ECM Bifurcated Intake Sample Probe, P/N 12-16a

The bifurcated sample probe provides a low-intrusive way to sample intake gases for EGR (exhaust gas recirculation) and intake $\%O_2$ measurement. Advantages of using this probe versus directly mounting the O_2 and pressure sensors in the intake manifold are: easier installation, ability to scan the intake manifold for EGR distribution, and improved resistance to installation drift[1]. Its disadvantages are: it gives a slower analyzer response time and the aluminum block of the probe needs to be supported. The bifurcated sample probe was designed to be used with the ECM Model 4830 and 5230 EGR Analyzers. Unlike other sampling systems, no mass is removed from the intake, no major pressure disturbance is created in the intake, and no pumps are required.

Figure 1 shows the probe. The bifurcated sample tube has two holes, separated by 180 degrees, at the end that goes into the intake manifold. The tube is to be orientated so that one hole directly faces the flow. The O_2 and pressure sensors should be pointing down (as shown in Figure 1).

An internal wall goes up the length of the tube. Gases entering the inlet hole facing the flow will be decelerated by the wall creating a raised pressure at the inlet. These gases go up the tube and into the aluminum mounting block where the O_2 and pressure sensors are. Gases exit the probe and return to the intake manifold via the hole opposite the inlet hole. At the backside of the tube, a recirculation zone is created causing a lowered pressure at the exit hole. The raised pressure at the inlet hole and the lowered pressure at the exit hole is what drives the gases through the probe. See Figures 2A, B, C.

The probe is mounted in the intake via a Swagelok fitting with a ¼" tapered tread. The ferrules used in the mounting fitting, the "T", and the elbow are teflon. By using teflon ferrules, the sample point of the probe in the intake can be adjusted and the bifurcated tube can be replaced. By changing the sample point, the EGR distribution in an intake manifold can be mapped. See Figures 3A, B.

Figures 4A, B shows the fittings removed from the bifurcated tube. It is important during reassembly that the hole away from the end of the tube lines up with the "T". If it does not, the probe will not work.

To attenuate installation drift, up to four orifices can be installed (screwed) in the connection tubes (see Figure 5). More orifices mean more attenuation but a slower response time. The orifices do not affect the steady-state accuracy of the measurement, they just slow the time it takes the gases to reach the sensors. It is recommended that 1, 2, 3, then 4 orifices be installed until the difference between the $\%O_2$ of the sensor in free air and the $\%O_2$ of the sensor mounted in the probe of a running engine are within 0.1% O_2.

[1] Installation drift refers to the rise in displayed intake $\%O_2$ over ambient $\%O_2$ when the O_2 and pressure sensors are directly mounted in the intake of a running engine with zero EGR. This does not occur in all engines, but when it does, the intake $\%O_2$ will rise between 0.1 and 0.5% over the $\%O_2$ reading when the sensors are in free air. This rise has two causes: pressure oscillations that the O_2 sensor reacts to but are too high in frequency for the pressure sensor to detect and compensate for, and convective heat transfer off the body of the O_2 sensor.

Normally, calibration (Air-Cal or SPAN) is performed with the O_2 and pressure sensors out of the probe, pointing down, and in quiescent air. When calibrated this way and after being installed in a clean probe with the sensors pointing down, the $\%O_2$ reading will initially drift from the calibrated value and then return after approximately ½ hour. Sometimes, the $\%O_2$ reading will not return after ½ hour. This is due to residue water and other materials on the inside of the aluminum block evaporating and diluting the air in the aluminum block. When in use, flow through the aluminum block will minimize the effect of this evaporating material.

Alternatively, calibration can be performed with the sensors mounted in the probe in a running engine. With the EGR valve closed (i.e. zero EGR), calibrate (Air-Cal or SPAN) to the $\%O_2$ in air. An advantage of this technique is that it helps cancel out installation drift.

One method to shorten the response time of the probe in boosted applications (and only in boosted applications) is to put a 2 lpm bleed from the aluminum block. This can be done by mounting a valve in the side of the block. A 2 lpm bleed is insignificant in comparison to the flowrate of air through any engine. Alternatively, this bleed could be routed to the intake of the engine.

