General

The purpose of the **Mill E-Z™ CCR** is to isolate a well bore in various temperatures and pressures so remedial cement work can be conducted. The **Mill E-Z™** line of composite products is made of a patented design of materials that drastically decreases the amount of time it takes to drill out or remove with rotary or cable tool methods. The Magnum **Mill E-Z™ CCR** takes much less time to drill out or remove when compared to cast iron cement retainers.

All **Mill E-Z™** products are designed slim to enable clearance in a wide range of casing weights while maximizing fluid bypass to aid in fluid displacement even when heavy mud permits.

Slide Valve Feature

The **Mill E-Z™ CCR** is designed with a slide valve in the lower section of the retainer which is pressure balanced in the closed position in order to restrain high pressure differentials that are encountered in typical well conditions. This slide valve system is often preferred throughout the industry when compared to poppet-valve or ball-valve constructions due to debris that is found in all wells.

Stinger

The **Mill E-Z™ CCR** utilizes its own unique stinger (“SSA”) manufactured by Magnum Oil Tools. This stinger will be secured to the tubing and once the tubing and stinger is landed, will actuate the slide valve in the open position in order to pump cement through the tool.

Hydraulic Forces Applied to Mill E-Z™ CCR

Pressures applied to the casing and tubing effect the stinger sub and tubing during cementing and pressure testing operations. These forces are variable and are affected by the area of the cement retainer seal bore, casing and tubing pressure changes at the **Mill E-Z™ CCR**, tubing size and weight and fluid weight.

An increase in casing pressure at the **Mill E-Z™ CCR** will lift the tubing which can cause the Slide Valve to close. The amount of force generated by a casing pressure increase is calculated by the following formula;

(Casing pressure x Area of tubing)
- Seal bore area of the tool
= Force at the Mill E-Z™ CCR

A pressure increase in the tubing exerts a lifting force at the top of the string which will reduce the effective hook load. A pressure increase in the tubing at the **Mill E-Z™ CCR** will tend to hold the Stinger Sub in the tool and keep the Slide Valve open. The net of these two forces is upward and is equal to the increase in tubing pressure multiplied by the area of the seal bore in the cement retainer. When this force is equal to the tubing weight, any additional pressure will lift the tubing and allow the Slide Valve to close.

Therefore, the minimum setting depth will depend on the applied pressure changes in the tubing and casing acting to lift the available tubing weight.

The amounts of tubing and annulus pressure that can be applied are limited for any size and length of tubing. When the total of the forces is equal to the weight of the tubing in fluid, an increase in either tubing or casing pressure will raise the tubing and close the Slide Valve. However, the cementing pressure may be increased if the casing pressure is decreased and vice versa.

Hydraulics of Cementing Operations:

Various forces created by pressures applied to the casing and to the work string act on the Stinger Sub Assembly ("SSA") and work string during cementing operations. These forces and their effects are governed by the size of the Stinger Sub Assembly, the size, weight per foot and length of the tubing or drill pipe, the mud weight, the annulus pressure and the work string pressure.

Annulus Pressure

When Tubing OD is greater than the Retainer Bore, the annulus pressure tends to lift the Stinger Sub Assembly upward trying to pull it out of the retainer. This force is equal to the annulus pressure (at the Cement Retainer) times the difference between the area of the tubing OD and the area of the Cement Retainer Bore.

When the Tubing OD is less than the Retainer Bore, annulus pressure tends to push the Stinger Sub Assembly downward holding it in the retainer. This force is equal to the annulus pressure (at the Cement Retainer) times the difference between the area of the Cement Retainer Bore and the area of the tubing OD.

Tubing Pressure

When the Tubing ID is greater than the Retainer Bore, the tubing pressure tends to push the Stinger Sub Assembly downward holding it in the retainer. This force is equal to the tubing pressure (at the Cement Retainer) times the difference between the area of the tubing ID and the area of the Cement Retainer Bore. Also any pressure applied to the tubing string equal to the tubing pressure times the area of the tubing ID. This upward force reduces hook load but does not reduce the original slack off weight on the Stinger Sub Assembly until the hook load is reduced to zero.

