



## TerraMax™ Milling System

The TerraMax™ milling system improves coiled tubing (CT) milling time by reducing travel time within the wellbore to the obstruction and the time required to complete the milling operation. The system is ideal for plug milling, scale and cement milling operations, wellbore obstruction milling, fish removal and burn-over operations.

# TerraMax™ Milling System

Technical  
Summary

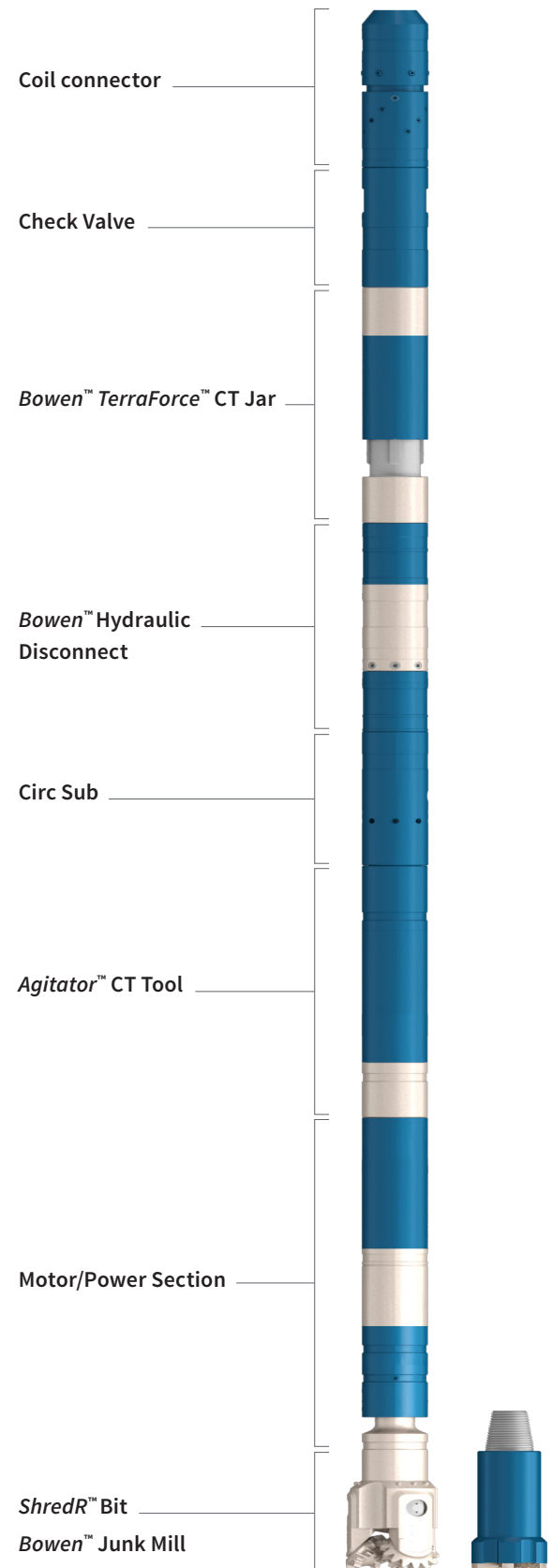
The TerraMax™ milling system improves coiled tubing (CT) milling time by reducing travel time within the wellbore to the obstruction and the time required to complete the milling operation. The system is ideal for plug milling, scale and cement milling operations, wellbore obstruction milling, fish removal and burn-over operations.

## The milling system includes:

- Coil connector
- Twin flapper check valve
- Bowen™ TerraForce™ CT Jar
- Bowen™ hydraulic disconnect
- Friction reduction technology
  - Agitator™ XP oscillation CT tool
  - Agitator™ NEO™ oscillation CT tool
  - Echo™ CT motor
- CT motor assembly
- ShredR™ bit or Bowen™ mill

## Features/Benefits

- Individual tools within the BHA are:
  - Field proven with thousands of runs on assemblies
  - Assembled with the NOV Certified assembly process
    - Full traceability on all independent components of the assembly
    - Trained service technicians
- Technical support available for tools
- Designed for long aggressive jobs
- Ideal for a wide range of CT milling applications



## The NOV Commitment of Excellence

When one of our tools arrives at your drill site, you're receiving more than just another piece of equipment. You're receiving countless hours of research, design, testing, and improvement. You're receiving the years of experience in the hands of our engineers, machinists, and technicians, and you're getting a partner in NOV.

During every moment in the life of our tools, we're committed to superior performance, efficiency, and customer satisfaction. We're committed to quality. When our solutions arrive at a well site, we want to deliver performance—so you can.

Within NOV we have structured systems that create and measure our performance on Certified assemblies, product traceability and continuous Improvement for the tools.

## Certified Assemblies

From the birth of an idea through the final delivery to your well site, we have highly qualified people endorsing each aspect of our solutions and guaranteeing the integrity of our tools. Through training, experience, competency, and individual ownership, we improve the production of our equipment so you can improve the production of your operation.

## Full Product Traceability on each Assembly

Our Track-A-Tool System lets us keep track of everything about our tools. It stores serial numbers, run hours, lifetime limits, and material certifications for every rental asset. This system gives us incredible insight into the ways you use our tools, and we use that to engineer future technology, improve upon current designs, and better support our current products.

## Continuous Improvement on each Assembly

Over the last 170 years, we've had a lot of success, but still we strive to improve. We're always learning, raising our standards, and getting better through purposeful innovation. Our teams of engineers monitor all trends affecting tools, so we can deliver tool improvements based on these trends and your feedback.

# Full Size Dimple / Slip Connector

External combination dimple and slip connectors are the solution for high torque and tensile loads.

Drilling, fishing, and completion work are ideal for these premium connectors.

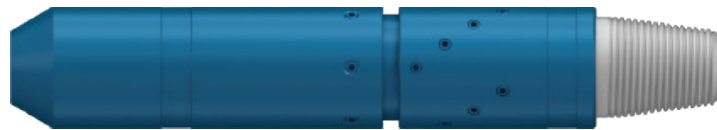
Available with a wide variety of ODs and pin connections to accommodate most jobs without the need for any crossovers.

Full size connectors will provide extra strength where the OD of the connector is not critical.