Replacement Parts:

P/N 12-17 Replacement Bifurcated Tube, 8mm

P/N 12-18a Aluminum O_2 Sensor Mounting Block

Teflon Ferrules: T-8M3-1, T-8M4-1 (get from Swagelok)

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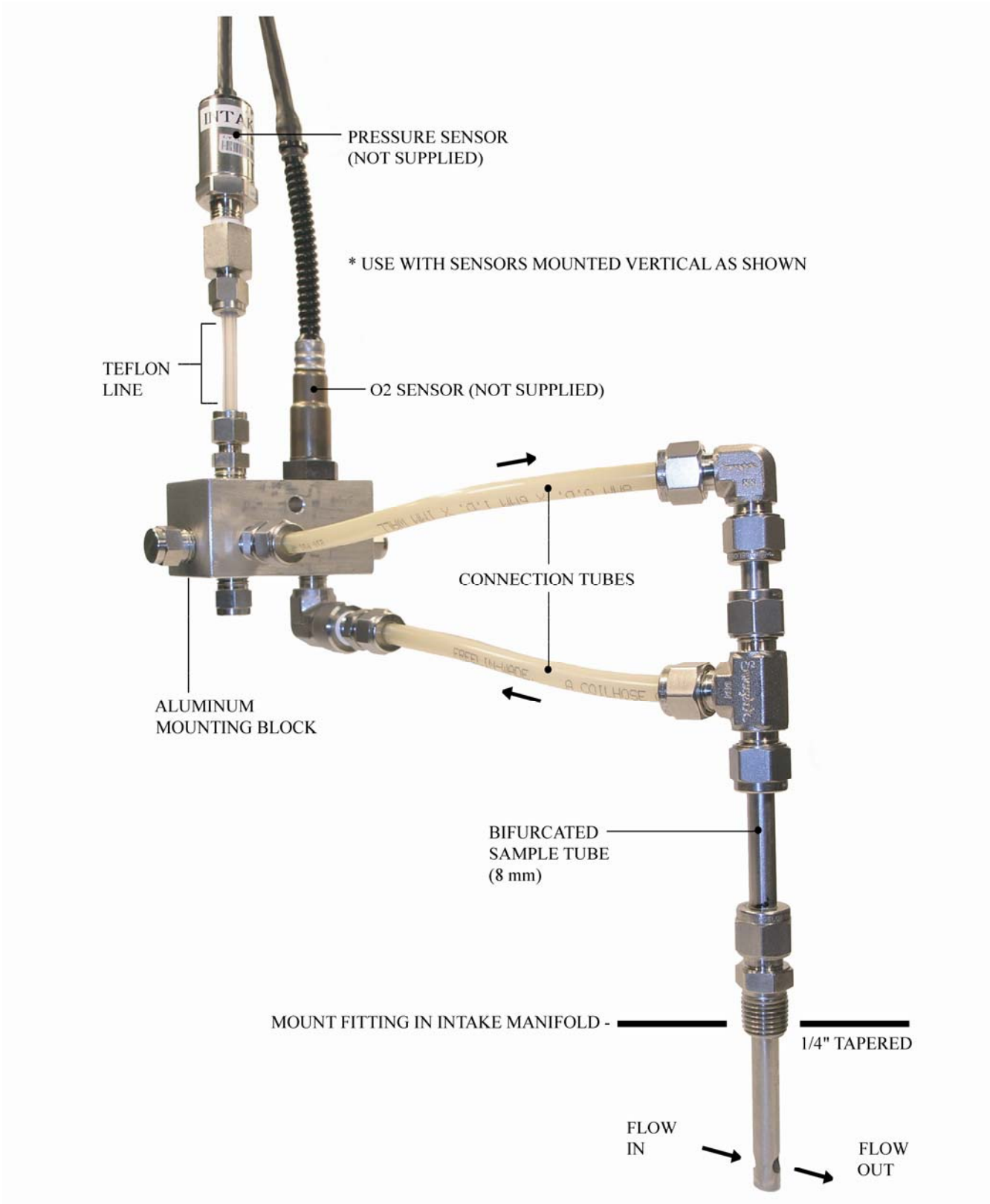