When Tubing ID is less than the Retainer Bore, the tubing pressure tends to lift the Stinger Sub Assembly upward trying to pull it out of the retainer. This force is equal to the tubing pressure (at the Cement Retainer) times the difference between the area of the Cement Retainer Bore and the area of the tubing ID. Also, any pressure applied to the tubing exerts an upward force on the top of the tubing string equal to the tubing pressure times the area of the tubing ID. This upward force reduces hook load but does not reduce the original slack off weight on the Stinger Sub Assembly until the hook load is reduced to zero.

The amount of weight that must be set on the Cement Retainer to keep the Stinger Sub Assembly in place and the Sliding Valve open depends on both the pressure in the annulus and in the work string. The amount of work string and annulus pressure that can be applied will therefore be limited for any size and length of work string.

Use the "Area (in sq. in.) Acted Upon by Tubing and Annulus Pressures" table and the calculations in the next section to determine if the Stinger Sub will be lifted out of the retainer bore and the Cement Retainer Sliding Valve will be closed. Additional set down weight or changes in work string and annulus pressures will then be needed to keep the Stinger Sub Assembly in the retainer and hold the Sliding Valve open.

How to Use Area Pressure Chart for the Mill E-Z™ Composite Cement Retainer

The values given in the chart on the following page "Areas (in sq. in.) Acted Upon by Tubing and Annulus Pressures" are printed shaded and unshaded. These values are not only the number of square inches acted upon by the pressure change, but also the direction of the resultant force. The areas shown unshaded will cause, with a pressure increase, and downward force tending to keep the Sliding Valve open. The areas shown shaded will result in an upward force, or a force tending to close the Sliding Valve.

When the net force is upward additional setdown weight or altered annulus pressure must be used to keep the Valve open.

Note: columns 1, 2, 4, 5, 6 and 7 must be multiplied by the change in pressure at the tool. Column 3 must be multiplied by the tubing gage pressure

1. Multiply the change in tubing pressure at the tool by Columns 1, 4, or 6, whichever is applicable.

2. Multiply the change in annulus pressure at the tool by Columns 2, 5 or 7, whichever is applicable. If the total of these two forces is tending to close the Sliding Valve additional set-down weight is required to overcome the new upward forces.

3. Multiply the tubing gage pressure by Column 3. Since Column 3 is always shaded, the resulting force tends to close the Sliding Valve by lifting the work string at the surface, This force is restricted to reducing the hook load until the hook load is reduced to zero. Any additional force will then act to lift the tubing string and Stinger Sub.

Add all three forces. If the result is a force tending to lift the Stinger Sub the Sliding Valve will be closed. Since hook load is the limiting factor, high pressures at relatively shallow depths might be prohibitive.

Areas in Inches^2 (Millimeters^2) For Cement Retainers Acted Upon By Tubing and Anullus Pressures

NOTE:
Areas that lead to upward forces (close valve)
Areas that lead to downward forces (maintain valve open)

