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MODEL: XTG168I

250 Ton Casing Running System

MAINTENANCE AND OPERATION MANUAL



Foreword

Based on the wellbore structure, casing string needs to be set for each wellbore interval accordingly. The drilled borehole (especially the open hole) encounters undersizing, collapsing, cuttings depositing and many other issues frequently, however, during the conventional rotary rig casing running process, operations like mud circulation, casing rotation, raising or lowering the casing, cannot be performed simultaneously and will not adapt to the wellbore very well, thus the casing may not be able to reach the bottom of the hole. With the development of the drilling industry, casing running equipment and technology is advancing rapidly. With more and more focus on drilling speed and efficiency, the application of more advanced top drive casing running system is becoming highly necessary, and this will surely bring the drilling industry remarkable social and economic benefit.

The performance and operating time of the top drive Casing Running System (CRS) depends not only on the design and manufacturing of this product, but also the proper operation by the operators. We will provide you products with high quality in compliance with the specification of the quality assurance system of ISO 9001:2000. At the mean time, to make sure you are operating this equipment properly, please read this operation manual carefully before you start. The reliability and performance data may change as the operation and service of the equipment goes on, and it relies on the proper operation and quality level of the maintenance work.

This manual is intended for the operation and maintenance of the CRS manufactured by the company. It may not serve for special applications, so the operator should make the right judgement on the selection and applications of the CRS. As the products upgrade, the actual product may not be exactly the same as the one mentioned in the manual, but this will not affect the understanding of the structure, performance and operation of the product, and also the function. If in doubt, please contact us immediately, and we will give you detailed instructions.

As the drilling technology continuous improves, the customers will have new requirements on the application. We will improve our products continuously to meet your special requirements. We value your comments and suggestions. Welcome to contact us by the following methods.


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1. Safety Information

The top drive Casing Running System (CRS) should be operated by personnel with top drive experience. Please read this manual and relevant technical documents before the operation.

Notes, Cautions and Warnings provide user with additional information, and to advise the user to take specific action to avoid personal injury and damage to the equipment. Please pay close attention to these advisories.

Note  The note symbol indicates that additional information is provided about the current topic.

Caution  The caution symbol indicates that potential damage to equipment, or injury to personnel exists. Follow instructions explicitly.

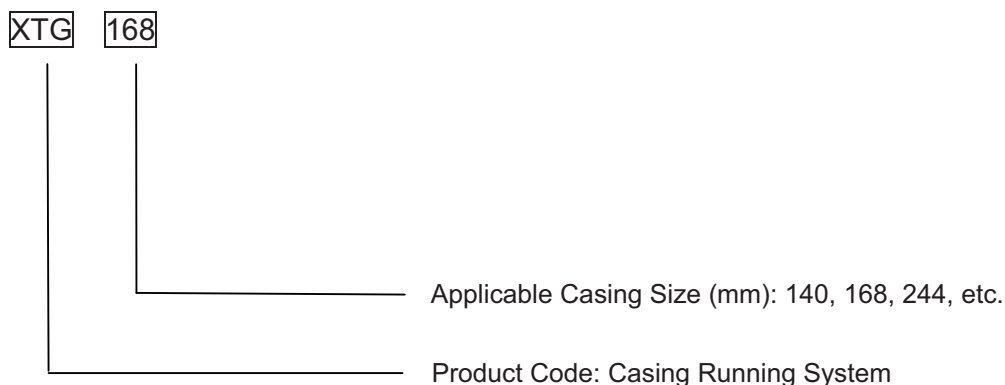
Warning  The warning symbol indicates a definite risk of equipment damage or danger to personnel. Failure to follow safe work procedures could result in serious or fatal injury to personnel, significant equipment damage, or extended rig down time.

2. General Information

Integrating mechanical and hydraulic system, the CRS has emerged recently as a casing running device based on the top drive drilling system. A series of products have been developed for different sizes of casings, so they are applicable for running casing with regular wall thickness. It replaces casing tongs and other casing running equipment which is widely used in drilling operation. Fully utilizing the advantage of the top drive, CRS makes automatic connection of the casing string possible, and it provides the ability of casing rotation and mud circulation, which greatly reduces the chances of stuck casing and other potential safety hazards, thus improves the efficiency of the casing running operation. CRS makes sure to set the casing to the expected depth, and minimizes the number of casing crews that are required, so it is safe and effective.

The successful application of the CRS is a technology advance of the domestic drilling equipment, and it will boost the mechanization and automatization level of the Chinese drilling equipment. The CRS expands the range of application of the top drive, and has great potential for further promotion and market outlook.

3. Model Description



4. Structure and Working Principles

The CRS is divided into two categories, namely, the internal gripping and external gripping structure depending upon the casing size. When the diameter of the casing is smaller than 168mm, external gripping equipment will be used, and when the diameter is equal to or greater than 168mm, internal gripping equipment will be used. Both of the devices have main structure such as: the connecting thread with the top drive, hydraulic mechanism to actuate the slips to engaged or disengaged position, slip mechanism to transfer work load (tensile and torque load), sealing packer for mud circulation and stabbing guide for casing connection. The internal structure is shown in Figure 1. In order to achieve a reliable connection and for the sake of safety, there is anti-rotation mechanism and ect. The schematic drawing for the top drive and the CRS is shown in Figure 2.

This device is connected with the main shaft of the top drive at the upper end, so the make-up torque is precisely controlled during the casing running operation. The working principles are as follows: through the hydraulic supply of the top drive, the upper or lower chamber of the actuating cylinder is filled up with fluid and when the working pressure is reached, piston will move up or down to drive the slip mechanism to disengage or engage, so as to release or grip the casing, transfer torque and hoisting load, accomplish casing make-up and hoisting or lowering operation. This device employs self-sealing cup packer mechanism, which enables the mud circulation during casing running operation, so as to reduce or avoid tragic accident.

The safety of the casing running operation is extremely important, so the device has incorporated hydraulic lock design and self-locking slip mandrel structure to ensure the

safety and reliability of the product. Hydraulic lock is realized through the application of hydraulic valves to keep a stable pressure inside the actuating cylinder in case of emergency or loss of hydraulic source, thus avoiding any accident that can be caused by fluctuation of the pressure. The self-locking slip mandrel structure is shown in Figure 3. As a tapered structure is applied between the mandrel and slips, the slips tend to move downward along the taper to create a self-locking effect under the weight of the casing strings, so a self-locking mechanism is formed to ensure that there will not be slip-off of the casing and thus a safe casing operation.