## Features and Benefits

- High tensile strength
- High torsional strength
- Internal pressure seal
- Replaceable slips



Full Size Dimple / Slip Connector

## Full Size Dimple / Slip Connector Technical Specifications

Part Number	CT Size	OD	ID	Service	Connection	Length	Service Kits	Pressure Rating	Min Temp Rating	Max Temp Rating	Tensile Strength	Torque Max
632-050	1 ½ in.	2.875 in.	1.125 in.	H <sup>2</sup> S	2 ¾ in. PAC	14.250 in.	632-050-RDK	5,000 PSI	-20°F	300°F	160,000 lbs	2,900 ft-lbs
633-050	1 ¾ in.	2.875 in.	1.250 in.	H <sup>2</sup> S	2 ¾ in. PAC	13.750 in.	633-050-RDK	5,000 PSI	-20°F	300°F	140,000 lbs	2,900 ft-lbs
634-050	2 in.	2.875 in.	1.250 in.	H <sup>2</sup> S	2 ¾ in. PAC	14.000 in.	634-050-RDK	5,000 PSI	-20°F	300°F	84,000 lbs	2,500 ft-lbs
634-100	2 in.	2.875 in.	1 in.	H <sup>2</sup> S	1 ½ in. AMMT	14.375 in.	634-100-RDK	5,000 PSI	-20°F	300°F	77,000 lbs	1,050 ft-lbs
632-150	1 ½ in.	3.125 in.	1.250 in.	H <sup>2</sup> S	2 ¾ in. REG	14.250 in.	632-150-RDK	5,000 PSI	-20°F	300°F	160,000 lbs	2,900 ft-lbs
635-150	2 ¾ in.	3.375 in.	1 in.	H <sup>2</sup> S	2 ¾ in. PAC	14.500 in.	635-150-RDK	5,000 PSI	-20°F	300°F	98,000 lbs	3,000 ft-lbs
635-200	2 ¾ in.	3.375 in.	1 in.	H <sup>2</sup> S	2 ¾ in. REG	14.000 in.	635-200-RDK	5,000 PSI	-20°F	300°F	98,000 lbs	3,000 ft-lbs
636-000	2 ¾ in.	4.750 in.	2.25 in.	H <sup>2</sup> S	3 ½ in. IF	16.500 in.	636-000-RDK	5,000 PSI	-20°F	300°F	217,000 lbs	6,800 ft-lbs
636-200	2 ¾ in.	4.750 in.	2.44 in.	H <sup>2</sup> S	2 ¾ in. EUE	16.500 in.	636-000-RDK	5,000 PSI	-20°F	300°F	116,000 lbs	2,250 ft-lbs
637-000	3 ½ in.	4.750 in.	2.69 in.	H <sup>2</sup> S	3 ½ in. IF	16.500 in.	637-000-RDK	5,000 PSI	-20°F	300°F	212,000 lbs	6,800 ft-lbs

# Twin Flapper Check Valve

The twin flapper check valve is a standard coiled tubing string component. It provides a means of preventing the back flow of well fluids into the coiled tubing.

The design of the twin flapper check valve incorporates a dual sealing system in each flapper assembly for increased safety. A non-stick seal provides the primary low pressure seal, while at higher pressure the flapper seals into a metal-to-metal arrangement.

Maximum flow area through the flapper cartridges reduces unnecessary back pressure on the surface pumps. The flow path through the flapper cartridges does not restrict the passage of balls or darts if required during operations such as cementing.

## Features and Benefits

- Full flow through bore
- Dual sealing in each flapper cartridge  
(low pressure seat/seal and high pressure full metal-to-metal seat/seal)
- Full bore fluid passage for balls, darts and plugs
- Removable flapper cartridges



