

Coring Options & Comments

For reentry & coring of Megascorides-1 there are two primary methods of coring available; conventional & wireline retrievable. As for the different hole diameters that are being considered (8-1/2", 6-3/4" & 6-1/8"), most coring contractors in the Far East are generally set up for coring in 8-1/2" & 6" hole.

This then leaves three options:

1st Rathole coring with 6" coring assembly in 6-3/4" (has been done in past but not recommended) or 6-1/8" hole (has been done in past with success & generally equipment can be sourced from other regions for full hole coring).

2nd Design & build coreheads & stabilizers to suit 6-3/4" or 6-1/8" hole (expensive & reasonable lead time required if not available from other regions).

3rd is to fullhole core in 8-1/2" hole.

Based on these options, Corpro will base the remainder of the Coring Tender document on the assumption that coring will either be conducted in 8-1/2" hole or 6-1/8" hole. Should it be decided in the future that coring may in fact take place in 6-3/4" hole, pricing has been attached to cover this eventuality.

For sidetracking, it is advisable to keep Dog Leg Severity to below 3° per 30m if coring is planned. Core barrels are generally well packed assemblies with stabilizers placed ever 20' (6m) or 30' (9m) & significant reaming may be required to get through the build.

Conventional Coring Recommendations 8-1/2" Full Hole Coring

Corpro recommend the use of a core barrel length of between 20' (6m) & 100' (30m), quite dependent on the rig drive mechanism, whether it is Kelly or Top Drive. A shorter overall core barrel length should be considered for Kelly, this is due to the fact that every 30', the core barrel has to be picked up off bottom to add another single of drill pipe. Each time the core is broken off bottom, there is always the distinct possibility of not being able to restart once the connection is completed.

For conventional coring, Corpro offer the following inner barrel options:

- Aluminium Inner Barrels
- Fibreglass Inner Barrels
- Thin Sleeve System (TSS) with Aluminium Liners
- TSS with "Half Moon" Aluminium Liners
- TSS with "On Ice" Aluminium Liners

For the Megascorides-1 reentry, Corpro suggest that utilizing the Thin Sleeve System with "On Ice" Aluminium Liners will yield the best results in terms of core recovery, coring efficiency, rate of penetration, core useability at rig site, core handling & safety.

The TSS is a unique design that Corpro developed & refined into the optimum inner coring assembly.

Corpro Corebarrels

INTRODUCTION

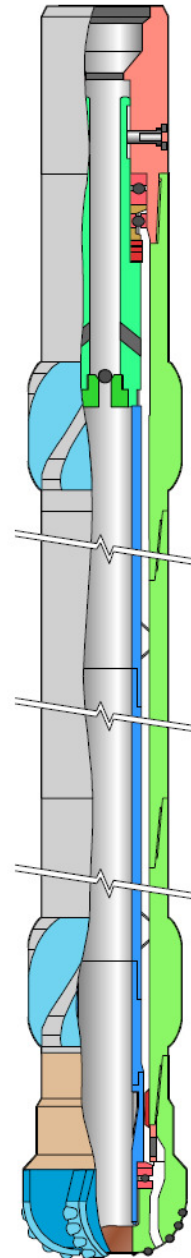
Coring companies generally have been operating with technology that has remained largely unchanged for over 30 years. Corpro Systems Ltd identified this and seized the opportunity to develop a pioneering coring system, which has revolutionised the Coring Industry. The resulting innovative coring system based on the latest materials technology, has set and maintained benchmark standards for coring in the petroleum industry.

The Corpro coring concept has been specifically designed to enable the retrieval of longer, higher quality cores. Faster penetration rates, reduced incidence of core jamming, improved reliability and reduced core damage are four of the benefits offered by the new system.

Corpro believe that correct stabilisation is one of the most important factors governing a successful coring operation.

The majority of core barrel systems are unable to properly transmit the weights on bit required for modern coring operations. Without the outer barrel correctly stabilised, bending within the well bore will occur. This is evident from the polished areas found on the outer tubes between the stabilisers after retrieving the core barrel. The deflection of the barrel impinges wear on the well bore (overgauge hole) and produces eccentric bit rotation (poor quality, undergauge core).

Corpro, using computer aided modelling techniques, established the best position of the stabilisers. The result of this research was the development of core barrels in 20 ft stabilised sections. For high angle and horizontal holes, a stabiliser can be placed midway in the lower section, giving three stabilisers within the bottom 20 ft.



FEATURES

DOUBLE BEARING PACK

The system incorporates a unique combination of thrust and radial bearings located both at the top in the barrel head and at the lower end, in the corehead. This feature provides a significant improvement in the rotational independence between the inner and outer barrels.