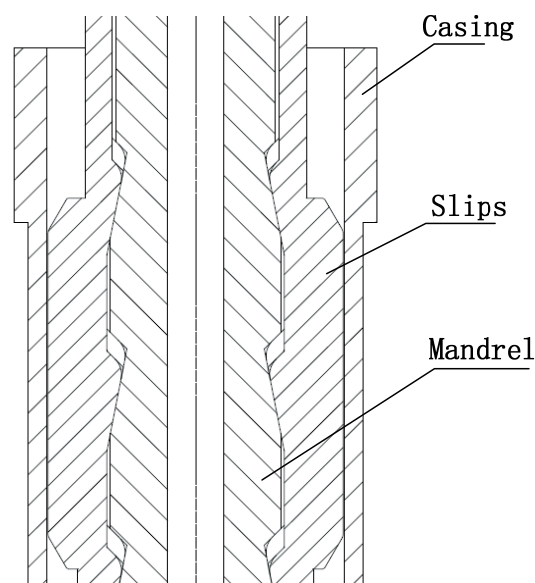


Fig. 3 Self-locking Mechanism

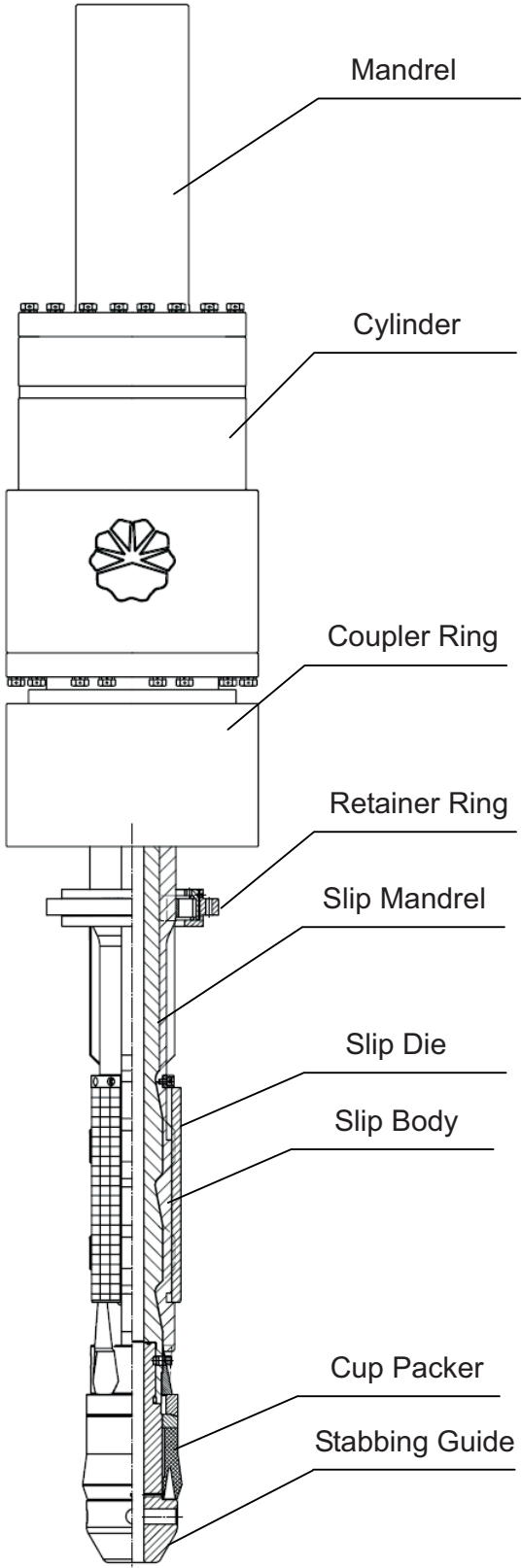


Fig.1 Casing Running System Structure Schematics

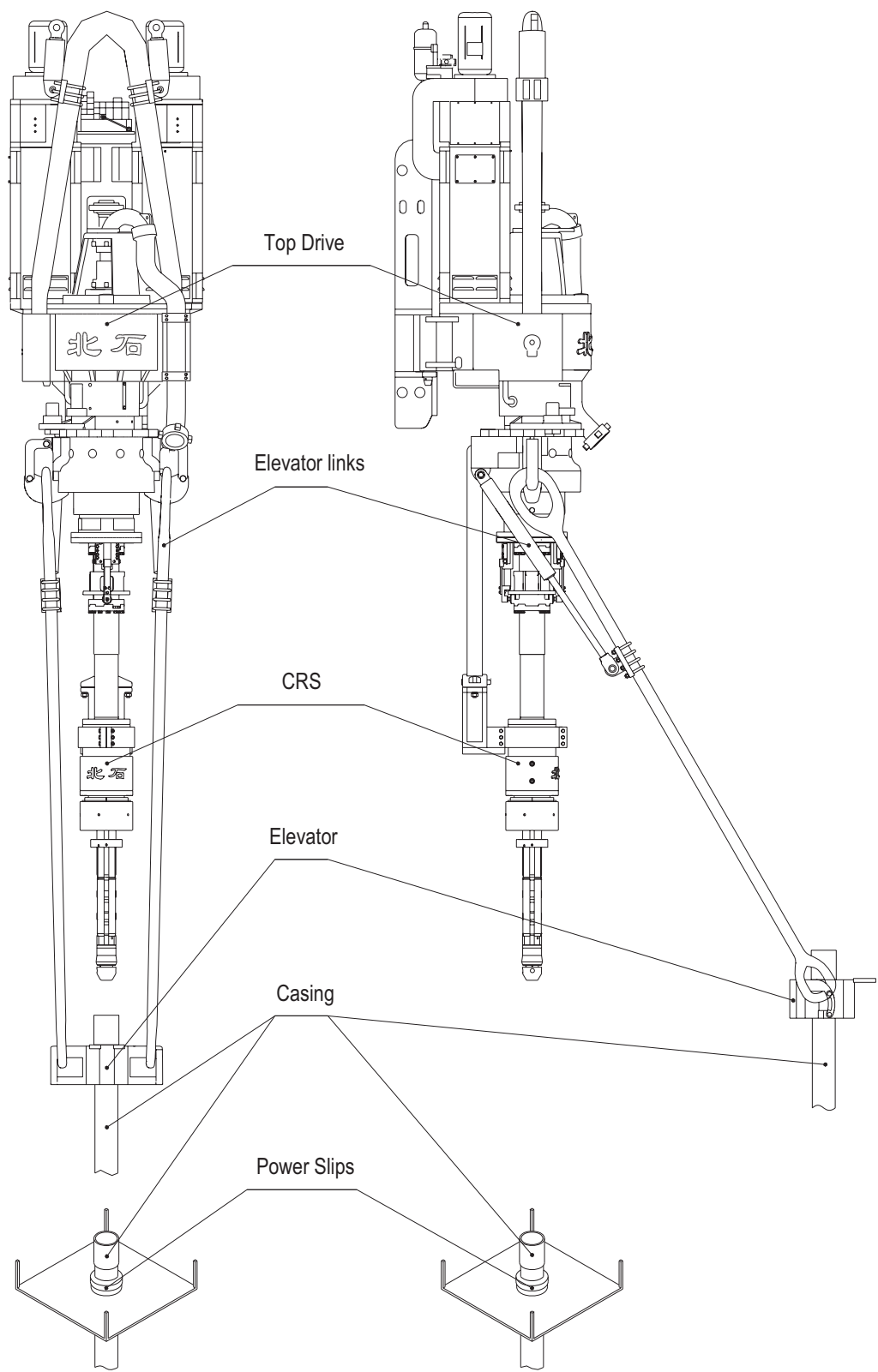


Fig. 2 Top Drive and CRS Working Schematics

5. Technical Specifications

Technical specifications of the CRS are listed in Table 1.

