

High-Pressure and High-Temperature Probes for pH, ORP, Conductivity, Potential, and Electrochemical Studies

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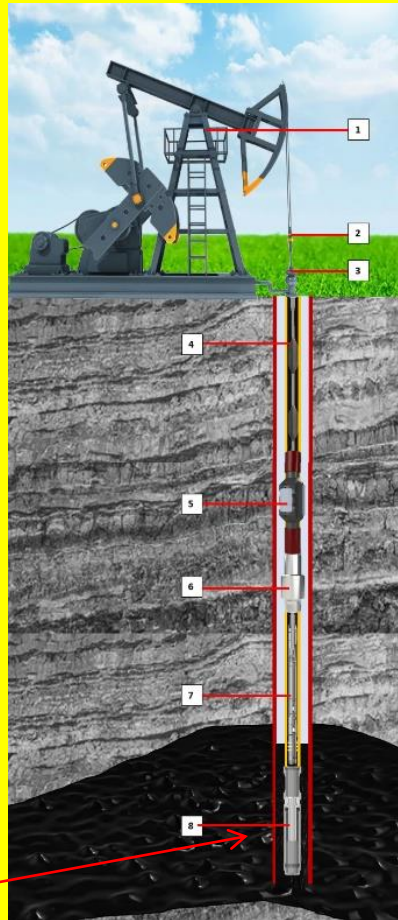


Needs for High-Pressure (HP) and High-Temperature (HT) Probes

- Deep Oil and Gas Wells
- Underground Formations
- Geothermal Plants
- Chemical Processing Plants
- Carbon Capture and Storage Programs
- Pulp and Paper



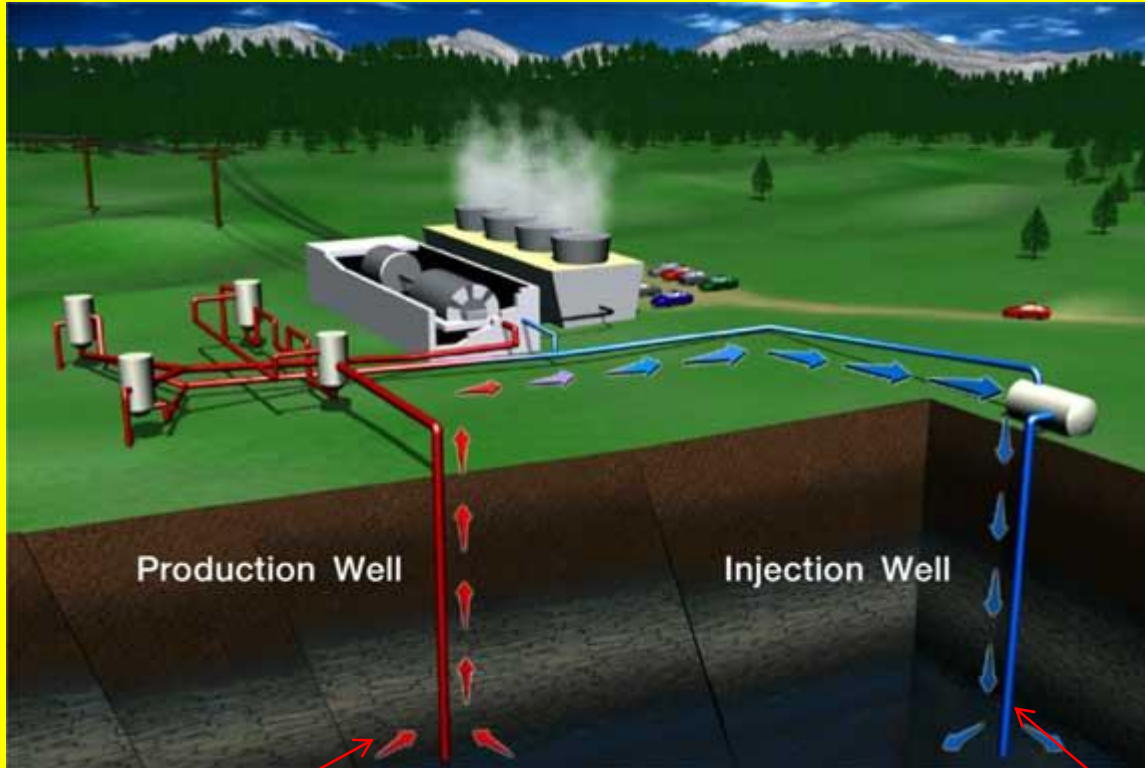
Oil and Gas Wells and Underground Formations



Up to 485 °F (250 °C)
and 10000 psi
(700 bar)

Courtesy: Black Gold Pump & Supply, Inc.
<https://www.blackgoldpump.com/rodliftcompletion>

Geothermal Plants



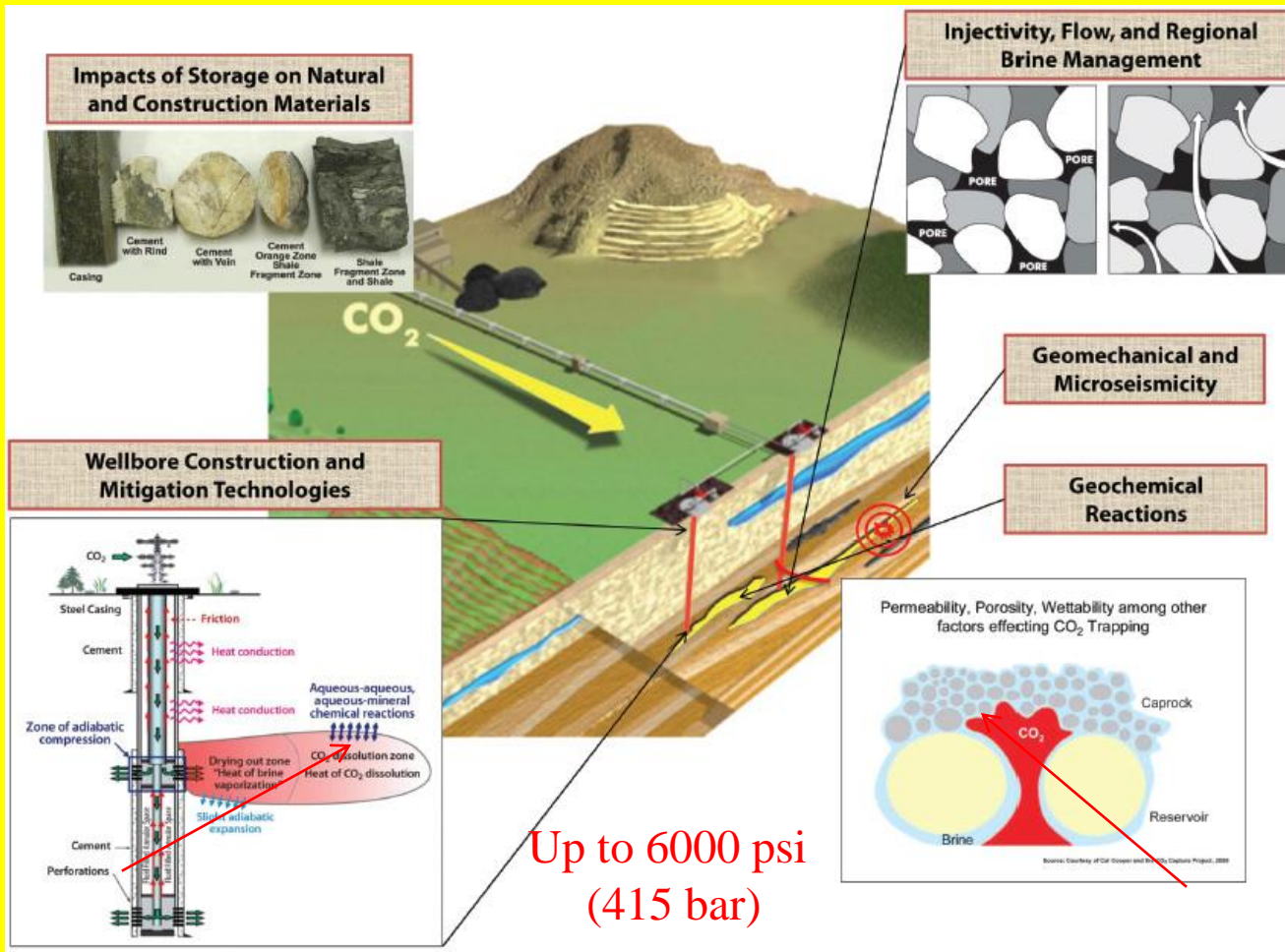
Geothermal Reservoir

Up to 700 °F (370 °C)