## Twin Flapper Check Valve Technical Specifications

Part Number	Size	OD	ID	Service	Connections	Length	Service Kits	Operating Pressure	Min Temp Rating	Max Temp Rating	Tensile Strength	Flapper Cartridge Part Number	Flapper Cartridge OD
C165-072-08	1 11/16 in.	1.687 in.	0.750 in.	STD	1 in. AMMT Box x Pin	13.75 in.	C165-072-08/KS	5,000 PSI	0°F	350°F	52,380 lbs	C165-008	1.365 in.
C165-033-09	2 1/2 in.	2.125 in.	0.890 in.	STD	1 1/2 in. AMMT Box x Pin	12.75 in.	C165-033-09/KS	5,000 PSI	0°F	350°F	92,230 lbs	C165-014	1.511 in.
C165-019-23	2 7/8 in.	2.875 in.	1.375 in.	STD	2 3/8 in. PAC Box x Pin	15.00 in.	C165-019-23/KS	5,000 PSI	0°F	350°F	140,000 lbs	C165-010	2.240 in.
C165-023-10	3 1/2 in.	3.125 in.	1 in.	STD	2 3/8 in. REG Box x Pin	15.00 in.	C165-023-10/KS	5,000 PSI	0°F	350°F	162,000 lbs	C165-010	2.240 in.
C165-127-08	1 1/2 in.	1.500 in.	0.500 in.	H <sup>2</sup> S	1 in. AMMT Box x Pin	8.00 in.	C165-127-08/KS	5,000 PSI	0°F	350°F	33,628 lbs	C165-004	0.933 in.
C165-076-08	1 11/16 in.	1.687 in.	0.750 in.	H <sup>2</sup> S	1 in. AMMT Box x Pin	13.75 in.	C165-076-08/KS	5,000 PSI	0°F	350°F	37,662 lbs	C165-008	1.365 in.
C165-066-08	1 3/4 in.	1.750 in.	0.750 in.	H <sup>2</sup> S	1 in. AMMT Box x Pin	13.50 in.	C165-066-08/KS	5,000 PSI	0°F	350°F	48,310 lbs	C165-008	1.365 in.
C165-129-09	2 in.	2.000 in.	0.890 in.	H <sup>2</sup> S	1 1/2 in. AMMT Box x Pin	11.75 in.	C165-129-09/KS	5,000 PSI	0°F	350°F	55,200 lbs	C165-014	1.511 in.
C165-067-09	2 1/2 in.	2.125 in.	0.890 in.	H <sup>2</sup> S	1 1/2 in. AMMT Box x Pin	12.00 in.	C165-067-09/KS	5,000 PSI	0°F	350°F	61,160 lbs	C165-014	1.511 in.
C165-082-09	2 1/4 in.	2.250 in.	1.030 in.	H <sup>2</sup> S	1 1/2 in. AMMT Box x Pin	13.25 in.	C165-082-09/KS	5,000 PSI	0°F	350°F	51,150 lbs	C165-009	1.803 in.
C165-083-09	2 3/8 in.	2.375 in.	1.032 in.	H <sup>2</sup> S	1 1/2 in. AMMT Box x Pin	14.50 in.	C165-083-09/KS	5,000 PSI	0°F	350°F	60,185 lbs	C165-009	1.803 in.
C165-106-23	2 7/8 in.	2.875 in.	1.375 in.	H <sup>2</sup> S	2 3/8 in. PAC Box x Pin	16.50 in.	C165-106-23/KS	5,000 PSI	0°F	350°F	93,380 lbs	C165-010	2.240 in.
C165-084-23	3 1/2 in.	3.125 in.	1.375 in.	H <sup>2</sup> S	2 3/8 in. PAC Box x Pin	15.75 in.	C165-084-23/KS	5,000 PSI	0°F	350°F	108,000 lbs	C165-010	2.240 in.
C165-122-08	1 11/16 in.	1.687 in.	0.687 in.	STD	1 in. AMMT Box x Pin	11.00 in.	C165-122-08/KS	10,000 PSI	0°F	350°F	38,800 lbs	C165-115	1.310 in.
C165-113-09	2 1/2 in.	2.125 in.	0.890 in.	STD	1 1/2 in. AMMT Box x Pin	12.25 in.	C165-113-09/KS	10,000 PSI	0°F	350°F	64,000 lbs	C165-087	1.514 in.
C165-142-09	2 3/8 in.	2.375 in.	0.687 in.	H <sup>2</sup> S	1 1/2 in. AMMT Box x Pin	14.50 in.	C165-142-09/KS	10,000 PSI	0°F	350°F	47,700 lbs	C165-117	1.803 in.
C165-151-23	2 7/8 in.	2.875 in.	1.375 in.	STD	2 3/8 in. PAC Box x Pin	17.50 in.	C165-151-23/KS	10,000 PSI	0°F	350°F	141,600 lbs	C165-098	1.400 in.
C411-313-2-23	3.125 in.	3.125 in.	1.375 in.	H <sup>2</sup> S	2 3/8 in. PAC Box x Pin	15.75 in.	C411-313-2-23/KS	10,000 PSI	0°F	350°F	130,500 lbs	C410-224-2	1.375 in.
C165-019-24	2.875 in.	2.875 in.	1.400 in.	STD	2 3/8 in. PAC DSI Box x Pin	17.50 in.	C165-019-24/KS	5,000 PSI	0°F	350°F	141,600 lbs	C165-010	2.240 in.
C165-084-24	3.125 in.	3.125 in.	1.400 in.	H <sup>2</sup> S	2 3/8 in. PAC DSI Box x Pin	16.00 in.	C165-084-24/KS	5,000 PSI	0°F	350°F	112,400 lbs	C165-010	2.240 in.

# Bowen™ TerraForce™ Coiled Tubing (CT) Jar

Technical  
Summary

The Bowen™ TerraForce™ coiled tubing (CT) jar operates in conjunction with our coiled tubing jar intensifier, helping you control the intensity of jarring impacts by varying the applied load. The Terraforce jar has been optimized for a short BHA and delivers very high impact and impulse forces.

The Bowen TerraForce CT jar is ideal for a wide range of coiled tubing applications:

Milling • Fishing • Cleanout • Cutting • Stimulation

## Features and Benefits

- Short, robust design
- High temperature capabilities
- Increased torque handling capacity
- Fully bi-directional operation
- New spline design offers increased reliability
- Improved CT milling performance
- Easy to assemble and maintain
- CT jar placement program calculates impact at stuck points and optimizes the BHA to deliver the maximum impact and impulse values

## Technical Specifications

Size	2 7/8 in.	3 1/8 in.
Top connection	2 3/8 in. PAC	2 3/8 in. API REG
Bottom connection	2 3/8 in. PAC	2 3/8 in. API REG
Overall length (closed)	56 7/10 in.	58.45 in.
Weight	93 lbs	99 lbs
Max overpull	32,000 lbs	50,000 lbs
Max overpush	32,000 lbs	50,000 lbs
Torsional yield	4,100 ft-lb	7,300 ft-lb
Stroke length	10 3/10 in.	10 3/10 in.
ID	1 in.	1 in.



# Bowen™ TerraForce™ Coiled Tubing Jar

Performance  
Summary

2 7/8" Bowen TerraForce coiled tubing jar achieves outstanding performance jarring the BHA free.

## Challenge:

Successfully free the BHA after it was stuck for 3 days due to a hole developing in the coiled tubing on the reel.

## Solution:

The 2 7/8" Bowen™ TerraForce™ coiled tubing jar was run on a 2" coil for a plug milling job. After fully milling the 18th plug, a pin hole developed in the coil on the reel and the BHA become stuck. After multiple attempts of surging and shutting in the well, multiple repairs were made to the coil, which increased the time stuck to within 3 days. The TerraForce coiled tubing jar was then fired over 20 times over the course of 12 hours, freeing the BHA.

BHA: 2" Coil Connector, Dual Back Pressure Valve, 2 7/8" TerraForce Coiled Tubing Jar, Hydraulic Disconnect, HydroPull\* Extended Reach Tool, Motor, 3 1/4" Mill

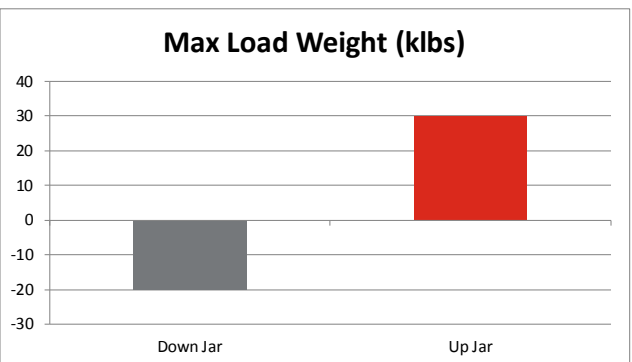
## Results:

- Achieved outstanding results by retrieving BHA
- Excellent durability and performance was demonstrated over the 20+ jar firings
- Exceeded clients expectations

## Features and Benefits:

- Short length design
- High torque
- Better suited for milling applications
- Bi-directional
- Improved CT milling/drilling performance
- CT Jar Placement available
- Reliable

Client	Shell
County	Red River Parrish
State	Louisiana
Country	USA
Date	Q3 2012



# Bowen™ TerraForce™ Coiled Tubing Jar

Performance  
Summary

2 7/8" Bowen TerraForce coiled tubing jar helps recover stuck drill-out BHA from within 5" casing.

