# MAGNETIC ORIENTATING TOOL (DC-MOT)
## STANDARD SERVICE PROCEDURE

SSP

## Document Control

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Owner : CHS Dimension Bid (M) Sdn. Bhd.
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Reviewer : Abdul Rahman Kamal
Approver : Mohd Zahir Manan

## Private

## Revision History

| Revision | Date | Description | By |
|---|---|---|---|
| 0.0 | 8-Oct-2018 | First Document Creation | Azrul Rezuan |
| | 6-Dec-2018 | Converted to SSP Template | Kamel Nor |
| | 28-Feb-2019 | Establishment of SSP | Azrul Rezuan |

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# DESIGN

## 1.1 Introduction to Tool

The D.C. M.O.T. (Magnetic Orienting Tool) is used when it is necessary to orient perforations in a direction relative to an adjacent tubular(s). The DC MOT is physically attached to the top of a zero-phase perforating gun and aligned with the known position of the DC MOT.

## 1.2 Tool Specifications

**Hunting Titan Part Number: 8037-17551EC075-12-06**
*1 3/4" DC-MOT (Perforating)*

| | |
|---|---|
| **Mechanical-** | |
| • Tool Diameter | *1 3/4" (4.44 cm)* |
| • Tool Length from top of CCL to bottom of Shock Sub | *125.81" (319.55 cm)* |
| • Weight (MOT only) | *27 lbs. (12.25 kg)* |
| • CCL Length | *15.90" (39.62 cm)* |
| • Bow Spring Anchor Length | *26.54" (67.41 cm)* |
| • M.O.T. Length | *71.74" (182.21 cm)* |
| • Shock Sub Length | *11.63" (29.54 cm)* |
| **Environmental -** | |
| • Temperature Rating | *350° F (176.66 C) for 10 Hrs* |
| • Pressure Rating | *18,000 PSI (124 MPa)* |
| ***Operating Voltage & Current @ Cable Head -** | |
| • Recommended Logging Speed (CCL) | *50 Ft. (15.2 M)/ Min* |
| • Electronics | *105 VDC @ 25 mA* |
| • Electronics & Exciter | *120 VDC @ 50 mA* |
| • Electronics, Exciter & Motor | *140 VDC @ 110 mA* |
| **Measure Point -** | |
| • Bottom of Shock Sub to CCL Center | *117.8" (299.21 cm)* |

## 1.3 Review Client Requirement

1. Meet with client and finalize the program. Confirm on the perforation interval.
2. Gather the following information:
    a. $H_2S$ & $CO_2$ content
    b. BHT & BHP
    c. WHP and MEWHP
    d. Tubing Tally
    e. Well Survey: Depth, Deviation, Maximum Dog Leg(s)
    f. Casing/ tubing depth, minimum restriction, Casing size, Weight

## 1.4 Confirm requirements can be met

1. Confirm the operation is within tool specifications.
2. Inform the client on the limitation of the tools, equipment, well condition and etc.

## 1.5 Determine Service Configurations

1. Ensure availability of the standard tool configurations.
2. Consider the following requirements when combining the DC-MOT with other CCL. Specific CCL for DC-MOT need to be used.
3. Select downhole auxiliary equipment.
    a. Adaptors to be used to connect to toolstring.
    b. Centralizer to be used to centralize the tool in the borehole.
    c. Shock Sub to be used to connect to toolstring.
    d. Eline/Ballistic Conveyance Rollers for higher deviations.

## 1.6 Generic Main Tool Planning

1. Please discuss with FSM and HO PEXS on the availability of the equipment.

# PREPARE

## 2.1 Collect Downhole Equipment

1. Collect the components of the DC-MOT:
    a. CCL
    b. DC-MOT
    c. Shock Absorber
    d. Centralizers
    e. Eline/ Ballistic Conveyance Rollers if applicable

## 2.2 Prepare tools

### Prepare DC-MOT

1. Perform visual check outside housing for any damage.
2. Ensure FIT was done as per FIT checklist.
3. Verify that the tools are thoroughly cleaned.
4. Verify there is no oil leaking from the tool, no bending or visible damage, dents or scratches on the surface of the tools.
5. Remove the thread protectors and verify if the threads are clean and lubricated. Check that all Shop and Field Joints are tight and lock rings are secured.
6. Check the condition of pin on the upper heads.
7. Check the lower head for bent or pushed-in pins.
8. Clean the head pins of any dirt, oil, grease or debris.

## 2.3 Prepare downhole accessories

### Prepare Centralizers

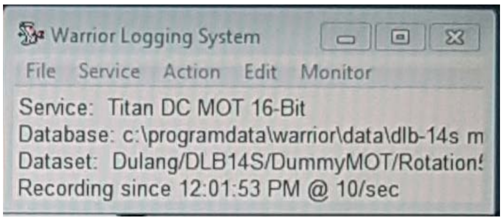
1. Perform visual check outside housing for any damage.
2. Make sure the blades of centralizers are in good shape. Look for excessive wear on arms.
3. Ensure FIT was done as per FIT checklist.

### Prepare Shock Absorber

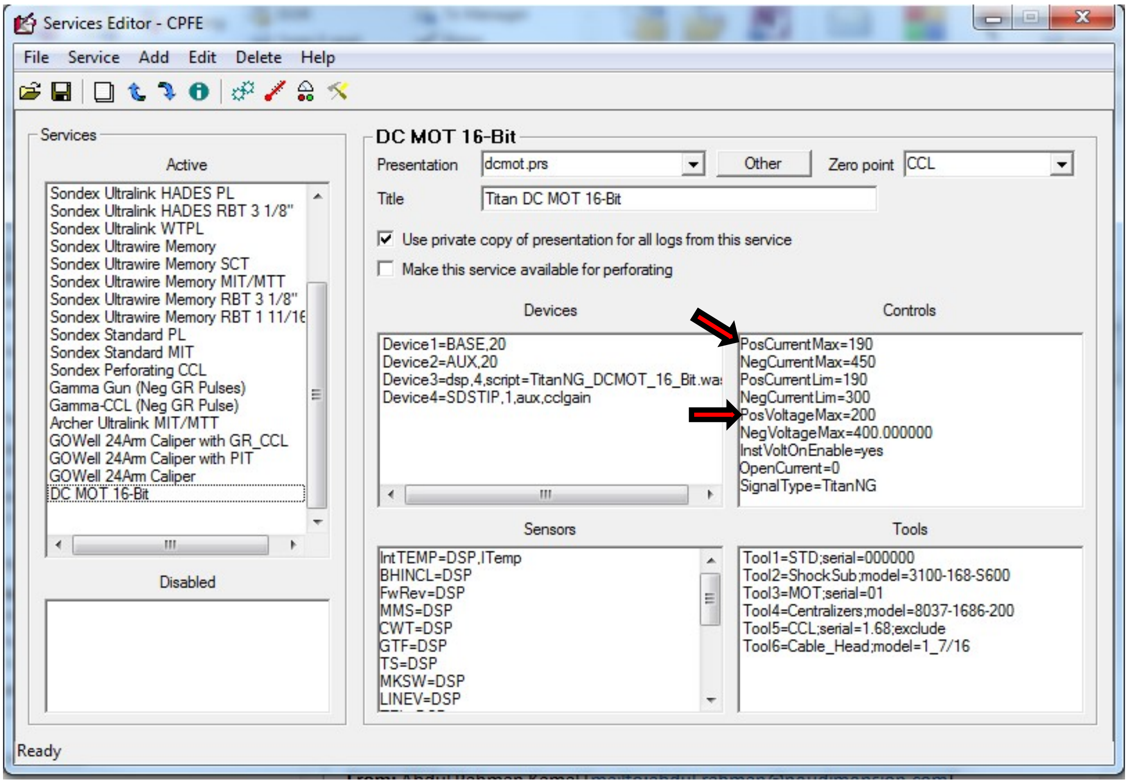
1. Perform visual check outside housing for any damage.
2. Make sure the shock absorber is in good shape. Look for excessive wear on arms.
3. Ensure FIT was done as per FIT checklist.

