

U.S. Department of Energy

Microdrill Initiative
Initial Market Evaluation

Prepared by

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Executive Summary

- o The US Department of Energy is launching a major R&D initiative to drill small, inexpensive holes with coiled tubing. This report documents the state of the coiled tubing market and trends in drilling costs in the US.
- o 700-900 wells are drilled or re-entered with coiled tubing each year. Alberta, Canada, with 85% of the drilling, is by far the region with the greatest number of holes drilled. Alaska is second, with 4%.
- o CTD wells in Canada are about 2% of the total drilling while in the US, CTD wells are less than 1%. Even with such small market penetration, CTD appears to have plateaued.
- o Conventionally drilled 3000' wells cost about \$43 per foot to drill and complete. In Canada, CTD wells cost about \$33 per foot.
- o Alaska's producers report that the cost of reentering a well with CTD is about one-third the cost of drilling a new well conventionally.
- o \$22 billion will be spent in 2003 drilling and completing all wells in the US. About \$70 million of this will be associated with coiled tubing drilling.
- o Schlumberger is the largest coiled tubing service company, but Precision Drilling is the largest CTD service company, drilling about half of all wells.
- o The total coiled tubing service market will be about \$1 billion in 2003.
- o Current CTD advantages over conventional are smaller pad size, easier logistics and favorable drilling speeds, but the greatest reservoir advantage is its suitability for underbalanced drilling.
- o System limitations appear to be the most acute in motor performance. The smallest diameter motors are not designed for long life.
- o Composite pipe is available, but has not been embraced by the market.
- o All CTD work has been geared for enhancing mature field production. Exploration work is extremely rare.

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Objectives

The U.S. Department of Energy (DOE) is launching a major research and development initiative to create a small, fast, inexpensive and environmentally friendly rig for drilling 5000' boreholes to investigate potential oil and gas reservoirs. DOE wishes to get input from petroleum industry operators, service companies and equipment suppliers on the operation and application of this coiled-tubing-based drilling unit. To that end, DOE has asked Spears & Associates, Inc. (SAI) to prepare a special state-of-the-market report and assist during a DOE-sponsored project-scoping workshop in Albuquerque near the end of April 2003.

Specific Study Requirements

The scope of the project is four-fold:

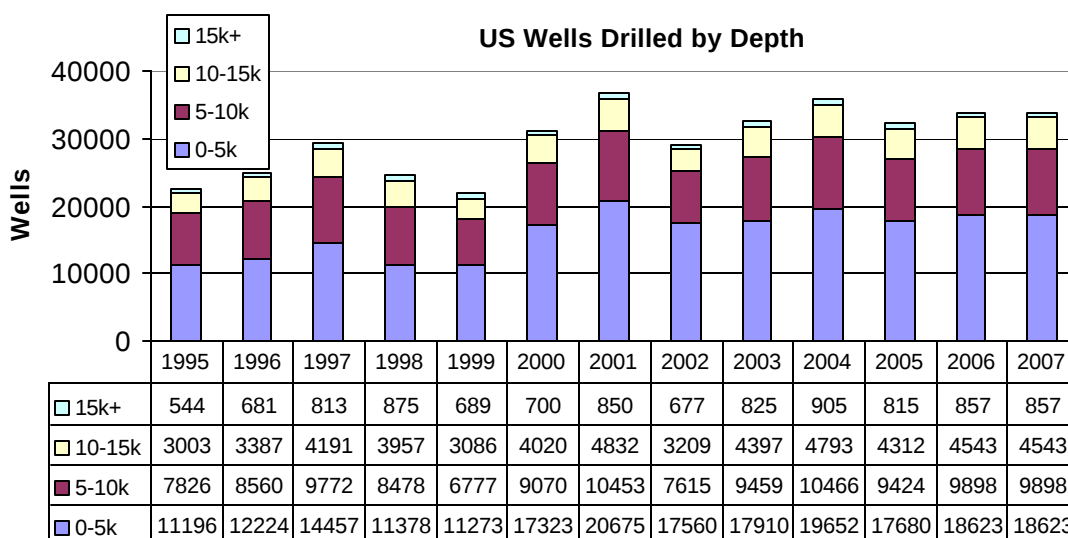
- o **Evaluate the history, status and future of demand for very small bore-hole drilling.**
- o **Measure the market for coiled tubing drilling and describe the state-of-the-art.**
- o **Identify companies and individuals who should have an interest in micro drilling and invite them to the DOE workshop.**
- o **Participate in 3 concurrent workshop sessions, record and evaluate participant comments and report workshop conclusions.**

This work will provide a framework inside of which workshop participants can better describe how and where this unit should work.