AUTOMATIC INNER BARREL SPACING

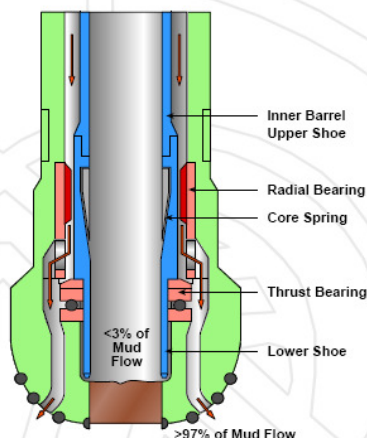
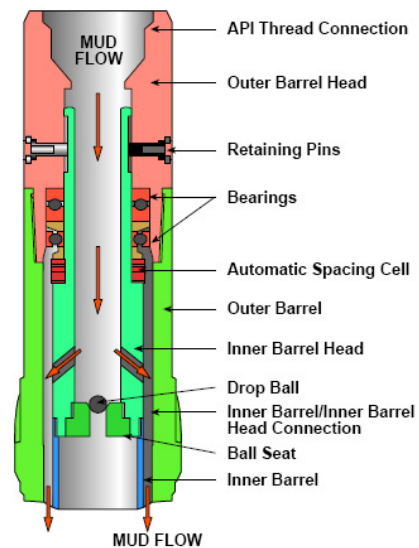
Corpro have eliminated the time consuming process of spacing out the inner barrels. It is achieved by incorporating an Automatic Spacing Cell in the outer barrel head. This ensures that the spacing is both accurate and consistent, particularly where expendable inner tube expansion is unpredictable due to downhole temperatures not being accurately known.

INNER BARREL SYSTEM

- The Corpro inner tube system is less prone to flexing than any other, by virtue of its geometry and strong threaded connections.
- Depending upon the inner tube type, the inner assembly is stabilised at 20 ft intervals, which minimise the stress mechanisms acting on the core.
- Available in Steel, Aluminium, GRP and Thin Sleeve System construction.

DRILLING FLUID CRITERIA

- The Corpro System has been specifically designed to minimise the internal pressure drop along its length.
- The low pressure drop feature enables the use of higher flow rates, which allows circulation times to be significantly reduced.
- Glassfibre inner tube collapse mode failure is eliminated.
- Lost circulation material can be utilised.



CORE CATCHING MECHANISMS

Corpro's selection of core catchers has been successful in recovering all core textures encountered by the Oil Industry. The following mechanisms have achieved the greatest success:

- **Spring Catcher:** A spring reset, wedge type catcher, suitable for most core textures.
- **Slip Catcher:** A thin wedge-shaped catcher sliding on a taper, normally used in scribing shoes for orientated coring.
- **SoftCatch:** A hydraulically operated tube-closure catcher, suitable for extremely unconsolidated formations.

BENEFITS

- Transfer of power through corebarrel to corehead without power loss due to buckling.
- Torsional and tensile strengths are higher than any alternative systems in the market place.
- Flow rates similar to that for drill bits can be used, if desired.
- Stabiliser positions at 20ft intervals leads to improved hole gauge and minimal eccentricity.
- Using Corpro Tandem and Extended Tandem Assemblies enable success in high angled wells.

TECHNICAL SPECIFICATIONS

Flow path dimensions within the barrel have been calculated to keep pressure losses to a minimum. This is of particular importance when using GRP inner tubes and longer coring assemblies

To prevent stalling and the difficulties associated with restarting, the torque limit should be adjusted to the maximum safe level prior to starting. The new 7" and 9" heavy duty barrels are capable of withstanding downhole torque's in excess of that which can be applied to the drill pipe. Therefore the tools can be operated with confidence at the upper torque limits.

NOMINAL HOLE SIZE	6" HOLE	8 1/2" HOLE	12 1/4" HOLE
Outer Barrel	OD 4.75" ID 3.75"	OD 7" (nominal) ID 5.625"	OD 9.50" ID 7.00"
Inner Barrel	OD 3.375" ID 2.875"	OD 4.70" ID 4.125"	OD 6.00" ID 5.50"
Section Length	20 ft	20 ft	20 ft
Top Connection	3 1/2" IF	4 1/2" IF	6 5/8" Reg
Core Diameter	2.56"	4.00"	5.25"
Make Up Torque	7,860 ft.lb	30,000 ft.lb	42,500 ft.lb
Maximum Torque	20,000 ft.lb	68,000 ft.lb	203,000 ft.lb
Operating Torque	To 15,000 ft.lb	To 30,000 ft.lb	To 40,000 ft.lb
WOB	To 15,000 lb	To 40,000 lb	To 50,000 lb
Maximum Overpull	301,000 lb	860,000 lb	1,550,000 lb
Flow Rate	50 - 200 gpm	50 - 400 gpm	50 - 600 gpm
Rotary Speed	40 to Motor rpm	40 to Motor rpm	40 to Motor rpm