PRESSURE SENSOR
(NOT SUPPLIED)
* USE WITH SENSORS MOUNTED VERTICAL AS SHOWN
TEFLON
LINE
O2 SENSOR (NOT SUPPLIED)
CONNECTION TUBES
ALUMINUM
MOUNTING BLOCK
BIFURCATED
SAMPLE TUBE
(8 mm)
MOUNT FITTING IN INTAKE MANIFOLD -
1/4" TAPERED
FLOW
IN
FLOW
OUT

Figure 1

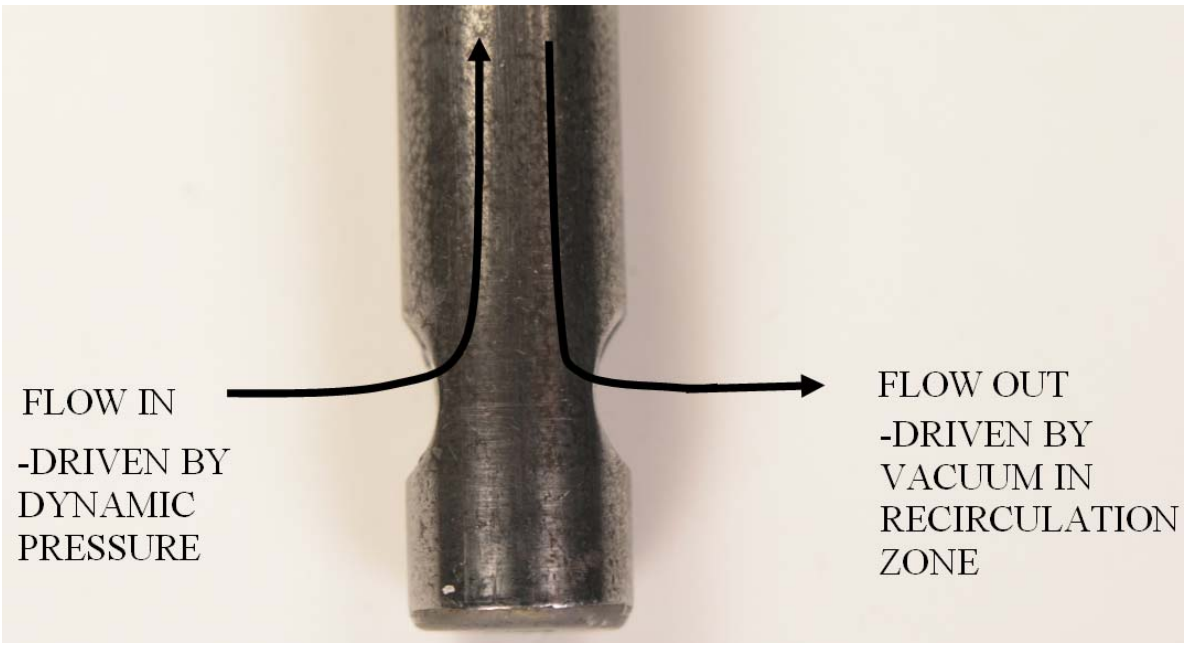
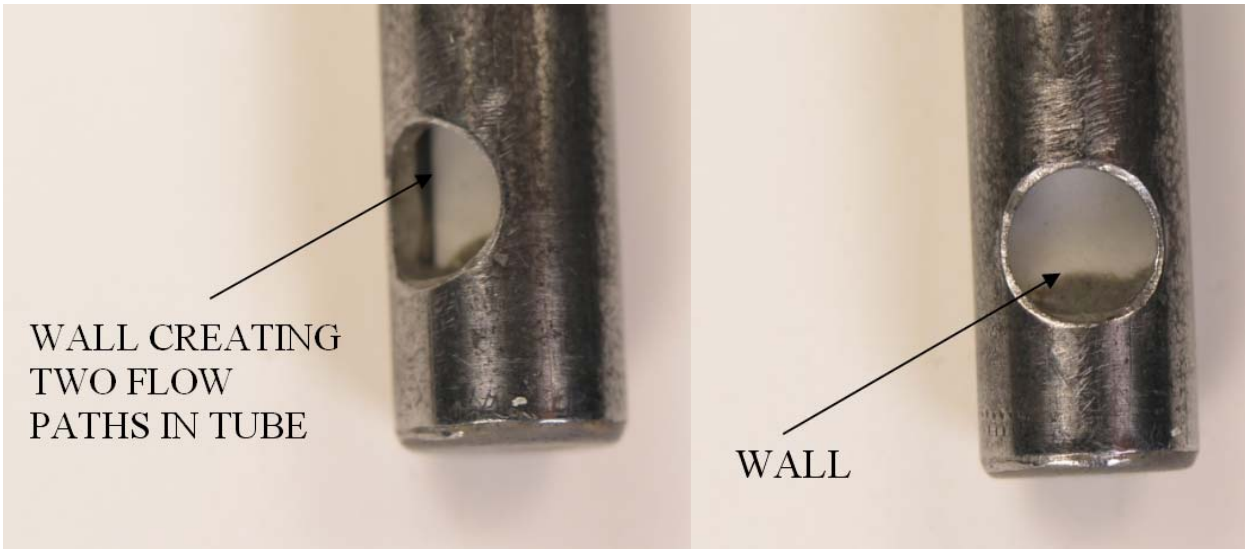
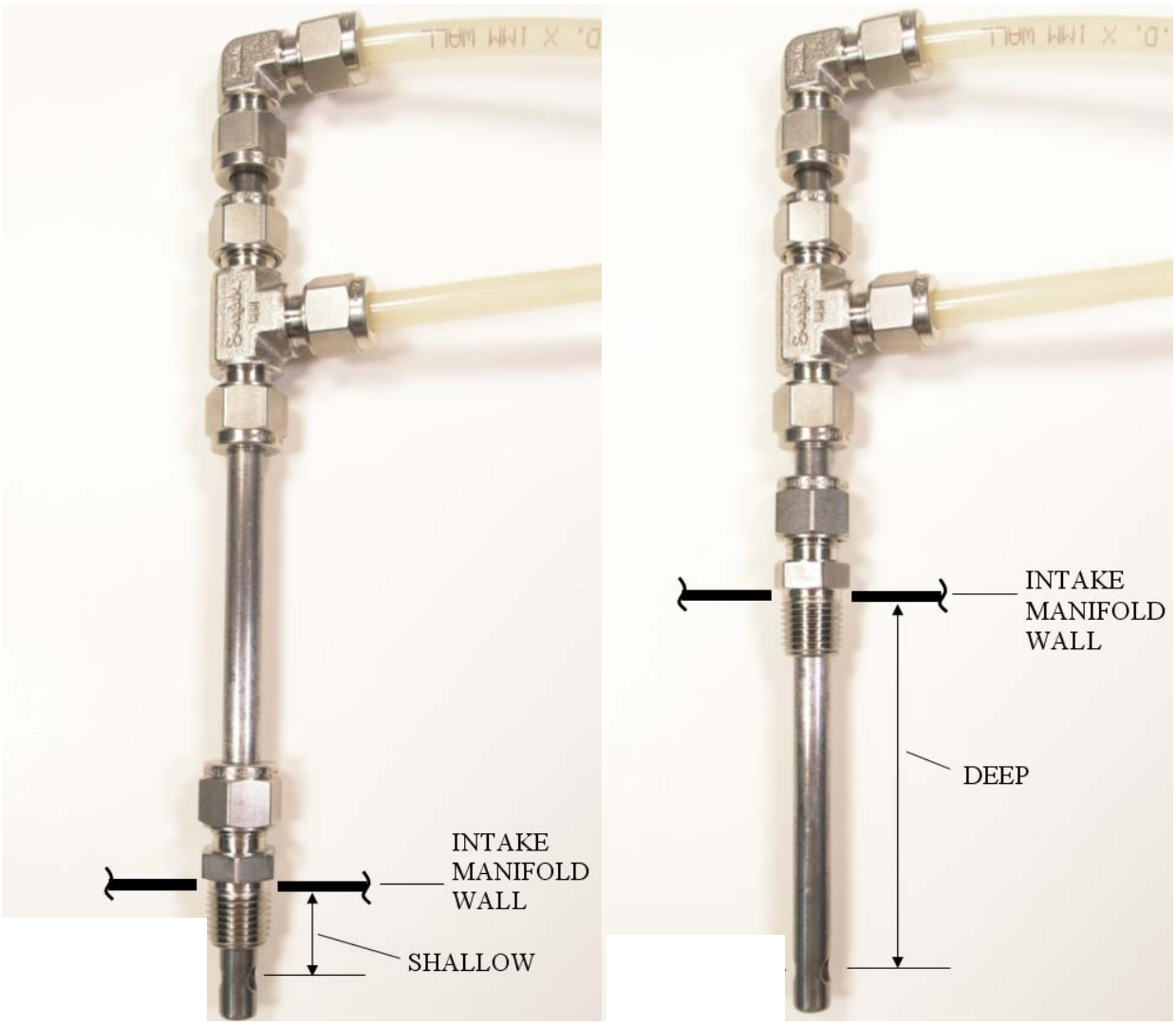