US Drilling Forecast

Summary

2003 is a recovery year for the US petroleum industry, with drilling expected to climb about 12% from the prior year. 2004's totals should also be higher by another 10% before cycling down:



Source: Spears & Associates, Inc.'s *Drilling and Production Outlook*, March 2003

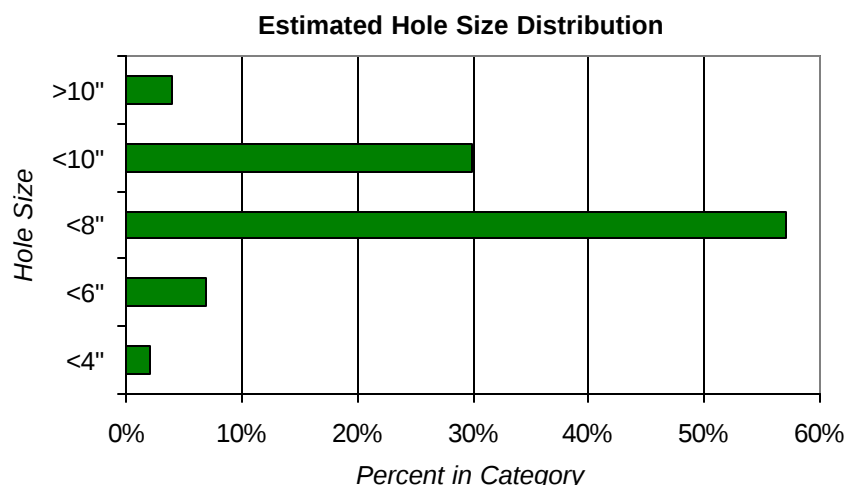
Spears & Associates expects drilling shallower than 5000' to be higher during this decade than during the prior decade as operators invest in coal seam gas developments. This focus on coal gas has made shallow drilling rise by about 35% when compared with the 1995-1999 period.

The following table estimates current exploration drilling, which is a subset of the table above:

Exploration Drilling - US														
2003 Estimated Activity														
Region	0-5000 ft			5000-10000 ft			10000-15000 ft			15000+ ft			Total	
	Average Depth	Foot	Cost/ (\$mil)	Average Depth	Foot	Cost/ (\$mil)	Average Depth	Foot	Cost/ (\$mil)	Average Depth	Foot	Cost/ (\$mil)	Average Depth	Foot
Land Explo Conventional	2,833	\$43		6,941	\$69		12,023	\$130		16,624	\$274		6,445	\$105
Land Explo Sidetrack	4,300	\$50		5,610	\$160		4,867	\$159		4,200	\$344		4,931	\$180
2003 Estimated Activity														
Region	0-5000 ft			5000-10000 ft			10000-15000 ft			15000+ ft			Total	
	Wells	Footage (000)	Cost (\$mil)	Wells	Footage (000)	Cost (\$mil)	Wells	Footage (000)	Cost (\$mil)	Wells	Footage (000)	Cost (\$mil)	Wells	Footage (000)
Land Explo Conventional	1,061	3,007	\$128	851	5,905	\$407	442	5,309	\$691	93	1,546	\$424	2,447	15,767
Land Explo Sidetrack	2	8	\$0	10	55	\$9	18	86	\$14	6	25	\$8	35	174
Total	1063	3,015	\$128	860.5	5,960	\$415	459.2	5,394	\$705	99	1,571	\$432	2,482	15,940

Hole Size

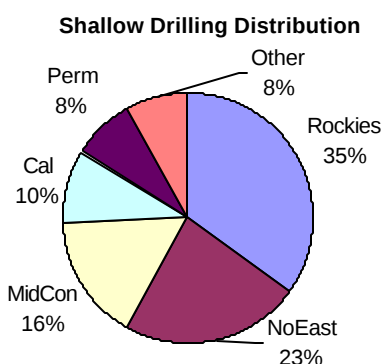
It is very difficult to accurately determine the footage drilled each year by hole size or bit size. The chart below is our rough estimate of this hole size distribution based on analysis of casing runs and on sales of drill bits over the past few years. For a more precise analysis, we recommend that a large drill bit manufacturer – Smith Bits, for example – be asked to evaluate these measures using their extensive drill bit database.



The smallest common bit size appears to be 3-1/2", although smaller sizes are available through specialty bit manufacturers. We believe that only 1-2% of the footage drilled is 3" and smaller¹.

Regional Drilling

Details on regional drilling activity can be found in the next section under "*Regional Drilling Costs*". For drilling shallower than 5000', the Rockies and the Northeast represent about 60% of the market in the US:

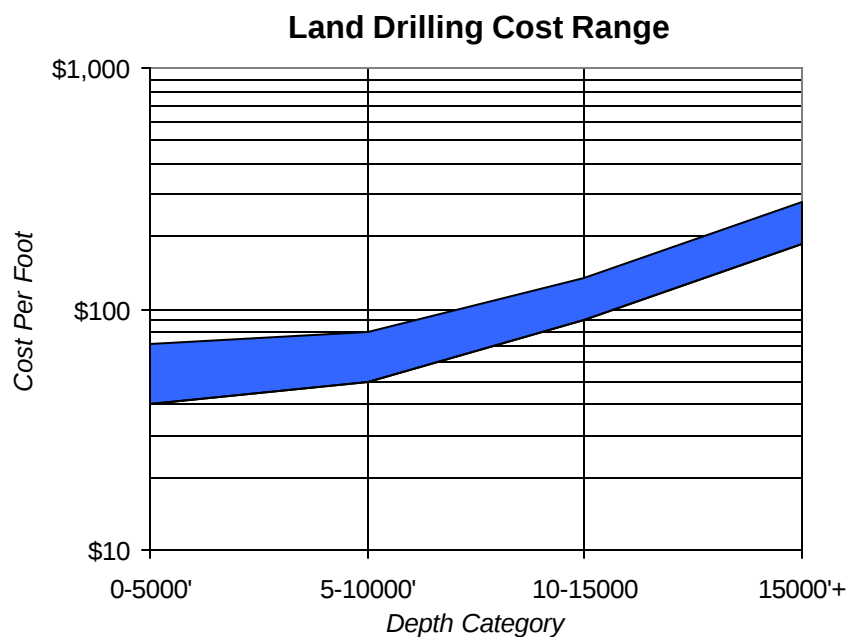


¹ The main point here is that the drilling industry is geared for larger hole sizes since the majority of holes are development wells requiring production tubing and downhole lift systems in many cases.

Cost of Drilling

Summary – Land Wells

As a rule of thumb, as well depth increases, the per foot cost of drilling rises logarithmically. The following chart indicates the range in drilling costs for all land wells drilled in the US – for example, wells drilled in the US between the depths of 5000' and 10,000' cost between \$50 per foot and \$80 per foot to drill and complete:

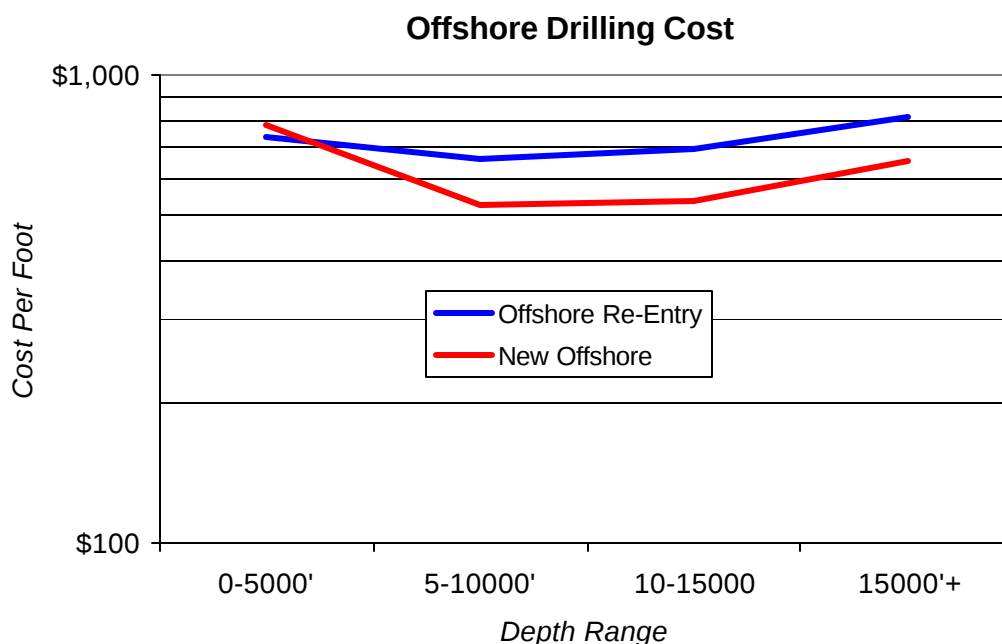


Source: Joint Association Survey and Spears & Associates

Please note that the average per foot cost of drilling a shallow hole is about the same as the average per foot cost to drill a 5-10,000' hole. Rig mobilization charges for a 2000' hole are about the same as for a 7500' hole, but the shallower hole has fewer feet to distribute the costs over. As a result, the cost per foot for a shallow hole is about the same as for a medium depth well in the US.

Summary – Offshore Wells

Close to 1200 wells will be drilled offshore this year, about half of which will be reentry drilling and the other half new. These offshore wells show almost no change in per foot drilling costs as wells get deeper because fixed costs are extremely high and Gulf of Mexico drilling is fairly uniform at all depths:



Source: Joint Association Survey and Spears & Associates

Comparing the Costs of Conventional Drilling and Coiled Tubing Drilling

Other than re-entry wells in Alaska and other places, few new wells have been drilled in the US with coil, so data is scarce. On the other hand, thousands of wells have been drilled with coil in Canada. Although the comparison is not exactly “apples to apples”, below we have estimated the per foot costs of drilling a MidContinent well with a conventional rig and a Canadian well with a coiled tubing drilling rig.

3000' well per foot cost

REGION	CONTRACTOR	PIPE ²	OTHER ³	TOTAL
MidCont Rotary	\$15	\$5	\$23	\$43
Canada CTD	\$15	\$4	\$14	\$33

Source: Spears & Associates

² Both wells have surface pipe set at 300'. The MidContinent well's production string is 4.5" and the Canadian production string is 2-7/8".

³ Cement, drilling fluids, logging, site preparation and damages, logistics, fuel, production tubing, etc.