Thin Sleeve System™

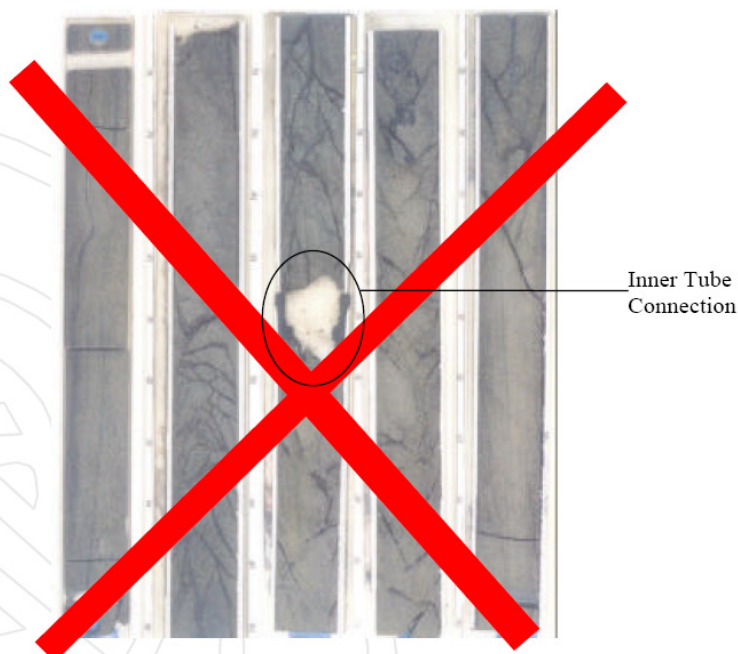
INTRODUCTION

Damaged core is wasted money. If damage is systematic, it may bias reservoir models with potentially disastrous financial implications. A study by Corpro Systems of fracture damage to cores from a wide range of areas shows direct correlation between areas of core damage and the threaded connections on expendable barrels.

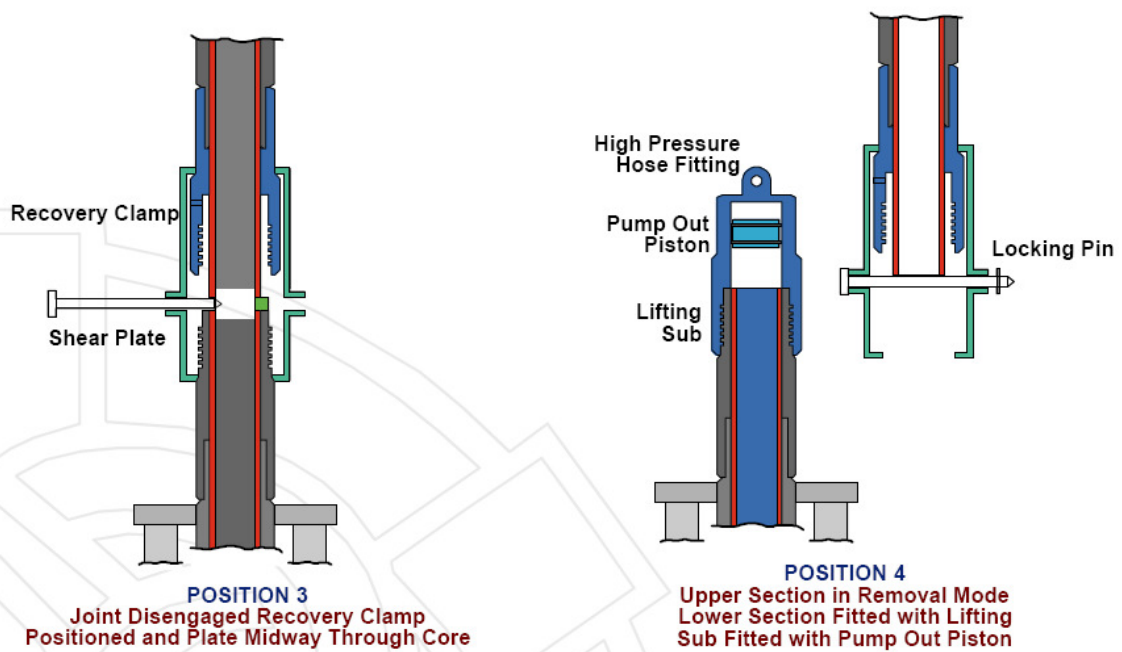
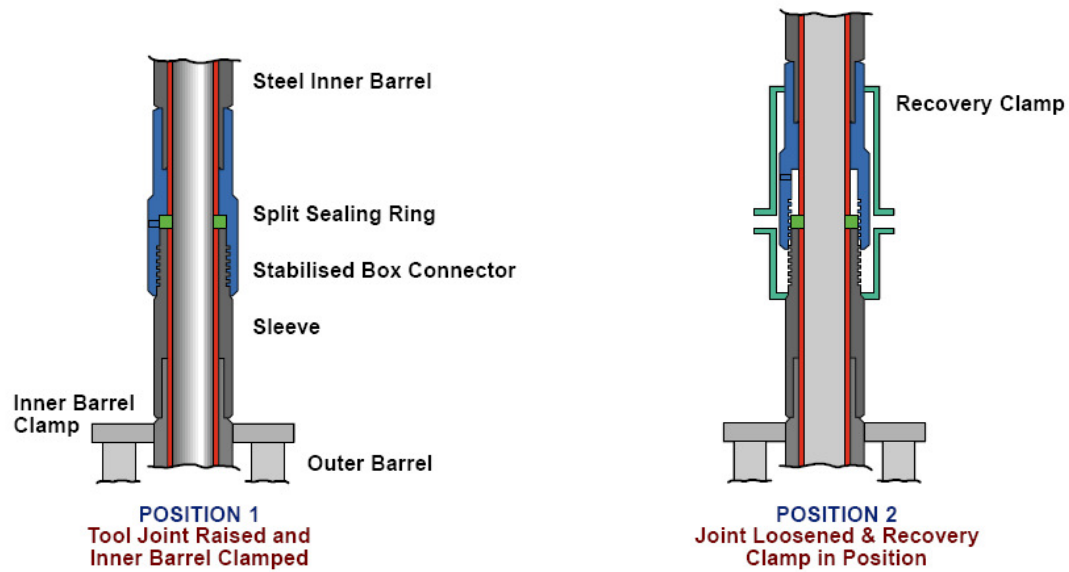
From this study Corpro identified a need for a coring system that minimised the torsional damage occurring during the recovery process. This led to the development of Corpro's T.S.S.™ System which significantly reduces torque transmission to the core.