## 2.4 Prepare acquisition software (Warrior 8)

1. Ensure you have the requirement below for software system:
    a. Warrior 8, 32-bit (Warrior 8 64-bit has been found to have problems with tool communication. Windows 64-bit systems are also advised to use 32-bit Warrior 8)
    b. Service File: DC MOT 16-BIT

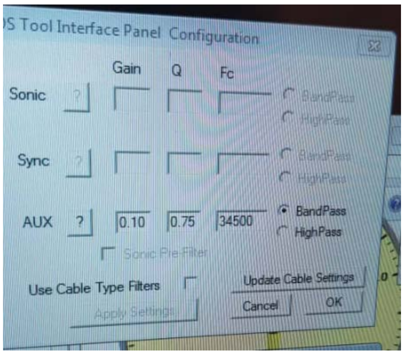


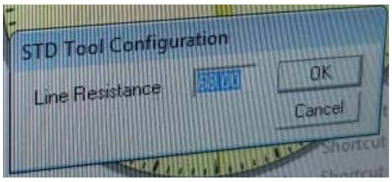

2. Below are the service settings if opened in services editor. Note that cutoff for positive voltage and current was increased from 150V (150mA) to 200V (190mA) due to the extra load from MOT-CCL when powering up.



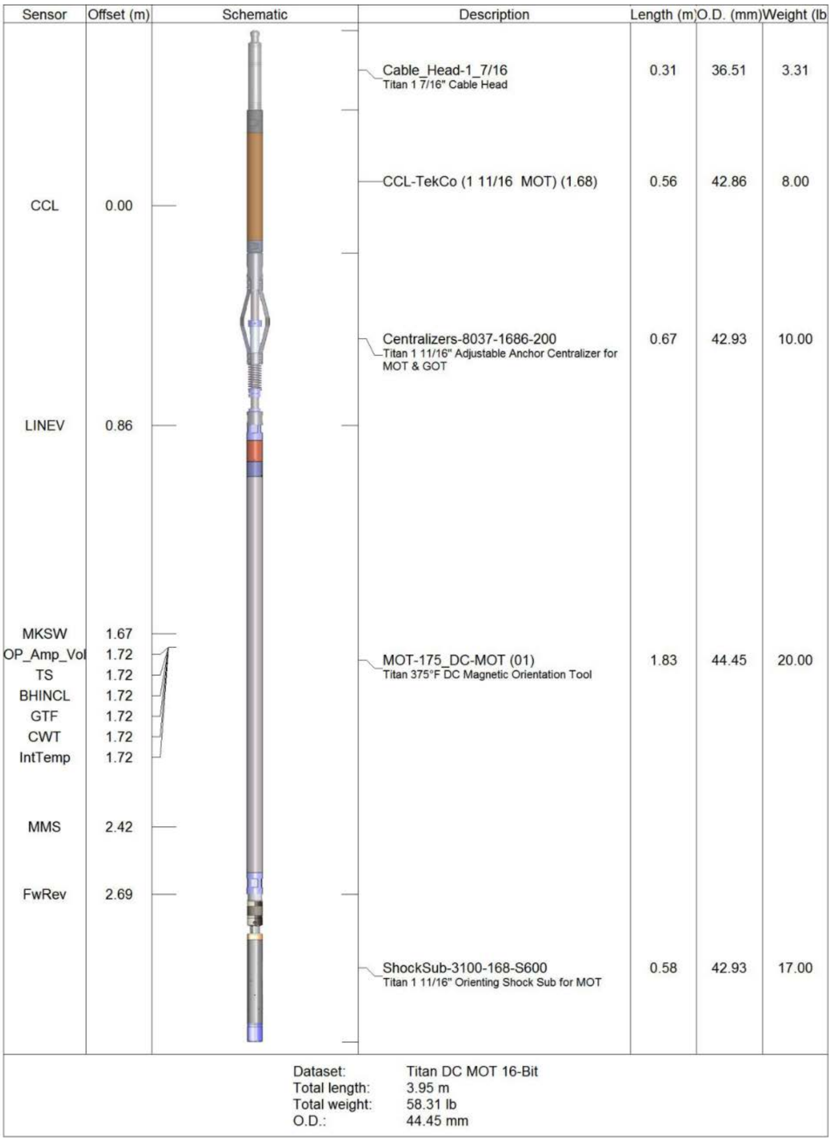

3. **SDSTIP Settings.**

   Open SDS Tool Interface Panel Configuration. Best settings will depend on line resistance. Below are the settings used for 70 ohm cable:



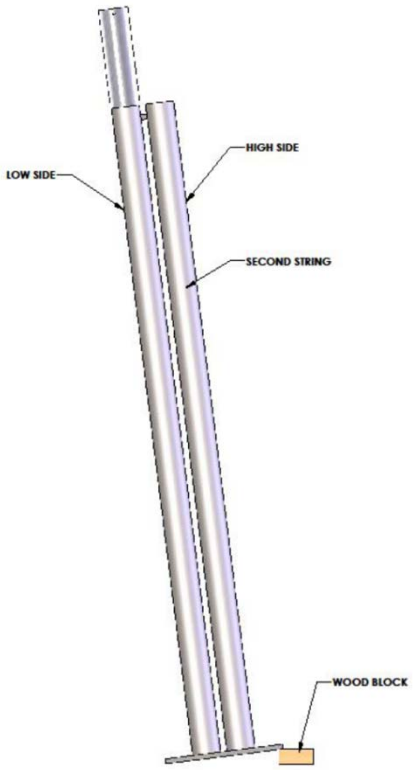

4. Below is an example of the toolstring declared in Warrior 8.
    a. Zero the tool at CCL (CCL to MMS sensor is 2.42m).



## 2.5 Perform Operational Check

### MOT Jig Setup

1. Connect the tools as per toolstring declared in Warrior.
2. Assemble DC-MOT in test jig vertically making sure that the tool is centered in the test fixture and with wireline (cable head) attach to the top of the DC-MOT.
3. Use a paint marker to make a mark just below the top adapter sub, lining up with the MOT alignment notch at bottom. This will make it easier to check the notch facing without pulling the tool completely out of the jig.
4. Make another mark on the tool above MOT (CH/Centralizer) facing the adjacent tubing for comparison with notch after pulling the tool completely out of the jig.
5. MOT jig setup as in picture below. Make sure the top adapter sub is centered on the tool to avoid tool drag which will affect MOT log.
6. The jig should be slightly lifted on one side of tubing to allow for verification of GTF (Gravity Tool Face).
7. Surface check can be done vertically at lubricator before connecting full toolstring for actual run.




*For in-house setups, make sure to use DLC (Dummy Logging Cable).*

### Powering Up DC-MOT

1. Enable power in Warrior and roll power up to 105V to allow the electronics to come on. There are 3 stages to power up the MOT.
   i. 100V – 110V @ ~25mA, ~100V (LineV) Electronics on, Exciter and Motor off
   ii. 120V – 130V @ ~120mA, ~119V (LineV) Electronics and Exciter on, Motor off.
   iii. 140V – 150V @ ~140 -150 mA, ~140V (LineV) Electronics, Exciter and Motor on.