Courtesy: Geothermal Education Office

<http://geothermal.marin.org/geopresentation/sld037.htm>

Carbon Sequestration Programs

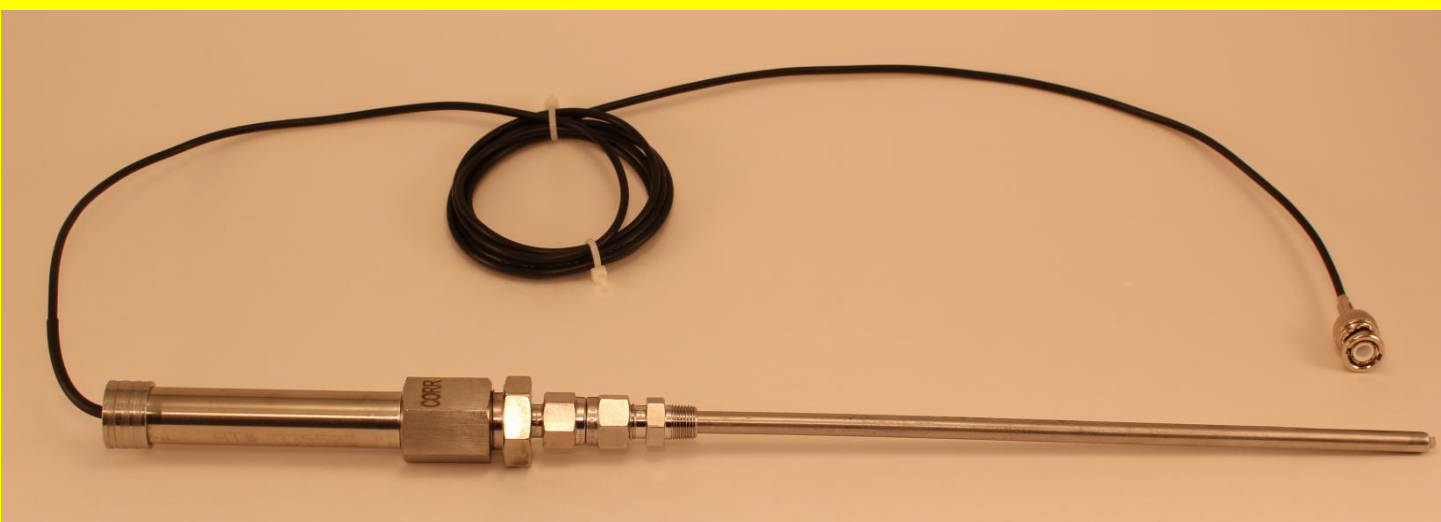


Courtesy: U.S. DEPARTMENT OF ENERGY

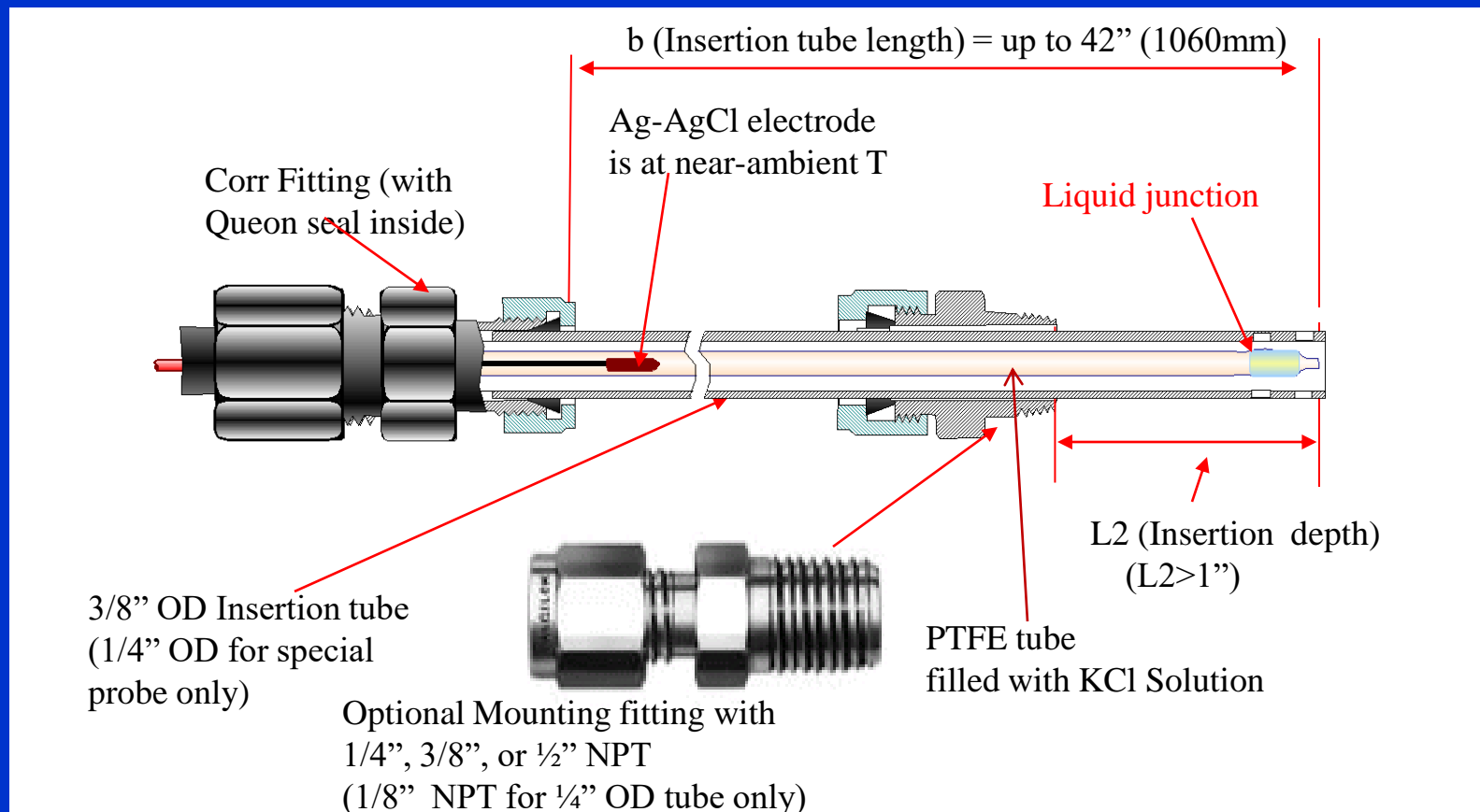
http://www.netl.doe.gov/technologies/carbon_seq/corerd/storage.html

Patented UltraDeg[®] Reference Probes

T up to 305 °C (581 °F); P up to 7500 psi (520 bar)

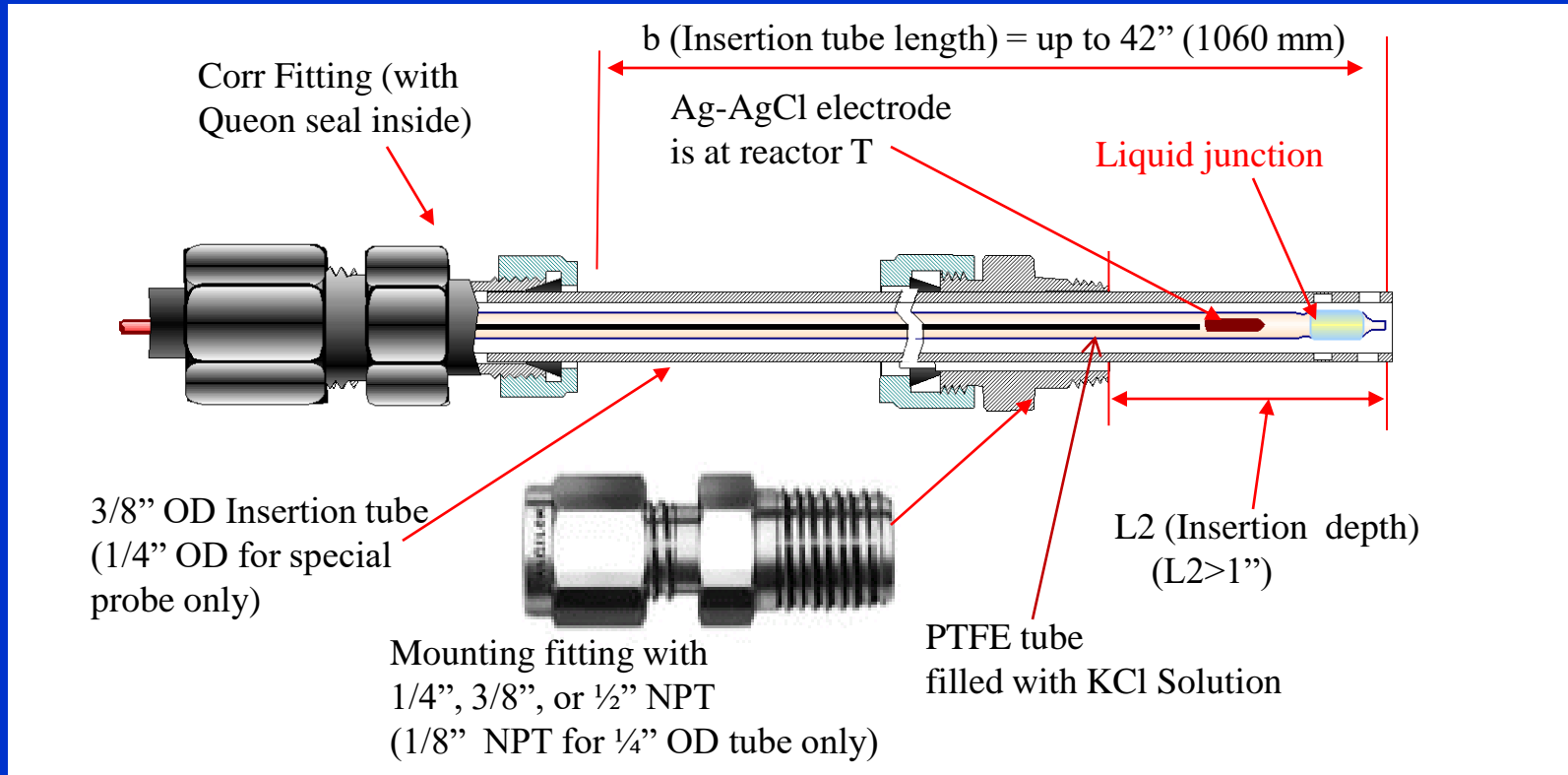


Typical External UltraDeg Reference Probes



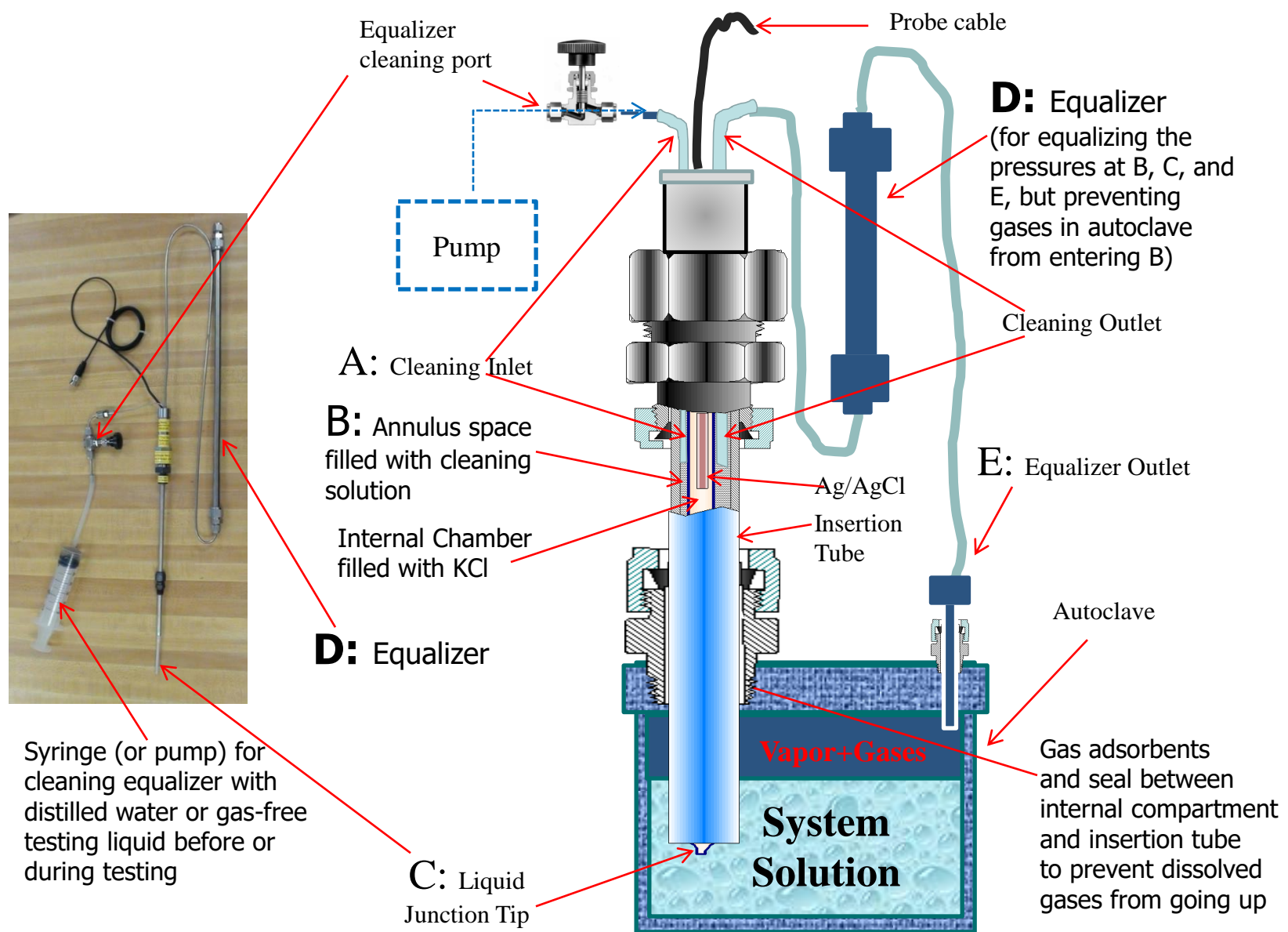
In the external reference probe, the electroactive reference material (Ag/AgCl) is away from heated location and maintained near ambient temperature so that the probe is more stable when used at $T > 100$ °C

