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# Low Flow Orifice Adapters
# Packing List

| *Part #* | *Description* | *Flow Rate* |
|---|---|---|
| VUA-561 | Low-flow adapter (M6) for Isokinetic Meter Console, ~1 LPM, 1/2in Male-1/4in Female Quick Connect, Brass | ~1 LPM |
| VUA-562 | Low-flow adapter (M6) for Isokinetic Meter Console, ~2 LPM, 1/2in Male-1/4in Female Quick Connect, Brass | ~2 LPM |
| VUA-565 | Low-flow adapter (M6) for isokinetic Meter Console, ~0.5 LPM, 1/2in Male- 1/4in Female Quick Connect, Brass | ~0.5 LPM |

## Applicability

The low flow orifice adapter is used to convert the Method 5 metering console (MC-572) to a low, fixed flow rate for use in VOST and Method 6-type sampling methods. Section 7.2 of US EPA Method 6 states that a critical orifice may be used in place of the DGM provided that it is calibrated. The calibration procedures are described on next page.

## Critical Vacuum Determination

Determine the suitability and the appropriate operating vacuum of the critical orifice as follows: if applicable, temporarily attach a rotameter and surge tank to the outlet of the sampling train. Turn on the pump, and adjust the valve to give an outlet vacuum reading corresponding to about half of the atmospheric pressure. Observe the rotameter reading. Slowly increase the vacuum until a stable reading is obtained on the rotameter. Record the critical vacuum, which is the outlet vacuum when the rotameter first reaches a stable value. Orifices that do not reach a critical value shall be used.

## Leak-Check Procedure

A leak-check before the sampling run is recommended, but is optional. A post-test leak-check is not necessary because the post-test calibration run results will indicate whether there is any leakage. The leak-check procedure is as follows: Temporarily attach a soap bubble meter and surge tank to the outlet of the pump. Plug the probe inlet, pull an outlet vacuum of at least 254 mm Hg (10 in. Hg), and note the flow rate as indicated by the rotameter or bubble meter. A leakage rate not in excess of 2 percent of the average sampling rate ($Q_{std(avg)}$) is acceptable. Slowly release the probe inlet plug **before** turning off the pump.

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APEX INSTRUMENTS *SOURCE TESTING EQUIPMENT*

Critical Orifice Calibration Procedures

The critical orifice is calibrated using a 500cc soap bubble meter or equivalent which is attached to the inlet of the probe and an outlet vacuum of 25 to 50mm Hg (1 to 2 in Hg) above the critical vacuum. Calculate the standard volume of air measured by the soap bubble meter and the volumetric flow rate using the equations below:

$V_{sb(std)} = V_{sb} (T_{std}/T_{amb})(P_{bar}/P_{std})$ Eq. 6-4

$Q_{std} = V_{sb(std)}/q$ Eq. 6-5

where:

$P_{bar}$ = Barometric pressure, mm Hg (in. Hg).
$P_{std}$ = Standard absolute pressure, 760mm Hg (29.92 in. Hg).
$Q_{std}$ = Volumetric flow rate through critical orifice, scm/min (scf/min).
$T_{amb}$ = Ambient absolute temperature of air, °K (°R).
$T_{std}$ = Standard absolute temperature, 273°K (528°R).
$V_{sb}$ = Volume of gas as measured by the soap bubble meter, $M^3$ ($ft^3$).
$V_{sb(std)}$ = Volume of gas as measured by the soap bubble meter, corrected to standard conditions, scm (scf).
q = Time, min.

## Assembly Procedures

**1.** Insert the 1/2 inch male quick connect of the orifice adapter (VUA-561) into the 1/2 inch female sample inlet on the metering console.
**2.** Attach the VOST umbilical (VU-30) 1/4 inch male quick connect into the 1/4 inch female quick connect on the VUA-561.
**3.** Attach all of the appropriate electrical and thermocouple fitting between the VU-30 and the metering console.
4. To set up the impinger section of the sampling train, reference the methodology or the appropriate Apex Instruments' sampling kit manual.

## Sampling

Operate the sampling train for sample collection at the same vacuum used during the calibration run. Start the watch and pump simultaneously. Take readings (temperature, rate meter, inlet vacuum, and outlet vacuum) at least every 5 minutes. At the end of the sampling run, stop the watch and pump simultaneously. Conduct a post-test calibration run using the calibration procedure. If the Qstd obtained before and after the test differ by more than 5 percent, void the test run; if not, calculate the volume of the gas measured with the critical orifice, Vm(std)' using Equation 6-6 and the average of Qstd of both runs as follows:

$$Vm(std) = \frac{Q_{std}(1-B_{ws})(P_{bar}+P_{sr})q_s}{(P_{bar}+P_c)} \quad \text{Eq. 6-6}$$

where:

Vm(std) = Dry gas volume measured with the critical orifice, corrected to standard conditions, dsc(dscf).
Qstd(avg) = Average flow rate of pretest and post-test calibration runs, scm/min (scf/min).
Bwa = Water vapor in ambient air, proportion by volume.
qs = Sampling time, min.
Pc = Inlet vacuum reading obtained during the calibration run, mm Hg (in.Hg.).
Psr = Inlet vacuum reading obtained during the sampling run, mm Hg (in.Hg.).