*STIP is voltage supplied by STIP, displayed on STIP Panel, LineV is voltage reaching top of MOT. Current varies with resistance. These are typical readings using 70 ohm cable, with MOT CCL in toolstring.*

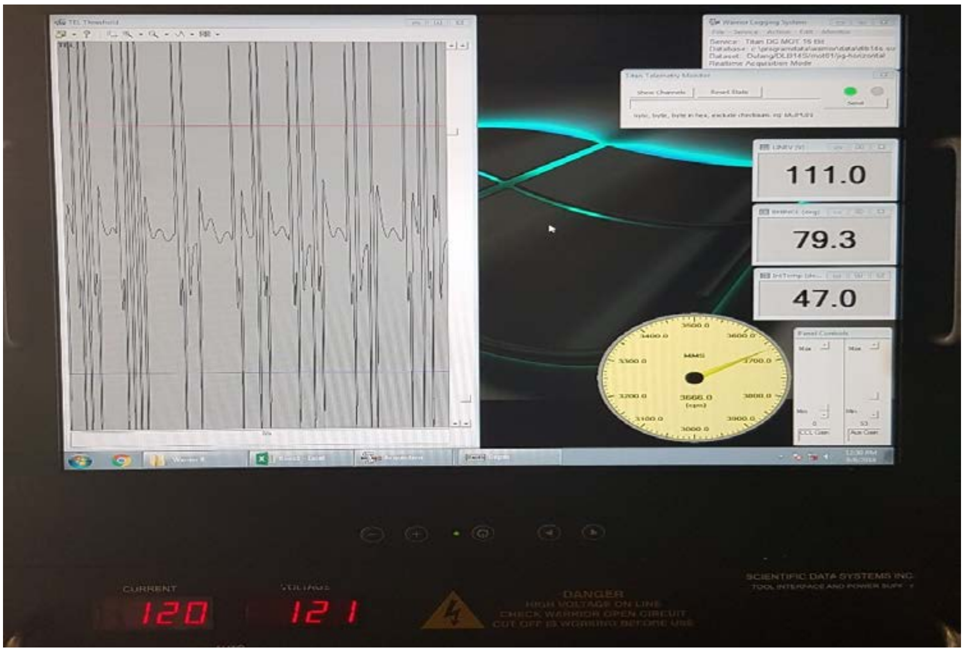
*Head voltage and current will be lower without MOT CCL in toolstring;*

*105V (~25mA), ~100V (LineV) Electronics*

*120V (50mA), ~115V (LineV) Exciter*

*140V (110mA), ~135V (LineV) Motor*

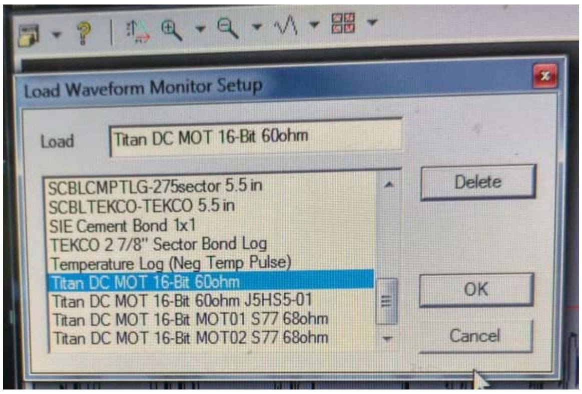
2. From 0V, increase the STIP voltage to 105V to turn on electronics, then slowly to 120V. Once the exciter starts current will jump and the voltage will drop, increase the voltage back until stable again at approximately 120V (120 mA).




### Establish Telemetry

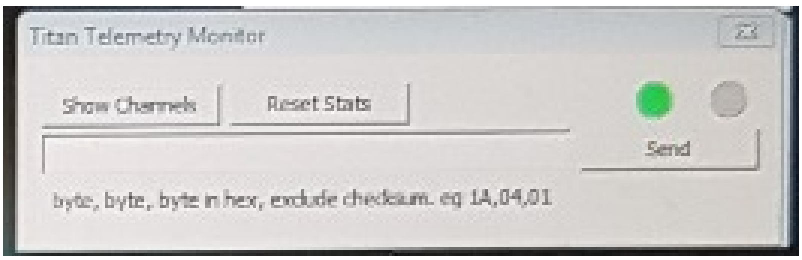
1. Adjust the Aux gain on the slider bar so that the digital data seen in the telemetry window (PMON/TEL Threshold) fills the window top to bottom. Aux Gain of 53 was used in this example.


2. Load saved settings if available by clicking top left arrow on TEL Threshold window.




3. Green light should appear in Titan Telemetry Monitor if settings are correct. If not, the threshold settings need to be found manually as below:
    a. Adjust the positive threshold (Red line) while so that it close to the top of the telemetry window. (One click from top)
    b. Adjust the negative threshold (Blue line) so that it is close to the bottom of the telemetry window. (One click from bottom).
    c. Adjust the positive threshold (Red line) downwards until Green Light comes on.
    d. Adjust the negative threshold (Blue line) upwards until Green Light is on and Red Light is off

*This procedure needs to be done one "click" at a time, with 1 sec between each click, as the refresh rate of the telemetry window is slow, and the response after adjustment can be delayed.*

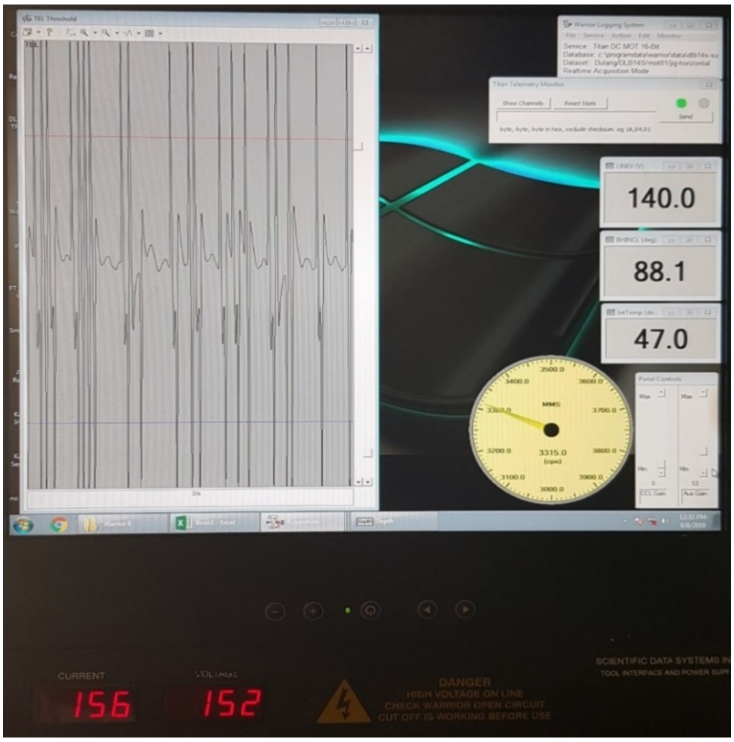


### Check Communication

1. Open the “monitor outputs” window and check to see if the tool is communicating correctly.
2. Make sure every reading read the correct value as testing vertically inside the test fixture. Check the LineV, deviation, and gravity tool face to make sure they read as expected:
    a. Angular Metal Mass (MMS) will read a number but will not change since the motor is not on.
    b. Markers (MKSW) will either read 0 or 1000, but should not change since the motor is not on.
    c. Deviation (BHINCL) should read within +- 2 deg of the actual deviation if the test stand is tilted.
    d. Gravity Tool Face (GTF) should read the degrees that the tool is facing in relation to the high side of the pipe. This will be at 0 Degrees if the notch in the tool is facing the high side of the pipe.

### Start the Motor

1. Increase the voltage slowly to 150V. Once the motor starts the current will jump and voltage will drop, increase the voltage back slowly until LineV is 140V (STIP 152V, 156 mA in this example).