The Thin Sleeve System™ is a two part inner barrel system. A specially designed inner barrel carries within it a second thin walled tube. A patented connection enables the tool joint to be broken and disengaged without rotating the thin inner tubes. This feature eliminates torsional damage to the core during the breakout procedure. The box connector contains six ribs that keep the inner tubes centrally positioned within the outer barrel.

Available in Aluminium and GRP material format, the Thin Sleeve System™ offers significant technological benefits.



PRINCIPLE



BENEFITS

- Delivers up to 20% more usable core due to the elimination of torsional damage during drill floor retrieval procedures.
- Better stabilisation of the inner barrels.
- Allows installation of lift plugs without disturbing the core sample, (up to 2.5 % recovered core can be disturbed in this process).
- Uses inner barrel tool joints that will not back out.
- Prevents inner barrel failure (implosion etc.) and exploits the material properties of steel.
- Encases the core sample in a material that will effectively maintain its profile.
- Ensures adequate pressure relief from the core.
- Longer run lengths achievable.
- Better value than traditional expendable systems.
- Eases the servicing of the coring equipment.

SPECIFICATIONS

	Aluminium	GRP
Wall Thickness	0.085"	0.100"
Stiffness / Rigidity	Excellent	Good
Friction Coefficient	0.40	0.38
Temperature Rating	To 200°C	To 135°C
Compressive Load Rating	15 t	6 t
Diamond Cutting Blades	No	Yes

'ON ICE' CORING™



Slide into high efficiency coring,
Hit your targets with the Corpro '*On Ice*' Coring System

INTRODUCTION

'On Ice' is an innovative technology designed by Corpro to combat the serious problem of core barrel jamming.

Core Barrel jamming is a major cause of the early termination of coring, which not only increases operations costs but can also compromise core quality.

Embarking on a comprehensive research programme Corpro developed the breakthrough 'On Ice' inner tube system, built on the proven 'Half-Moon' platform.

'On Ice' uses a patented proprietary technology and is major step towards significantly reducing the friction forces that inhibit smooth entry of core into the inner barrel.

The 'On Ice' development was focused on reducing the frictional forces between the inner barrel and the core, achieving the lowest friction coefficient in the industry.

While reducing the friction coefficient to zero is physically impossible, Corpro has concentrated on reducing the friction coefficient to the minimum practicable level.

APPLICATIONS

'On Ice' will be invaluable in problematic and difficult applications, where the frequency of jamming is high, and when the frictional forces result in excessive stresses that cause core damage: Typical conditions include:

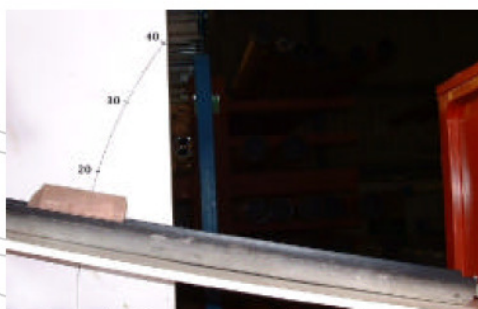
- Swelling clays combined with water-based mud.
- Highly deviated and horizontal coring (particularly where well bore intersects across the angle of formation dip).
- Low mechanical strength formations.
- Excessive build-up of mud filter-cake.
- Fractured reservoirs.

The common factor in each case is nominal increase in effective core diameter that results in additional contact between the core and the inner barrel. This contact results in an additional resistance to entry of the core into the inner barrel. Laboratory tests have been performed to identify the best method to reduce this resistance.

COMPARATIVE TEST RESULTS

A total of 30 tests were performed in order to measure the friction coefficient of industry standard expendable inner tube systems; (slick aluminium, fibreglass and fluted aluminium) in comparison with our new 'On Ice' system. **The 'On Ice' system results in a 61% reduction in resistance to core entry over the next best available system.** This is demonstrated in the following table.

Inner Tube Type	Aluminium	Fibreglass	'On Ice'
Angle	27.2°	26.3°	10.7°
Friction Coefficient	0.51	0.49	0.19



*On-Ice'
(Half Moon Liner)
Showing core movement as the
liner reaches 10.7°*



*Fibreglass Liner
(with the same piece of core)
The liner needs to reach 26.3° for the
core sample to slide.*

Half Moon Tube™

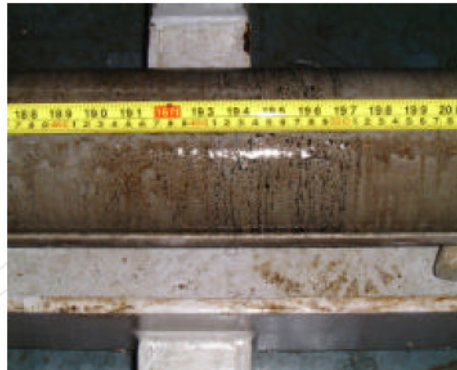
INTRODUCTION

Rig site recovery of a core from inside an inner tube can be a very time-consuming and cumbersome task. It can also have an adverse effect on the quality and usability of the core. This operation is necessary when the core must be visually examined before processing it; specifically, when structural analysis and Core Imaging™ services are required prior to the core leaving the rig site. Therefore, Corpro has designed the **Half Moon Tube?** to facilitate these procedures and improve the overall efficiency of coring operations.