Regional Drilling Costs

Spears & Associates has assembled from Joint Association Survey (JAS) data the following table of regional drilling cost information. These per foot average costs have been married with the projected number of wells in each region for 2003 to yield the amount of money to be spent this year on drilling and completing wells in the US. Obviously these averages mask a wide range of actual costs, but these tables give strong guidance regarding the money spent on drilling:

Region	2003 Estimated Activity												Total	
	0-5000 ft		5000-10000 ft		10000-15000 ft		15000+ ft							
	Average	Cost/	Average	Cost/	Average	Cost/	Average	Cost/	Average	Cost/				
	Depth	Foot	Depth	Foot	Depth	Foot	Depth	Foot	Depth	Foot				
Onshore Re-entry	2,198	\$129	3,056	\$156	5,139	\$212	8,166	\$277			4,478	\$207		
Offshore Re-Entry	2,352	\$736	6,439	\$660	9,671	\$693	15,569	\$814			9,303	\$723		
New Offshore	3,706	\$779	8,017	\$529	12,420	\$536	18,170	\$652			11,552	\$572		
Mid Continent	2,549	\$43	7,273	\$59	12,011	\$102	16,940	\$185			5,466	\$59		
Permian	3,516	\$48	7,187	\$59	11,529	\$59	16,932	\$259			6,616	\$71		
Rockies	1,292	\$72	7,323	\$83	11,738	\$106	15,868	\$231			3,197	\$87		
California	2,116	\$40	6,966	\$167	11,698	\$265	18,643	\$459			2,974	\$104		
South Texas	3,364	\$44	7,278	\$75	11,687	\$132	16,447	\$261			8,502	\$120		
Ark-La-Tex	2,391	\$43	9,359	\$67	11,812	\$104	15,960	\$209			9,654	\$99		
Gulfoast	2,641	\$97	7,555	\$89	12,254	\$164	17,061	\$243			8,083	\$156		
Northeast	2,790	\$41	5,737	\$33	11,233	\$101	0	\$0			3,366	\$39		

Region	2003 Estimated Activity												Total	
	0-5000 ft			5000-10000 ft			10000-15000 ft			15000+ ft				
	Wells	Footage	Cost	Wells	Footage	Cost	Wells	Footage	Cost	Wells	Footage	Cost	Wells	Footage
	(000)	(000)	(\$mil)	(000)	(000)	(\$mil)	(000)	(000)	(\$mil)	(000)	(000)	(\$mil)	(000)	(000)
Onshore Re-entry	95	211	\$27	359	1,098	\$171	499	2,566	\$543	106	881	\$244	1,052	4,755
Offshore Re-Entry	26	62	\$46	202	1,299	\$857	253	2,443	\$1,694	107	1,661	\$1,352	587	5,465
New Offshore	31	116	\$90	231	1,852	\$979	276	3,429	\$1,840	124	2,259	\$1,474	663	7,656
Mid Continent	2,794	7,123	\$306	2,105	15,309	\$910	552	6,632	\$674	64	1,078	\$200	5,515	30,142
Permian	1,422	5,002	\$240	2,145	15,416	\$909	521	6,005	\$531	61	1,028	\$266	4,149	27,480
Rockies	6,103	7,894	\$568	1,615	11,829	\$982	544	6,389	\$678	24	368	\$90	8,287	26,491
California	1,716	3,631	\$143	181	1,265	\$212	51	596	\$170	7	128	\$59	1,955	5,619
South Texas	342	1,149	\$90	722	5,251	\$395	601	7,035	\$929	91	1,497	\$420	1,755	14,923
Ark-La-Tex	392	936	\$40	723	6,040	\$404	799	9,436	\$980	20	313	\$65	1,933	16,725
Gulfoast	592	1,564	\$151	427	3,225	\$296	431	5,279	\$957	184	3,140	\$762	1,634	13,208
Northeast	4,066	11,342	\$453	868	5,555	\$185	6	86	\$7	0	0	\$0	5,040	16,963
Total	17581	39,021	\$2,127	9677	68,138	\$6,290	4633	49,865	\$9,911	769	12,374	\$4,933	32,590	169,398

Source: Joint Association Survey and Spears & Associates

Coiled Tubing Drilling – State of the Market

Coiled tubing (CT) services can be broken into two categories: Production services and drilling services. Production, or well intervention, services are the original application of coiled tubing. The continuous tube can be tripped into a well more quickly than conventional tubing. Another advantage is that a continuous tube can be tripped in and out while the well is under pressure. CT drilling appears to be maturing, particularly in Canada where shallow, directional wells are used to produce oil, and in Alaska, where the technique has been used to reenter wells for many years.

Coiled tubing expands its applications by a few percent each year, so its overall market is growing. The improving quality of the tube itself and the predictability of its performance has won it this increasing demand in new applications. Credibility is improving. Canada is leading the world in innovative use of coiled tubing, although Venezuela had been aggressively adopting the service prior to its political problems last year.

With better tracking of pipe use, operators are today able to use continuous tubing about 25% longer than 5 years ago, so each foot of pipe is spending more time in the hole, which improves ROA to service companies.

During the most recent uptick in the oilfield services market, conventional CT services, which represent 75% of CT spending, were growing about 10-12% per year while frac and drilling were growing 30%. This move toward drilling and stimulation has been driving demand for larger diameter pipe.