TOOL		TUBING OR DRILL PIPE			TUBING PRESSURE GREATER THAN ANNULUS PRESSURE AT THE TOOL		TUBING PRESSURE AT THE SURFACE	ANNULUS PRESSURE GREATER THAN TUBING PRESSURE AT THE TOOL		ANNULUS PRESSURE GREATER THAN TUBING PRESSURE AT THE TOOL DUE TO SWABBING	
Sizes inch (mm)	**Seal Bore** inch (mm)	**O.D.** inch (mm)	**Weight** lb/ft (kg/m)	**I.D.** inch (mm)	**Tubing Area** **Col 1** in^2 (mm^2)	**Annulus Area** **Col 2** in^2 (mm^2)	**Tubing ID Area** **Col 3** in^2 (mm^2)	**Tubing** **Col 4** in^2 (mm^2)	**Annulus Area** **Col 5** in^2 (mm^2)	**Tubing Area** **Col 6** in^2 (mm^2)	**Annulus Area** **Col 7** in^2 (mm^2)
4", 4-1/2", 5" (101.6, 114.3, 127.0)	1.345 (34.2)	1.250 (31.8)	1.800 (2.7)	0.938 (23.8)	0.720 (464.5)	0.180 (116.1)	0.690 (445.2)	0.720 (464.5)	0.180 (116.1)	0.720 (464.5)	0.180 (116.1)
			1.200 (1.8)	1.046 (26.6)	0.550 (354.8)		0.860 (554.8)	0.550 (354.8)		0.550 (354.8)	
		1.500 (38.1)	1.900 (2.8)	1.192 (30.3)	0.290 (187.1)	0.360 (232.3)	1.120 (722.6)	0.290 (187.1)	0.360 (232.3)	0.290 (187.1)	0.360 (232.3)
			1.800 (2.7)	1.227 (31.2)	0.230 (148.4)		1.180 (761.3)	0.230 (148.4)		0.230 (148.4)	
			1.600 (2.4)	1.291 (32.8)	0.100 (64.5)		1.310 (845.2)	0.100 (64.5)		0.100 (64.5)	
			1.400 (2.1)	1.340 (34.0)	0.020 (12.9)		1.430 (922.6)	0.020 (12.9)		0.020 (12.9)	
		1.660 (42.2)	2.400 (3.6)	1.380 (35.1)	0.090 (58.1)	0.750 (183.9)	1.500 (967.7)	0.090 (58.1)	0.750 (183.9)	0.090 (58.1)	0.750 (183.9)
		1.900 (43.2)	2.900 (4.3)	1.610 (40.9)	0.630 (406.5)	1.430 (922.6)	2.040 (1,316.1)	0.630 (406.5)	1.430 (922.6)	0.630 (406.5)	1.430 (922.6)
		2.063 (52.4)	3.300 (4.9)	1.751 (44.5)	1.000 (645.2)	1.930 (1,245.2)	2.410 (1,554.8)	1.000 (645.2)	1.930 (1,245.2)	1.000 (645.2)	1.930 (1,245.2)
		2.375 (60.3)	4.700 (7.0)	1.995 (50.7)	1.720 (1,109.7)	3.020 (1,948.4)	3.130 (2,019.4)	1.720 (1,109.7)	3.020 (1,948.4)	1.720 (1,109.7)	3.020 (1,948.4)
		2.875 (73.0)	6.500 (9.7)	2.441 (62.0)	3.270 (2,109.7)	5.080 (3,277.4)	4.680 (3,019.3)	3.270 (2,109.7)	5.080 (3,277.4)	3.270 (2,109.7)	5.080 (3,277.4)
		3.500 (88.9)	13.300 (19.8)	2.764 (70.2)	4.590 (2,961.3)	8.210 (5,296.8)	6.000 (3,871.0)	4.590 (2,961.3)	8.210 (5,296.8)	4.590 (2,961.3)	8.210 (5,296.8)
			9.300 (13.8)	2.992 (76.0)	5.620 (3,625.8)		7.030 (4,535)	5.620 (3,625.8)		5.620 (3,625.8)	

Example

Cement Retainer .... 4-1/2"
Tubing .... 2-3/8" OD EU
Maximum Hook load before Stinger Sub .... 7,000 lbs.
Maximum Cementing Pressure .... 3,000 lbs.
Change in tubing pressure at tool .... 3,500 psi
(due to heavier fluid introduced during cementing pressure)

Annulus Pressure to be applied during cementing .... 1,000 psi
3,500 psi (Tubing Pressure Change at Tool) x 1.72 (Col 1) .... = 6,020 lbs DOWN
1,000 psi (Tubing Pressure Change at Tool) x 3.02 (Col 2) .... = 3,020 lbs UP
6,020 - 3,020 = 3,000 lbs.
Only a minimum set down is required
3,000 psi (Gage Pressure) x 3.13 (Col 3) .... = 9,390 lbs UP
6,020 - 3,020 - 9,3000 .... = 6,300 lbs UP

This is less than the maximum hook load of 7,000 lbs., therefore job may be performed.