

PROJECT: ESP Deep water sample module

ENGINEER: M.Brown

Title: Force and stroke for depressurization cylinder

UNITS:

$$\text{kip} = 1000 \cdot \text{lbf} \quad \text{ksi} = \frac{\text{kip}}{\text{in}^2} \quad \text{psi} = \frac{\text{lbf}}{\text{in}^2} \quad \text{k} = \text{kip} \quad \text{ksf} = \frac{\text{kip}}{\text{ft}^2} \quad \text{psf} = \frac{\text{lbf}}{\text{ft}^2} \quad \text{pcf} = \frac{\text{lbf}}{\text{ft}^3} \quad \text{plf} = \frac{\text{lbf}}{\text{ft}}$$

PROPERTIES & ASSUMPTIONS:

Pressure conversion factor	$P_c := .445 \cdot \text{psi}$	Bulk Modulus of seawater	$\beta := 3.39 \cdot 10^5 \cdot \text{psi}$
Pressure at depth	$P_{\text{design}} := \frac{1000 \cdot \text{m} \cdot P_c}{\text{ft}}$	Liters	$L := 1000 \cdot \text{mL}$
Design depth 1000 meters	$P_{\text{design}} = 1.46 \times 10^3 \text{ psi}$	Volume	$V := 2.0 \cdot L$
Piston diameter	$D_p := .562 \cdot \text{in}$		
Piston area	$A_p := \frac{D_p^2 \cdot \pi}{4}$		

CALCULATION:

Change in volume due to pressure	$B := \frac{P_{\text{design}}}{\frac{\Delta V}{V}}$	Solve for ΔV :	$\Delta V := \frac{P_{\text{design}} \cdot V}{\beta}$	$\Delta V = 8.613 \text{ cm}^3$
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Stroke of piston required to de-pressure	$L_{\text{stroke}} := \frac{\Delta V}{A_p}$	$L_{\text{stroke}} = 2.119 \text{ in}$
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Force on piston	$F_p := P_{\text{design}} \cdot A_p$	$F_p = 362.166 \text{ lbf}$
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