Coiled Tubing Fleet

Almost 800 units are in the current coiled tubing fleet. :

UNITS	SERVICE COMPANY
200	Schlumberger
165	BJ Services
105	Halliburton
38	Superior Energy Services
23	Cudd Pressure Control
11	Precision Drilling
6	Technicoil
5	Tucker Energy Services
5	Saber Energy Services
4	Advanced Coiled Tubing
3	Baker Hughes Inteq
210	Others
775	TOTAL

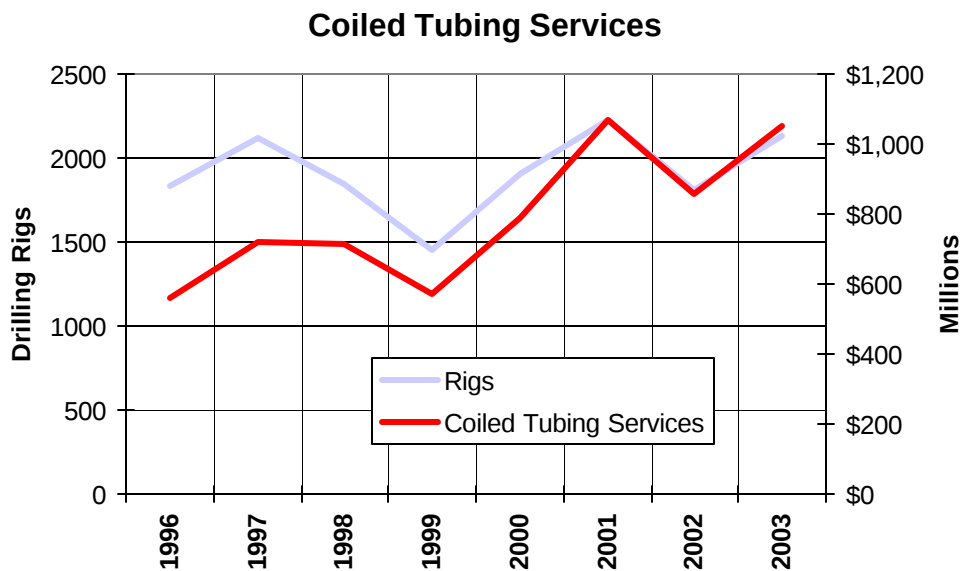
Source: Spears & Associates, Inc.

It is possible that the "Others" category could be larger and may add as many as 200 to this list. Russia and China are not included.

Coiled Tubing Services Market

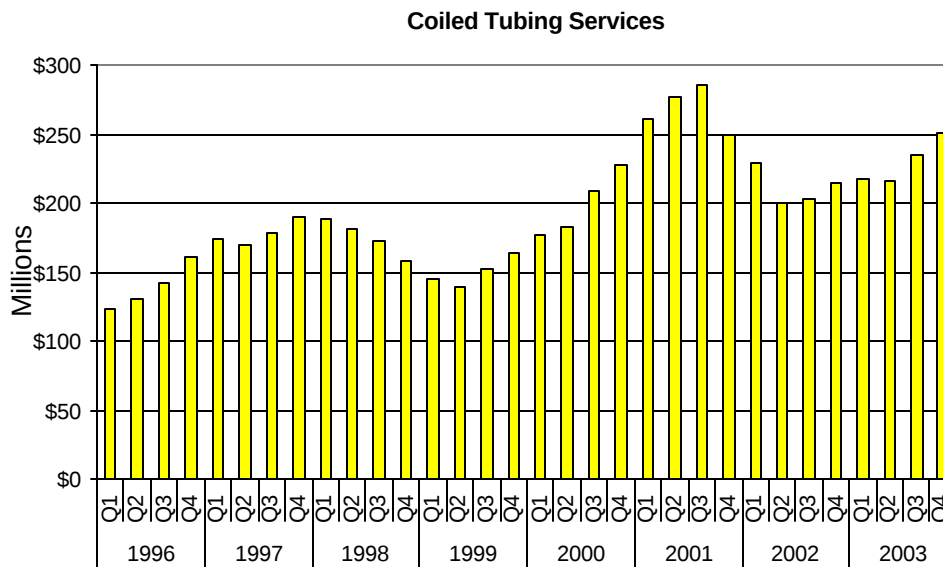
Coiled tubing services doubled from 1999 to 2001 as the US moved toward gas well drilling and as a result of a trend toward completing wells under pressure. Conventional well servicing rigs were also booked up during the 2001 period. With a recovery in drilling in 2003, sales are expected to increase.