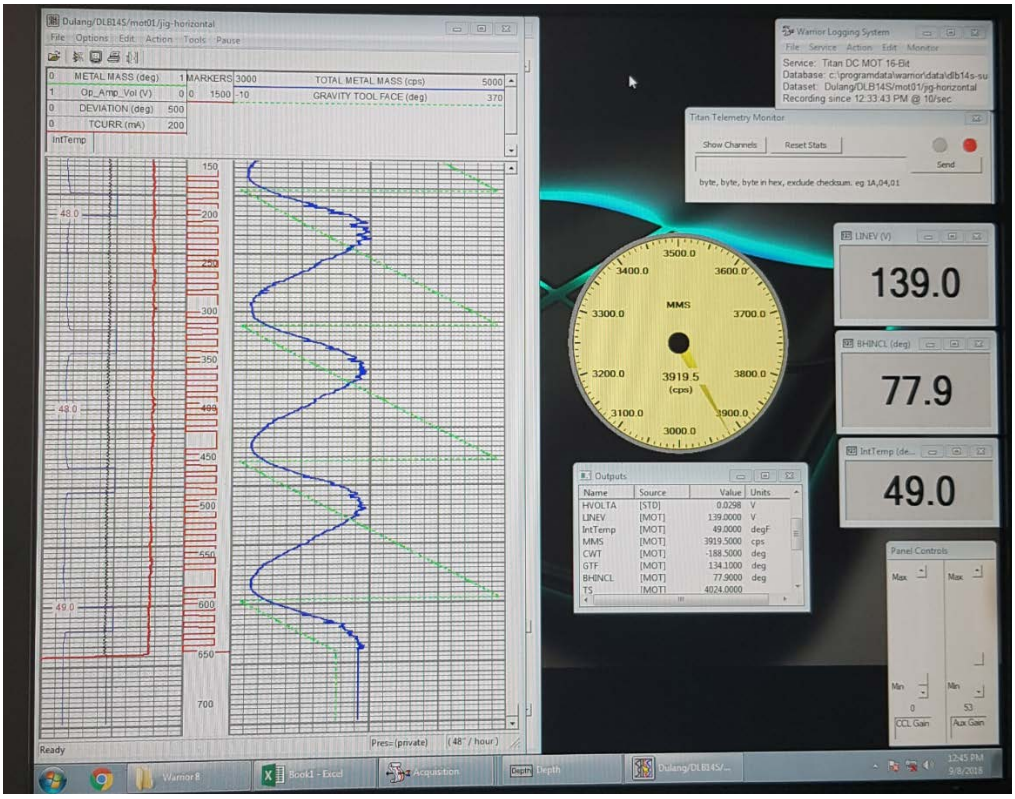

2. Start a “Record on Time” pass, change the vertical scale to 75 seconds per inch and record three full rotations.

*Each rotation should take about 2 minutes and 45 seconds.*

3. The MMS curve should change and the markers should come on and off as the tool rotates. The markers should have 11 marks and then a gap that will occur at the same spot in relation to the MMS curve.

4. This indicates the MOT is turning without any sticking. The Gravity Tool Face curve should also cross the 0 deg line at low peak if adjacent tubing at low side, and at high peak if adjacent tubing at high side.

5. Monitor pattern for high peak. Stop the tool on the high peak by powering down the tool and the motor will stop. Stop the log pass.




6. Check the relation of the mark to the second string. The tool will typically be just past center if the tool is stopped at the high count, due to the lag time in the computer.

7. Lay the test fixture over. Verify the notch by pulling MOT out of jig. While removing DC-MOT, do not allow tool to rotate from the last stop position it was stop.

8. Just before the lower end of the DC-MOT is removed from the test fixture, watch for the position of the alignment notch. It should be facing the adjacent tubing. If not, do not use that tool.

### Perform Hot Check

1. Once it is verified that the alignment notch stopped at the correct position, the firing circuit needs to be checked.

2. Power up tool with multimeter checking voltage between tool lower electrical contact and body.

3. Check for DC and AC voltage. No voltage should be present. Replace MOT if there is any voltage and tag for repair.

4. Power down tool and set safety and shooting panels to fire on negative.

5. Apply negative voltages of -100VDC, -200VDC, -250VDC from the shooting panel while checking with multimeter at tool lower electrical contact.

6. Repeat MOT and CCL opchecks after performing Hot Check.

### Sensors in DC-MOT

1. Angular Metal Mass (MMS). The metal mass count detected by MOT.
    a. With no casing outside the tubing (as in MOT jig): When the tool is stopped on the High Peak, the notch will be facing the adjacent tubing.
    b. With casing outside the tubing: When the tool is stopped on the High Peak, the notch will be facing the casing (away from adjacent tubing).

2. Borehole Inclination (BHINCL) identifies the deviation of the string and can produce a deviation survey of the well. Deviation (BHINCL) should read within +- 2 deg of the actual deviation. Note that the deviation is not accurate at 0 degrees or above 35 degrees according to the specs on the accelerometer.

3. Gravity Tool Face (GTF) identifies the high side of the hole (deviated well) to help give a relationship between MOT and the second string.
    a. If the adjacent tubing is on the high side of the tool, GTF curve will be right at 0 degrees when the notch is facing the second string (High Peak).
    b. If the adjacent tubing is on the low side of the tool, GTF curve will be at 0 degrees when the notch is 180 degrees from the adjacent tubing (Low Peak).

4. Markers (MKSW) are used to help ensure that the tool is rotating while in the hole and should have 11 marks and then a gap that will occur. MKSW reads 0 when no marker and 1000 as the markers are seen

5. The CWT curve can be used for a collar locator as well as to help identify additional jewelry on the backside of the casing or tubing.

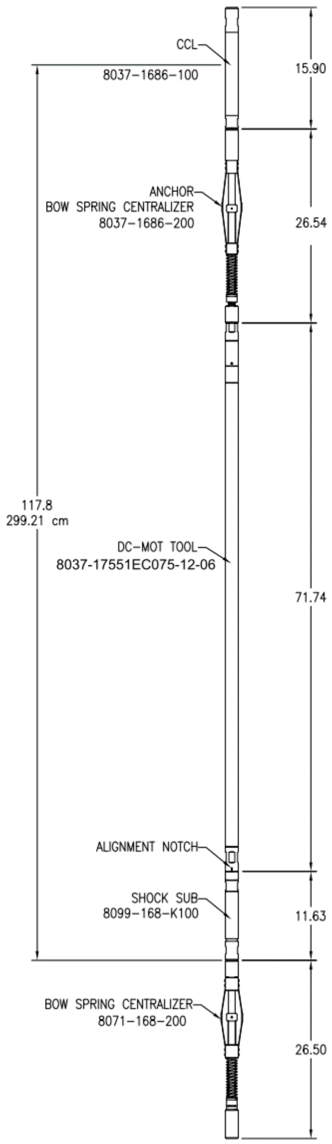
## 2.6 Service Specific Logistics

1. CCL needs to be transported separately to avoid any damage due to electromagnetic contact.

# EXECUTE

## 3.1 Perform wellsite preparation

1. Confirm well and hole properties with Wireline Supervisor.
2. Check continuity and isolation for cable, collector, and head.
3. Confirm all tool measurements as shown on right.
4. Prepare the tools and equipment as per FIT checklist.




For actual gun, ensure to follow all procedures as per
**DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD**

## 3.2 Service Specific Rig Up

1. Prepare the tools and equipment as per FIT checklist.
2. Make up the MOT consisting of CCL, Shock Absorber, Centralizer and Gun.
3. Ensure that Anchor centralizer is 10-20% larger than tubing ID. Measure with caliper.
4. To align the gun, it is easier to first tighten the gun securely to the Shock Sub using C-Plate at BOP. Once tightened, lift the toolstring back onto main deck.
5. Use the locking nut on the pin end of the Shock Sub to align the charges to the MOT alignment notch.

## 3.3 Rig floor operational check

1. Confirm all tool measurements as shown on right.
2. Perform the rig floor operational check as per steps mentioned in section 2.5.
3. Perform quick telemetry check. Simulate CCL signal and perform several collar checks.

*MOT CCL is passive CCL. Hence, if sending power to MOT while RIH/POOH, the CCL reading will be invalid.*

4. Perform hot check by sending 250 VDC from the unit. Measure the value sent using the multimeter. Record the voltage value measured.

## 3.4 Perform Logging Operation

### DUMMY MOT

1. Dummy MOT is recommended to gather data before actual run.
2. Run-in-hole (RIH) with Dummy tool string until HUD is encountered. Unless recommended, RIH speed to be 10m/min while passing through restrictions or well accessories and 30m/min while passing through tubing.