## Challenge:

To fish a drill-out BHA from within 5" production casing that was lost during drill out operations.

## Solution:

During plug drill-out operations, the D/O BHA became packed-off just beyond the dogleg and transition from 5 1/2" to 5" casing. The hydraulic disconnect was activated, releasing the BHA at a depth of 9891 ft, nearly 1000 ft into the lateral. The 2 7/8" Bowen™ TerraForce™ Jar was used on the subsequent fishing job to help retrieve the stuck fish. Varying overpulls were applied, resulting in four up-jarring loads that successful freed the fish.

**BHA:** Coil Connector, Twin Flapper Check Valve, Index Tool Intensifier, WT bar, WT bar, 2 7/8" TerraForce Coiled Tubing Jar, Hydraulic Disconnect, GS Tool

Our Jar Placement Program calculates the impact loads and impulse at the applied overpull as follows:

Overpull	Impact	Impulse
12,000 lbs	193,486 lbs	325 lbs-sec
22,000 lbs	296,223 lbs	522 lbs-sec
22,000 lbs	296,233 lbs	522 lbs-sec
32,000 lbs	399,906 lbs	725 lbs-sec

Field/Block	Eagle Ford
County	La Salle County
State	Texas
Country	USA
Date	Q3 2012



## Features and Benefits:

- Short length design
- High torque
- Better suited for milling applications
- Bi-directional
- Improved CT milling/drilling performance
- CT Jar Placement available
- Reliable



# Bowen™ Hydraulic Disconnect

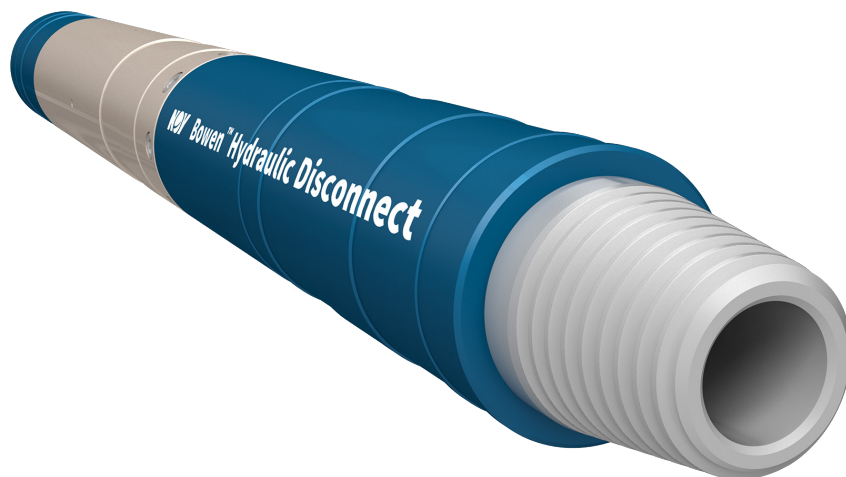
The Bowen™ hydraulic disconnect activates by a drop ball, which allows the tool string to detach at a predetermined point. Designed for aggressive use, the assembly operates with friction reduction tools and high torque motors. While in operation, the torque transfers through internal splines that accept significant torque and have a long component life. Once the tool is disconnected, an internal GS fishneck remains in the well for retrieval purposes.

## Benefits

- Lower section of disconnect is retrievable with standard GS running tool
- High torque feature is protected from wellbore fluids while in use
- Impact resistant to jarring
- Industry-leading torque, tensile and shock rating

## Bowen Hydraulic Disconnect Specifications

Bowen Hydraulic Disconnect	3 1/8 in.	2 7/8 in.
Connection	2 3/8 in. reg box x pin	2 3/8 in. pac box x pin
Pressure	15 ksi	15 ksi
Tensile	128 klbs	90 klbs
Torque	4,600 ft.lbs	3,200 ft.lbs
Service	STD	STD
Length	30.2	28.5
Max O.D.	3.125 in.	2.875 in.
Min I.D.	0.8 in.	0.8 in.
Weight	40 lbs	37.5 lbs



# Agitator™ Coiled Tubing Tools

Technical  
Summary

Our *Agitator*™ oscillation tools have provided unparalleled friction reduction longer than any other tool in the industry, and our *Agitator* coiled tubing (CT) tools further that tradition. With our *Agitator* CT tools in your bottomhole assembly (BHA), you can drill faster and drill farther.

## Proven Friction Reduction, Improved Weight Transfer

The *Agitator* CT tool increases the reliability of your coiled tubing operation and allows you to reach significantly greater depths in torturous, horizontal wellbores. By creating gentle oscillations along the longitudinal axis of a coiled tubing string, the *Agitator* CT tool reduces downhole friction, improves weight transfer to the BHA, and significantly extends the point of lock-up.

Proven in a wide range of applications, the *Agitator* CT tool improves rate of penetration (ROP) and enhances your efficiency in coiled tubing milling and intervention operations.

## Reliability With Every Turn

When you include our *Agitator* CT tools in your BHA, you get more than a piece of equipment—you're getting a partner. We have years of experience and thousands of runs from which we've learned and improved our *Agitator* oscillation tools. With drilling solutions engineer (DSE) support worldwide and more than 150 service locations around the globe, we deliver the highest quality products and equipment, as well as the support to meet the needs of your operation.