Typical Internal UltraDeg Reference Probes



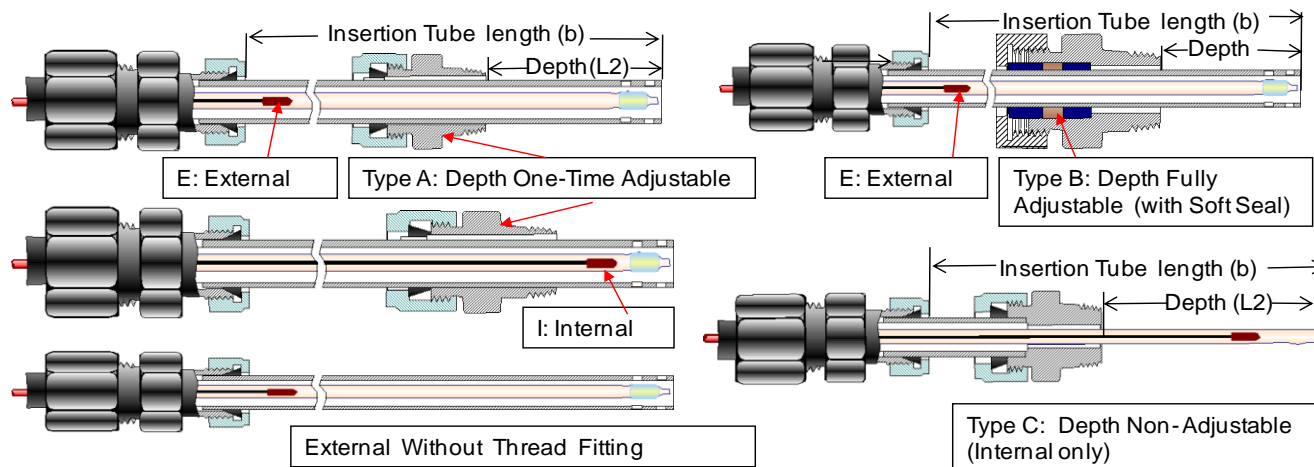
In the internal reference probe, the electroactive reference material (Ag/AgCl) is in the heated location so that the probe has a better defined thermodynamic potential. This probe is not recommended for long-term use at $T > 145$ °C

Gas-Tolerant Reference Probe for Use in Systems with H₂S and High-Pressure Gases

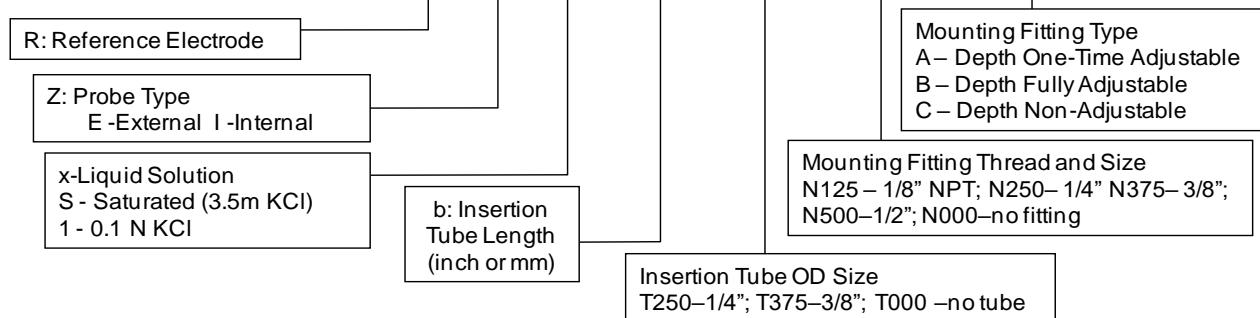


Summary for Reference Probes

Schematic diagram of High TP_pH_Ref_probes_v1206A



Ordering Code: R Z - x - b - T250 - N250 A



Our patented UltraDeg Ref. Electrodes are divided into three types (A, B, and C):

Type A or B has a compression fitting with NPT* thread and an insertion tube. The fitting of **Type A** has a metal seal that will lock to the insertion tube upon first use (insertion depth adjustable one-time only). The fitting in **Type B** has a soft seal that can be repositioned on the insertion tube after each use (insertion depth fully adjustable). **Type C** is compact and may be used in autoclaves with smaller access ports (0.18" or 4.5mm ID). The insertion depth for Type C is fixed at factory (non adjustable). Type C is available for internal design only.

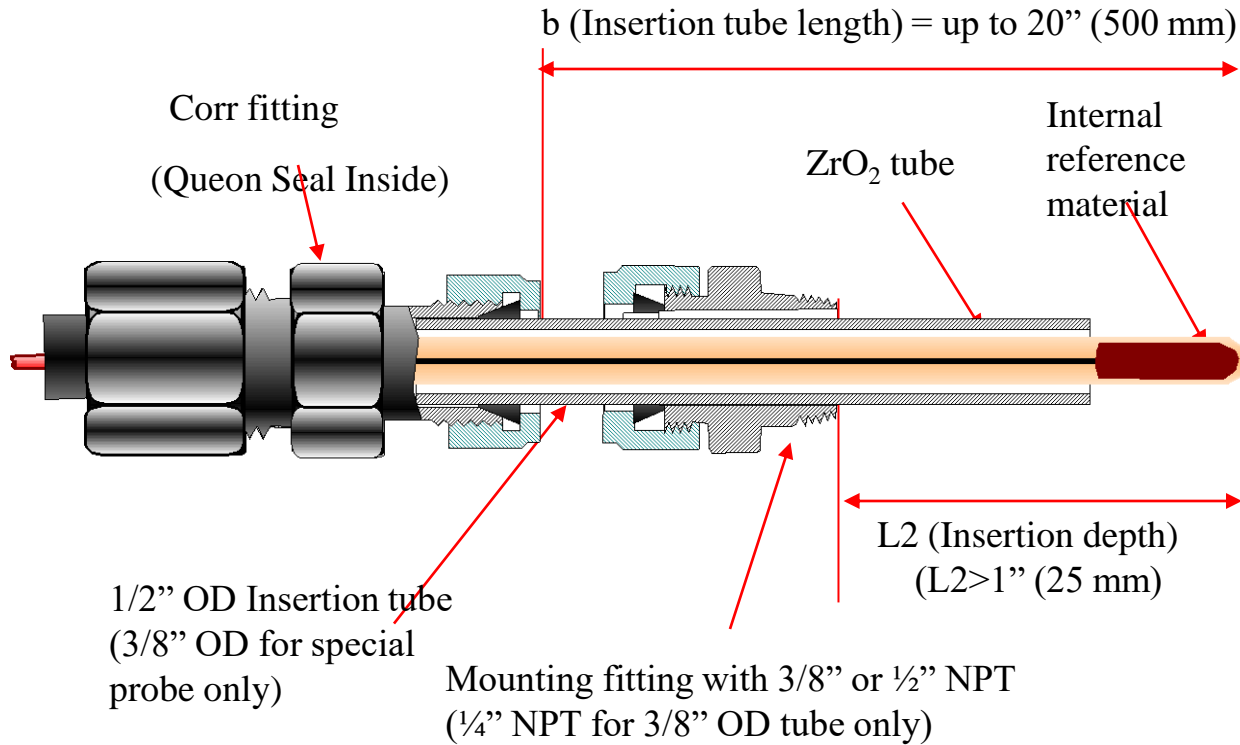
Gas-Tolerant Reference Probes for use in H₂S and CO₂ systems are also available.

UltraDeg[®] HT and HP ZrO₂-based pH Probes

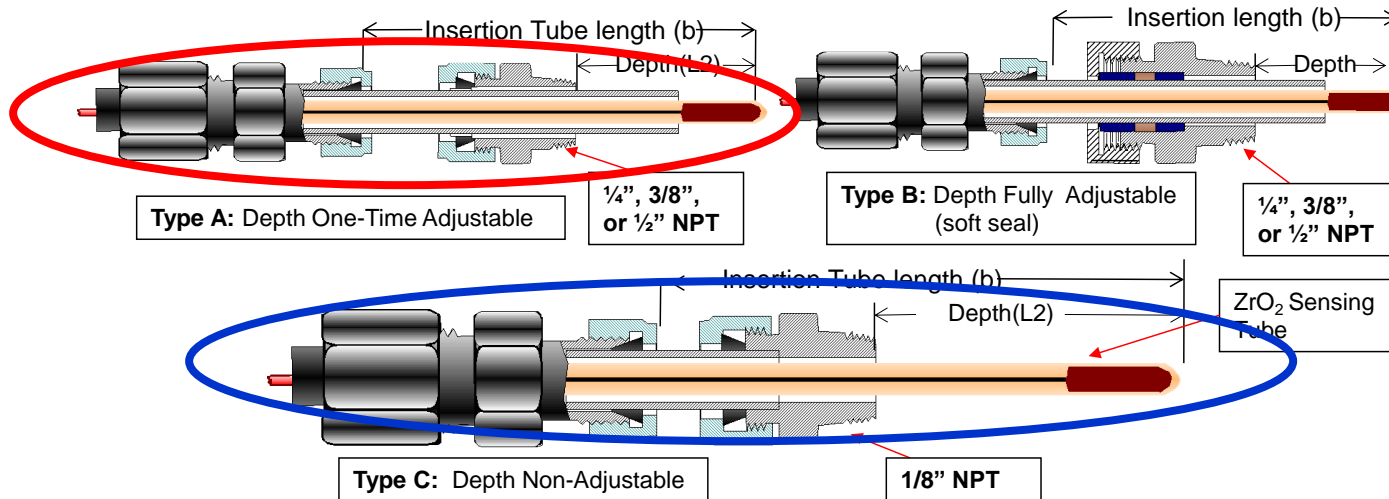
T=80 to 150 °C, 90 to 305 °C, or 180 to 343 °C, Depending on Models
P up to 6000 psi (413 bar)



Typical UltraaDeg ZrO₂-Based pH Probes

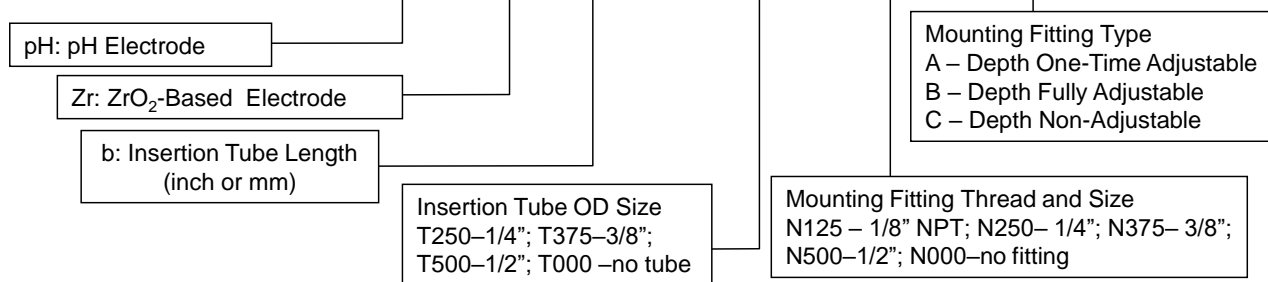


Summary for ZrO₂-Based pH Probes



Schematic diagram of High TP_pH_Ref_probes_V1206A

Ordering Code: pH - Zr - b - T500-N375 A



UltraDeg ZrO₂-based pH electrodes are divided into three types (A, B, and C):

Type A or B pH electrode has a compression fitting with NPT thread and an insertion tube. The fitting of **Type A** has a metal seal that will lock to the insertion tube upon first use (insertion depth adjustable one-time only). The fitting in **Type B** has a soft seal that can be repositioned on the insertion tube after each use (insertion depth fully adjustable).