*To give confidence on MOT performance at target depth, it is recommended to perform MOT function test at least once after passing safe depth (before angle kick-off depth).*

3. Perform correlation pass as per DB E-line procedure. A pup joint or completion accessories can be a distinctive marker. Perform 2 correlation passes:
    a. 1st using CCL as per standard procedure.
    b. 2nd using CWT to help identify additional jewelry on the backside of the casing or tubing which may interfere with MMS reading.

    **STEPS:** Power tool up to 119V according to LineV in order to turn on the electronics and exciter (but not motor). Perform log up pass covering all CCL stop depths. Take note of potential signal interference areas.

4. Adjust depth in the Smart Monitor and RIH to the bottom depth.
5. Log up to the agreed depth and this time the depth should be matching with the reference log.
6. POOH slowly to the 1st CCL stop depth.
7. Rotate the MOT and cross check the log with the surface simulation log.
8. Perform minimum 3 full cycle and verify the signal/pattern is good.
9. Repeat MOT rotation log at top perf interval.
10. POOH once all data confirmed to be good.

*It is advisable to perform rotation log at all target CCL stop depths. Additional stops just above or below the target depths may also give helpful data.*

### ACTUAL MOT PERFORATION

- Connect MOT to the sinker bar and function test for telemetry.
- Perform the rig floor operational check as per steps mentioned in section 2.5.
- Hook up digital multi-meter and perform Hot Check Test by sending 250VDC voltage and minimum 1.5A of current for not more than 10 seconds.
- Simulate CCL signal and perform several collar checks.
- Zero the gun string at center of CCL on main deck.

## ⚠ Before Arming Gun

- Ensure to take all safety precautions as per **DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD**
- Place safety and perforation panel keys in "safe" position and remove keys.
- Shut off AC generator. Do not restart until gun is 350 ft (107 meters) below sea floor.
- Turn off all power switches and leave "off" until gun is 350 ft (107 meters) below sea floor.
- Put perforating warning signs out along all access roads.
- Clear line of fire for all personnel and clear area of all unnecessary personnel.
- Check voltage between the rig, casing, and cable armor using a multimeter. Eliminate it at its source, if present.
- Check the tool ground and GO plunger for sparking. Use alligator clip to short pin to body.

- Prepare detonator in the arming sub. Arm the gun electrically by connecting the arming sub to the bottom of double pin adapter. Ballistic arming takes place by connecting the arming sub to the gun section.
- Use the locking nut on the pin end of the Shock Sub to align the charges to the MOT alignment notch.
- Physically measure the distance from the centre CCL to the top shot of the gun. This length will be known as CCL to Top Shot Depth (CTSD).
- Run-in-hole (RIH) until bottom of correlation interval. Unless recommended, RIH speed to be 10m/min while passing through restrictions or well accessories and 30m/min while passing through tubing.
- Log up and perform correlation pass from the decided interval. A pup joint or completion accessories can be a distinctive marker.
- Stop at the agreed depth and then correlate depth. Verify with client on depth shift. Adjust depth in the Smart Monitor and RIH to bottom of log interval.
- Log up to the agreed depth and this time the depth should be matching with the reference log.
- POOH slowly to the CCL stop depth.

⚠ *CCL Stop Depth = Top Shot Depth – CCL to Top Shot Distance*

- Stop at the stop depth and re-confirm the shooting depth.
- Rotate the MOT and cross check the signal with surface simulation test
- Perform minimum 3 full cycle and verify the signal/pattern is good. Once the maximum peak is reached, stop the MOT and switch to firing mode.

⚠ **Inform client representative. Only once authorized shooting sequence may be initiated.**

- Take note of pre-fire hanging weight, SITHP of LS and SS. Standby for cable vibration.
- Fire the gun and observe for current and voltage deflection. A short circuit will normally occur, indicating that the gun has been fired.
- Monitor SITHP of LS and SS, hanging weight and cable vibration. Observe for any changes. **REPEAT** the shooting sequence if needed.
- Wait for 5 minutes and before re-sending power.
- If the gun successfully detonated, wait for 3 minutes for debris to settle down and then POOH to surface, not exceeding 30 m/min.
- Once the tool reach at surface, follow all procedures as per **DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD**

## 3.5 Rig Floor Post Job Operations

1. Pull the tool out of hole and power down the tool
2. Clean the tool during rig down while it hangs out from the lubricator.
3. Rig down toolstring and report any anomalies found.

## 3.6 Complete Post Job Reports

1. Generate the wellsite product as per contract.
2. Select a log format for a client presentation.
3. Organize the field print as per client SOP.
4. Make the required prints/data as per logging program.
5. Give the data to the client.
6. Arrange de-mobilization of the equipment back to base.

# CLOSE

## 4.1 Post Job

1. Post Job Maintenance
2. Post Job Reporting
3. Submit any lessons learnt and improvement suggestions to FSM.
4. Attend debriefing with FSM.

## 4.2 DC-MOT SSP Summary, Opcheck, and FIT Checklist

| DC-MOT SSP CHECKLIST | | |
|---|---|---|
| **At Base: Design & Prepare** | | |
| Design | Client has provided the well information, confirmed final perforation interval and signed the work program. | ☐ |
| | Confirm the operation is within tool specifications. | ☐ |
| | Client has already been informed on the limitation of the tools, equipment, well condition and etc. | ☐ |
| | Ensure availability of the standard tool configurations. | ☐ |
| Prepare | Consider the following requirements when combining the MOT-DC with other CCL. Specific CCL for MOT-DC need to be used. | ☐ |
| | Discussed with FSM and HO PEXS on the availability of the equipment: CCL, Centralizer, Adaptor, Shock Sub, and Eline/Ballistic Conveyance Rollers | ☐ |
| | Prepare all the tools and accessories as per maintenance manual. Verify with lab team on the maintenance. | ☐ |
| | Ensure all consumables and spare parts are ready in the package. | ☐ |
| | Prepare Acquisition Software (Warrior 8) as per SSP. Refer to opcheck checklist. | ☐ |
| | Perform MOT Opcheck. (Refer to Opcheck checklist) | ☐ |
| | Perform CCL & Hotcheck. (Refer to Opcheck checklist) | ☐ |
| | Backup all Warrior config files after complete Opcheck. | ☐ |
| **At Well Site: Execute** | | |
| Rigup | Confirm well and hole properties with Wireline Supervisor (LS and SS Shut In, Gas lift closed, etc). | ☐ |
| | Check continuity and isolation for cable, collector, and head. | ☐ |
| | Perform FIT on tools and equipment. (Refer to FIT checklist) | ☐ |
| | Verify all tool measurements with Wireline Supervisor. | ☐ |
| | Make up MOT toolstring as per program. | ☐ |
| | Zero toolstring at center of CCL on main deck. | ☐ |
| | Perform MOT Opcheck. (Refer to Opcheck checklist) | ☐ |
| | Perform CCL & Hotcheck. (Refer to Opcheck checklist) | ☐ |
| Dummy MOT | Perform Dummy MOT as per procedure mentioned in SSP. | ☐ |
| | Perform CCL correlation pass. | ☐ |
| | Perform CWT correlation pass. | ☐ |
| | Perform MOT rotation log at bottom and top targeted CCL stop depths. | ☐ |
| | Confirm log is good before POOH. | ☐ |
| Actual MOT Perforation | Perform Actual MOT Perforation run as per SSP. | ☐ |
| | Ensure to take all safety precautions as per DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD. | ☐ |
| | Use the locking nut on the pin end of the Shock Sub to align the charges to the MOT alignment notch. | ☐ |
| | Physically measure the distance from the centre CCL to the top shot of the gun. | ☐ |
| | Verify the CCL stop depth and shooting interval. | ☐ |
| | Perform correlation pass and verify with client on depth shift. | ☐ |
| | Receive Greenlight from client rep to proceed to CCL-Stop depth for MOT rotation log. | ☐ |
| | Perform MOT rotation log minimum 3 cycles before stopping at high peak. Verify with client rep on MOT rotation log. | ☐ |
| | Receive Greenlight from client rep to proceed shooting sequence. | ☐ |
| | Take note of pre-fire hanging weight, SITHP of LS and SS. | ☐ |
| | Perform shooting sequence and observe for current/voltage deflection and cable vibration. | ☐ |
| | Monitor post-fire SITHP of LS and SS, hanging weight and cable vibration. REPEAT the shooting sequence if needed. | ☐ |
| | If the gun successfully detonated, wait for 3 minutes for debris to settle down. | ☐ |
| | POOH to surface, not exceeding 30 m/min. | ☐ |
| | Ensure to follow all procedures as per DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD. | ☐ |
| Post Job | Clean the tool during rig down while it hangs out from the lubricator. | ☐ |
| | Rig down toolstring and report any anomalies found. | ☐ |
| **Return to Base: Close** | | |
| Close | Generate the wellsite product as per contract. Organize the field print as per client SOP. | ☐ |
| | Arrange de-mobilization of the equipment back to base. | ☐ |
| | Complete Post Job Maintenance and Reporting. | ☐ |
| | Submit any lessons learnt and improvement suggestion to FSM. | ☐ |
| | Attend debriefing with FSM. | ☐ |