## Agitator™ CT Tools Highlights

**Extends your reach and improves load transfer** by reducing friction downhole

**Improves your ROP** by allowing for increased weight-on-bit

**Delays sinusoidal/helical buckling** and decreases motor stalls by reducing weight stacking

**Allows for higher flow rates** with redesigned power section and valve assemblies (*Agitator* NEO CT tool)

**Uses optimal operational frequencies** that further enhance the efficiency of your BHA.

## Agitator™ CT Tool Technical Specifications

Tool size (OD)	2 1/8 in	2 7/8 in	3 1/8 in
Overall length	73 in	52 in	52 in
Recommended mud weight	8.4-10 ppg	8.4-10 ppg	8.4-10 ppg
Recommended flow rate	40-80 gpm	40-150 gpm	40-160 gpm
Temperature range	150-302 °F	150-320 °F	150-320 °F
Operational frequency	9 Hz @ 40 gpm	15 Hz @ 120 gpm	15 Hz @ 120 gpm
Pressure rating	5,000 psi	5,000 psi	5,000 psi
Max tensile	20,000 lbs	85,000 lbs	130,000 lbs



# Agitator™ NEO Coiled Tubing Tools

Technical  
Summary

Featuring a shorter length and improved design, the Agitator NEO CT tool is an integral component of your extended reach BHA. Our engineers have designed the power section and valve assemblies for the Agitator NEO CT tool to improve performance: the new power section design allows you to pump at higher flow rates and can withstand pressures up to 10,000 psi, and we redesigned the valve assemblies to work at optimum operational frequencies.

These improvements produce axial vibrations that further enhance the efficiency of the BHA. The Agitator NEO CT tool allows for increased weight-on-bit and extended reach, improving your rate of penetration and helping you reach total depth.

## Agitator™ NEO CT Tools Highlights

**Extends your reach and improves load transfer** by reducing friction downhole

**Improves your ROP** by allowing for increased weight-on-bit

**Delays sinusoidal/helical buckling** and decreases motor stalls by reducing weight stacking

**Allows for higher flow rates** with redesigned power section and valve assemblies (Agitator NEO CT tool)

**Uses optimal operational frequencies** that further enhance the efficiency of your BHA.

## Agitator™ NEO CT Tool Technical Specifications

Tool size (OD)	*1 11/16 in	3 1/8 in	3 1/2 in
Overall length	35 in	46 in	52 in
Recommended mud weight	8-10 ppg	8-10 ppg	8-12 ppg
Recommended flow rate	30-65 gpm	110-210 gpm	110-210 gpm
Temperature range	150-320 °F	150-320 °F	150-320 °F
Operational frequency	14 Hz @ 65 gpm	9 Hz @ 210 gpm	8 Hz @ 210 gpm
Pressure rating	10,000 psi	10,000 psi	10,000 psi
Max tensile	37,150 lbs	120,000 lbs	190,800 lbs

\*Currently in field trials



# Agitator™ NEO tool completes back to back 9,000 ft lateral to TD

Performance Statement

**3 1/8" Agitator™ NEO tool achieves outstanding performance and reliability by completing a 29 plug milling operation.**

**Challenge:**

To successfully mill through 29 zones/plugs and reach TD on the 9,100 ft lateral while pumping 5 bpm utilizing one BHA.

**Solution:**

The 3 1/8" Agitator™ NEO was used in aiding the milling operation from 8,195 ft until reaching TD at 17,295 ft for an interval of 9,100 ft consisting of 29 plugs. The NEO helped reduce friction of the 2 5/8" coil aiding the BHA to TD within a 45 hour period. The average mill time between each plug was 5.65 min/plug.

Field/Block	Eagleford
County	Dimmit
State	Texas
Country	USA
Date	02/05/2016



The Valley Wells C5H and C6H were drilled on the same pad with a combined lateral section of 18,191 ft. The Agitator™ NEO successfully drilled a combined total of 40 zones/plugs with an average mill time of 6.01 min/plug while pumping 5 bpm through the BHA. Thus, sustaining performance and reliability.



**Results:**

- Milled all 31 plugs in one BHA
- Flowed 5 bpm through tool
- Achieved outstanding results
- Excellent durability and performance
- Exceeded customer expectations

Item #	Tool Description	OD	ID	Length
1	Coil Connector ADAP	3.125	1.375	0.35
2	Dual Back Pressure Valve	3.125	1.00	1.26
3	Hydraulic Jar	3.125	1.00	5.55
4	Hydraulic Disconnect	3.125	1.25	1.73
5	<i>Agitator™ NEO 210 GPM</i>	<i>3.125</i>		<i>4.24</i>
6	Hi-Temp Motor	3.125		12.86
7	Crossover		1	0.57
8	Bit	4.500		0.45

# Agitator™ NEO Coiled Tubing Tool

Performance  
Summary

## 3 1/8 in. Agitator™ NEO CT Tool reaches TD in a 10,200 ft lateral during a clean out operation

### Challenge:

To test the functionality and reliability of the 3 1/8" Agitator™ NEO coiled tubing tool while pumping up to five barrels per minute.

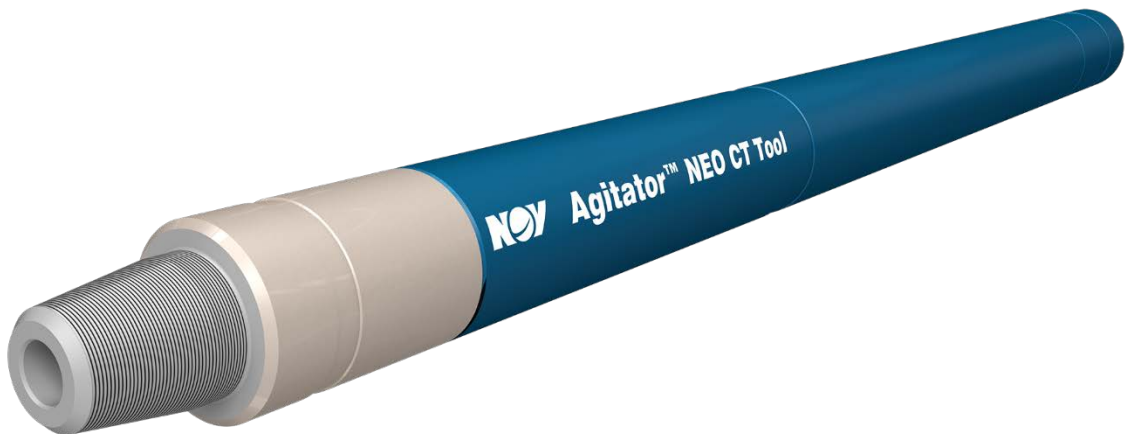
### Solution:

The 3 1/8" Agitator NEO CT tool was ran on a 2 5/8" coil pumping five barrels per minute. Cerberus modeling showed the customer needed a tandem Agitator BHA to reach TD. The Agitator NEO reached the TD of 15,784ft during the cleanout run in one trip.

