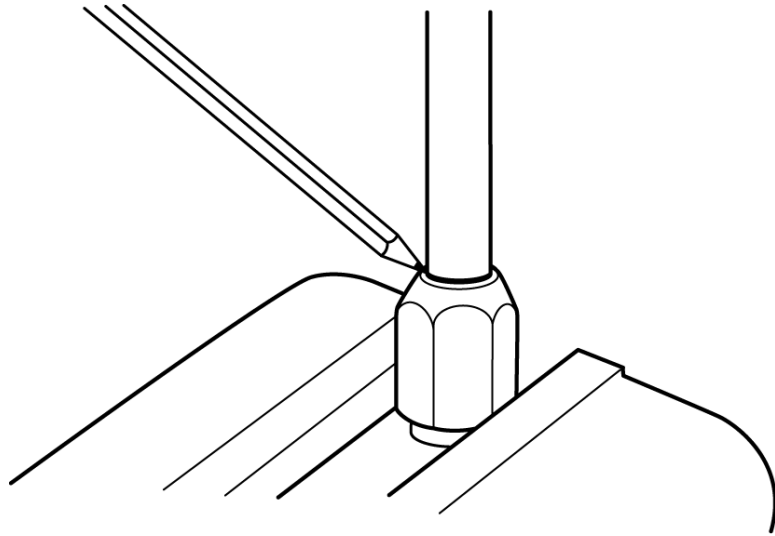
Sufficiently Tightened



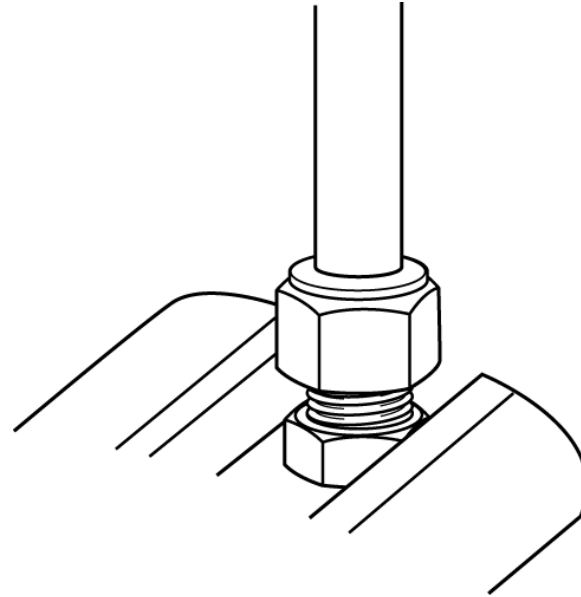
Additional Tightening  
Required

# Depth Marking Tool

- A visual tool to verify that the tubing has been properly bottomed out.



**With tubing fully bottomed, mark the tubing at the top of the DMT**



**Any tubing below the mark must not be visible when bottomed in the fitting body**

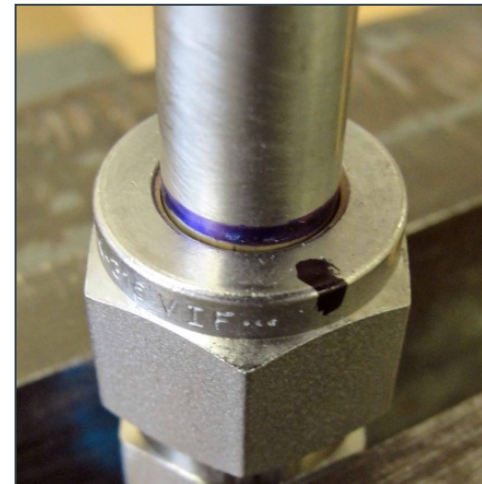
# Verify Presence of DMT Tube Mark

- Visually inspect the tube entering the nut confirming mark is made during assembly
- Mark should be even with the top of the nut.
  - No tubing should be visible below DMT mark after inserted into fitting body