Figure 2A



Figures 2B and 2C



Figures 3A and 3B

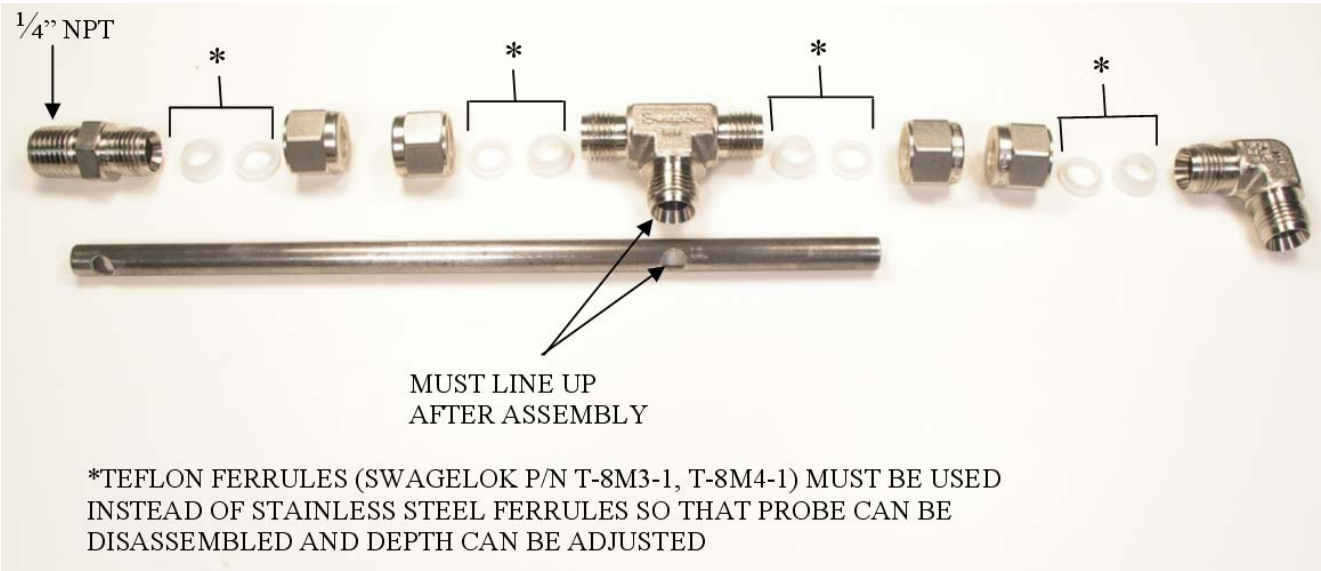


Figure 4A