Prior to the design of the **Half Moon Tube?**, there were only two methods of visually examining the core on the rig site; these included:

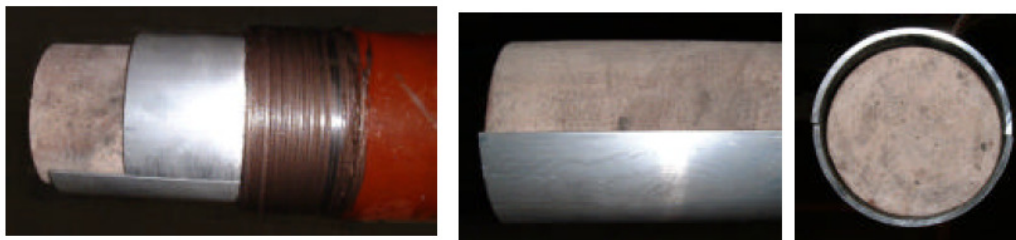
- ?? sliding the core out of the inner tube manually, or
- ?? cutting the entire length of the inner tube with a longitudinal saw

Neither of the procedures is appropriate when handling such a critical component of a well. Both techniques expose the core to elements in the atmosphere for extended periods of time; this could disrupt the quality of the core and alter its vital characteristics. The methods also expose personnel to unnecessary safety risks. The **Half Moon Tube™** provides a quick and easy way to visually examine the core on the rig site without needlessly jeopardizing the safety of personnel, nor carelessly affecting the quality and characteristics of the core. Furthermore, the **Half Moon Tube?** is utilized with the Thin Sleeve System?, also developed by Corpro, to offer additional core quality.



OPERATING PRINCIPLE

The procedure for utilizing the **Half Moon Tube**® is very simple. The lifting sub is connected to the first 20 ft. section of barrel and is brought out of the hole. The connection is broken at the bottom of the 20 ft. section and the shear boot is fitted into place. The TSS® is then lowered down the V-door to the catwalk and the steel tube is placed on the Corpro Lay-Down Cradle. The **Half Moon Tube**® is then pulled out of the steel tube manually or extracted with the pump out unit. Once the half moon tube is positioned on the cradle, the upper portion is removed and the core is available for inspection.

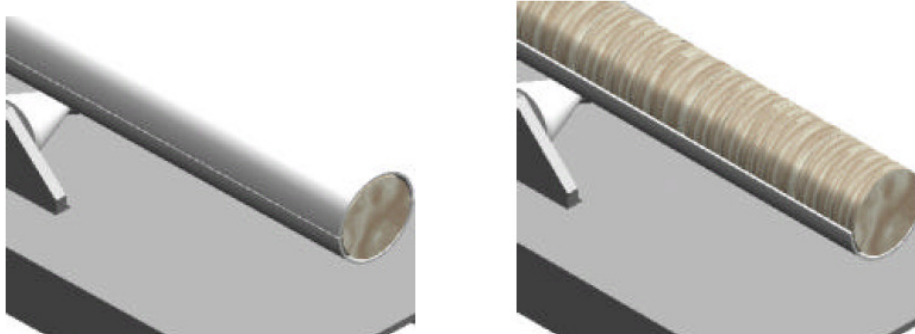


FEATURES & BENEFITS

- ?? Expedites operational procedures by allowing a quick view of the whole core shortly after being recovered
- ?? Improves full size sample for SCAL recovery and quality.
- ?? Reduces core exposure during conventional longitudinal cut.
- ?? Allows gas to be easily vented while tripping out of hole or upon arrival to surface.
- ?? Improves overall core quality.
- ?? Reduces risks associated with core handling procedures.

APPLICATIONS

- ?? Core Imaging™.
- ?? On Site Geological requirement.
- ?? Whole Core recovery for full size preservation
- ?? Trapped gas exposure.
- ?? Speed up core processing and reduce core damage in the lab.



Note: View of the Half Moon Tube® on Corpro Lay-Down Cradle ready for inspection

Should it be decided not to utilize the TSS system with Half Moon & On Ice, Corpro also offer “standard” expendable inner barrels either constructed of aluminium or fiberglass. Aluminium is recommended for this application.

Expendable Inner Tubes

INTRODUCTION

The major reason for using expendable tubes are;

- Ease of core entry due to lower friction than conventional steel inner barrels
- Reduction in core jamming and longer core runs due to lower friction co-efficient
- Improved recovery rates
- Enhanced recovery of friable and unconsolidated formations
- Recovery of undisturbed cores of improved quality
- Reduction of on site core processing

All inner tubes are relatively thin-walled. The Steel, Aluminium or Fibreglass tubes are very limber assemblies in lengths over 10 ft. These tubes rely on the outer barrels for support, without which they cannot be run. Any bending of the outer barrel downhole is translated to the inner barrel when contact occurs between both barrels.