When coiled tubing services revenues are plotted against active US drilling rig count, we see that sales of CT services are growing at a rate faster than rig count. As the following chart clearly indicates, coiled tubing is a growth market:



Source: Spears & Associates

This is a cyclic business. Viewed quarterly, sales fell abruptly at the end of the last “boom” in mid-2001, but have been slowly increasing since mid 2002:



Coiled Tubing Services				
Global				
	Revenues (Millions)			
	2000	2001	2002	Share
Schlumberger, Ltd.	\$240	\$310	\$265	31%
BJ Services	\$172	\$260	\$190	22%
Halliburton Corp.	\$135	\$155	\$135	16%
Superior Energy Services, Inc.	\$43	\$65	\$45	5%
Cudd Pressure Control	\$35	\$50	\$35	4%
Sangel Cementers Ltd.	\$25	\$31	\$25	3%
Trican Well Service Co., Ltd.	\$22	\$32	\$25	3%
Precision Drilling Corp.	\$21	\$30	\$24	3%
Technicoil Corporation, Inc.	\$4	\$17	\$15	2%
Pride International, Inc.	\$13	\$18	\$14	2%
Ensign Resource Service	\$7	\$5	\$4	0%
Others	\$71	\$96	\$83	10%
Total Market	\$788	\$1,069	\$859	100%

Source: Spears & Associates

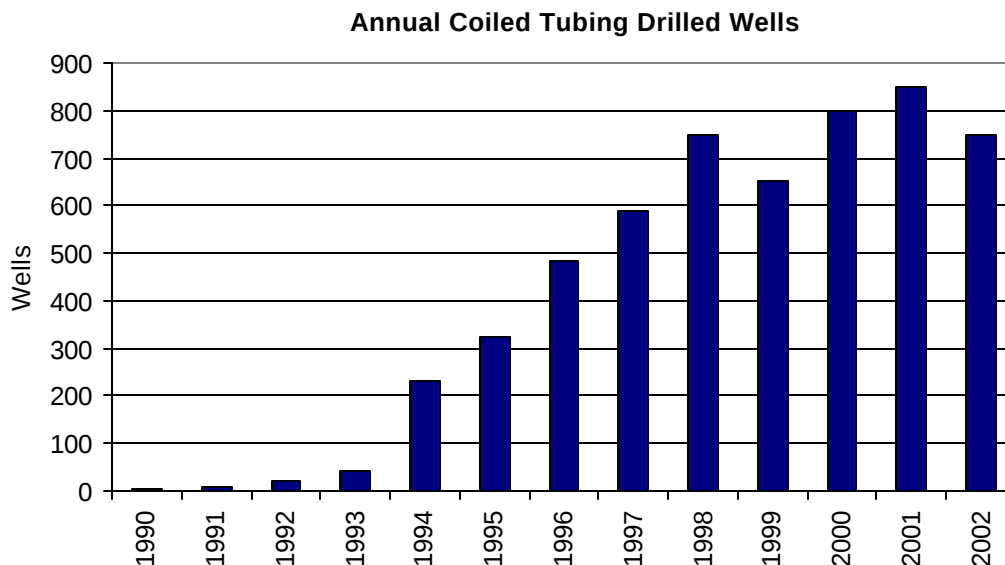
Stimulation through coiled tubing is finding a broader audience than just in Canada, where it has become quite popular. The July 2002 issue of the Journal of Petroleum Technology lists recent applications in the UK Central North Sea, the Appalachian Basin and Virginia. Craig Cipolla with Pinnacle Technologies points out that coiled tubing allows the economic stimulation of multiple zones in marginal reservoirs. In 2002, suppliers in Canada reported that about 800 wells to date had been frac'd through coiled tubing with about 4 zones per well being treated on average.

Within the \$1 billion coiled tubing services market, we forecast that **about \$70 million will be spent this year hiring coiled tubing drilling services** around the world⁴. About half will go to Precision Drilling, who specializes in drilling hundreds of shallow wells in Canada each year. We estimate that Schlumberger is second with about \$10-15 million in CTD sales.

⁴ SPE distinguished lecturer Curtis Blount, ConocoPhillips, has suggested the number might be closer to \$43 million. The main point is, CTD is a tiny portion of the coiled tubing services market and the contract drilling market.

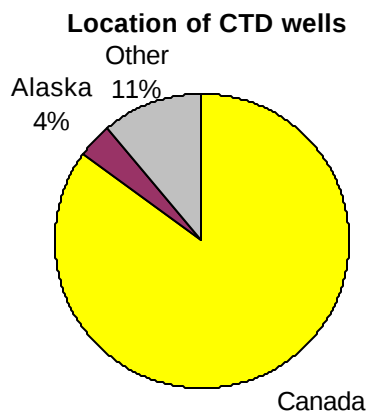
CTD Metrics

By the end of 2003, about 7000 wells will have been drilled with coil, with about 750-850 being added each year. As the following chart indicates, CTD appears to have plateaued a couple years ago:



Source: Spears & Associates interviews with service providers and operators

Most coiled tubing drilled wells are in Canada, which are simple vertical, non-steered holes. Higher cost reentries are performed in Alaska and the North Sea. The lower-48 in the US has seen about 300 CTD wells to date⁵:

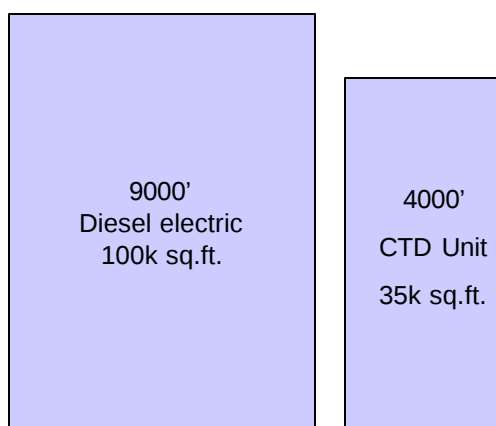


⁵ A primary source of this data is Alex Sas-Jaworski via a survey his firm, SAS, takes annually. Spears has supplemented SAS data with recent drilling activity information.