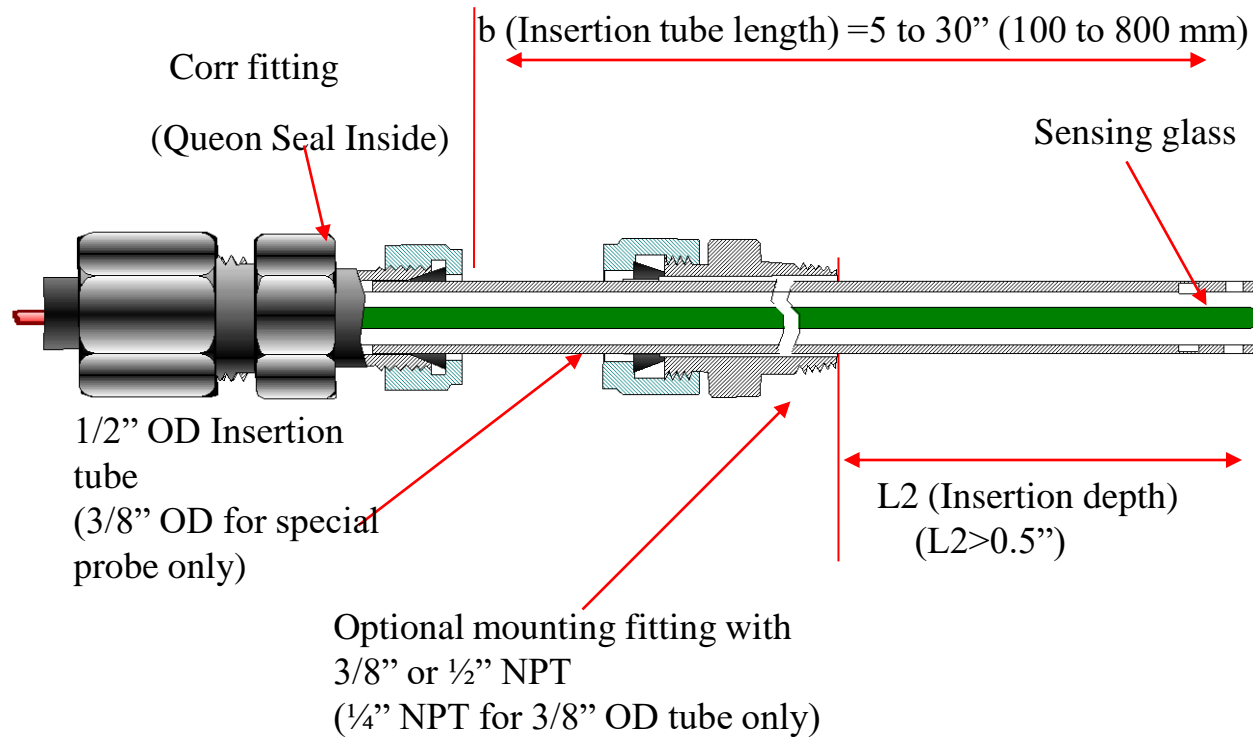
Type C Type C design is ultra compact and may be used in autoclaves that have smaller access ports (1/8" NPT). The insertion depth for Type C is fixed at factory (non adjustable).

UltraDeg[®] Glass-Based pH Probes

T=1 to 80 °C; P =up to 4000 psi (or up to 7500 psi without CO₂ or H₂S)

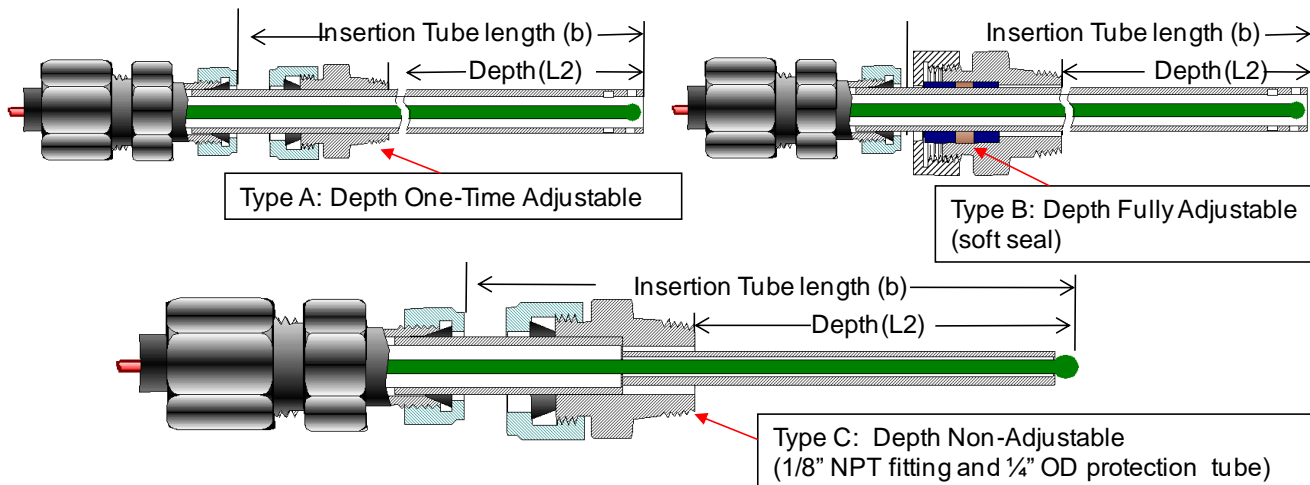


Typical UltraDeg Glass-Based pH Probes

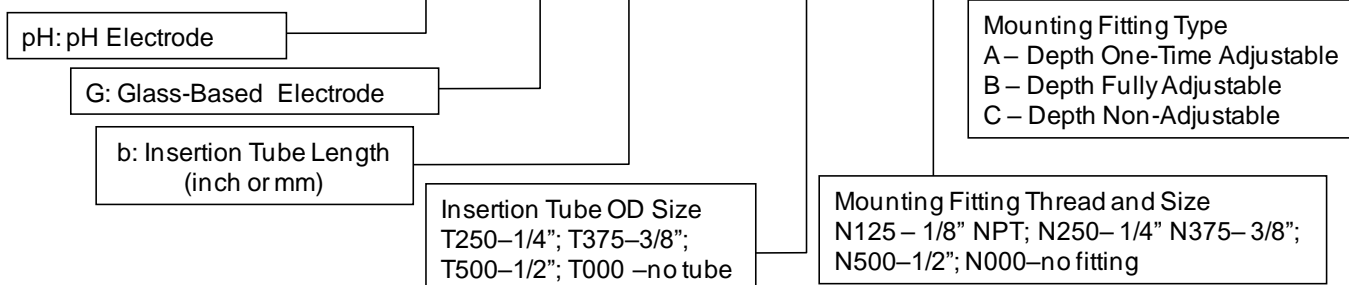


Summary for Glass-Based pH Probes

Schematic diagram of High TP_pH_Ref_probes_V1206A



Ordering Code: pH - G - b - T500-N375 A



Our patented Glass-based high-P pH electrodes are divided into three types (A , B, and C):

Type A or B pH electrode has a compression fitting with NPT* thread and an insertion tube. The fitting of Type A has a metal seal that will lock to the insertion tube upon first use (insertion depth adjustable one-time only). The fitting of Type B has a soft seal that can be repositioned on the insertion tube after each use (insertion depth fully adjustable).

Type C design is ultra compact and may be used in autoclaves that have smaller access port (1/8" NPT). The insertion depth for Type C high-pressure pH electrode is fixed at factory (non adjustable).

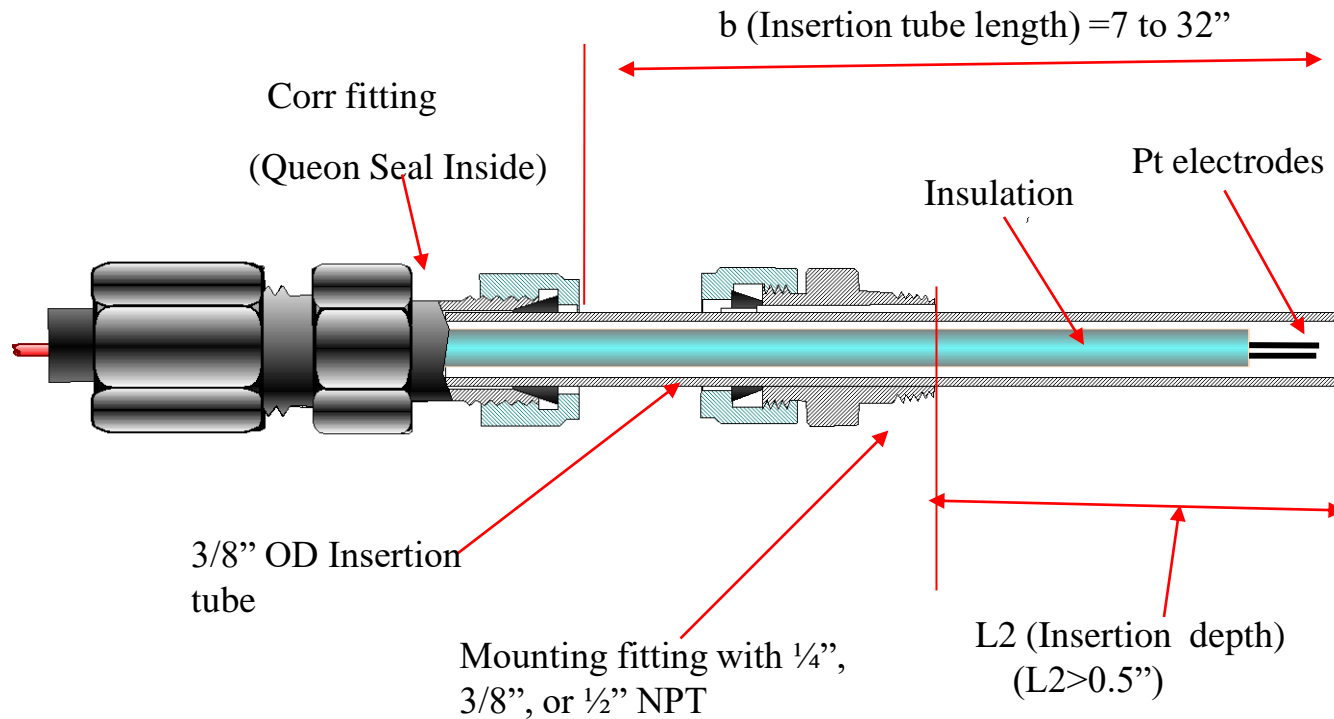
UltraDeg[®] Conductivity Probes for Low Conductivity