| | | | |
|---|---|---|---|
| **Name:** | write your name here | | |
| **Date:** | dd/mm/yyyy | **Signature:** | sign here |

## DC-MOT OPCHECK CHECKLIST

| | | |
|---|---|---|
| **Warrior 8** | | |
| **Software & Toolstring** | Warrior 8, 32 bit version used. | ☐ |
| | DC MOT 16-BIT service file is selected. | ☐ |
| | Service settings and SDS Tool Interface Panel Configurations have been set correctly. | ☐ |
| | Toolstring has been properly declared. | ☐ |
| | Tool lengths have been verified. | ☐ |
| | Toolstring zero is at CCL. | ☐ |
| **MOT** | | |
| **Telemetry** | From 0V, the STIP voltage is increased to 105V to turn on electronics, then slowly to 120V. | ☐ |
| | The exciter starts and current jumps while voltage drops. The voltage is increased back until stable at approximately 120V (120 mA). | ☐ |
| | Aux gain on the slider bar has been adjusted so that the digital data fills the telemetry window from top to bottom. | ☐ |
| | Positive threshold (Red line) and negative threshold (Blue line) have been adjusted correctly. | ☐ |
| | Green light is on and Red Light is off in Titan Telemetry Monitor. | ☐ |
| **Monitor Outputs** | Angular Metal Mass (MMS) reads a number but does not change since the motor is not on. | ☐ |
| | Markers (MKSW) reads 0 or 1000, but does not change since the motor is not on. | ☐ |
| | Deviation (BHINCL) reads within +- 2 deg of the actual deviation if the test stand is tilted. | ☐ |
| | Gravity Tool Face (GTF) reads the degrees that the tool is facing in relation to the high side of the pipe. This will be at 0 Degrees if the notch in the tool is facing the high side of the pipe. | ☐ |
| **Motor** | Voltage is increased slowly to 150V, starting the motor. | ☐ |
| | Current jumps and voltage drops. Voltage is increased back slowly until LineV is 140V. | ☐ |
| **Rotation Log & Notch Alignment** | Rotation log is started with vertical scale set to 75 seconds per inch. | ☐ |
| | MMS curve records a series of high and low peaks. One full rotation takes approximately 2 minutes and 45 seconds. | ☐ |
| | Markers (MKSW) have 11 marks and then a gap that occurs at the same spot in relation to the MMS curve. | ☐ |
| | Gravity Tool Face (GTF) curve crosses the 0 deg line at low peak if adjacent tubing at low side, and at high peak if adjacent tubing at high side. | ☐ |
| | After 3 complete rotations, the tool is stopped on the high peak by powering down the tool. Rotation pass is stopped. | ☐ |
| | DC-MOT is removed from the test fixture while not allowing it to rotate from last stop position. | ☐ |
| | Position of alignment notch is observed to be facing the adjacent tubing. | ☐ |
| **CCL & Hot Check** | | |
| **CCL** | Simulate CCL signal and perform several collar checks. | ☐ |
| **Hot Check** | Tool is powered up with multimeter checking voltage between tool lower electrical contact and body. | ☐ |
| | No AC/DC voltage is present while MOT is powered up/rotating. | ☐ |
| | Tool is powered down and safety and shooting panels are set to Fire on Negative. | ☐ |
| | Negative voltages of -100VDC, -200VDC, and -250VDC are fired from panel while checking with multimeter at tool lower electrical contact. | ☐ |
| **Post Check** | Repeat MOT and CCL opchecks after Hot Check. | ☐ |

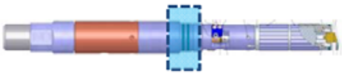
# DC-MOT FIT CHECKLIST

| OBJECTIVE |
|---|
| i - To conduct Fast Inspection of Tools (FIT) prior to performing job. |
| ii - To identify any anomalies/possible damage after run. |

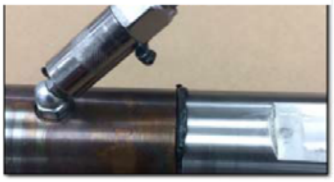
## DC-MOT

**TOOL DIAGRAMS**

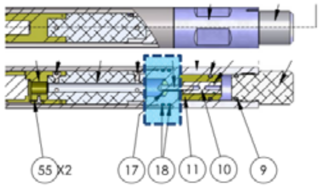
**O-ring 125 at Top Sub (Motor Section)**



**Grease Motor Bearings**



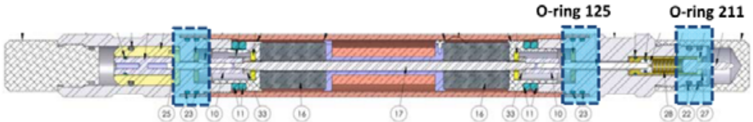
**O-ring 125 at Bottom Sub (Notch)**



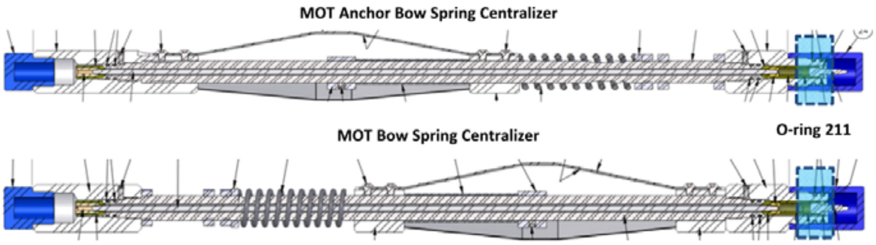
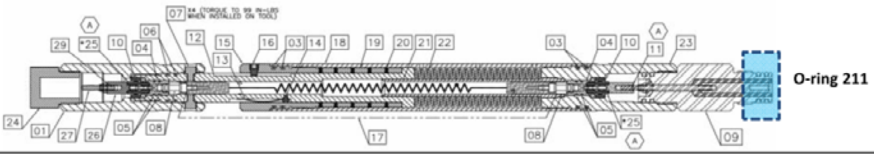

| PRE JOB | |
|---|---|
| 1. Check O-ring 125 condition at Top and Bottom subs and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 2. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 3. Grease the motor bearings with high temp grease. | ☐ Tick if done |
| 4. Ensure all screws and connections have been tightened. | ☐ Tick if done |

## MOT CCL

**TOOL DIAGRAMS**




| PRE JOB | |
|---|---|
| 1. Check O-ring 211 condition at head connector and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 1. Check O-ring 125 condition at Top and Bottom subs and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 2. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 4. Ensure all connections are tightened. | ☐ Tick if done |