To drill a 4000' grassroots well in Canada with **coil requires about one-third the space and one-third the number of loads when compared with a conventional SCR drilling rig.**

The most active coiled tubing drilling contractor is Precision Drilling in Canada. With 11 units pursuing work, Precision Drilling can punch about 500-1000 holes each year. Comparing minimum location size of Precision Drilling's coiled tubing units with their small conventional drilling rigs, coiled tubing clearly has the size advantage – well sites are only one-quarter to one-third the size of a conventionally drilled pad:

Minimum Location Size
Precision Drilling Co.
Conventional SCR Rig vs. Large CTD Unit



Along with smaller location size are fewer loads required to deliver equipment to location. The **conventional drilling rig requires 27 loads in the winter and the coiled tubing unit requires only 9 in the winter**⁶.

The previous information comes from Precision Drilling. Technicoil, also of Calgary, through a new rig design, has further reduced the number of trips required to haul equipment to location and has possibly reduced the minimum location size as well.

Key Canadian grassroots drilling metrics are as follows:

Average measured well depth:	3200'
Penetration rate:	220 feet per hour
Days to drill:	2-2.5
Casing program:	5-1/2" surface casing 2-7/8" production casing
Deviation:	<3 degrees
Pad size:	115' x 215'
CTD contractor invoice:	USD 30-40,000
Total completed well cost:	USD 80-100,000

⁶ Winter drilling in Canada requires extra heating equipment to prevent freeze up.

Active Coiled Tubing Drilling Service Companies

Drilling with coil is fairly mature. Alaskan fields have seen drilling with coil for over 10 years already. Although many predicted it, a significant offshore market never did develop because, for the most part, the small cranes found on old platforms in the Gulf do not have the hoisting capacity to lift a spool of coiled pipe up onto the work platform.

Industry experts say that many coiled tubing service companies have drilled with coil, especially in Canada and Alaska, but that most drill only one or two holes per year. **The companies we have listed below appear to be the current leaders in the CTD marketplace**, either in number of holes drilled or in application of new technology.

BJ SERVICES **Houston, Texas**

BJ Services drills with coil in a variety of locations, but focuses mainly on re-entry-type applications. Most are 6" holes using 2-7/8" or 3-1/2" tubing.

HALLIBURTON ENERGY SERVICES **Houston, Texas**

Halliburton's coiled tubing drilling has been limited. The company, however, developed an innovative carbon fiber composite tubing drilling unit called Anaconda that remains in the development stage today. One of their suppliers/partners, Fiberflex, designed and made composite pipe that included power and communications cables within the structure of the pipe. This holds great promise for future advances in the technology.

PRECISION DRILLING **Calgary, Alberta, Canada**

Precision Drilling, with its acquisition of Plains Energy, drills more wells with coiled tubing each year than all other service companies combined, according to our research. The company's 11 CTD units can each drill 2-4000' holes in about one day. In fact, one limitation is the rate at which small water well drilling rigs can work in front of the CTD units drilling and setting surface pipes. Precision has elected to add no more CTD units in the last 2 years, believing that market saturation is near at hand.

Precision Drilling bought CTD units from HydraRig/Varco besides fabricating their own design. A recent HydraRig unit included the custom design/build of a four-trailer coiled tubing drilling system consisting of a coiled tubing unit, power cat walk, doghouse unit, and combination unit. The rig had a Bradon Injector rated at 80,000 pounds for 2.875 to 3.5 inch tubing and a Bradon Drawworks also rated at 80,000 pounds (four part line).

SCHLUMBERGER **Sugar Land, Texas**

Schlumberger Coiled Tubing Drilling Services (CTDS) claims to be the leading supplier of underbalanced directional coiled tubing drilling services worldwide, particularly for CTD engineering and execution of thru-tubing horizontal sidetracks. Schlumberger also does turnkey new wells from surface. Schlumberger has 5 CTDS centers worldwide. Schlumberger's reputation for drilling was made in Alaska, where the company has kept two units busy drilling re-entry sidetracks for ConocoPhillips.

TECHNICOIL CORPORATION
Calgary, AB, Canada

Technicoil is one of the CTD industry's leaders, specializing in drilling with coil and in fracturing through coil. The company runs 9 units, of which 2 are purpose-built, state of the art drilling units that can both rotary drill using a top drive and drill using coiled tubing.

During calendar 2002, Technicoil drilled about 85 wells with coiled tubing at an average cost of USD 40,000 per well⁷. Total sales of CTD services were about USD 3.3 million.

During this same period, Technicoil was on over 1000 frac jobs with their other coiled tubing units.