Contact between the rotating outer barrel and the ‘stationary’ inner barrel will exert a torque on the inner tube. It is best that contact between the two barrels is minimised by some form of stabilisation/centralisation. This is even more critical in longer barrel assemblies where the torque acting on the inner is even greater, especially at both ends of the inner barrel.

A well centralised inner assembly requires a correctly stabilised outer barrel before any benefits may be derived in both core quality and hole gauge.

CHARACTERISTICS

	GRP	ALUMINIUM
Deflection under load for 20ft	5.6 inches (14.22 cm)	1/2 inch (1.25 cm)
Temperature Limit	250°F (130°C)	350°F (150°C)
Collapse Pressure	580 psi (40 bar)	2333 psi (160 bar)
Compressive Load	2000 psi (138 bar)	3500 psi (241 bar)

Aluminium Inner Barrels

INTRODUCTION

Aluminium is now our most widely used expendable inner barrel for various reasons:

- Aluminium withstands high downhole temperatures and will operate with high compressive loads.
- Aluminium is less likely to suffer from structural damage.
- Corpro Systems have perfected one pass dry cutting of aluminium innertube and core, using special blades. Dry cutting avoids unnecessary core contamination. The saw unit is designed to provide proper health and safety protection.
- Can be fitted with pressure relief plugs to enable evacuation of unwanted gas.
- Excellent Value for money.

SPECIFICATIONS

	ALUMINIUM		
Hole Size	12 1/4"	8 1/2"	6"
Barrel Size	9 1/2"	7"	4 3/4"
Inner Barrel OD	6"	4 5/8"	3 3/8"
Inner Barrel ID	5 1/2"	4 1/8"	2 7/8"
Collapse Pressure (psi)	3000	2333	1140
(bar)	(207)	(161)	(78)
Maximum Load - Compressive (lbs)	35000	25000	12000
- Tensile (lbs)	25000	20000	10000
Max. Operating Temperature	180°C	180°C	180°C
	350°F	350°F	350°F

Glassfibre Reinforced Plastic

INTRODUCTION

In formations, which are soft and poorly cemented, extensive coring has shown the use of GRP inner tubes will improve the recovery of core samples. The Corpro system is constructed in a 20ft modular system complete with recovery tubes to ease the handling of the GRP inner tube. The GRP inner tube is made from fibrous strand rovings, which are impregnated with epoxy resin and helically wound, under tension, onto a polished mandrill. This material and the method of manufacture gives the GRP tube a polished internal wall, resulting in a low co-efficient of friction, which allows smooth transfer of core into the inner tubes. Due to this, core jamming is reduced and consequently higher core recovery is attained. GRP inner tubes are resistant to the corrosive effects of acids, salts and other chemicals often used in drilling fluids. Due to the non-toxic properties, core samples can be safely stored in GRP sections.

After the inner tubes have been recovered, the GRP inner tubes are easy to cut into selected lengths. These selected sections are then delivered to the laboratories for analysis. The GRP tube is strong and lightweight, allowing easy handling on the rig site.

Corpro provide lay down cradles to prevent any flexing while the tubes are in transit from the rig floor to the process area.

SPECIFICATIONS

	GRP		
Hole Size	12 1/4"	8 1/2"	6"
Barrel Size	9 1/2"	7"	4 3/4"
Inner Barrel OD	6"	4 5/8"	3 3/8"
Inner Barrel ID	5 1/2"	4 1/8"	2 7/8"
Collapse Pressure (psi)	700	652	300
(bar)	(48)	(45)	(21)
Maximum Load - Compressive (lbs)	25000	15000	10000
- Tensile (lbs)	18000	14000	7000
Max. Operating Temperature	130°C	130°C	130°C
	250°C	250°F	250°F

Conventional Corehead Selection (8-1/2" x 4")

Coreheads utilized on Megascolides-1 did not display significant wear or damage in the upper or lower formations (FC264 & FC284) when utilized for wireline retrievable coring (8-1/2" Hole, 6-3/4" Core Barrel, 2.02" Core Diameter).

Core recovery was also good. The main area that should be built on from lessons learnt during Megascolides-1 is delivery of increased ROP. The well had thick shale packages that often only returned a little over 2 to 3m/hr.

Corpro propose the use of the 8-1/2" x 4" MCP662 as the primary corehead, built with 0.010" chamfered cutters (those run on Megascolides-1 were 0.020" chamfer), low cutter back rake & large open face volume to minimize potential balling in shale packages. All of these combined features will result in improved coring ROP, without sacrificing core recovery or quality.



MCP662

Should any harder formations be encountered, Corpro recommend the use of the MCP682. It is a heavier set corehead which is usually built with 0.010" or 0.020" cutter chamfer & less aggressive backrake angles.