Table 1 Technical Specifications of the CRS

Technical Content		Technical Data			
Product Model		XTG140	XTG168	XTG244	XTG340
Applicable Casing	inch	4-1/2~5-1/2	6-5/8~9-5/8	9-5/8~13-3/8	13-3/8~20
Nozzle Diameter	inch	1-1/4	1-1/4	2	3
Rated Hoist Load	US ton	350	250	500	500
Rated Torque Load	ft-lbs	30,000	30,000	40,000	40,000
Nozzle Pressure	psi	—	5,000	5,000	5,000
Upper Connection Thread	API	6 5/8 REG BOX			
Hydraulic Supply	psi	2,280			
Hydraulic Supply Flow	L/min	40			
System Height	inch	100			

6. Hoisting and Storage

As the CRS is a hydraulically actuated device, there are strict requirements for safety and reliability in the field. It is necessary to follow the rules of hoisting, shipping and storage strictly:

- 1) Make sure the hoisting device is working properly, the ancillary equipment is in good condition, and the lifting height satisfies requirement.
- 2) Based on the recommended hoisting point on the equipment, hoist slowly and smoothly.



Caution: Do not damage the connection thread, hydraulic ports, surface strengthening area.

- 3) Have wood blocks around the equipment during shipping; avoid bumping of the vehicle to minimize rolling and colliding of the equipment.
- 4) The products should be kept horizontally in a dry, clean and ventilating storage. If kept outdoors, a cover is recommended to protect the products from corrosion.
- 5) Rubber sealing element should be kept in a dry and cool storage place, and should not be kept more than 18 months.

- 6) If the assembly is kept for more than 18 months, sealing components and perishable medium should be replaced before operation.

7. Installation and Testing

The installation and testing of the CRS should be performed by certified and experienced personnel, who has also received training on drilling operation and drilling safety. Please be aware of the following guidelines:



Wear protection appliances in accordance with the rules (such as gloves, apparel, safety hat, etc.)



When work high above the ground, please wear a safety belt, and the tools and components should be tied with safety rope or put in a tool bag to avoid falling off.

7.1 Installation

1) Preparation before Installation

- a) The technical and safety supervisor installation should be assigned, and meetings should be arranged for technical communication, and technical plan should be discussed and finalized, making sure that everyone for this job knows the installation plan and safety measures clearly.
- b) It is necessary to check all the equipment and accessories according to the shipping list, and to make sure they are in place and in good condition, and that the lubricating product, tools and other accessories are readily available, so as to avoid work interruption because of insufficient preparation during the installation process.

2) Installation Procedure

- a) Shut down the power and hydraulic supply of the top drive.
- b) Remove the regular 120" elevator links of the top drive, determine whether to remove the torque wrench, hydraulic hoses and fittings.

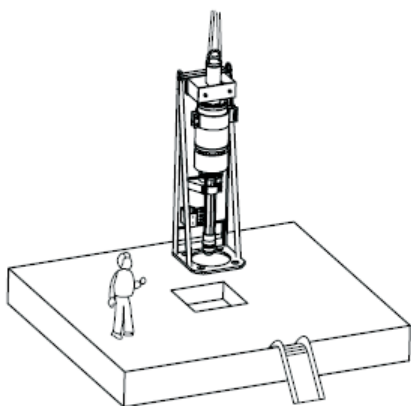


Note: Before removal of the hydraulic hoses, prepare suitable containers, cotton cloth and plugs to avoid the hydraulic oil spill and contaminating the equipment and surrounding environment.

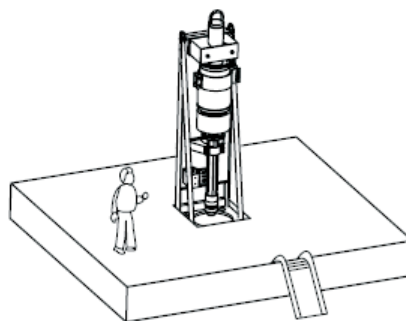


Warning: Shut off valves in the system and relieve the system pressure slowly before removing the hydraulic hoses.

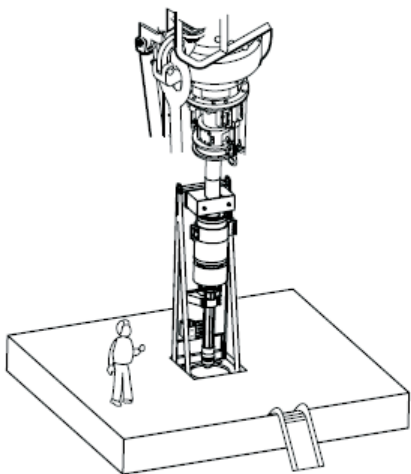
- ❗ Warning: The hydraulic oil might be hot after operation, so it takes some time for it to cool down to a level for access.
- c) Remove the thread protector and other protectors, then apply thread compound or grease accordingly.
 - d) Based on casing size, wall thickness or inner diameter, and refer to Appendix B, choose the right slip dies, cup packer, stabbing guide and packer cap.
 - e) Lift the CRS together with shipping frame to rig floor, adjust the shipping frame to fit with the rotary table. Remove the lifting sub, align the mandrel of the CRS



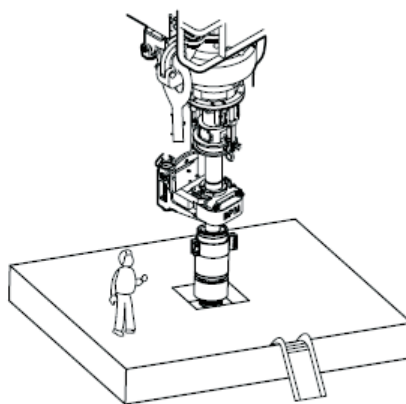
(1) Hoist the CRS with Shipping Frame to Rig Floor



(2) Adjust the Shipping Frame to Fit with Rotary Table



(3) Align the Connection Thread of the CRS and top drive



(4) Make up the Connection through Torque Wrench

Fig. 4 Installation of the CRS

with the main shaft of the top drive, and thread on through the top drive shaft rotation. Remove the shipping frame and make up the connection between the CRS and top drive through torque wrench.

- f) Have the CRS connected to the top drive through anti-rotation bracket.