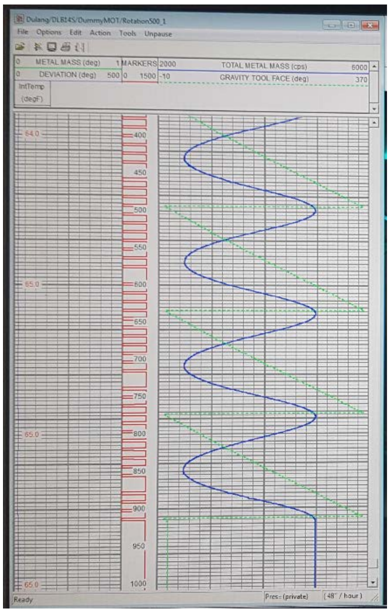
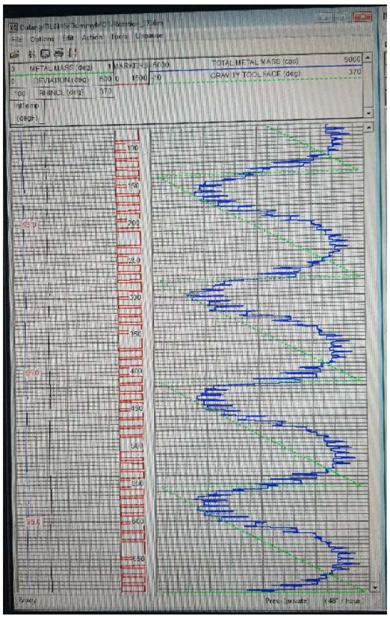
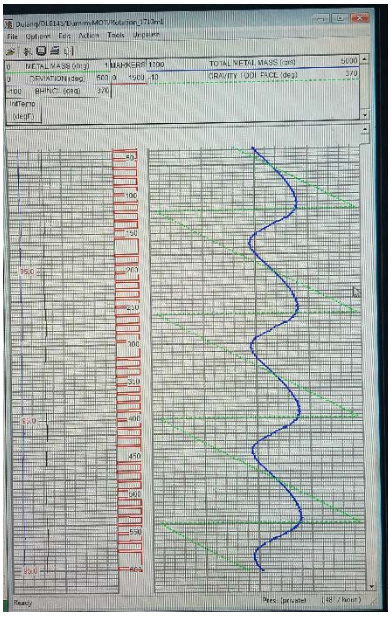
| | |
|---|---|
| **MOT CENTRALIZERS** | |
| **TOOL DIAGRAMS** | |
|  | |
| **PRE JOB** | |
| 1. Check O-ring 211 condition at head connector and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 2. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 3. Check upper to lower pin resistance with multimeter to be not more than 5 ohms.<br>i. If greater than than 5 ohms rework assembly. | ☐ Tick if done |
| 4. Using a Meggar meter set to 500 Vdc, check insulation leakage between contact and body to be greather 10Mohms.<br>i. If less than 10Mohms, rework assembly. | ☐ Tick if done |
| 5. Ensure bowspring is 10-20% larger than tubing size. | ☐ Tick if done |
| 6. Ensure all screws and connections are tightened. | ☐ Tick if done |
| **SHOCK ABSORBER** | ☐ **Tick if done** |
| **TOOL DIAGRAMS** | |
|  | |
| **PRE JOB** | |
| 1. Perform visual inspection for deformed or damaged parts, such as belled housing or galled threads.<br>i. If any damage found, replace shock absorber and tag for repair | ☐ Tick if done |
| 2. Inspect movement of the mandrel with respect to the remainder of the tool when placed under tension or compression.<br>i. If movement greater than 1/8" is seen, rework assembly and verify free movement has been eliminated. | ☐ Tick if done |
| 3. Check O-ring 211 condition at head connector and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 4. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 5. Check upper to lower pin resistance with multimeter to be not more than 5 ohms.<br>i. If greater than than 5 ohms, inspect cable & boot assembly and replace if necessary. | ☐ Tick if done |
| 6. Using a Meggar meter set to 500 Vdc, check insulation leakage between contact and body to be greather 10Mohms.<br>i. If less than 10Mohms, rework assembly. Inspect the Cable & Boot Assembly, Vespel Insulators and Feedthru Bulkheads for leakage. Replace if broken or damaged. | ☐ Tick if done |
| 7. Ensure all screws and connections are tightened. | ☐ Tick if done |
| **POST JOB** | |
| **POST JOB** | |
| 1. Clean the tool before disconnecting toolstring. Observe for any anomalies/possible damage. | ☐ Tick if done |
| 2. Ensure there is no well fluid entry at upper and lower electrical connectors. | ☐ Tick if done |
| 3. Refit thread protectors. | ☐ Tick if done |

# APPENDICES

## 5.1 MOT Log Examples

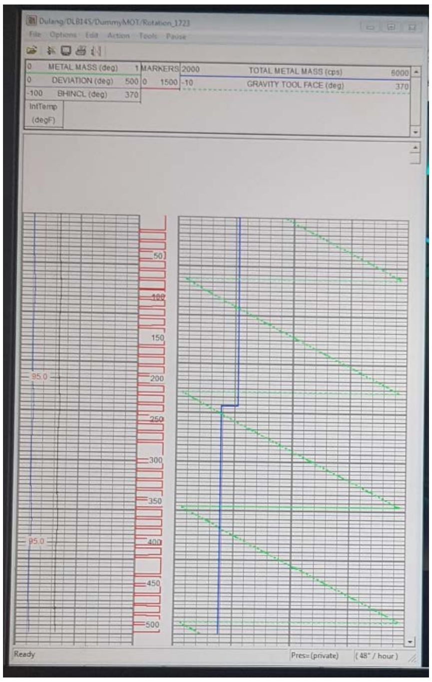
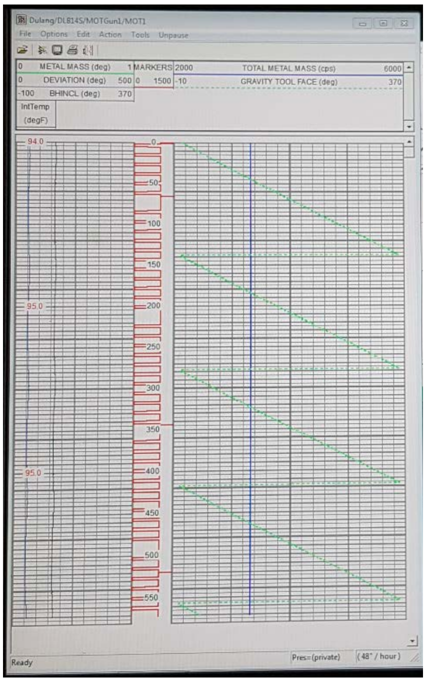
### Normal Rotation Logs

1. Easy to differentiate between MMS high and low peaks. The markers have 11 marks and a gap occurs at the same spot in relation to the MMS curve indicating the MOT is turning without any sticking.
2. GTF curve crossing the 0 deg line at high peak indicates adjacent tubing is at higher side in relation to tool, and lower side for 0 deg at low peak.

