********** User Input Data **********

$H2O := 999.973 \cdot kg \cdot m^{-3}$	Density of water
$SG := 1.0$	Product specific gravity
$Steel := 0.2833 \cdot lb \cdot in^{-3}$	Weight of steel in air
$D := 40 \cdot ft + 0 \cdot in$	Length of pipe
$E := D + 4.375 \cdot in$	Center of joint to end of pipe
$PipeOD := 4.5 \cdot in$	Pipe O.D.
$PipeWgt := 10.79 \cdot lb \cdot ft^{-1}$	Pipe weight per foot
$ElbowWgt := 6 \cdot lb + 4.02 \cdot lb$	90 degree S.R. Std Wgt Elbow w/ vortex breaker
$ElbowLen := 4 \cdot in$	Elbow center-to-face distance
$JointWgt := 78 \cdot lb$	Swingjoint weight
$FlangeWgt := 13 \cdot lb$	Slip on 150# flange weight
$SteelLbs := 0 \cdot lb$	Weight of steel counterweight
$SteelLoc := E$	Location of steel counterweight
$ChainWgt := 25 \cdot ft \cdot 0.7lb \cdot ft^{-1} + 1lb$	Weight of 1/4" steel chain hold down and lug
$ChainLoc := 35 \cdot ft + 0 \cdot in$	Location of steel chain hold down on pipe
$IndicatorWgt := 0 \cdot lb$	Indicator system weight
$RolLoc := E + 0 \cdot in$	Roller location
$RolWgt := 0 \cdot lb$	Roller weight
$FltLgt := 4 \cdot ft + 0 \cdot in$	Floats 1 and 2 length (maximum length 9'-9")
$FltLoc := E$	Location of floats 1 and 2 $FltLoc = 484.375\,in$
$FltOD := 18 \cdot in$	Float outside diameter
$FltTk := 0.1345 \cdot in$	Float material thickness
$FltEndTk := 0.1875 \cdot in$	Float end plate thickness
$FltBrktWgt := 4.9 \cdot lb \cdot ft^{-1}$	Float bracket weight (3 x 3 x 1/4 angle)
$FltLgt2 := 0 \cdot ft + 0 \cdot in$	Floats 3 and 4 length (maximum length 9'-9")
$FltLoc2 := 0$	Location of floats 3 and 4 $FltLoc2 := 0$

********** Floats' Weight Calculations **********

$F1 := FltOD \cdot 3.1416 \cdot FltTk \cdot FltLgt \cdot Steel$	Floats 1 and 2 rolled plate	$F1 = 103.427\,lb$
$F2 := (FltOD - FltTk \cdot 2)^2 \cdot \frac{3.1416}{4}$	Area of each float end plate	
$F2 := F2 \cdot FltEndTk \cdot Steel \cdot 2$	Weight of 2 float end plates	$F2 = 26.232\,lb$
$FSL1 := PipeOD + 30.375 \cdot in$	Length of float supports	$FSL1 = 34.875\,in$
$F4 := (FSL1 + 12in \cdot 2) \cdot FltBrktWgt$	Weight of 1 float support	$F4 = 24.041\,lb$
$FltWgt := F1 + F2 + F4 + 3 \cdot lb$	Total weight of 1 float1 or 2	$FltWgt = 156.7\,lb$
$F5 := FltOD \cdot 3.1416 \cdot FltTk \cdot FltLgt2 \cdot Steel$	Floats 3 and 4 rolled plate	$F5 = 0$
$FltWgt2 := F5 + F2 + F4 + 3 \cdot lb$	Total weight of 1 float 3 or 4	$FltWgt2 = 53.273\,lb$
$FltLoc2 := if(FltLgt2 > 0, FltWgt2, 0 \cdot lb)$	Zero floats 3 and 4 if needed	$FltLoc2 = 0\,lb$

********** Float Displacement **********

$FltDisp := FltOD^2 \cdot \frac{\pi}{4} \cdot (FltLgt + FltEndTk)$	Floats 1 or 2 volume	$FltDisp = 12262\,in^3$
$FltDisp2 := FltOD^2 \cdot \frac{\pi}{4} \cdot (FltLgt2 + FltEndTk)$	Floats 3 or 4 volume	$FltDisp2 = 48\,in^3$

********** Net Weight of Steel in Product **********

$Product := H2O \cdot SG$	Weight of product	$Product = 62.426\,ft^{-3} \cdot lb$
$NetStWeight := Steel - Product$	Weight of steel in product	$NetStWeight = 0.247\,lb \cdot in^{-}$
$SteelNet := \frac{NetStWeight}{Steel}$	Steel percentage	$SteelNet = 0.87248$

********** Net Weight of Steel in Water **********

$Product := H2O$	Weight of water	$Product = 62.426\,ft^{-3} \cdot lb$
$NetStWeight := Steel - Product$	Weight of steel in water	$NetStWeight = 0.247\,lb \cdot in$
$SteelNet2 := \frac{NetStWeight}{Steel}$	Steel percentage	$SteelNet2 = 0.87248$