MCP682

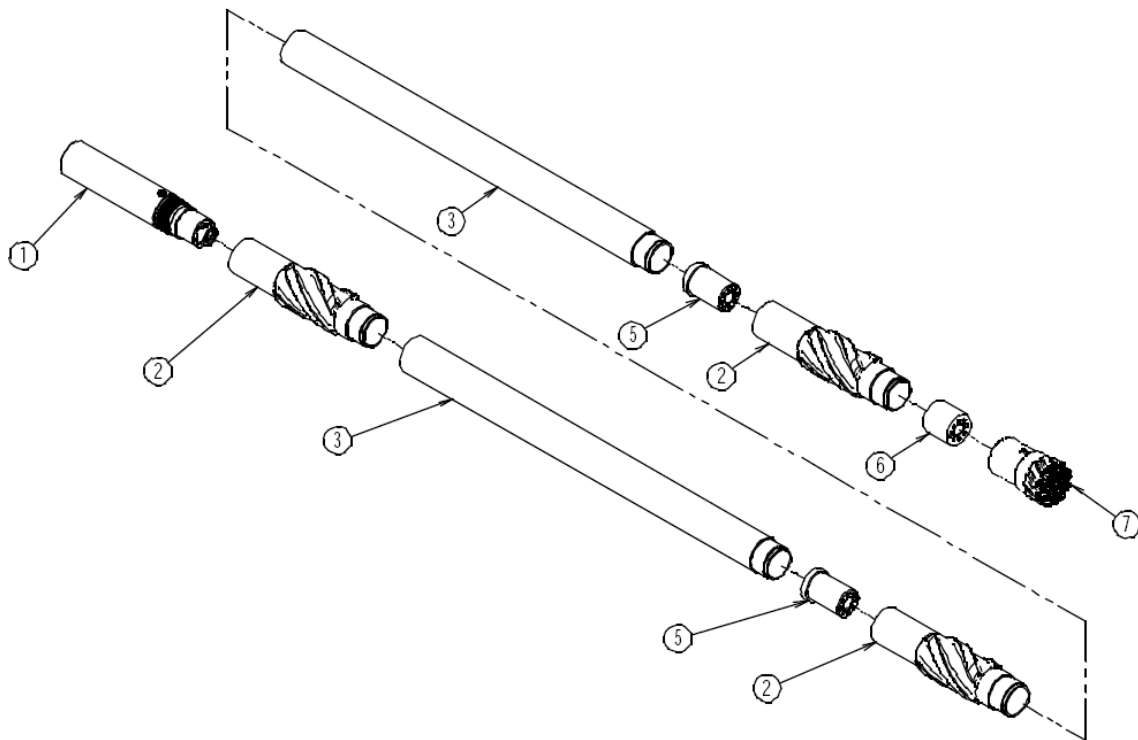
Wireline Retrievable Coring Recommendations 8-1/2" Full Hole Coring

Corpro recommend the use of a core barrel length of between 20' (6m) & 40' (12m), also dependent on the rig drive mechanism, whether it is Kelly or Top Drive.

The 7" x 1.875" wireline system offered by Corpro is a robust tool that can also be fitted with a Drill Plug Assy to allow alternate drilling & coring without tripping the whole drill string out of the hole. The drift require for the inner barrel assembly is only 2.3", much less than other competitors' drift requirements which can approach 3". The benefit of the reduced OD of Corpro's equipment is that the inner barrel can be retrieved through the drill string to surface much faster without increasing the risk of swabbing the wellbore.

For surface handling, the core can be left within the 6m inner barrels, cut into 1m lengths or pumped out of the inner barrels to enable re-use.