### Results:

- Accomplished TD of 15,784 ft in one trip
- Higher flow rate vs. the legacy Agitator tool
- Achieved outstanding results
- Excellent durability and performance
- Exceeded customers expectations

Client	Top Notch
Well Name	B-14HLA Mota Zav W 3H
Field/Block	Eagleford Shale
County	Zavala
State	Texas
Country	USA
Date	Q1 2015



### Benefits:

Improves Coiled Tubing Intervention performance in:

- Extended reach
- Stimulation
- Manipulation
- Scale/fill removal
- Logging
- Fishing
- Running liners
- Cementing

# Agitator™ NEO tool achieves outstanding performance and reliability

Performance Summary

## 3 1/8 in. Agitator™ NEO tool completed a 44 composite plug milling operation.

### Challenge:

To test the functionality and reliability of the 3 1/8 in. Agitator™ NEO coiled tubing tool up to 4.75 barrels per minute.

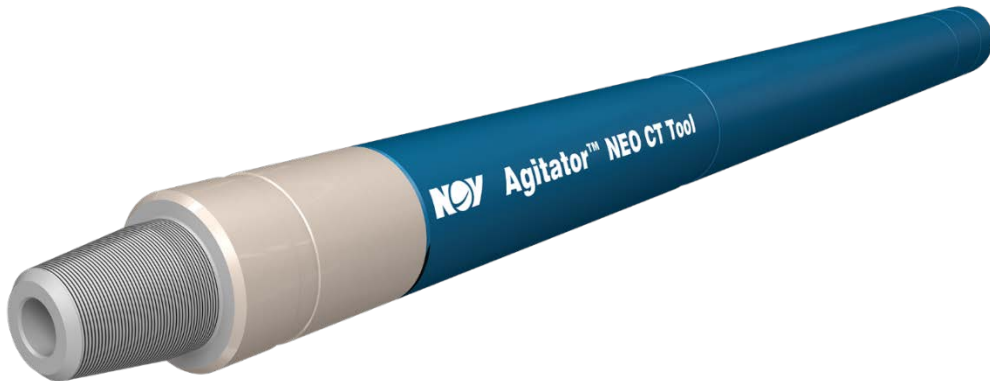
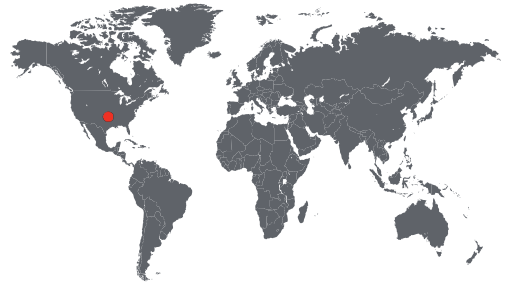
### Solution:

The 3 1/8 in. Agitator NEO CT tool on a 2 5/8 in. coil was used with a fresh water based solution at a flow rate of 4.75 bbl/min. The CT tool achieved exceptional performance by successfully milling all 44 plugs in 515 combined minutes averaging 11.7 min/plug. The Agitator NEO CT tool reached a PBSD of 15,354 ft. within a span of 92 hours total.

### Results:

- Milled all 44 composite plugs within one trip
- Lower standpipe pressure vs. legacy Agitator
- Achieved outstanding results
- Excellent durability and performance
- Exceeded customers expectations

Client	Top Notch
Well Name	University 12 RE #1029HS
Field/Block	Permian Basin
County	Reagan
State	Texas
Country	USA
Date	Q1 2015



Plugs	Avg. Mill Time	Avg. Time Between Plugs	Avg. Circ. Pressure	Flow Rate
44	11.7 minutes	59 minutes	4,200 PSI	4.75 bbl/min

# Super Pulse Coil Tubing Agitator™ tool surmounts expectation

NOV's 3-1/8" Super Pulse CT Agitator sees significant improvement in performance

Performance  
Summary

## Challenge:

Decreasing the time in between plugs for faster well completions.

## Solution:

The NOV Super Pulse Coil Tubing *Agitator*™ tool was utilized due to its unique pressure drop setup which requires the tool to obtain a pressure drop between 900-975 psi rating at 160 GPM. The higher pressure drop aids in faster well completions by increasing lateral and axial performance and decreasing travel time between plugs.

Client	Chesapeake
Well Name	Faith Yana H3H
Field/Block	Eagle Ford
County	Dimmit
State	Texas
Country	USA
Date	6/2/2016
Plug Type	Composite

## Results:

- Successfully completed well with 23 composite plugs in 24 hours
- Average plug mill outs of 9 minutes
- Average time in between plugs 41 minutes
- Tool reached TD without issues
- Customer was satisfied with the tools performance
- Customer stated the higher pressure drop allowed them to see more action than the NOV XP CT *Agitator* tool set up.



## BHA Description:

Item #	Tool Description	OD, in	ID, in	Length, ft
1	Coil Connector	3.125	1.3	.88
2	BPV	3.125	1.0	1.24
3	BI- DI Jar	3.125	1.0	5
4	Disconnect	3.125	.875 ball	1.73
5	NOV SP Agitator	3.125	N/A	4.74
6	Crossover	3.125	N/A	.67
7	CT Motor	3.125	N/A	14.32
8	Rock Bit	4.5	N/A	.5



# South Texas *Agitator*™ Tremor tool trial success

Performance  
Summary

## South Texas *Agitator* Tremor Tool averages 21 minutes in between each plug reaching TD

### Challenge:

To decrease time in between plugs and mill outs in a lateral with severe deviations while fighting friction. Also, without the use of friction reducing fluid and limiting short trips to reach TD.

### Solution:

To combat the well profile, the South Texas *Agitator*™ Tremor Tool was used in the BHA. The PBDT was 15,397' with the lateral length of 6,128' and a total of 26 plugs spaced out an average of 211'. This specific system is newer to coiled tubing application which was once thought for no need of utilization. The tool produces a hydraulic pressure pulse which allows the tool to generate a mechanical force. This force allows the tool to have an aggressive axial load on the BHA and coiled tubing string. This aids when fighting friction within the casing, helping the coiled tubing string/BHA get to the next plug and ultimately reaching TD.