T= 0 to 305 °C; P up to 7500 psi; Conductivity < 500 $\mu\text{S}/\text{cm}$



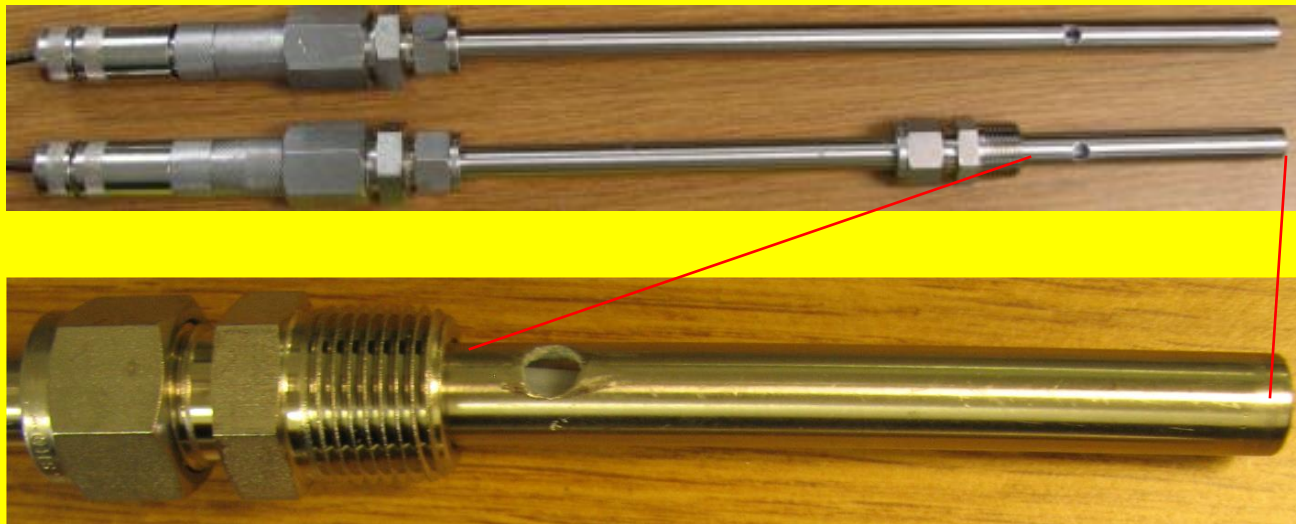
UltraDeg[®] Conductivity Probes for Low Conductivity

T= 0 to 305 °C; P up to 7500 psig; Conductivity < 500 μ S/cm



UltraDeg[®] Conductivity Probes for High Conductivity

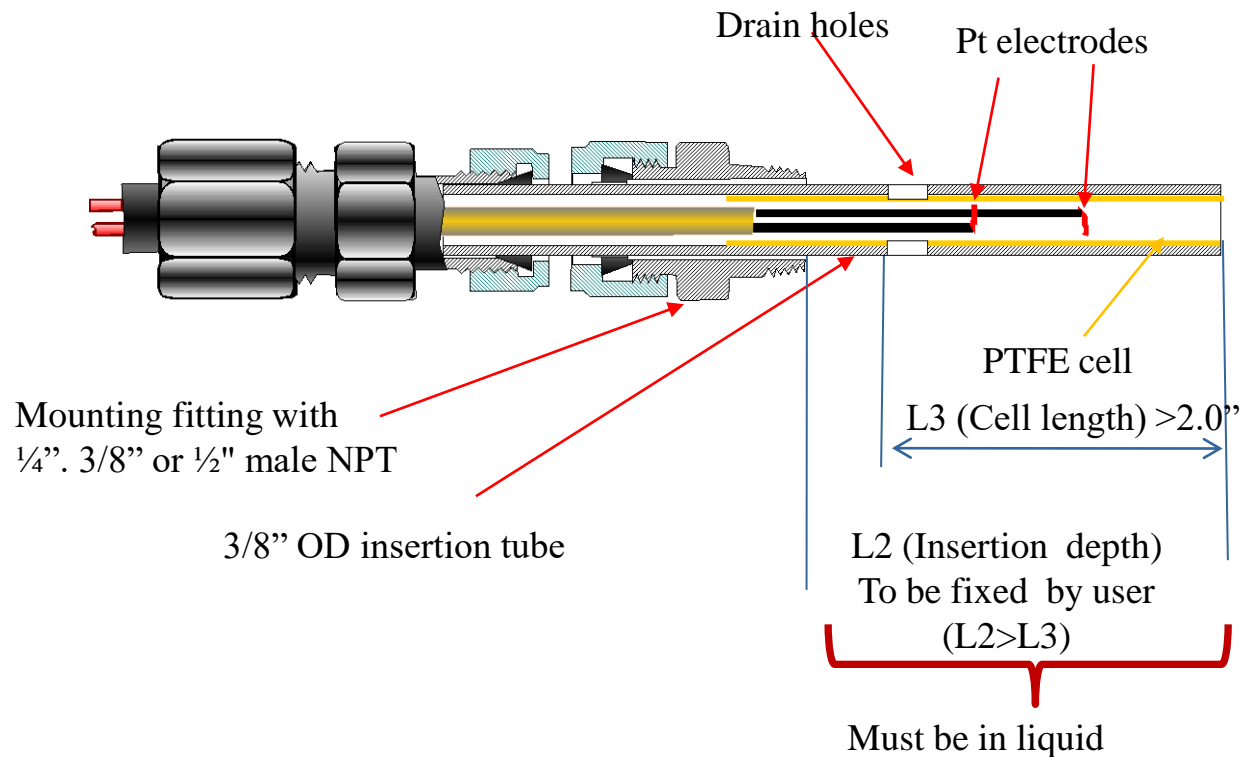
T= 0 to 305 °C; P up to 7500 psig; Conductivity up to 200 mS/cm



UltraDeg Conductivity Probes for High Conductivity

(T= 0 to 305 °C; P up to 7500 psig; Conductivity up to 200 mS/cm)

Cell Constant 1 to 20 cm^{-1}



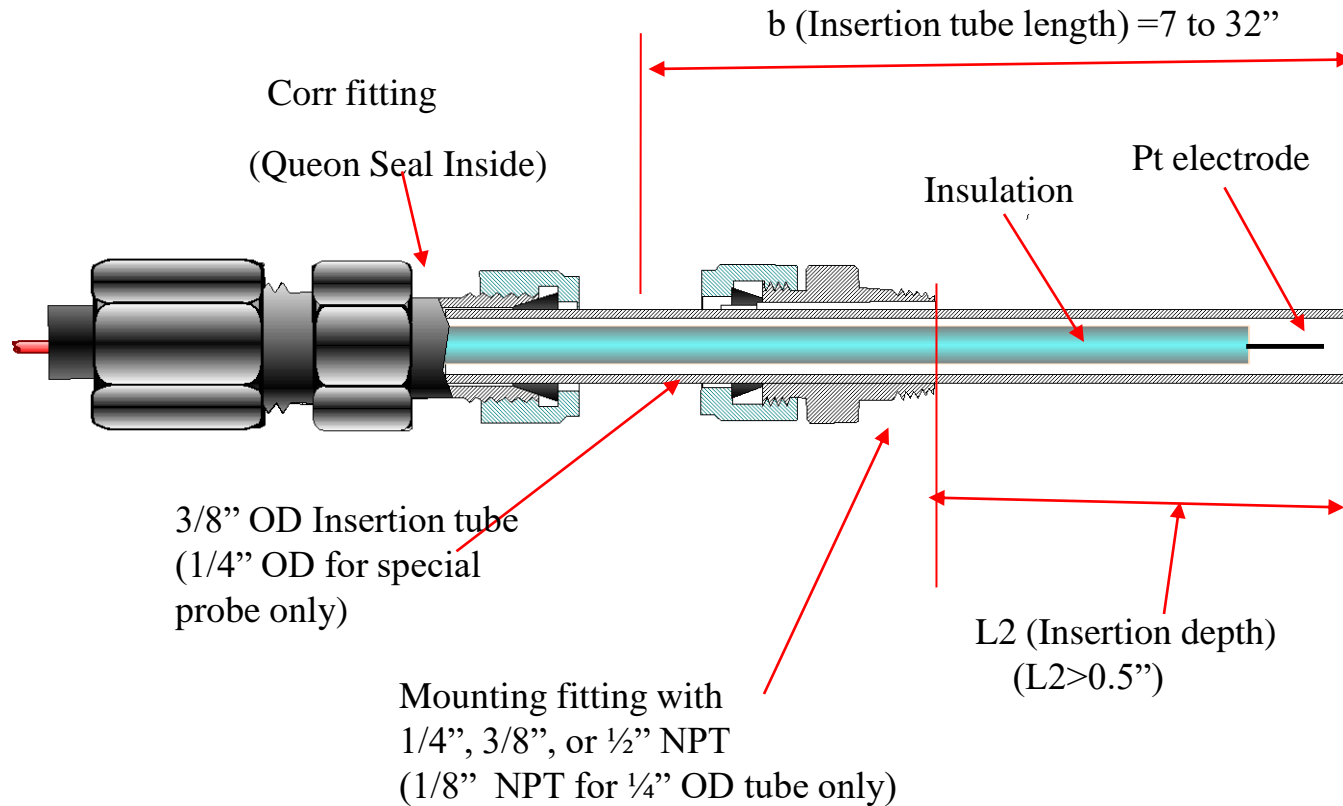
HT and HP Oxidation/Reduction Potential (ORP) Probes