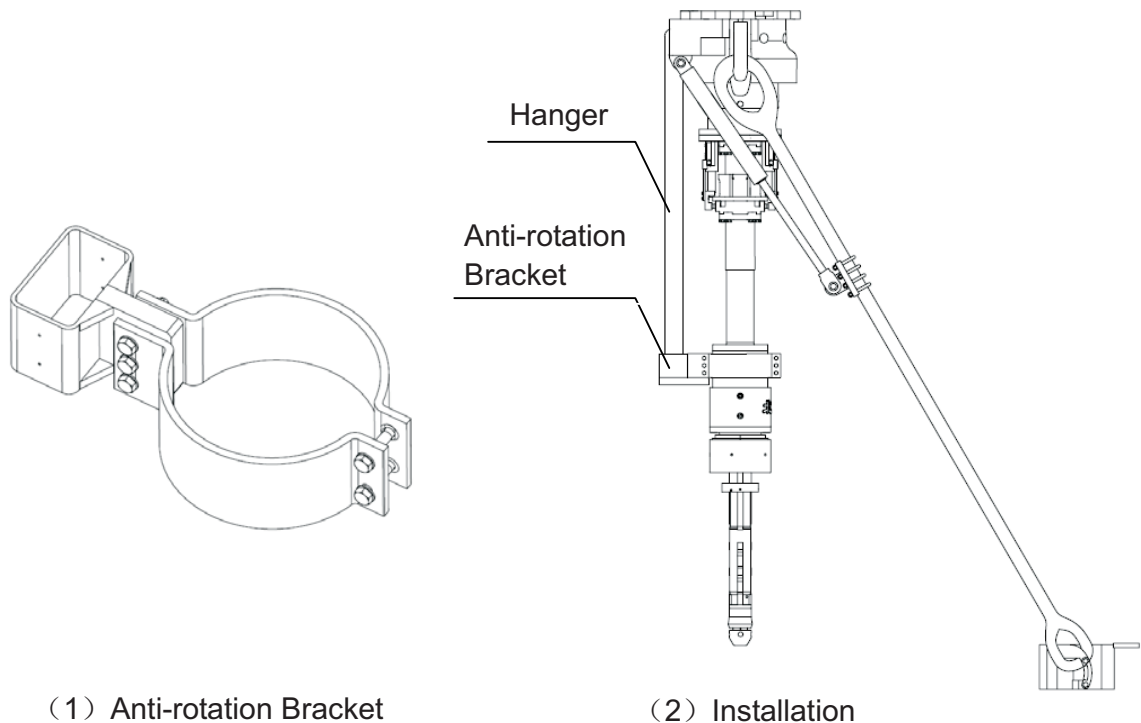


Fig.5 CRS Anti-rotation Bracket and Installation

- g) Connect hydraulic hoses between the power supply and CRS actuating cylinder through proper fittings.
- h) Adjust the CRS upper inlet pressure to 16MPa (2280 psi).
- i) Install the proper elevator links and casing elevator.

7.2 Testing

- 1) Inspect the installation and connections, and make sure they are correct before testing.
- 2) Perform functional test in accordance with the testing procedures of the top drive operation manual, making sure the top drive works properly.
- 3) Raise and lower the CRS along the top drive rail all the way and turn the rotating head for 360° to make sure the CRS and the hydraulic hoses do not have any interference anywhere.

- 4) Open the hydraulic supply, pressure up the upper and lower chamber of the actuating cylinder, and monitor whether the pressure is normal and the slips can perform disengaged and engaged function.
- 5) Rotate the main shaft of the top drive for a few minutes continuously, and see whether the CRS works properly.

8. Application and Operations

Well completion is a project that requires close coordination and cooperation to accomplish. From the wellbore quality to the drilling mud properties, from the well completion plans to operations, every single step is essential and there will be no guarantee for quality if any step is problematic. Casing running operation is the most significant step of all and it will determine the well completion quality.

As it is going to be the first time for some casing crews to run casing with top drive and casing running equipment, it will be totally different from the conventional casing running operation. So to ensure a successful casing job, please read the following materials thoroughly and follow the exact procedures listed here.

8.1 Preparation before Running Casing

Because of the process of the casing job and all the hazards that will be confronted with, it is important to be able to run the casing continuously. So it is essential to be fully prepared for the following aspects:

- 1) Casing preparation, such as making a record of the quantity, specification, size, and labeling the casing.
- 2) Surface equipment preparation, such as examining the derrick, crown block, top drive, braking system, transmission system, pneumatic system, hoisting system, circulation system, weight indicator, pump pressure indicator, blowout preventer equipment, electrical equipment and electric circuit, so as to make sure that the surface equipment works properly. Casing running equipment and the tools should be in place, and spare parts should be ready.
- 3) Elevator links preparation, normally 180" elevator links are configured for CRS. Please user or drilling contractor prepare the proper elevator links for this application.

- 4) Wellbore preparation, such as flushing the wellbore based on the design and drifting with drill bit.
- 5) Before casing running, drilling supervisor should organize a meeting for engineering personnel to communicate with the casing crews for technical details, also make sure the job is clearly assigned, and safety precaution, work standard and project schedule is clear.

8.2 Casing Running

(1) Casing Job Precautions:

- a) Take care of the connection thread on the casing, prevent damage or dirt which could lead to bad connection.
- b) Operate smoothly, control the speed when lowering, apply the assisted braking in time. Any abrupt raising, lowering and braking is prohibited.
- c) It is prohibited to throw casing protectors from the drill floor to the ground to avoid injuries. Casing protectors should be collected and sent to the ground with winch.
- d) Casing should be centralized before making the connection. Turn the casing slowly at the beginning, and if there is any sign that the casing cannot be made up, break out the connection, examine or rework the thread, and then stab the casing, make up the connection and lower the casing into the wellbore.
- e) During make-up, if the casing vibrates too much, the make-up speed should be slowed down. If the problem still exists, then it might be caused by disalignment of the axis of the thread and the casing, and this is an indication of quality issue, therefore the casing should not be run into the wellbore.
- f) When lowering the casing, avoid impact load which could lead to casing body, coupler shoulder and thread damage.
- g) When lowering the casing, perform the automatic mud fill-up timely, and if necessary, inject the drilling mud after each casing is run.
- h) When lowering the casing, minimize the inactive time, and move the casing up and down.
- i) When lowering the casing, if stuck casing or other complex situation happens,

take advantage of the top drive, for example, rotate the casing, raise or lower the casing, circulate the mud and etc. Avoid the situation getting worse, and ensure a smooth casing running job.

- j) There should be assigned personnel to watch and record the drilling mud return, record the changes of the suspending load, and if there is abnormal situation, take measures accordingly.

(2) Casing Running Procedure:

- a) Field personnel should roll the casing to the catwalk, tie the rope sling to the casing firmly 1.5m away from the female thread, have the thread protector on and have it hung from the air hoist, tie down the rope sling.
- b) Hoist operator should follow the instructions of the rope sling operator, start the air winch to tighten the rope sling, wait till the field personnel to step to the safety zone, bring the casing to the catwalk, stop the movement when the female thread portion get onto the rig floor for around 2m, the casing operator remove the casing thread protector and rope sling.
- c) Operate the elevator link to forward position so that the casing elevator is close to the coupler of the casing that will be lowered, then the elevator hold the casing under the assistance of a rig floor crew, and lock up the elevator.

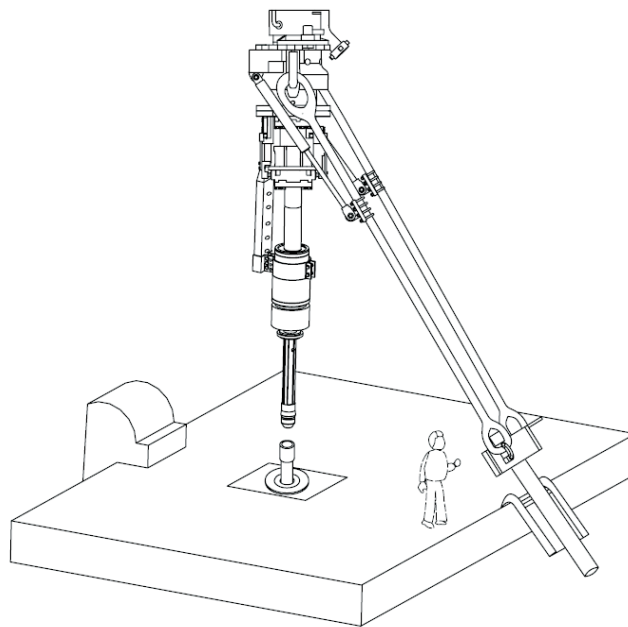


Fig.6 Have the Casing Held in Elevator

- d) Hoist the top drive and the casing, operate elevator link to backward position. When it returns to the center of the wellbore approximately, operate the elevator link to neutral position and tilt cylinders will be in unload mode.

