

## Calculations for Squeeze Bulb Inspection Procedure GDF IP-03

The CARB certification procedure, CP-201, limits the allowable leakrate of a refueling stem vapor check valve to 0.005 CFH (0.0000833 CFM) at a vacuum of 27.69 inches water column ("H<sub>2</sub>O). A typical volume of the vapor passage of a Bootless vacuum assist nozzle and 12 foot inverted coaxial hose is approximately 0.0111 cubic feet.

If this volume is subjected to a vacuum of 15 "H<sub>2</sub>O, and the vacuum degrades to 14 inches after 10 seconds, the leakrate can be approximated as follows:

$$Q = \left( \frac{1}{406.9} \right) (0.0111) \left( \frac{60}{10} \right) = 0.000164 \text{ cfm}$$

The maximum and minimum allowable leakrate, in cfm, at various vacuum levels can be approximated by one of the following two equations, depending upon assumptions of the relationship between  $Q_{15 \text{ inches}}$  and  $Q_{27.69 \text{ inches}}$ .

$$\text{Case 1} \quad Q = KP^{1/2}$$

$$\text{Case 2} \quad Q_{15} = Q_{27.69}$$

### Case 1:

$$K = \left( \frac{\frac{0.005}{60}}{27.69^{1/2}} \right) = 0.0000158$$

At 15 "H<sub>2</sub>O, the allowable leakrate is approximately:

$$Q_{15} = (0.0000158)(15^{1/2}) = 0.0000613 \text{ cfm}$$

The ratio of the leakrate if the vacuum changes 1 "H<sub>2</sub>O in 10 seconds to the CARB allowed leakrate is as follows:

$$R = \left( \frac{0.000164}{0.0000613} \right) \approx 2.7$$

**Case 2:**

The leakrate at 15 inches H<sub>2</sub>O is equal to the leakrate at 27.69 inches H<sub>2</sub>O.

$$Q_{15.0} = Q_{27.69} = 0.005 \text{ cfh} = 0.0000833 \text{ cfm}$$

The ratio of the leakrate, if the vacuum changes 1 "H<sub>2</sub>O in 10 seconds, to the CARB allowed leakrate is as follows:

$$R = \left( \frac{0.00164}{0.0000833} \right) \approx 2.0$$

If the vacuum degrades by 1 "H<sub>2</sub>O, or more, in ten (10.0) seconds, the state board should consider this a defect subject to an "Out of Order" tag pursuant to subsection 41960.2(c) of the CH&SC. Until the state board defines this defect as "Taggable", the operator should be provided with a notice specifying that the defect must be corrected within seven (7) days pursuant to subsection 41960.2(e) of the CH&SC.

If the vacuum degrades by 2.0 inches in 10 seconds, the ratios of allowable to measured leakrates, for Case 1 and Case 2 are as follows:

$$\text{Case 1} \quad R = \left( \frac{0.0003274}{0.0000613} \right) \approx 5.3$$

$$\text{Case 2} \quad R = \left( \frac{0.0003274}{0.0000833} \right) \approx 3.9$$