********** Torque Calculations **********

Item	Calculation	Torque
Joint	$T_0 := JointWgt \cdot 0.1667 \cdot (E - D) \cdot SteelNet$	$T_0 = 4\,ft \cdot lb$
Joint Torque	$T_1 := 15 \cdot lb \cdot ft$	$T_1 = 15\,ft \cdot lb$
Flange	$T_2 := FlangeWgt \cdot (E - D) \cdot SteelNet$	$T_2 = 4\,ft \cdot lb$
Pipe	$T_3 := PipeWgt \cdot D \cdot (E - D \cdot 0.5) \cdot SteelNet$	$T_3 = 7669\,ft \cdot lb$
Elbow	$T_4 := ElbowWgt \cdot (E + ElbowLen) \cdot SteelNet$	$T_4 = 356\,ft \cdot lb$
Steel	$T_5 := SteelLbs \cdot SteelLoc \cdot SteelNet \cdot 0$	$T_5 = 0\,ft \cdot lb$
Roller	$T_6 := RolWgt \cdot RolLoc \cdot SteelNet$	$T_6 = 0\,ft \cdot lb$
Floats	$T_7 := FltWgt \cdot 2 \cdot FltLoc$	$T_7 = 12650\,ft \cdot lb$
Roller up	$T_8 := 0 \cdot ft^3 \cdot H2O \cdot SG \cdot -RolLoc$	$T_8 = 0\,ft \cdot lb$
Floats up	$T_9 := FltDisp \cdot 2 \cdot H2O \cdot SG \cdot -FltLoc$	$T_9 = -35762\,ft \cdot lb$
Chain	$T_{10} := ChainWgt \cdot ChainLoc \cdot SteelNet$	$T_{10} = 565\,ft \cdot lb$
Floats 2	$T_{11} := 0$	$T_{11} = 0\,ft \cdot lb$
Floats2 up	$T_{12} := 0$	$T_{12} = 0\,ft \cdot lb$
Indicator	$T_{13} := IndicatorWgt \cdot E \cdot 0$	$T_{13} = 0\,ft \cdot lb$

********** Summarize Torques and Net Upward Force **********

$J := 0 .. 12$

$T_J =$

	0
0	4.14
1	15
2	4.14
3	7668.54
4	355.79
5	0
6	0
7	12650.24
8	0
9	-35762.14
10	564.93
11	0
12	0

$ft \cdot lb$

$\sum T = -14499.362\,ft \cdot lb$ Net torque for swingline (up is negative)

$NetUp := \frac{\sum T}{RolLoc}$ Net force up for swingline

$NetUp = -359.2\,lb$

A positive force means that the swingline does not float at all!

********** Torque Calculations for HydroTest **********

Item	Calculation	Torque
Joint	$T_0 := JointWgt \cdot 0.1667 \cdot (E - D) \cdot SteelNet2$	$T_0 = 4\,ft \cdot lb$
Joint Torque	T1 := Uses previous value	$T_1 = 15\,ft \cdot lb$
Flange	$T_2 := FlangeWgt \cdot (E - D) \cdot SteelNet2$	$T_2 = 4\,ft \cdot lb$
Pipe	$T_3 := PipeWgt \cdot D \cdot (E - D \cdot 0.5) \cdot SteelNet2$	$T_3 = 7669\,ft \cdot lb$
Elbow	$T_4 := ElbowWgt \cdot (E + ElbowLen) \cdot SteelNet2$	$T_4 = 356\,ft \cdot lb$
Steel	$T_5 := SteelLbs \cdot SteelLoc \cdot SteelNet2$	$T_5 = 0\,ft \cdot lb$
Roller	$T_6 := RolWgt \cdot RolLoc \cdot SteelNet2$	$T_6 = 0\,ft \cdot lb$
Floats	$T_7 := FltWgt \cdot 2 \cdot FltLoc$	$T_7 = 12650\,ft \cdot lb$
Roller up	$T_8 := 0 \cdot ft^3 \cdot H2O \cdot -RolLoc$	$T_8 = 0\,ft \cdot lb$
Floats up	$T_9 := FltDisp \cdot 2 \cdot H2O \cdot -FltLoc$	$T_9 = -35762\,ft \cdot lb$
Chain	$T_{10} := ChainWgt \cdot ChainLoc \cdot SteelNet2$	$T_{10} = 565\,ft \cdot lb$
Floats 2	$T_{11} := FltWgt2 \cdot 2 \cdot FltLoc2$	$T_{11} =$
Floats2 up	$T_{12} := FltDisp2 \cdot 2 \cdot H2O \cdot -FltLoc2$	$T_{12} = 0\,lb^2$
Indicator	$T_{13} := IndicatorWgt \cdot E$	$T_{13} = 0\,lb^2$

********** Summarize Torques and Net Upward Force for HydroTest **********

$T_J =$

	0
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0

lb^2

$\sum T = 0\,lb^2$ Net torque for swingline (up is negative)

$NetUp := \frac{\sum T}{RolLoc}$ Net force up for swingline

$NetUp = 0\,ft^{-1} \cdot lb^2$

A positive force means that the swingline does not float at all!

********** Restrain Chain Data **********

$Elev := 30 \cdot in - PipeOD \cdot 0.5$ * Set Elevation of pipe bottom $Elev = 27.75\,in$

$MaxDeg := 55 \cdot deg$ * Set Max Swingpipe Angle

$ChainLgt := \frac{ChainWgt - 1lb}{0.70 \cdot lb \cdot ft^{-1}} + 1.75 \cdot in \cdot 2$ $ChainLgt = 25.292\,ft$

$LugLoc1 := \frac{ChainLgt - Elev}{\sin(MaxDeg)}$ Lug location on Pipe $LugLoc1 = 28.052\,ft$

$LugLoc2 := LugLoc1 \cdot \cos(MaxDeg)$ Lug location on tank bottom $LugLoc2 = 16.09\,ft$