Technicoil took delivery on two state-of-the-art coiled tubing drilling units in about July 2002. These units, which cost USD 3.5 million each, are equipped with a top drive for standard rotary drilling and tripping casing.

⁷ This is the amount paid to Technicoil and may not include the cost of wireline logging, pipe, cement or other completion-related equipment needed to prepare the well for production.

Coiled Tubing Tools & Systems

A host of tools and systems are required to execute a coiled tubing drilling project. Following are just a few of the critical systems and some of the leading manufacturers of those systems.

Continuous Tubing

Constraints

- o Smallest diameter carbon steel tube normally available is 1-1/4". Smaller sizes require modifications to the tubing mill, which manufacturers are reluctant to make if order size is small.
- o Smallest diameter composite tube available may be 2-1/2".
- o Drilling with air accelerates corrosion of carbon steel tube.

Quality Tubing Inc. – Division of Varco International

QTI is a manufacturer of carbon steel continuous tubing for the coiled tubing service sector. QTI has annual sales of about \$50 million. The company has recently introduced 16-chrome tubing that, in many cases, is better suited for the corrosive environment found offshore than standard carbon steel.

Precision Tube Technology – Division of Maverick Tube

PTT is a manufacturer of carbon steel continuous tubing for the coiled tubing sector and also provides pipe for offshore flow lines. PTT has annual sales of about \$50 million. PTT's parent, Maverick Tube, recently acquired SeaCAT, which specializes in stainless steel continuous tube used mainly offshore, where Shell is a major customer.

Fiberspar Spoolable Products – JV with Halliburton

Manufacturer of continuous carbon fiber composite coiled tubing. We believe this was developed to support Halliburton's Anaconda drilling-with-coil project and is available with power and communication wires woven into the tube. Fiberspar has plenty of 2-1/2" and 3-1/2" composite tubing available for sale.

Surface Units

Constraints

- o Units equipped with large diameter carbon steel continuous tubing quickly exceed highway and bridge weight limits.
- o Hybrid CTD and rotary drilling units are said to be inefficient at running jointed pipe.

HydraRig – a Division of Varco International

HydraRig fabricates coiled tubing units and related systems. Annual sales are about \$50-100 million. HydraRig and its sister companies manufacture all systems and platforms needed for coiled tubing, nitrogen, pressure pumping and hydraulic snubbing⁸. Of particular note is HydraRig's injector, which is capable of providing precise control while tripping tubing.

Stewart & Stevenson

Stewart & Stevenson fabricates coiled tubing units and has annual sales of about \$5-10 million. SSSS also fabricates pressure pumping units and nitrogen units for total annual sales of about \$50 million. SSSS has been a manufacturer of these units for decades and is recognized around the world.

Crown Energy Technologies

Headquartered in Calgary, Crown is a leading Canadian fabricator of frac equipment, cementing equipment and coiled tubing units. Total enterprise sales are about USD 75 million, of which an unknown portion is coiled tubing units.

National Oilwell

National Oilwell (NOI) has unit sales of about \$45 million, which includes coiled tubing units; pressure pumping units, nitrogen and related equipment.

Downhole Systems

Downhole power for most CTD operations is provided by positive displacement motors (PDM), which provide high torque and low rotational speed downhole. But PDMs have short motor run lives in the smaller diameters, poor performance when subjected to high temperatures and a limited set of choices of drilling fluids that can power the systems.

Constraints

- o Small diameter mud motors are limited with respect to torque and operating life.
- o Smallest motor OD is about 1-11/16". These motors are designed for light, re-entry type drilling requiring lower torque and hours, not days, of drilling.
- o XL Technology developed an electric downhole motor for CT drilling and presented a paper at the 2001 coiled tubing roundtable. The first system used ESP cable in the coiled pipe, but this was deemed unsatisfactory for commercial use, so new pipe technology is being developed. Additional testing is required.

⁸ Total coiled tubing and pressure control sales in 2002 were about \$220 million. This includes downhole tools and systems.

Motors used in coiled tubing drilling are provided by⁹:

- o Baker Hughes Inteq
- o Smith Services
- o Sperry Sun (Halliburton)
- o Weatherford International Drilling & Intervention Group
- o Schlumberger
- o Black Max

We have seen motors as small as 1-11/16" OD, which may be the smallest commonly available size. We do not know if smaller diameter motors are available off the shelf.

Baker Hughes INTEQ

BHI provides drilling systems for every downhole application, including coiled tubing drilling. Their CoilTrak BHA system is design to both drill and evaluate holes. CoilTrak comes in one size: 2-3/8" and drills a 2-3/4" – 3-1/2" hole. The bottom hole assembly, which transmits data on a wireline, can measure directional, gamma ray and temperature data. Additional features can include weight on bit, annular and wellbore pressure.

Baker Hughes markets the NaviDrill motor for CTD applications.

Smith International

Smith Bits has developed a very aggressive single cone bit for shallow (800 meter) Canadian gas well drilling. ROP is about 250 meters per hour; meaning holes are drilled in hours rather than days. Smith has just begun marketing the big in Canada. Bits for CTD have been in development for several years.

⁹ Based on an informal survey of coiled tubing drilling service companies. This may not be an exhaustive list.