LONE STAR
ARTIFICIAL LIFT SYSTEMS

# Counterweight Position & Counterbalance Effect

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**Symbol Identification**

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| CBT: | Counterbalance Torque (inch-lbs.) |
| CBTC: | Counterbalance Torque due to Cranks (inch-lbs.) |
| CBE: | Counterbalance Effect at Polished Rod (lbs.) |
| $R_{cg}$: | Distance to Center of Gravity of Crank as Measured from Crank Shaft Center (inches) |
| SU: | Structural Unbalance (lbs.) |
| W: | Weight of Counterweight (lbs.) |
| CW: | Crank Weight (lbs.) |
| CPW: | Crank Pin Weight (lbs.) |
| $R_{1,2,or\ 3}$: | API 'R', Distance from Crank Shaft Center to Crank Pin Shaft Center (inches) |
| N: | Number of Same Counterweights |
| X: | Position of Counterweight* as Measured against Scale on Lone Star Crank Arm (inches from Crank Shaft Center) |
| | **Position of counterweight is measured at the location of the position arrow cast into the counterweight* |
| TF@ $90^{o:}$ | Torque Factor at 90 Degrees Crank Position |

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**Determine Counterweight Position, X,** to achieve a desired CBE

Solve for CBT: $CBT = (CBE - SU) * TF@\ 90^{o}$

Solve for CBTC: $CBTC = (2 * CW * R_{cg}) + (2 * R_{1,2,or\ 3} * CPW)$

Solve for X: $$X = \frac{CBT - CBTC}{N * W}$$

**Determine Counterbalance Effect, CBE,** at current counterweight position

Solve for CBTC: $CBTC = (2 * CW * R_{cg}) + (2 * R_{1,2,or\ 3} * CPW)$

Solve for CBT: $CBT = (X * N * W) + CBTC$

Solve for CBE: $$CBE = \frac{CBT}{TF@\ 90^{o}} + SU$$

*See example calculation below*

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# Sample Calculations

## 1. Calculate ECB, given X *(two different counterweight sizes)*

Ex) Determine ECB for the 912-365-168 unit w/ (2) #1 cwts at position 70 & (2) #2 cwts at position 80 as measured w/ scale on crank arm. Stroke position is in the long stroke.

CBTC = (2 * 4354* 49.5) + (2 * 53.54 * 403) = 474,199 inch lbs

CBT = ($X_1$ * N * $W_1$) + ($X_2$ * N * $W_2$) + CBTC; where X is position of counterweight on crank arm
CBT = (70 * 2 * 5280) + (80 * 2 * 4211) + 474,199 = 1,887,159 inch lbs

CBE = CBT/TF@90$^o$ + SU (TF determined from API linkage dimensions)
CBE = 1,887,159/78.581 - 320 = **23,695 lbs ECB**

## 2. Calculate X, given ECB *(two different counterweight sizes)*

Ex) Determine counterweight position $X_1$ and $X_2$ for (2) #1 & (2) #2 cwts as measured w/ scale on crank arm for a desired ECB of 20,000 lbs. for the 912-365-168 w/ stroke in the long stroke position.

CBT = (CBE – SU) * TF@90$^o$
CBT = (20,000 + 320) * 78.581 = 1,596,766 inch lbs

CBTC = (2 * 4354* 49.5) + (2 * 53.54 * 403) = 474,199 inch lbs

*Set a position of (2) #1 cwts at 70 inches, then calculate position of (2) #2 cwts*

$$X_2 = \frac{CBT - CBTC - (X_1 * N * W_1)}{(N * W_2)}$$

$$X_2 = \frac{1{,}596{,}766 - 474{,}199 - (70 * 2 * 5280)}{(2 * 4211)}; \qquad \mathbf{X_2 = 45.5 \text{ inches}}$$