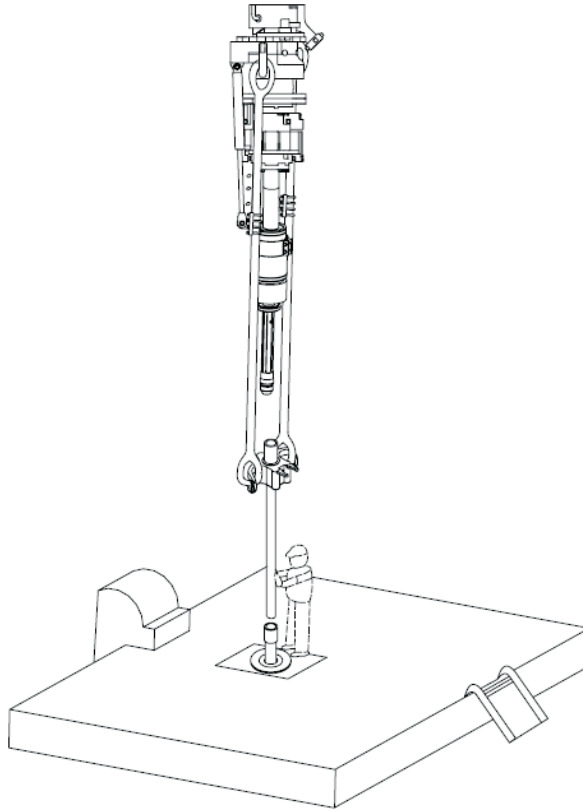



Fig.7 Hoist the Casing and Prepare for Connection Make-up

- e) Hoist the casing to return it to a center position. Remove the thread protector, apply casing grease and thread sealant evenly.
- f) Tighten up the casing guide shoes with the hydraulic tongs.
- g) Driller releases the brake, and the first casing will be set. Repeat the previous steps to hoist the second casing to a point where its male thread is 0.2m higher than the female thread of the previous casing segment.
- h) Rig crews remove the thread protector, and the driller releases the brake. Stab carefully to avoid cross threading. Avoid dust or dirt falling into the thread, and take care of the metal sealing area.
- i) After stabbing, operate the "Engage" button, start the CRS to actuate the slips to grip the casing, and then make up the connection to the specified torque with


the top drive.


- j) After the makeup operation, hoist the casing slowly for about 0.2~0.3m before braking, wait till the power slips of the rotary table releases, then apply the brake slowly, watch the weight indicator and lower the casing. When the elevator is about 2m above the rotary table, slow down and make the stop when the elevator is about 0.5m~1m above the rotary table. Apply the power slips to grip the casing. Repeat the previous steps to set all the casings into the wellbore.


 Warning: When lowering the casing into the wellbore, before the air slips grip the casing, do not disengage the casing elevator on the elevator links.

(3) Disassembly of the CRS

- a) After the completion of the casing job, disconnect all the piping connections, fasteners, accessories from the top drive.


 Note: Before disassembling the hydraulic hoses, prepare suitable containers, cotton cloth and oil plugs to avoid the hydraulic oil spill and contaminating the equipment and surrounding environment.

 Warning: Shut off the valves in the system and relieve the system pressure slowly before disassembling the hydraulic line. Make sure there is no trapped pressure in the system.

 Warning: The hydraulic oil might be hot after operation, so it takes some time for it to cool down to a level for access.

- b) Before disassembly, please mark the assembly positions for the connections for a correct re-assembly work.

- c) After disassembly, please inventory the parts and clean up for repair work or reuse.

 Note: After the disassembly, restore the top drive saver sub, retaining equipment, backup tong, hydraulic hoses and pressure relief valve to the original condition, making sure a safe application of the top drive next time.

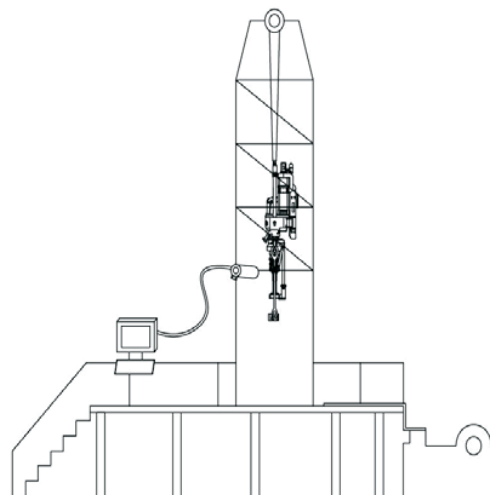
9. Intelligence Aided Equipment

In order to promote the CRS casing job automation and intelligentization, and to ensure job security and efficiency, devices like travel switch, and video monitoring system have

been integrated into the system design.

9.1 Video Monitoring System

In order to increase the visual monitoring ability in the casing running process, to decrease the labor intensity, to monitor the CRS insertion into and lower the casing, and to ensure the operation precision, the CRS is equipped with a Video Monitoring System: a color video camera that is infrared and explosion-proof is installed on the derrick, a monitor and a graphics controller are installed in the driller's console to achieve point to point video monitoring (refer to the figure on the right).



The installation height of the video camera should be about the same as the length of a casing stand above the drill floor. The video camera focus on the casing coupling that is hoisted, the casing hoisting, CRS lowering and inserting into the casing, slips engaging, casing rotation, casing string lowering, circulation are under monitoring. The zoom in ability of the video camera will surpass the eyes of a human for observing closely, so the working conditions of the slips and the abrasion of the cup packer can all be mastered in time.

10. Maintenance and Repair

A safe and reliable CRS determines whether the casing job will be successful or not and the benefit. So to ensure a properly working CRS during the casing job, there is relatively high requirements for the quality level of the routine maintenance and repair work.

i Notes: The CRS maintenance should be done in accordance with the requirements, it will increase the service life of the system and is very important for operation safety.

! Warning: The repair quality of the CRS is related to safety and reliability of this product, so the maintenance personnel must be trained and has valid certification for repair work from the equipment manufacturer, and written approval needs to be obtained for the repair work environment. It is strictly prohibited to disassemble the hydraulically actuating section for maintenance and replace the relevant parts for any company or individual without the authority and permission from the manufacturer. Otherwise, the maintenance personnel


should take full responsibility of the associated consequences. The normal replacement of the slips is not covered by this caution, but the repair personnel must be trained, qualified, and received the repair authority from the manufacturer.


10.1 Routine Inspection and Maintenance


1) Inspection Items:

- a) Check if the engage/disengage of the slips is normal.
- b) Check if there is any leakage of the hydraulic fluid.
- c) Check if there is any loose fasteners or damage of the fasteners.
- d) Check the abrasion condition of the seals.
- e) Check if there is abnormal condition of the surface-treated locations.
- f) Check the locations where grease is needed.