T= 0 to 305 °C ;P up to 7500 psi



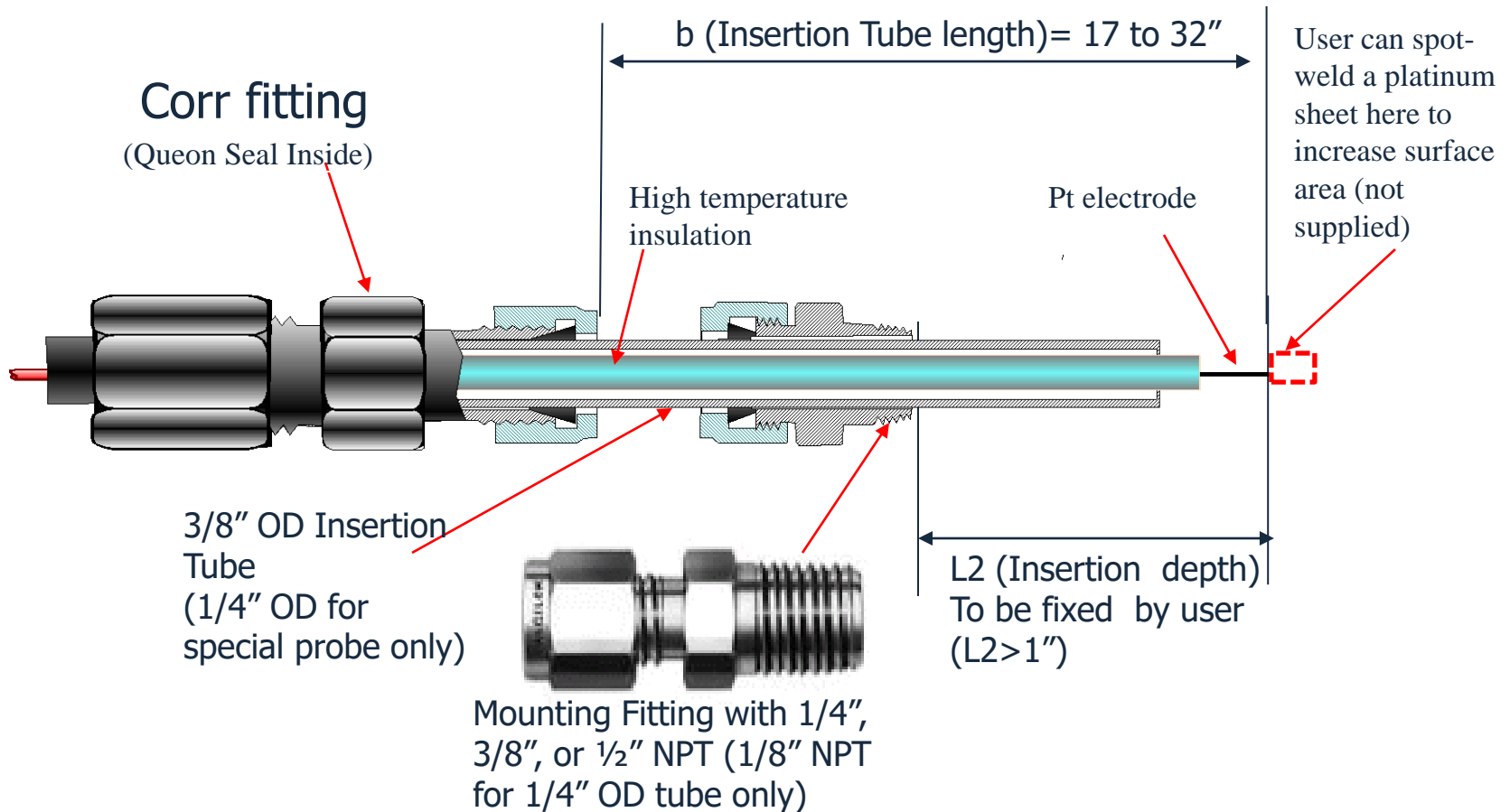
HT and HP Oxidation/Reduction Potential (ORP) Probes

P = 0 to 3750 psig; T up to 400 °C



High-Temperature Counter Electrode

P = 0 to 3750 psig; T up to 400 °C



High-P Working Electrode Holder with Spot-Welded Connection to Electrical Lead for Higher T Applications (T up to 400 °C)

Short 1.6 mm OD rod
(electrical lead)

4" ± 0.5"

Corr fitting
(Queon Seal Inside)

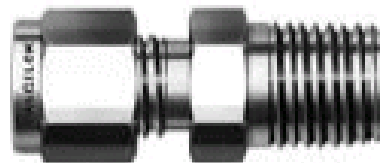
b (Insertion Tube length)= 7 to 30"

High temperature
insulation

Passive wire(C-
276 Wire)
with PTFE
insulation

User spot-
welded
Specimen

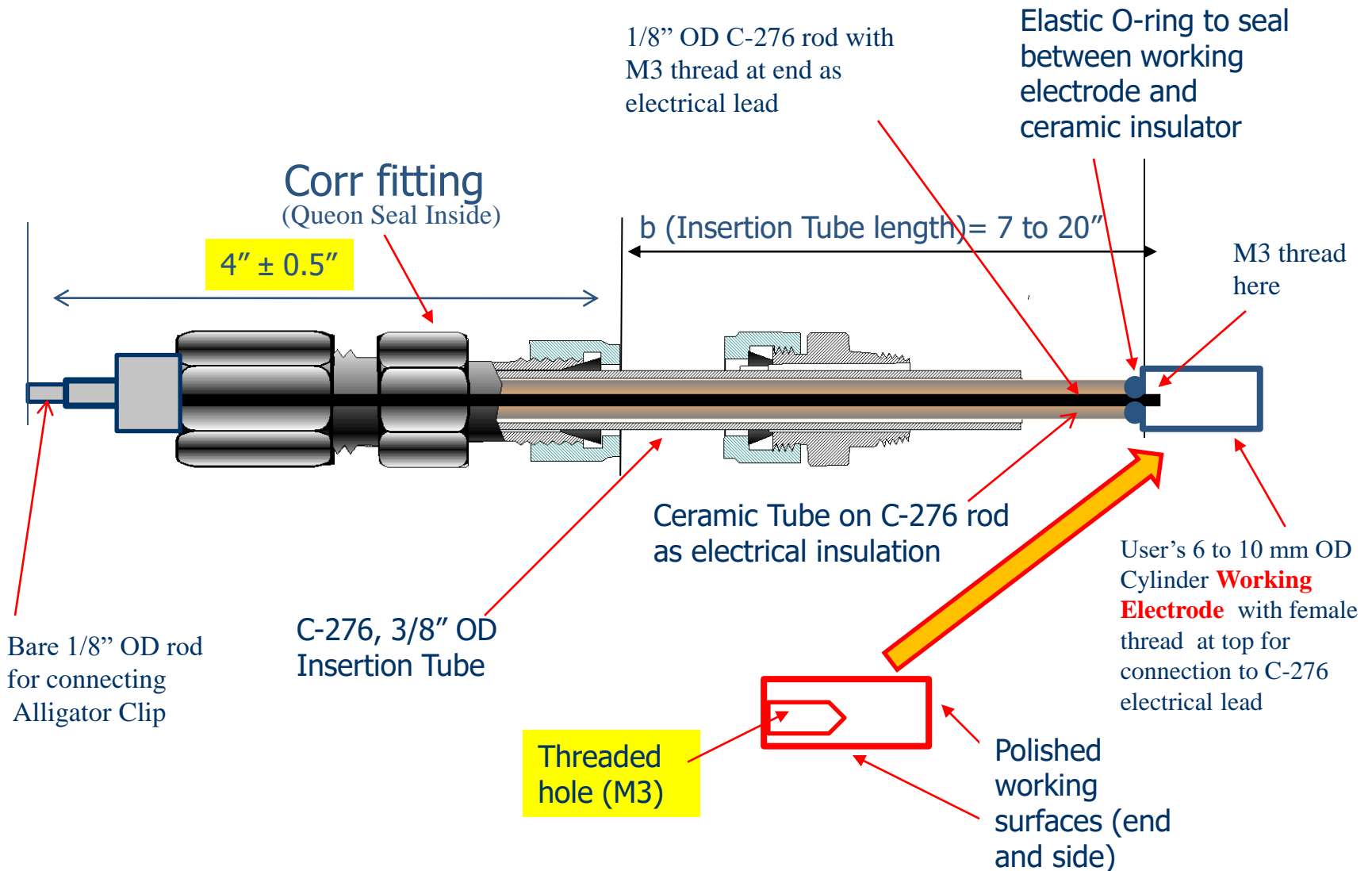
C-276, 3/8" OD
Insertion Tube
(1/4" OD for
special probe only)



L2 (Insertion depth)
To be fixed by user
(L2 > 2")

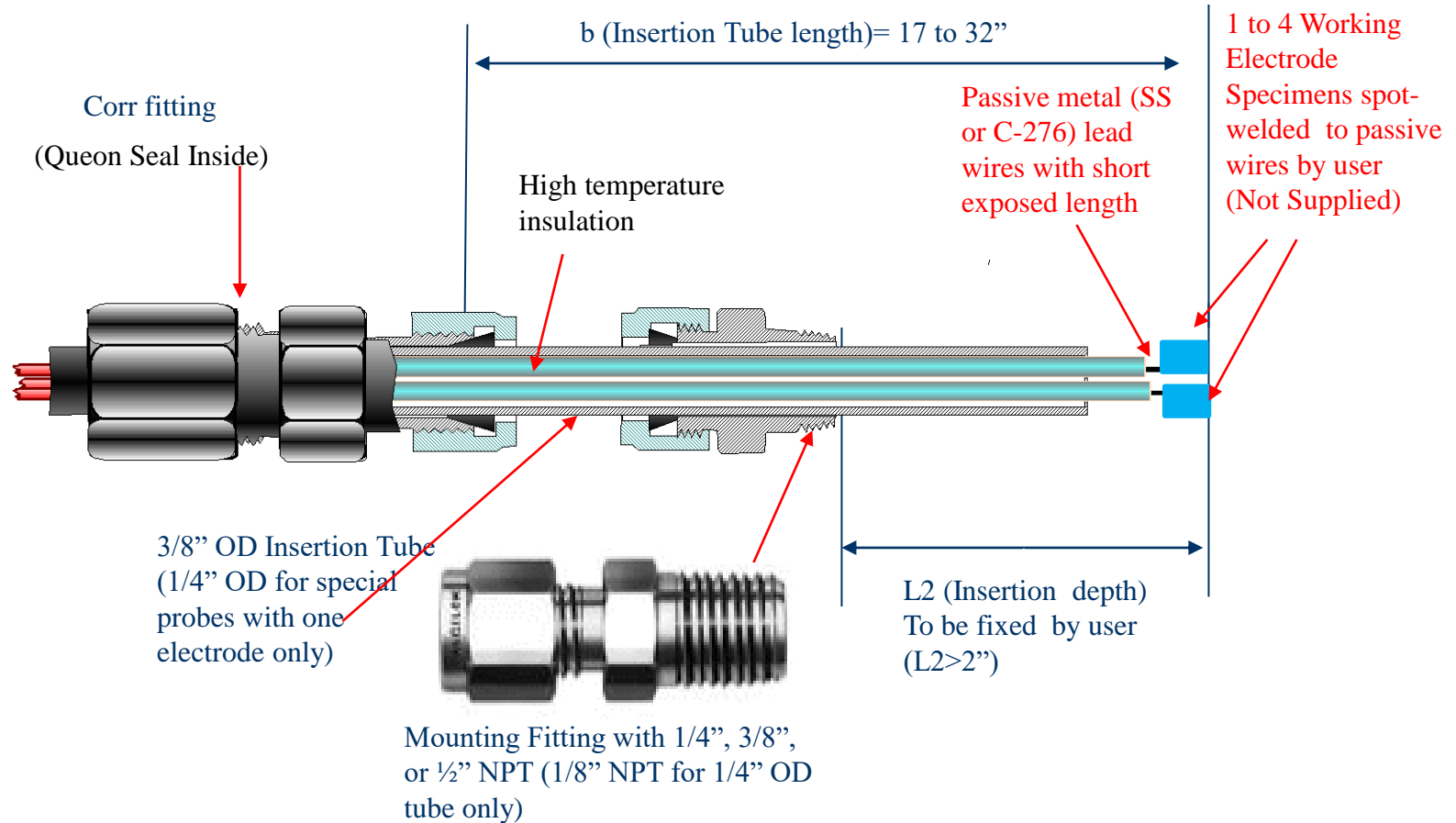
Mounting Fitting with 1/4",
3/8", or 1/2" NPT (1/8" NPT
for 1/4" OD tube only)