### Results:

- Successfully milled all 26 composite plugs
- *Agitator* Tremor tool averaged 21 minutes between plugs
- Reduced the number of short trips
- Less than 24 hours to complete the length of the lateral
- No friction reducing fluid was utilized on this well
- Customer was very pleased with the tools performance

Client	WS Energy Services
Well Name	22H Longheirs
Field/Block	Eagle Ford
County	LaSalle
State	Texas
Country	USA
Date	07/31/2016
Lithology	Composite Plugs



### BHA Description:

Item #	Tool Description	OD, in	ID, in	Length, ft
7	Coil Connector	2.375	N/A	1.24
6	BPV	3.125	N/A	1
5	Bi Directional Jar	3.125	.875 ball	1.73
4	Disconnect	3.125	N/A	4.74
3	Tremor	3.125	N/A	9.45
2	CT Motor	3.125	N/A	13
1	Mill	4.5	N/A	1.2





# Coiled Tubing Motor Assembly

Technical  
Summary

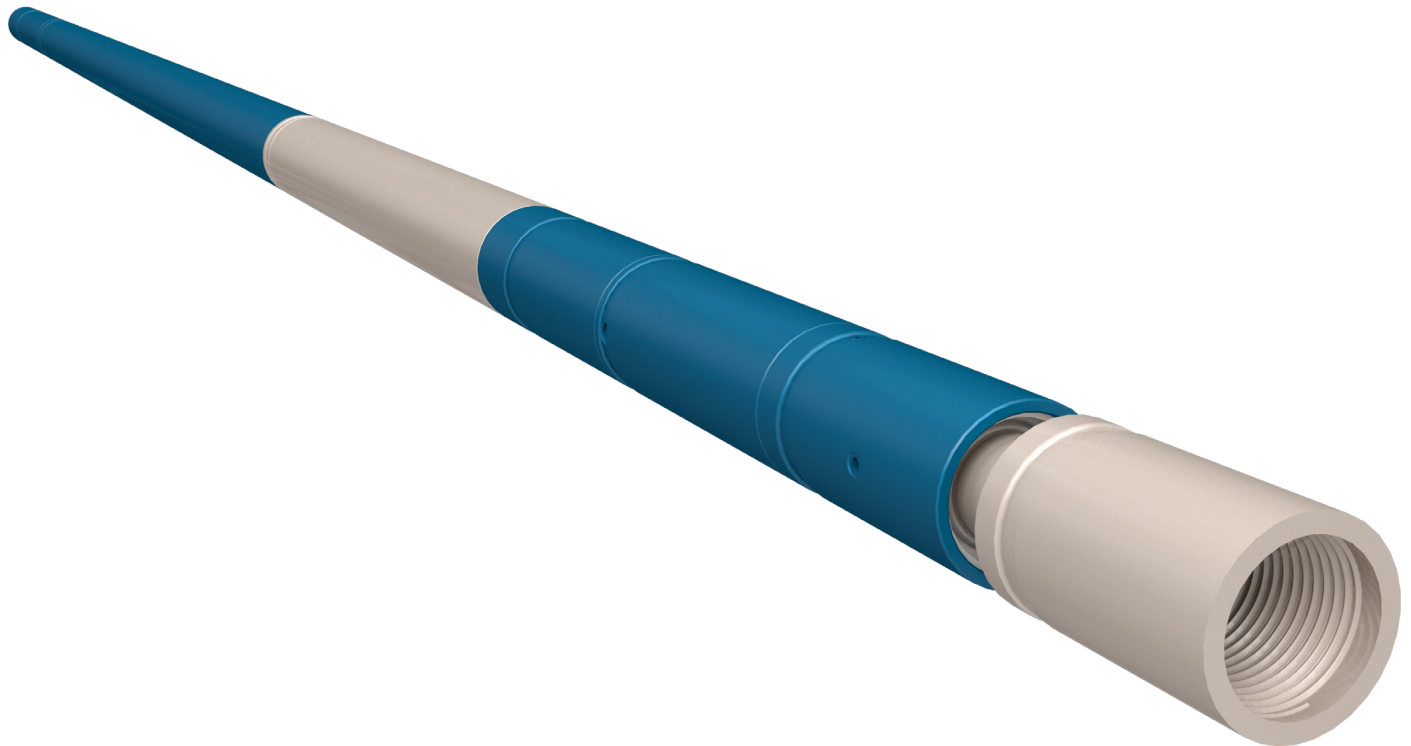
The coiled tubing motor assembly from NOV improves CT milling and drilling performance through the combination of a bearing assembly and the *PowerPLUS*™ CT power section.

The bearing assembly provides maximum tool life and class-leading torque ratings.

*PowerPLUS* power sections use a high-performance elastomer that delivers 50% more power and torque than conventional coiled tubing power sections. With proven performance in both water-based fluids and nitrogen, this power section is ideal for CT milling operations.

## Features/Benefits

- High torque capacity
- Maximum tool life
- High performance with water-based fluids and nitrogen
- Generates 50% more power than conventional power sections



## Coiled tubing drill bits technology

ShredR™ CT bits have been designed specifically for coiled tubing operations.

### CT designs feature:

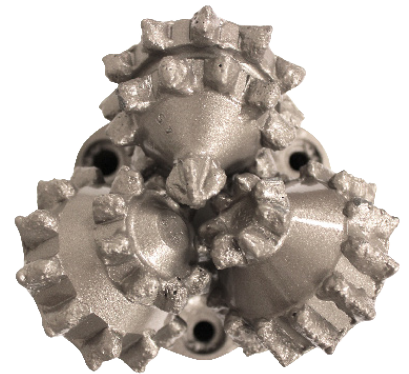
- Upreaming inserts in the shoulder reduce the chance of the BHA sticking downhole.
- Shirttail protection comes standard to prevent excessive wear in horizontal or tortuous applications.
- 2 1/4" safety neck is located between the shoulder and the threaded pin for bit makeup. The safety neck provides a smooth gripping surface, which greatly reduces the chance of pipe wrench slippage and potential injury.