2) Maintenance Items:

- a) Remove the oil contamination and foreign matters timely, avoid plugging the pressure balance orifice on the actuating cylinder.
- b) Ensure the fasteners are tightened and locked. Replace the damaged parts in time.
-  **Warning:** Prevent the fasteners from loosening up and hurting someone.
- c) There are bearings inside the actuating cylinder and slip coupler, so pump lithium based grease through the grease nipple and gaps regularly.
- d) If there is excessive wear or flake, then it needs repair or replacement.
- e) Watch the pressure gauge closely each time setting the casing, if the pressure is not stable, then it should be disassembled and repaired. In principle, all the seals and backup rings need to be replaced for each disassembly and repair.

 **Warning:** Avoid the hydraulic fluid leaking, as it might cause injury and slipping of slips.

 **Note:** After each completion of the casing job by the CRS, inspect each component carefully; make sure the hydraulic cylinder is working properly and leak free, and the slips are in good condition. If necessary, disassemble and repair the equipment to ensure a safe operation.


10.2 Repair Preparation

- 1) Disassembly and assembly frame, and proper tools (including special tools, pipe

tongs, chain tongs, nylon slings, and etc.).

- 2) All the lubricants (calcium based grease, lithium based grease, L-HM32 anti-friction hydraulic oil).
- 3) Documents associated with the equipment (including the Operation Manual, Seals Checklist and etc.).
- 4) Spare parts (including seals, backup rings and etc.).

10.3 Disassembly

 **Caution:** During disassembly, it is prohibited to nip the sealing surface and the outer surface of the thin wall sleeve. There is Y680 bonding agent applied on the connecting thread between the shaft and slip mandrel (normally, it is not necessary to unthread the connection between the mandrel and slip mandrel), so before breakout, the thread portion should be heated to around 250°C to break the bond between the parts, then unthread the connection.


1) Mount the CRS mandrel on the bench clamp of the disassembly breakout machine, prepare a container for oil collection, use Allen key to remove two hexagon plugs, and drain the hydraulic oil out of the two chambers.


2) Remove two hex. socket set screws on the stabbing guide with allen key, and then remove the stabbing guide.

3) Remove three hex. socket set screws on the outer sleeve of the retainer ring with allen key, then remove the outer sleeve, the leaf spring, retainer ring, inner sleeve.

4) Remove three socket head cap screws on the outer sleeve of the slip coupler with allen key, and than remove the sleeve, and the split coupler.

5) Remove the bearing housing, thrust ball bearing, slips, thrust ball bearing, and spacer sequentially.


 **Caution:** The slips may drop out after the constraints have been removed, so take caution and do not get hurt.

 **Warning:** The hydraulic cylinder will be disassembled starting from now, and unauthorized personnel should not take on this job, otherwise the the relevant personnels should be responsible for the consequences that followed.


- 6) Remove the locking wire on the hex head bolt.

- 7) Remove the hex head bolts and lock washers that are between the upper, lower cylinder head and the actuating cylinder, and then remove the upper and lower cylinder head.
- 8) Use the hoisting strap to remove the actuating cylinder and the piston together horizontally. Make sure the alignment of the actuating cylinder and mandrel.
- 9) Tie the hoisting strap to the lower end of the piston, then take the cylinder and piston apart.
- 10) Remove the backup ring, lock nut, tapered bearing, spacer, and tapered roller bearing sequentially from the mandrel.
- 11) Use the spline sleeve tool to remove the slip mandrel from the top drive shaft.
- 12) Remove the o-rings, backup rings, wiper rings and wear band from each component.
- 13) Flush all the components with cleaning equipment. Inspect all the components visually for any severe wear or damage. Examine the mandrel, slip mandrel, actuating cylinder, piston, slips and other important components nondestructively, and determine whether they need replacements accordingly.
- 14) All the sealings need to be replaced after each disassembly and repair.

10.4 Assembly

 **Caution:** During assembly, it is prohibited to nip the sealing surface and the outer surface of the thin wall sleeve. It is also prohibited to use sharp tool for the assembly of seals. It is recommended to use soft rubber/plastic tools.

- 1) Remove the components that were rejected after examination, and replace with new parts. Prepare for a set of backup seals and greasing tools.

 **Note:** Please refer to the instructions in the package for installation location.

- 2) Actuating System Assembly
 - a) Mount the mandrel on the bench clamp of the disassembly and assembly frame, Use the spline sleeve to engage the slip mandrel and mandrel following the instructions of Table 2.
 - b) Heat the inner ring of the tapered roller bearing and install it onto the mandrel (pay attention to the direction), and then install the spacer, and by the same way,

install the other inner ring of the bearing, then install the outer rings of the bearings from each side.

- c) Thread the clamping nut onto the mandrel, and tighten the thread with the groove on the outside, make sure the bearing has been pressed tight, and then install the elastic lock washer. Apply lithium based grease around the bearing.
- d) Install the backup ring, o-ring and wear band at the right place, and apply calcium based grease at the groove.
- e) Install the wear band inside the piston, Turcon Roto-glyd ring and Turcon Double Delta Seal Ring, then apply calcium based grease at the groove.



Caution: Ensure each part is clean, and it is prohibited to heat the seals with hot water.

- f) Push the piston assembly slowly into the actuating cylinder, pay attention to the seals and wear band, make sure it is clean inside the cylinder, the orifices, and there are no foreign matters in the orifices and injection ports.

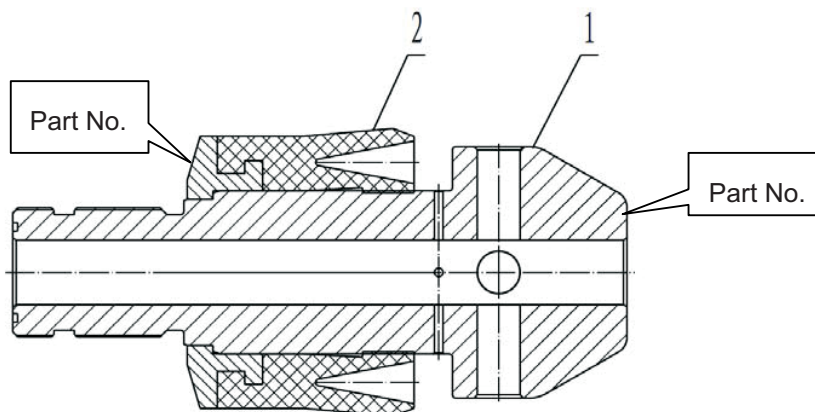
3) Slips Assembly

- a) Mount the mandrel on the bench clamp of the disassembly and assembly frame, hoist the actuating cylinder and piston assembly slowly and push the assembly from the right side of the slip mandrel till the face of the actuating cylinder inner bore aligns with the face of tapered roller bearing.
- b) Install the backup ring, o-ring, backup ring, o-ring, wear band, wiper ring at the corresponding locations, apply calcium based grease at the groove.
- c) Push the lower housing assembly onto the mandrel from the right side, pay attention to the seals, make sure to align the thread holes of the lower housing and the actuating cylinder.
- d) Slide the spring washer onto the hex head bolt, thread the bolts into the tapped holes in a diametrically staggered pattern following the instructions of Table 3.
- e) Fix the outer housing, and try to rotate the mandrel to make sure the mandrel can rotate smoothly and easily.
- f) Measure and remachine the upper housing to adjust the axial clearance of the bearing.
- g) Install the wiper ring in the upper housing, and push the upper housing