High-P Working Electrode Holder with Threaded Connection to Electrical Lead for Medium T Applications (T up to 200 °C)



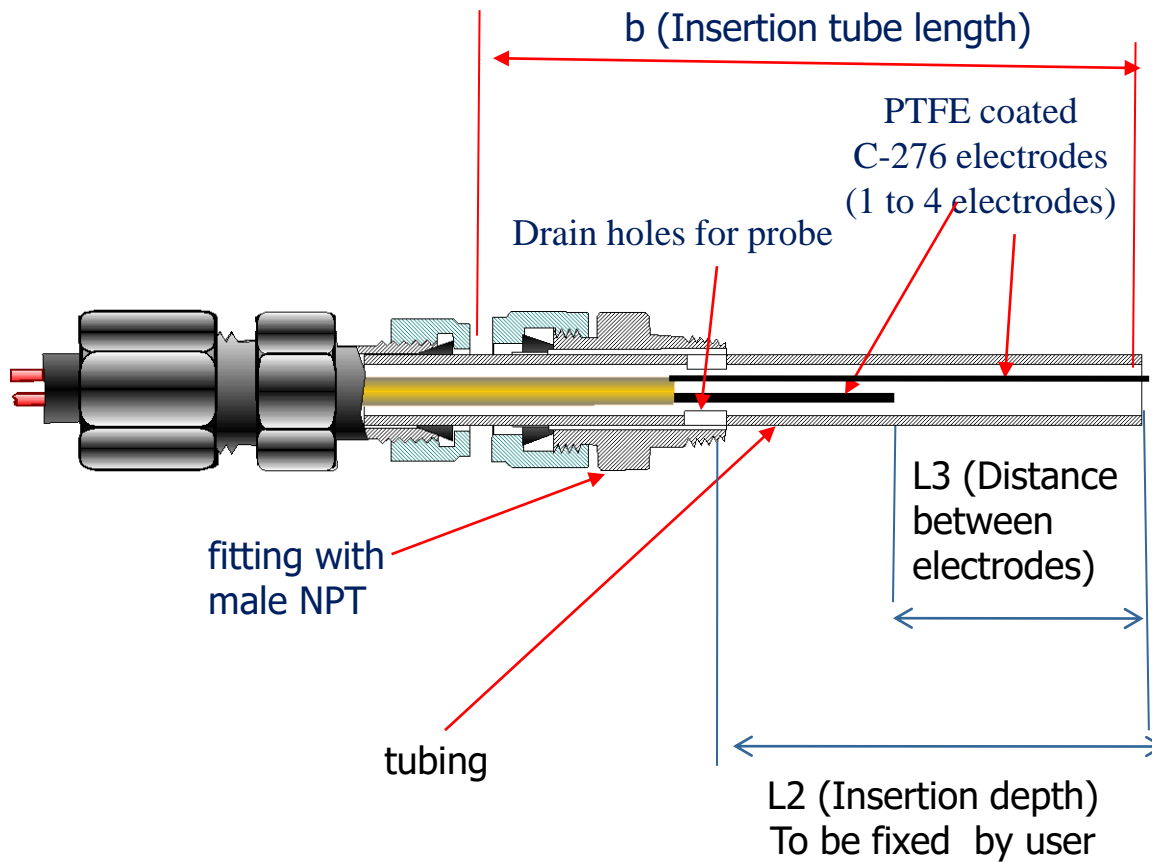
High-P Electrode Holder for Multiple Working Electrodes

P = up to 6000 psi; T = 0 to 400 oC, depending on models



HT and HP Level Probes

T = 0 to 305 °C ; P up to 5000 psi



Important Probe Components– Queon™ Seals for High-T & High-P without Leak after Temperature Cycling



Queon is the only electrically insulating seal for sealing electrodes at $T > 230\text{ }^{\circ}\text{C}$

Queon Seal can be made into various shapes



Queon Seal is particularly suitable for packing gland

Properties of Queon™ Seals and Comparison with PTFE (Teflon®) Seals

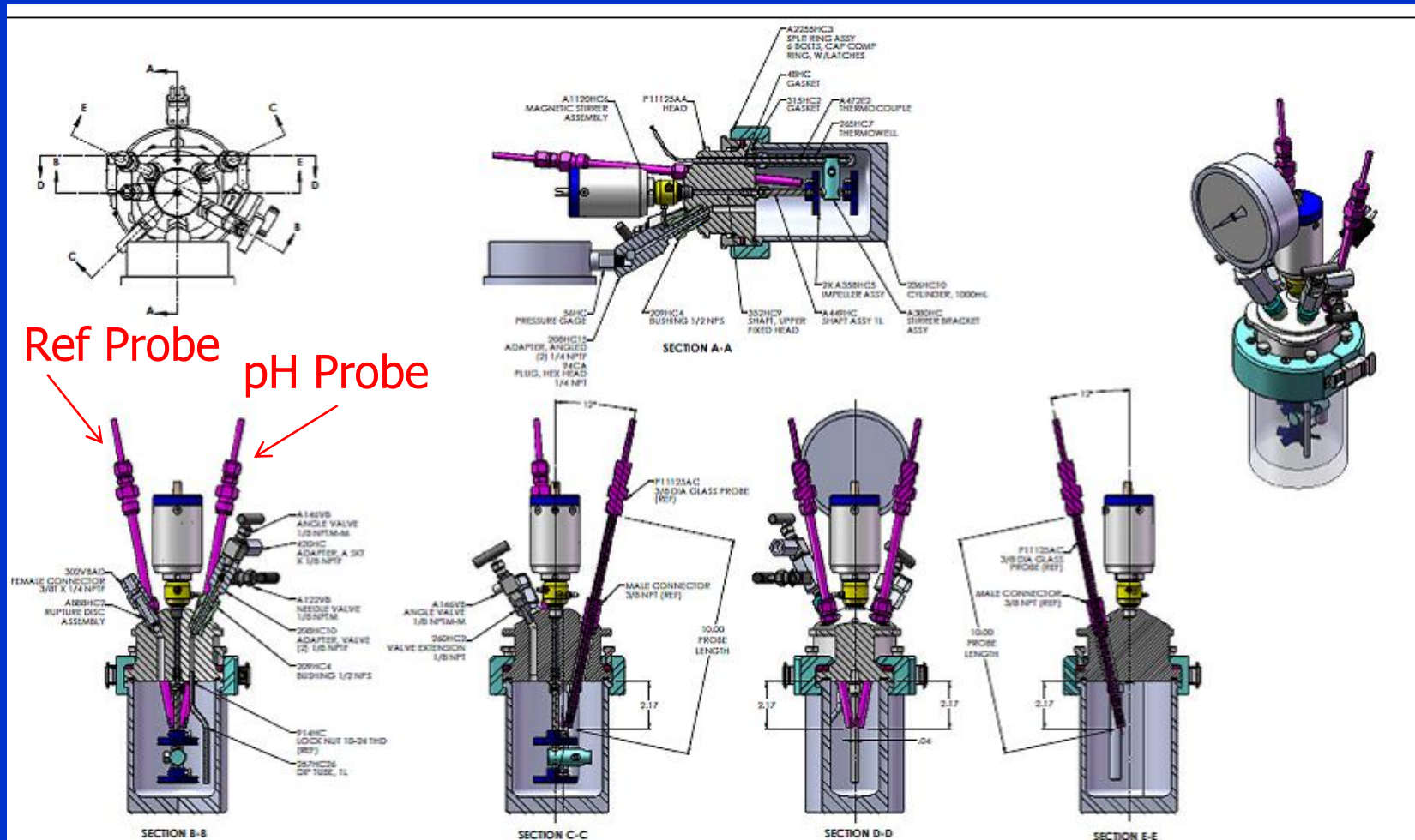
	Queon Seal	Teflon Seal
Continuous Working T	-185 to 343°C (-300 to 650°F) Maintains integrity after exposure to heat	-185 to 232°C (-300 to 450°F) Becomes loose after exposure to heat
Temperature Cycling	Withstand rapid heating to 343°C (650°F) and rapid cooling to 25°C (77°F)	Leak develops after slow cooling from 232°C (450 °F)
Chemical Stability	Excellent in water/steam or high pH solutions in packing gland at 343°C (650°F)	Excellent

Testing Results in Compression Fittings

Sealed Rod or Tube Size in Packing Gland	Before Baking (cc He/sec at 25°C)		After 320°C (cc He/sec at 25°C)		Electrical Resistance at 5000 V (ohm)		Maximum Pressure at 25°C	
	Queon	Teflon	Queon	Teflon	Queon	Teflon	Queon (before and after 320°C)	Teflon (before baking only)*
6.35-mm OD steel rod	2x10 ⁻⁸	Similar to Queon	2x10 ⁻⁸	Leak after Baking	2x10 ¹²	Similar to Queon	13000 psi/90 MPa	2000 psi/13.8MPa
1-mm OD steel wire	-----		2x10 ⁻⁸		2x10 ¹²		20000 psi /138 MPa	10000 psi / 69 MPa
3.18-mm OD steel rod	-----		2x10 ⁻⁸		2x10 ¹²		13000 psi/90 MPa	8000 psi / 55 MPa