Designs are available with an API or PAC connection. The PAC connection eliminates the need for a crossover sub when making up to small diameter motors.

## Technical Specifications

Bit Size	Bit Type	Part Number	Connection		IADC Code	WOB (klb)	RPM
			Size	Type			
3.625	CT21P	10108887	2.375	PAC Pin	216	3 - 10	60 - 600
3.750	CT21P	10101968	2.375	PAC Pin	216	3 - 10	60 - 600
4.375	CT21P	10101266	2.375	PAC Pin	216	3 - 10	60 - 600
4.500	CT11P	400F998	2.375	API Reg Pin	116	3 - 10	60 - 600
		10101263	2.375	PAC Pin	116	3 - 10	60 - 600
	CT21P	10101264	2.375	PAC Pin	216	3 - 10	60 - 600
		10101497	2.375	API Reg Pin	216	3 - 10	60 - 600
4.625	CT11P	10101262	2.375	PAC Pin	116	3 - 15	60 - 600
		400G000	2.375	API Reg Pin	116	3 - 15	60 - 600
	CT21P	10101238	2.375	PAC Pin	216	3 - 15	60 - 600
		10102544	2.375	API Reg Pin	216	3 - 15	60 - 600
		400G001	2.875	API Reg Pin	216	3 - 15	60 - 600
4.750	CT11P	400G002	2.875	API Reg Pin	116	3 - 15	60 - 600
	CT21P	10101265	2.375	PAC Pin	216	3 - 15	60 - 600
		10104745	2.375	API Reg Pin	216	3 - 15	60 - 600
		400G003	2.875	API Reg Pin	216	3 - 15	60 - 600

Note: all bit types include shirttail protection



ShredR CT drill bit

# Bit consistently performs outstandingly

Performance Statement

4 ½" NOV ShredR™ bit mills 58 composite plugs at 9.5 minute average

**Challenge:**

To drill all plugs with low mill time and good dull condition

**Solution:**

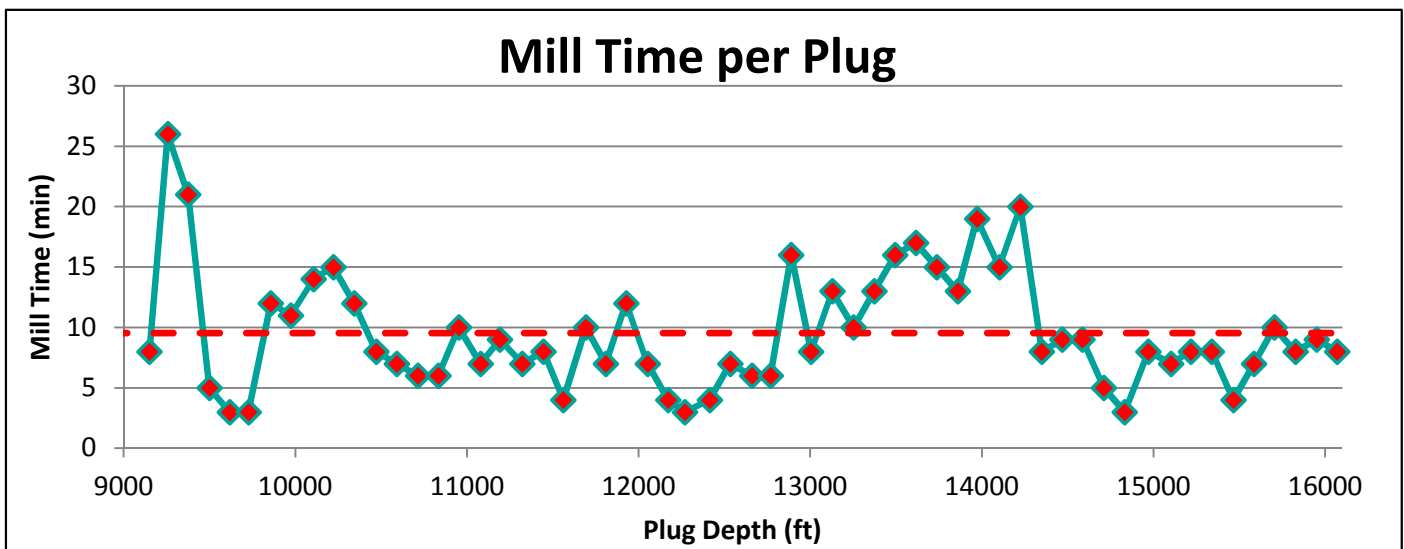
4 ½" ShredR™ coil-tubing bit was utilized to mill 58 composite frac plugs, including the kill plug, in Webb County, Texas. The bit was run on 2" coil-tubing with a 3.12" CT motor along with NOV's 3.12" CT Agitator™ tool.

Average mill time per plug was 9.5 minutes, and PBSD was reached in less than 9.3 hours of milling time. The bit came out in good condition and with all bearings still effective. Plug cuttings were finely cut and did not cause any issues during the job. The client was very pleased with the run. The same bit type had two additional runs in Webb Co., both milling 42 plugs with outstanding performance. The client said they will continue to use the ShredR™ bit due to its consistent good performance.

**Results:**

- Average mill time of 9.5 minutes per plug
- Total mill time of 9.23 hrs for 58 plugs
- Good dull condition of 3-6-BT-G-EEE-I-CT-TD
- Consistent performance

Well Name	Gates 05D 18-20
Location	Webb, Texas, USA
Date	Q4 2015



Bit Size	Bit Type	S/N	Total Mill Time (min)	Avg Mill Time (min)	Number of Plugs	Plug Type	Dull Condition
4 ½"	SH2P	D220201	554	9.5	58	Composite	3-6-BT-G-EEE-I-CT-TD
4 ½"	SH2P	D219052	382	9.1	42	Composite	3-6-BT-G-EEE-I-CT-TD
4 ½"	SH2P	D219054	418	9.9	42	Composite	3-6-BT-G-EEE-I-CT-TD

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	Estevan	93 Panteluk Street, Estevan SK S4A 2A6	306-634-8828	
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	Williston	5212 Dakota Parkway, Williston, ND 58801	701-774-0091	
	Anchorage	521 W. 41st Ave. Suite 102, Anchorage, AK 99503	907-644-8889	
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