APPENDIX C

BALLOONS TESTED: 5 STANDARD 11" LATEX BALLOONS

ASSUME SHAPE: SPHERE

VOLUME OF HELIUM NEEDED:

$$\forall = 5\left[\frac{4}{3}\pi r^3\right] = 5\left[\frac{4}{3}\pi\left(\frac{11}{2}\text{ IN}\right)^3\right] = 3485\text{ IN}^3$$

IF 24" LATEX BALLOON SELECTED:

$$\forall = \left[\frac{4}{3}\pi r^3\right] = \frac{4}{3}\pi\left(\frac{24}{2}\right)^3 = 7238\text{ IN}^3 \quad \checkmark \text{ SUFFICIENT}$$

LIFT 24" LATEX BALLOON REQUIREMENT

4.2 OZ OR 0.2625 lbf

WEIGHT OF TUBING:

$$\rho_{TYGON} = 1.21\ g/cm^3 = 2.35\ slug/ft^3$$

$$L = 5\text{ ft} \qquad ID = 3/32" \qquad OD = 5/32"$$

$$A = \frac{\pi}{4}\left[\left(\frac{5}{32}\text{ IN}\right)^2 - \left(\frac{3}{32}\text{ IN}\right)^2\right] = 0.012272\text{ IN}^2$$

$$m = \rho_{TYGON} A L = (2.35\ slug/ft^3)(0.012272\text{ IN}^2)\left(\frac{ft}{12\text{ IN}}\right)^2(5\text{ ft}) = 0.001\text{ slugs}$$

$$W_{TUBING} = mg = (0.001\text{ slugs})(32.2\text{ ft/s}^2) = 0.0336\text{ lbf}$$

WEIGHT OF WATER IN TUBING:

$$\forall = AL = \frac{\pi}{4}\left(\frac{3}{32}\text{ IN}\right)^2\left(\frac{ft}{12\text{ IN}}\right)^2(5\text{ ft}) = 2.40\times10^{-4}\text{ ft}^3$$

$$m_{H_2O} = \rho_{H_2O}\forall = (1.94\text{ slugs/ft}^3)(2.40\times10^{-4}\text{ ft}^3) = 4.65\times10^{-4}\text{ slugs}$$

$$W_{H_2O} = m_{H_2O}\,g = (4.65\times10^{-4}\text{ slugs})(32.2\text{ ft/s}^2) = 0.015\text{ lbf}$$

ADDITIONAL WEIGHT BALLOON CAN HOLD:

$$F_{\uparrow} = F_B - W_{TUBING} - W_{H_2O} = 0.2625\text{ lbf} - 0.0336\text{ lbf} - 0.0151\text{ lbf}$$

$$= 0.2138\text{ lbf}$$

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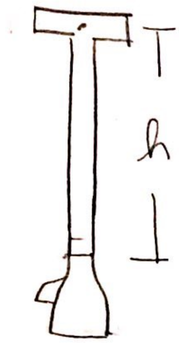

ASSUME

$V_1 = 0$ $\quad$ $P_2 = ATM$

$h_1 = 0$ $\quad$ $V_2 = 1\ ft/s$

ASSUME BERNOULLI'S

$$P_1 + \cancel{\frac{\rho V_1^2}{2}} + \cancel{\rho g h_1} = P_2 + \frac{\rho V_2^2}{2} + \rho g h_2$$

$$P_1 = 14.696\ psia + \left(1.94\ \frac{slugs}{ft^3}\right)\frac{(1ft)^2}{2} + \left(1.94\ \frac{slugs}{ft^3}\right)\left(32.2\ \frac{ft}{s^2}\right)(5ft)$$

$P_1 = 16.9$ psia

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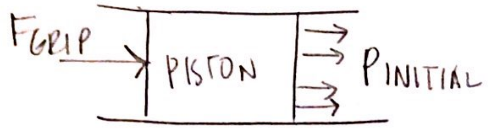

IF $P_{MIN} = 16.9$ psi

EXPECTED MIN $F_{GRIP} = 20\ lb_f$

$P = \frac{F}{A}$ $\quad A = \frac{F}{P} = \frac{20\ lb_f}{16.9\ \frac{lb_f}{IN^2}} = 1.18\ IN^2$

$D = \sqrt{\frac{A\,4}{\pi}} = \sqrt{\frac{(1.18\ IN)^2\,4}{\pi}} = \underline{1.22\ IN}$ $\quad$ MAX.

QUANTITY DESIRED $\underline{0.5\ oz}$ H_2O $\quad$ MINIMUM

IF STROKE LENGTH $\underline{1\ IN}$

$W = \frac{0.5\ oz}{16\ oz/lb_f} = 0.003\ lb_f$

$\forall = \frac{W}{\rho g} = \frac{0.003\ lb_f\ \frac{slug\ ft/s^2}{lb_f}}{(1.94\ slug/ft^3)(32.2\ ft/s^2)} = 5 \times 10^{-5}\ ft^3$

OR $0.086\ IN^3$

$\forall = AL \rightarrow A = \frac{\forall}{L}$

$A = \frac{0.086\ IN^3}{1\ IN} = 0.086\ IN^2$

$D = \sqrt{\frac{A\,4}{\pi}} = \sqrt{(0.086\ IN^2)\frac{4}{\pi}} = 0.33\ IN$ $\quad$ MINIMUM