- assembly from the left side of the mandrel. Make sure to align the tapped holes of the upper housing and the actuating cylinder. Apply Loctite 510 at the interface between the upper housing and the actuating cylinder.
- h) Fit the spring washer onto the hex head bolt, thread the bolts into the tapped holes in a diametrically staggered pattern following the instructions of Table 2.
 - i) Install the direct injection grease nipple at the corresponding location, and make sure the orifice is clean and clear.
 - j) Measure and remachine the spacer to adjust the axial clearance of the thrust ball bearing.
 - k) Fix the mandrel, mount the assembly on the bench clamp of the disassembly and assembly frame, support in the middle if necessary. Install the spacer, thrust ball bearing from the right side of the slip mandrel (pay attention to the direction), and then install the slips sequentially into the spline grooves, and hold them together with iron wire. Install the other thrust ball bearing (pay attention to the direction, and apply enough lithium based grease), then install the bearing housing to hold the bearing and slips.
 - l) Adjust the spacing between the piston and the bearing housing, connect the piston and the coupler ring with the split type coupler. Slide the sleeve onto the coupler and fasten with hex. socket set screws following the instructions of Table 2.
 - m) Slide the inner sleeve of the retainer ring onto the slips from the right side, install the four-pieces retainer ring onto the slip mandrel, and install four leaf springs at the corresponding locations of the retainer ring, then push the inner sleeve to the right so it touches the retainer ring and make sure the leaf spring is compressed. Slide the outer sleeve on from the right side, tighten the hex. socket set screws between the inner sleeve and the outer sleeve in accordance with the requirements of Table 2.
- 4) Guideline for Slips, Cup Packer, Stabbing Guide and Seal Cap Selection, Assembly and Disassembly
- a) Based on the specification of the casing (O.D. and Wall Thickness) and refer to Appendix A, pick the right Slips, Cup Packer, Stabbing Guide and Seal Cap for

the application. The first step is to know the specification of the casing (O.D. and Wall Thickness), for example, if 7" casing with wall thickness of 11.51mm will be set, then refer to Appendix A, Slip 9556910146 is selected, then Cup Packer 5303940220(7B) is the one to pick, and the stabbing guide 9556901158 follows, and then Seal Cap 9556902158. Pick these parts in the right order.

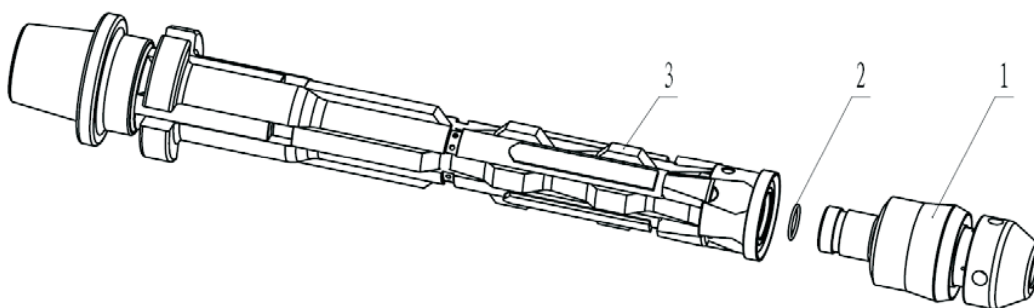
- b) Apply a thin layer of Calcium Based Grease on the Stabbing Guide. Figure 1 shows how the Stabbing Guide and Cup Packer fit together.



1. Stabbing Guide 2. Cup Packer

Fig 8. Cup Packer and Stabbing Guide

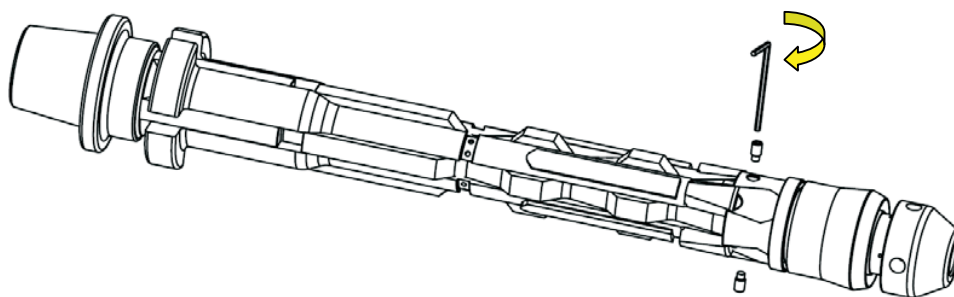
- c) Refer to Figure 2, install the Seal Cap at the right end of the Slip Mandrel. Install the O-ring at the left end of the Stabbing Guide, have the Stabbing Guide threaded to the Slip Mandrel. The Seal Cap now abuts against the Cup Packer.



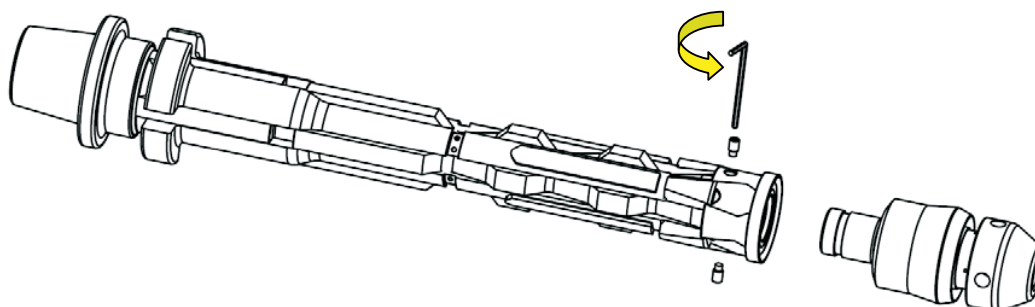
1. Cup Packer Assembly 2. O-ring 3. Slip Mandrel

Fig 9. Illustration for Assembly of the Stabbing Guide and Cup Packer

- d) Have the Set Screws threaded to the Slip Mandrel. The dog point sets into the groove in the Stabbing Guide for anti-loosening.



e) For disassembly, reverse the procedures above.



5) Assembly Completion

- Plug the tapped holes on the actuating cylinder with blanking plugs, tighten the plugs manually.
- Keep the hex head bolts from getting loose by using the iron wire to hold the bolts circumferentially.
- Inject bearing grease for the tapered roller bearing with grease gun till the chamber is full. The assembly is complete now.

i Notes: All the thread connections are to be tightened with grease and to the specified torque values according to Table 2.

Table 2 CRS Thread Connection Torque (kN·m) and Grease

Model	XTG140		XTG168		XTG244	
	Torque	Additive	Torque	Additive	Torque	Additive
Mandrel Thread	62	Loctite 680	62	Loctite 680	62	Loctite 680
Bolt Thread	0.33	Loctite 243	0.33	Loctite 243	0.33	Loctite 243
Screw Thread	Manually Tighten	MoS ₂ Grease	Manually Tighten	MoS ₂ Grease	Manually Tighten	Loctite 243
Other Thread	Manually Tighten	MoS ₂ Grease	Manually Tighten	MoS ₂ Grease	Manually Tighten	MoS ₂ Grease

11. Troubleshooting

Problems that might be encountered during the operation and the solutions:

Issue 1: The slips cannot engage the casing to transfer torque or hoist load

Solution:

- a) Check the hydraulic power supply to see if there is enough pressure (12 MPa ~16 MPa), the slips will not be able to engage the casing if there is not enough pressure. Please increase the hydraulic supply pressure.
- b) If the hydraulic supply pressure has reached the maximum working pressure (16MPa), then it might be caused by stucked components which transfer the power, or leaked seal, or severe wear of the slip teeth.