Thin mark

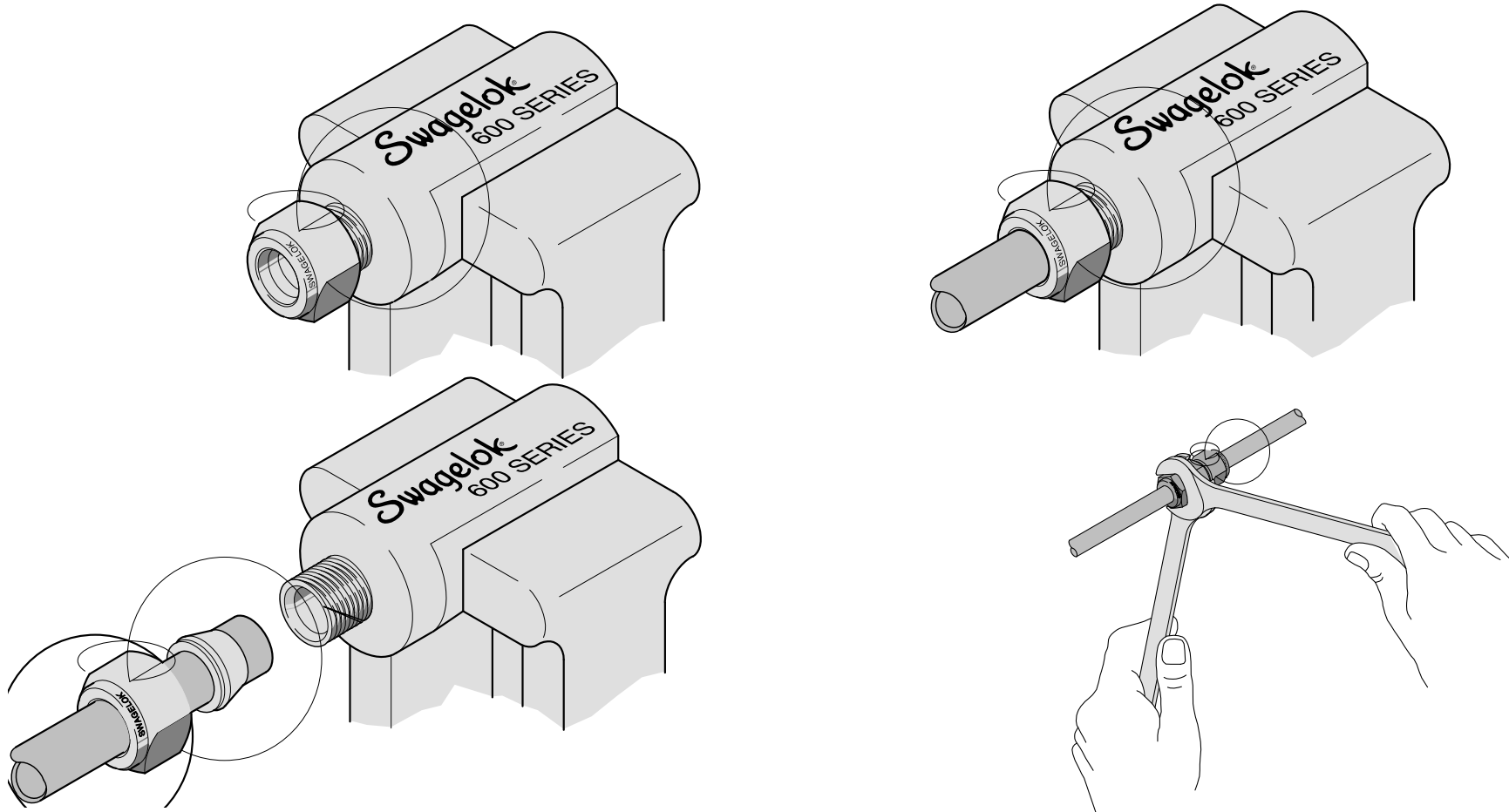


Thick mark



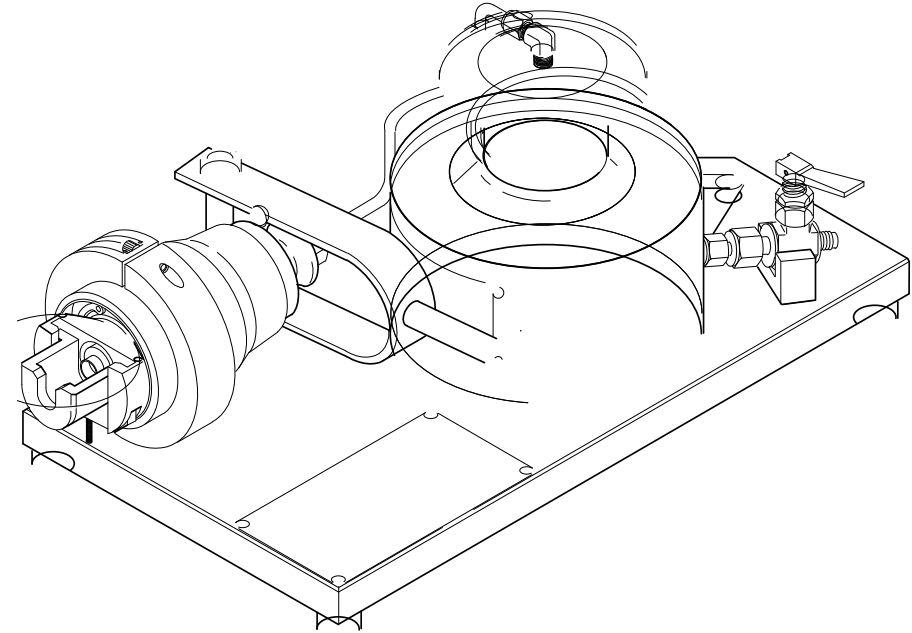
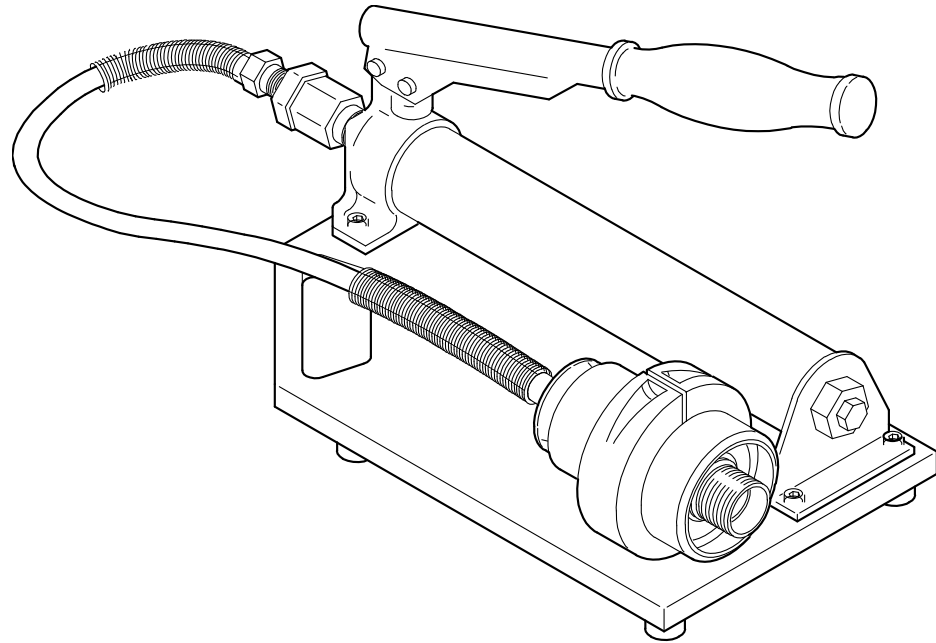
# Additional tools to pre-set the ferrules

- Preswaging Tool



# Hydraulic Installation of Swagelok Tube Fittings

- Multihead hydraulic swaging unit (MHSU)



**Air-actuated hydraulic swaging unit (AHSU)**

# Tube Fitting and Tube Bending 4 Hour Training

## Course Outline:

- Identify parts of a tube fitting
- Discuss and demonstrate proper installation and reassembly procedures
- Understand the differences in tube fitting designs, components and the importance of proper assembly
- Identify thread types and installation practices
- Discuss tubing variables and how to properly inspect and select tubing
- Learn cutting methods and proper techniques for deburring tubing
- Identify the parts and procedures of tube benders
- Perform hands-on fixture bending
- Calculate tubing runs from CAD drawings and bend tubing