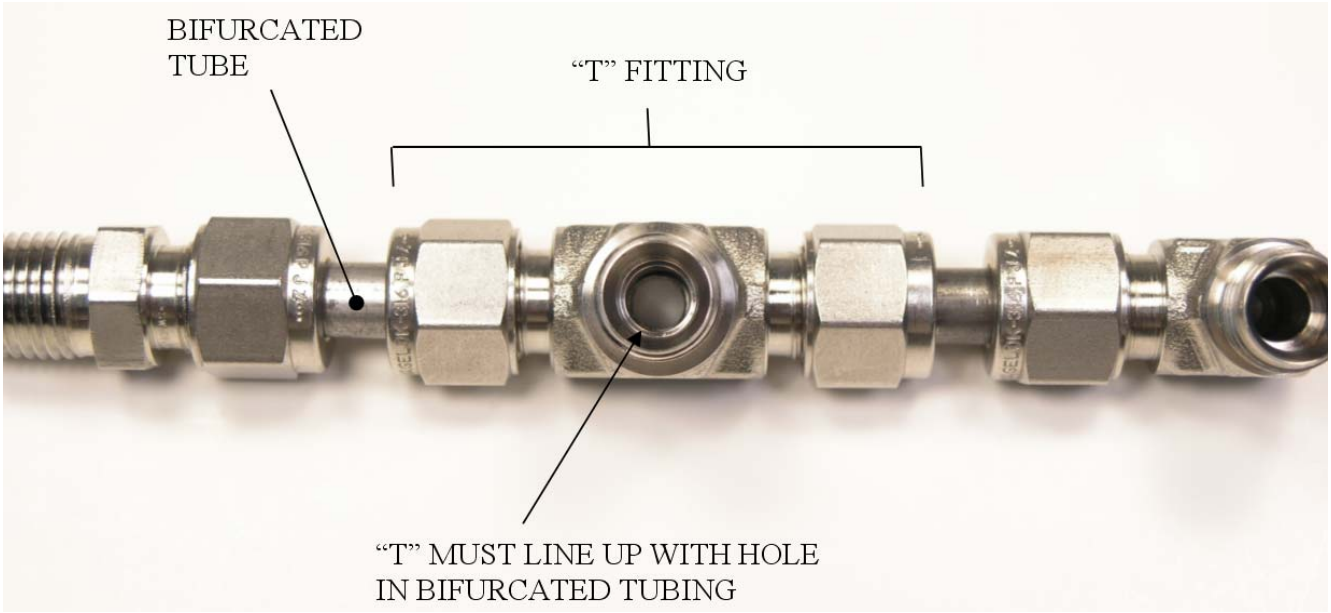


Figure 4B

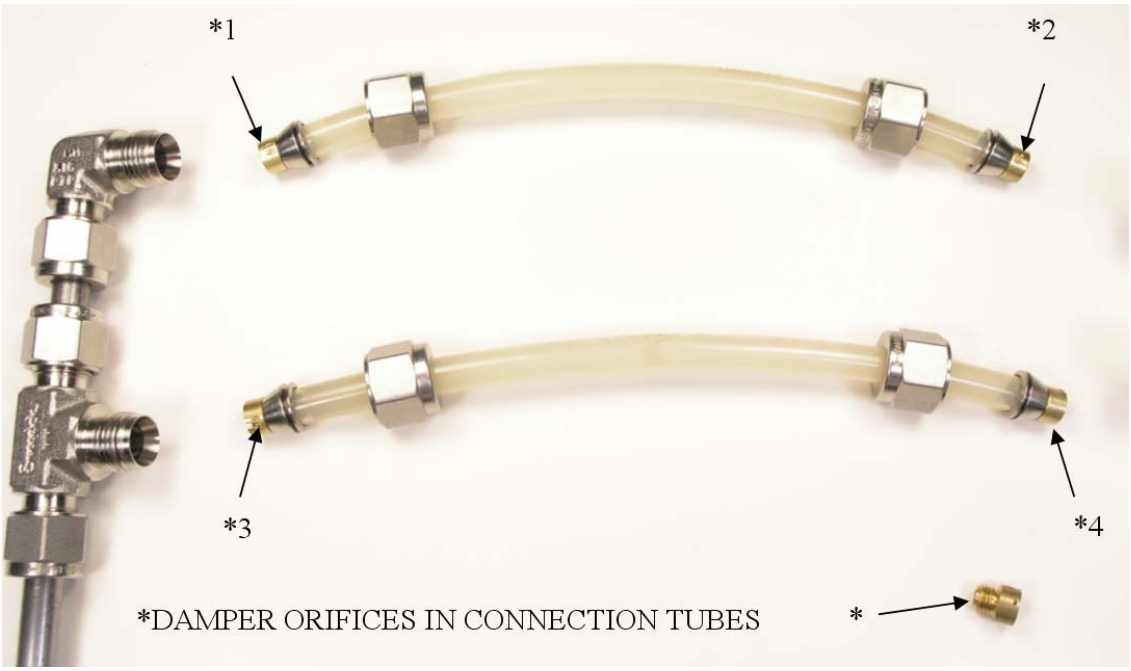


Figure 5