Issue 2: Mud circulation or casing pressure test cannot be performed normally:

Solutions:

- a) Compare the cup packer in application with the one specified Table 2 and see if the cup packer fits the application. If it does not fit, please replace the packer.
- b) If the cup packer fits the casing, then it might be caused by severe wear. Please replace the cup packer in time.

12. Spare Parts and Corollary Tools

Generally, after the operation of the CRS, all the seals should be replaced during each repair. Check the mandrel, cylinder, actuating cylinder, slip mandrel and the slips and other parts that are under loads, and parts under abrasion, and replace the damaged parts. Please refer to the spare parts list and special tools list (See Appendix B).

13. Corollary Equipment

To ensure a smooth and safe operation of the CRS, it is equipped with the following corollary equipments:

Table 3 CRS Corollary Equipment List

No.	Item	Order No.	Qty.	Notes
1	Casing Centralizer	9559500300	1	
2	Video Monitoring System	9556900510	1	to assist the driller for stabbing

3	Anti-rotation Bracket	9559500100	1	
4	Lifting Sub	9557001826	1	for lifting
5	Cup Packer	9556904000	one set	
6	Stabbing Guide	9556901000	one set	
7	Slips	9556911000	one set	
8	Seal Cap	9556902000	one set	

14. Order Notice

The reliability, service life and performance of the CRS are not only based on the manufacturing quality, but also on the right operation and repair. To make sure the products and components you need can be delivered to you correctly and timely, please pay attention to the following aspects:

1) Please write down the product model clearly, so if the model that the customer has ordered is revised, then the newest model will be provided and there will be no additional notice.

2) If there are special requirements for the products, please specify the details while ordering. If there is no instruction, the standard products will be provided.

3) If the components are ordered, then please specify part name, order number and quantity.

Appendix A: Slips, Cup Packer, Stabbing Guide and Seal Cap Selecting Guide

Pentacle Oilfield Supply Inc.
Model XTG1681

780-902-3485
www.pentacleoilfield.com

Casing Specification					Selecting CRS Components			
Size	O.D.	Wall Thick	I.D.	Drift Dia.	Slips	Cup Packer	Stabbing Guide	Seal Cap
6-5/8	168.28	7.32	153.64	150.46	9556910146	5303940220 (7B)	9556901158	9556902158
6-5/8	168.28	8.94	150.40	147.22				
7	177.80	5.87	166.06	162.88	9556910158	5303940210 (7A)	9556901158	9556902158
7	177.80	6.91	163.98	160.80				
7	177.80	8.05	161.70	158.52				
7	177.80	9.19	159.42	156.24				
7	177.80	10.36	157.08	153.90	9556910146	5303940220 (7B)	9556901158	9556902158
7	177.80	11.51	154.78	151.60				
7	177.80	12.65	152.50	149.32				
7	177.80	13.72	150.36	147.18				
7-5/8	193.68	7.62	178.44	175.26	9556910178	5303940430 (75A)	9556901178	9556902178
7-5/8	193.68	8.33	177.02	173.84				
7-5/8	193.68	9.52	174.64	171.46	9556910158	5303940440 (75B)	9556901158	9556902158
7-5/8	193.68	10.92	171.84	168.66				
7-5/8	193.68	12.7	168.28	165.10		5303940210 (7A)		
7-5/8	193.68	14.27	165.14	161.96				
7-5/8	193.68	15.11	163.46	160.28	9556910146	5303940450 (75C)	9556901158	9556902158
7-5/8	193.68	15.88	161.92	158.74				
7-5/8	193.68	17.45	158.78	155.60				
7-5/8	193.68	19.05	155.58	152.40				

Appendix A: Slips, Cup Packer, Stabbing Guide and Seal Cap Selecting Guide

Pentacle Oilfield Supply Inc.
Model XTG168I

780-902-3485
www.pentacleoilfield.com

Casing Specification					Selecting CRS Components			
Size	O.D.	Wall Thick	I.D.	Drift Dia.	Slips	Cup Packer	Stabbing Guide	Seal Cap
7-3/4	196.85	15.11	166.63	163.45	9556910158	5303940440 (75B)	9556901178	9556902178
8-5/8	219.08	6.71	205.66	202.48	9556910198	5303940400 (9D)	9556901198	9556902198
8-5/8	219.08	7.72	203.64	200.46				
8-5/8	219.08	8.94	201.20	198.02	9556910188	5303940410 (8A)	9556901188	9556902188
8-5/8	219.08	10.16	198.76	195.58				
8-5/8	219.08	11.43	196.22	193.04				
8-5/8	219.08	12.70	193.68	190.50				
8-5/8	219.08	14.15	190.78	187.60	9556910215	5303940420 (8B)	9556901215	9556902215
9-5/8	244.48	7.92	228.64	224.66				
9-5/8	244.48	8.94	226.60	222.63				
9-5/8	244.48	10.03	224.42	220.45				
9-5/8	244.48	11.05	222.38	218.41	9556910198	5303940250 (9B)	9556901198	9556902198
9-5/8	244.48	11.99	220.50	216.54				
9-5/8	244.48	13.84	216.80	212.83	9556910198	5303940390 (9C)	9556901198	9556902198
9-5/8	244.48	15.11	214.26	210.29				
9-5/8	244.48	15.47	213.54	209.58				
9-5/8	244.48	17.07	210.34	206.38				
9-5/8	244.48	18.64	207.20	203.23				
9-5/8	244.48	20.24	204.00	200.02				

Appendix B: Spare Parts and Corollary Tools

1. XTG168 Spare Parts List

No.	Part Name	Model	Part No.	Qty.	Notes
1.1	7" Casing Cup Packer	7A	5303940210	1	covering 6-5/8" casing
		7B	5303940220	1	
1.2	7-5/8" Casing Cup Packer	75A	5303940430	1	covering 7-3/4" casing
		75B	5303940440	1	
		75C	5303940450	1	
1.3	8-5/8" Casing Cup Packer	8A	5303940410	1	
		8B	5303940420	1	
1.4	9-5/8" Casing Cup Packer	9A	5303940240	1	
		9B	5303940250	1	
		9C	5303940390	1	
		9D	5303940400	1	
1.5	Slip		9556910146	1	
1.6	Slip		9556910158	1	
1.7	Slip		9556910178	1	
1.8	Slip		9556910188	1	
1.9	Slip		9556910198	1	
1.10	Slip		9556910215	1	
1.11	Thrust Ball Bearing		9557001200	2	
1.12	Hex. Socket Cap Screw		4202300010	8	
1.13	Hex. Socket Set Screw		4201030840	2	
1.14	Hydraulic Hoses		9556900008	6	1m
1.15	Seals Pack		9556900900	1	one set

2. Corollary Tools

No.	Part Name	Model	Part No.	Qty.	Notes
2.1	Corollary Tools		9556900913	1	