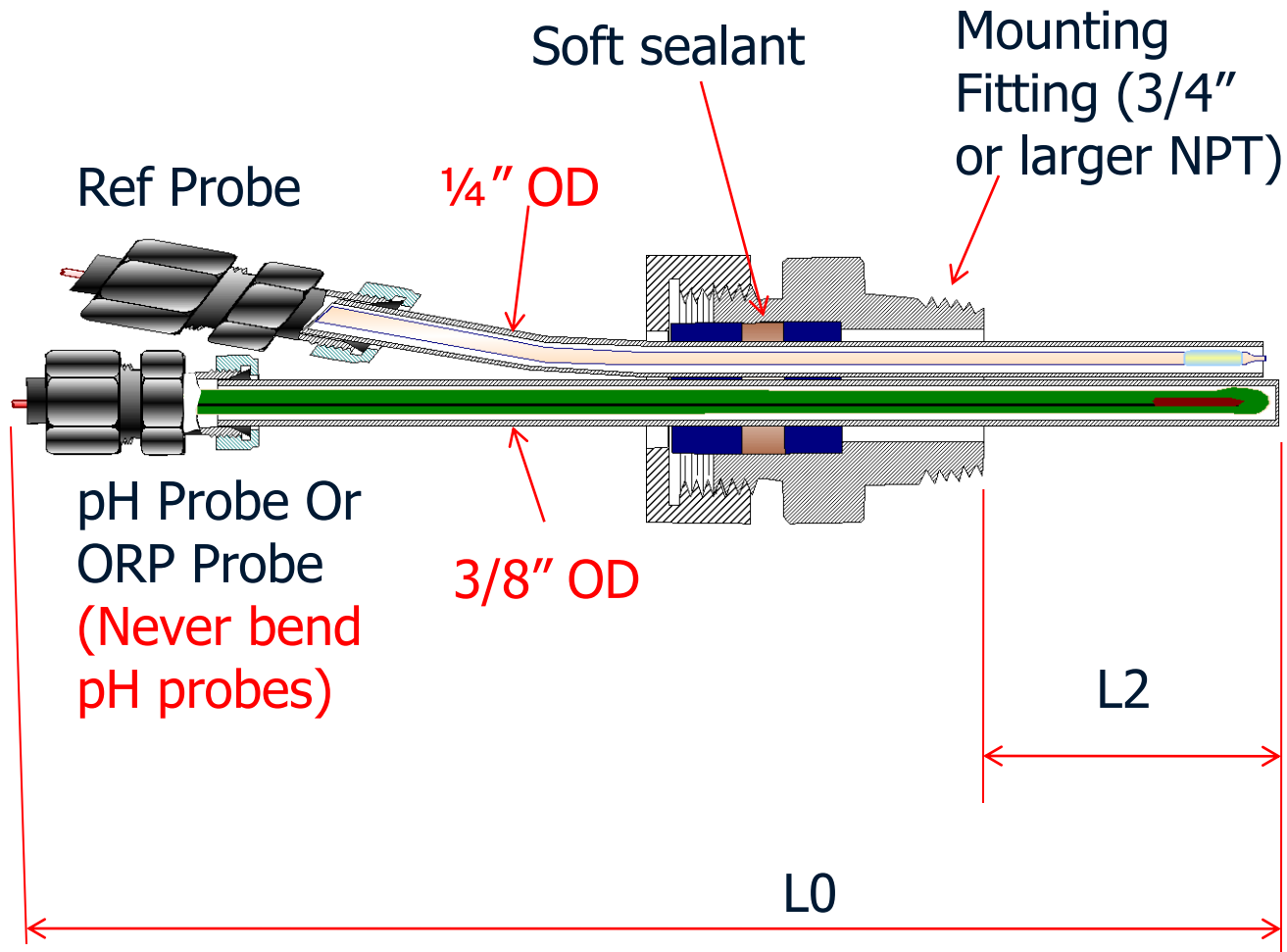
*Teflon seals leaked after baking and cannot withstand any pressure

Typical Installations of HP and HT Probes in Reactors/Autoclaves



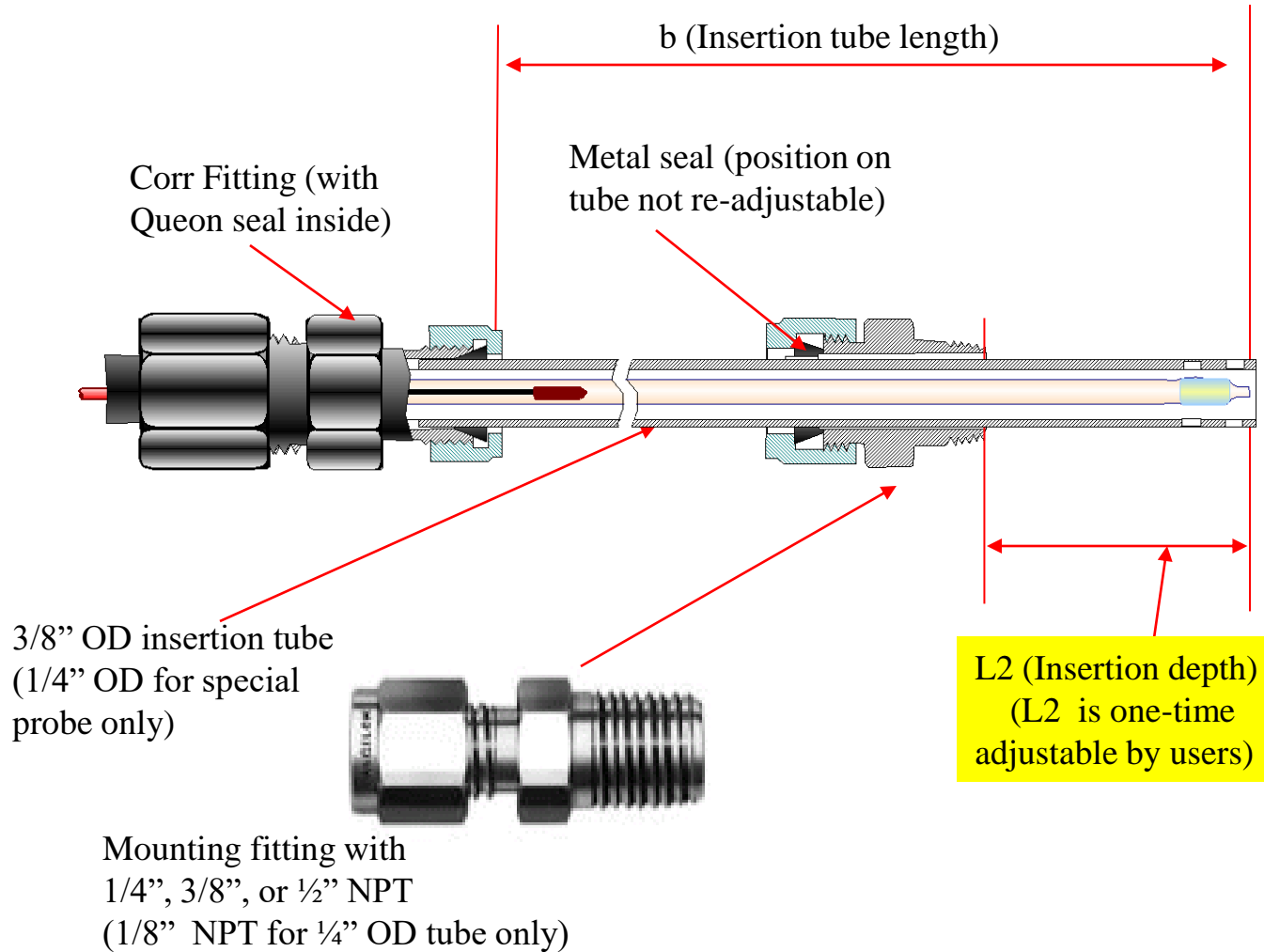
Combination pH or ORP Probes

(Reference probe can be bent for installation)



Type A Probes

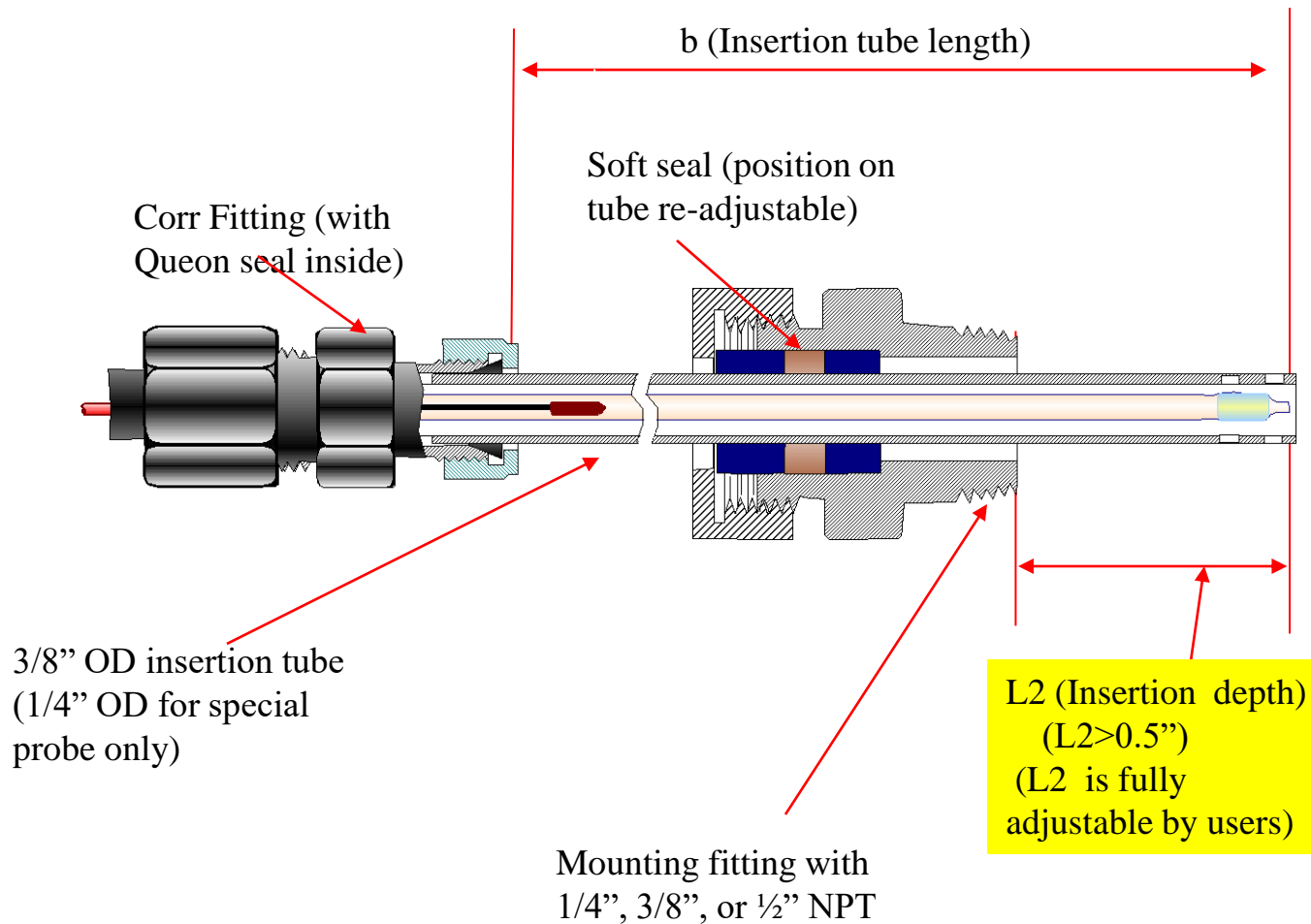
Insertion Depth Is One-Time Adjustable by Users



Type B Probes

Insertion Depth Is Fully Adjustable by Users

(P < 3000 psi only)



Back up slides

Typical curves

Connections

Meters

Data acquisition

Gas-tolerance/H₂S-Tolerant reference probes