- Properly assemble a box comprised of various tubing lengths

**Ensure system integrity and minimize leakage risks through proper fitting assembly and installation procedures.**



**Contact us to schedule your class:**  
[info@nctn.swagelok.com](mailto:info@nctn.swagelok.com)



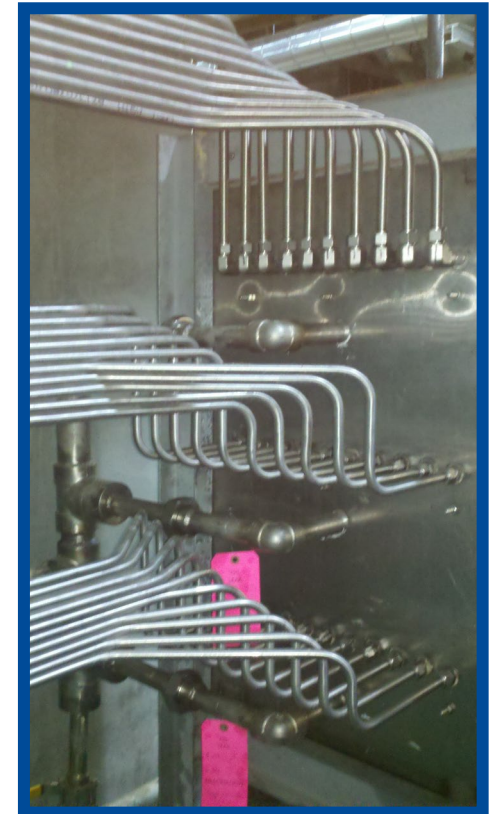
# Upcoming Tech Talks

## April Tech Talk: Tube vs. Pipe

Wednesday, April 21<sup>st</sup> 11:30 am to 12:00 pm

*Many facilities depend on fluid delivery sent through piping systems; however, stainless steel tubing, instead of hard pipe, can greatly simplify installation and plant maintenance. We will discuss specific advantages of tube over pipe including size and pressure ratings, end connections, improved flow, reduction of components used and other considerations*

*Reduce as many potential leak points from your system by bending the tubing versus using elbows, at a lower installed cost.*





# Questions?