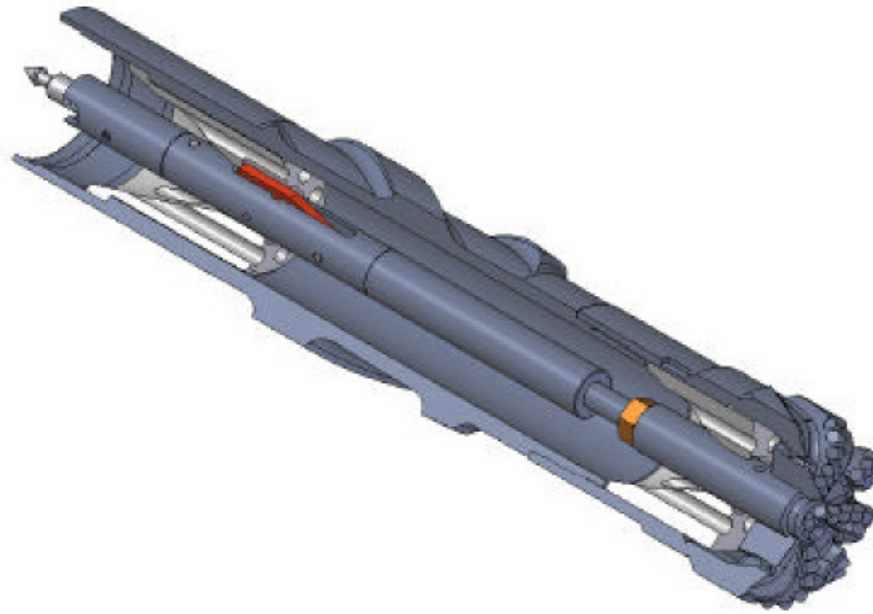
OUTER BARREL ASSEMBLY



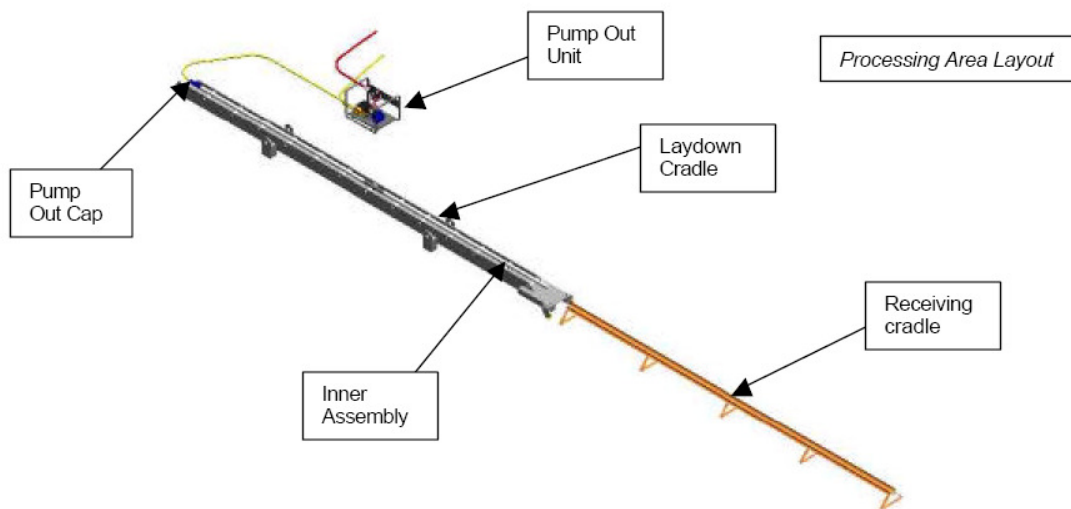
Item Number	Part #	Title	Quantity
1	W1762	OUTER BARREL HEAD ASSEMBLY-WIRELINE	1
2	W1476	CORE BARREL STABILISER (GH)	3
3	W1258	DIRECTIONAL OUTER BARREL - 7.5 FT	2
5	W1742	INTERNAL STABILISER-WIRELINE	2
6	W1743	STABILISING CROWN-WIRELINE	1
7	2384	WIRELINE COREHEAD 1.875"	1

In its standard configuration, the core barrel is 20Ft long. Depending the coring program, the total length can be adjusted to 30Ft or 40 Ft.

Experience has shown however that 20Ft is the optimum length and will secure a smooth and quick operation. Although possible, going for longer section will make the handling more difficult and time consuming.



Drill Plug Assembly



Surface Handling

Wireline Corehead Selection (8-1/2" x 1.875")

Corpro propose the use of the same equivalent design as recommended for the conventional coring. MCP662 & MCP682.

Conventional Coring Recommendations 6-1/8" Rathole Hole Coring with 6" Core Barrel

Corpro recommend the use of a core barrel length of between 20' (6m) & 80' (24m), quite dependent on the rig drive mechanism, whether it is Kelly or Top Drive.

As with the 7" x 4" equipment design for 8-1/2" hole, the 4-3/4" x 2-9/16" equipment can also be utilized with TSS & Standard expendable inner barrels.

TSS is the recommended system for this application, however, standard inner barrels could also be utilized.

Conventional Corehead Selection (6" x 2-9/16") Rathole Coring in 6-1/8" Hole

Coreheads utilized on Megascoldes-1 did not display significant wear or damage in the upper or lower formations (FC264 & FC284) when utilized for wireline retrievable coring (8-1/2" Hole, 6-3/4" Core Barrel, 2.02" Core Diameter).

Core recovery was also good. The main area that should be built on from lessons learnt during Megascoldes-1 is delivery of increased ROP. The well had thick shale packages that often only returned a little over 2 to 3m/hr.

Corpro propose the use of the 6" x 4" CM366 as the primary corehead, built with 0.010" chamfered cutters (those run on Megascoldes-1 were 0.020" chamfer), low cutter back rake & large open face volume to minimize potential balling in shale packages. All of these combined features will result in improved coring ROP, without sacrificing core recovery or quality.

The MCP472 is recommended as a back-up corehead. It is heavier set & a little less aggressive in its design.



CM366



MCP472

Wireline Retrievable Coring Recommendations 6-1/8" Rathole Hole Coring

Corpro recommend the use of a core barrel length of between 20' (6m) & 40' (12m), also dependent on the rig drive mechanism, whether it is Kelly or Top Drive.

The 4-3/4" x 1.77" wireline system offered by Corpro is a robust tool that can also be fitted with a Drill Plug Assy to allow alternate drilling & coring without tripping the whole drill string out of the hole.

The drift require for the inner barrel assembly is only 2.3", much less than other competitors' drift requirements which can approach 3". The benefit of the reduced OD of Corpro's equipment is that the inner barrel can be retrieved through the drill string to surface much faster without increasing the risk of swabbing the wellbore.

For surface handling, the core can be left within the 6m inner barrels, cut into 1m lengths or pumped out of the inner barrels to enable re-use.

Wireline Corehead Selection (6" x 1.77")

Corpro propose the use of the same equivalent design as recommended for the conventional coring. CM366 & MCP472.