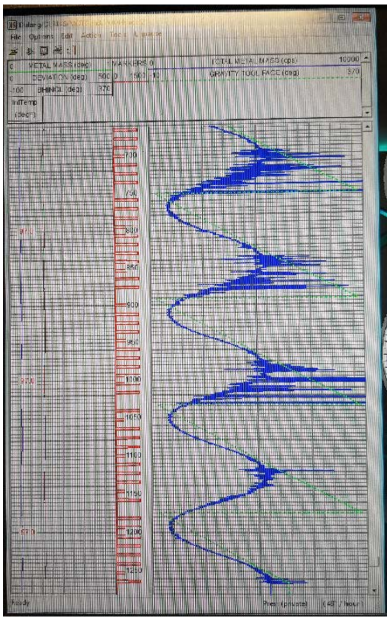
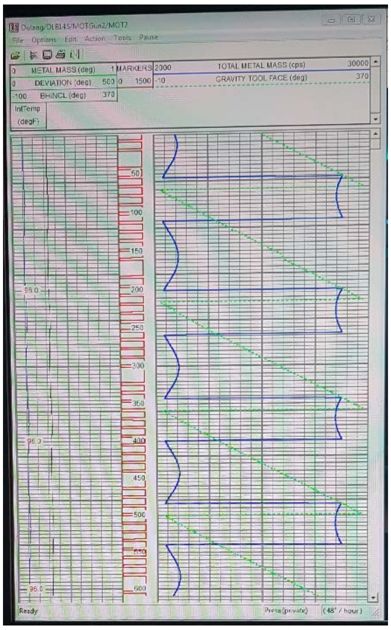
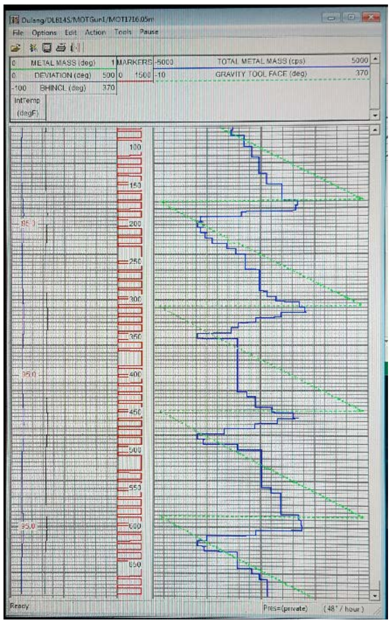
### MMS Flat at Blast Joint

1. It is not possible to differentiate between MMS high and low peaks. Markers and GTF indicate the MOT is turning normally however cannot be related to MMS curve.
2. Metal mass of blast joint may be cancelling out the signal between Exciter coil and the Receiver and Directional Coil. It is required to find the nearest depth without interference.
3. A spacer such as weight bar can also be placed between the MOT and the gun to allow MMS sensor to rotate at a higher depth.

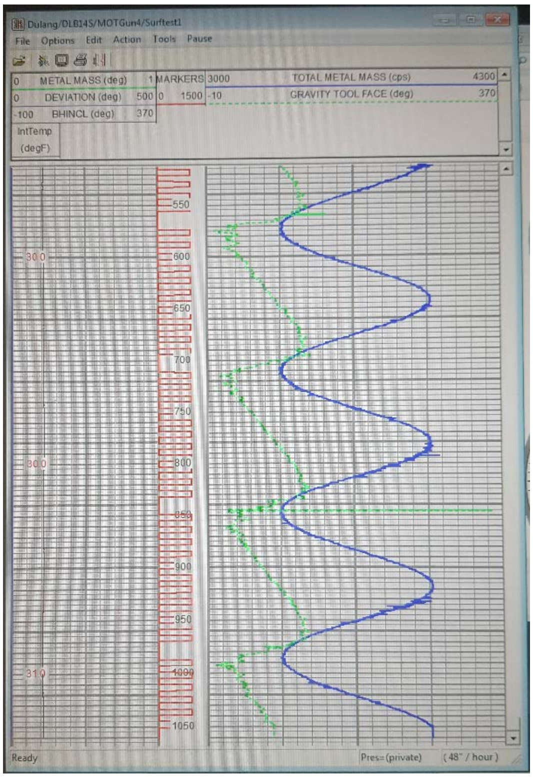
### Odd Rotation Logs

1. First from left MMS believed to be in SSD. 2nd and 3rd from left MMS in blast joint area. Although the logs may look odd, it is still possible to differentiate between MMS high and low peaks.
2. The markers have 11 marks and a gap occurs at the same spot in relation to the MMS curve indicating the MOT is turning without any sticking.
3. GTF curve crossing the 0 deg line at high peak indicates adjacent tubing is at higher side in relation to tool, and lower side for 0 deg at low peak.

### Odd GTF Curve in MOT Jig

1. GTF curve indicates that the tool is not inclined as MOT jig is not lifted on one side. Place a piece of wood under the jig to lift it on one side to verify GTF sensor.



## 5.2 DC-MOT STIP Voltage and Current supplied as per SIT/Acceptance

| SIT # | MOT SN | TEST CONDITION | TEST ANGLE (°) | TOOLSTRING | STIP CURRENT (mA) | STIP VOLTAGE (VDC) | REMARK |
|---|---|---|---|---|---|---|---|
| 1 | J5HS5-01 | IN 2-7/8" 6.4# TUBING | 90 | CH/INT iWHEEL/1.69" SWB/INT iWHEEL/2.00" SWB/CCL/AR CENT/MOT EC/MOT PSA/2.00" FH/3M GUN/BAL iWHEEL GUIDE | 152 | 146 | MOT Rotation OK Test Fire : 180 VDC Bottom MOT: 180 VDC |
| 2 | | | 80 | | 151 | 146 | |
| 3 | | | 70 | | 151 | 146 | |
| 4 | MOT: J5HS5-02 CCL: | IN 2-7/8" 6.4# TUBING | 90 | CH/INT iWHEEL/1.69" SWB/INT iWHEEL/2.00" SWB/CCL/AR CENT/MOT EC/MOT PSA/2.00" FH/3M GUN/BAL iWHEEL GUIDE | 151 | 144 | MOT Rotation OK Test Fire : 180 VDC Bottom MOT: 180 VDC |
| 5 | | | 80 | | 152 | 144 | |
| 6 | | | 70 | | 153 | 144 | |
| 7 | J8QG2-01 | IN 2-7/8" 6.4# TUBING | 90 | CH/INT iWHEEL/1.69" SWB/INT iWHEEL/2.00" SWB/CCL/AR CENT/MOT EC/MOT PSA/2.00" FH/3M GUN/BAL iWHEEL GUIDE | 145 | 155 | MOT Rotation OK Test Fire : 180 VDC Bottom MOT: 180 VDC |
| 8 | | | 80 | | 145 | 155 | |
| 9 | | | 70 | | 145 | 155 | |

## 5.3 Lessons Learnt

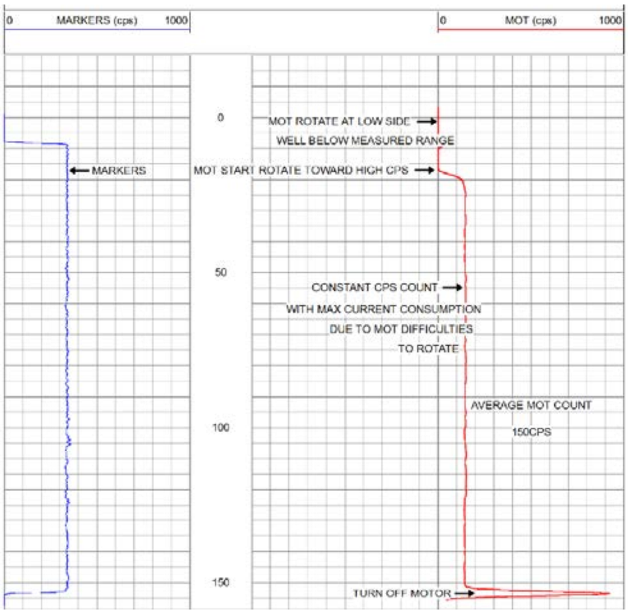
### Case 1: Large gun size (2-3/8") contributed to huge shock to MOT assembly, damaging mechanical section and MOT unable to rotate downhole

| | |
|---|---|
| Date | 24th September 2017 |
| Platform | SKO / BEDP-A |
| Well | Be-13S |
| Job | Oriented Perforation |
| BHA | CH + SWB + PCCL + CENTERLIZER + MOT + SHOCKSUB + DP + FH ASSY + 2-3/8'' HSC GUN |

**Incident #1: MOT unable to rotate downhole.**

On 4th Gun run (MOT main set), during MOT rotating sequence, FE observed high current consumption around 180mA when Motor was activated, indicating rotating difficulties. Normal operating current is 140 – 150mA.

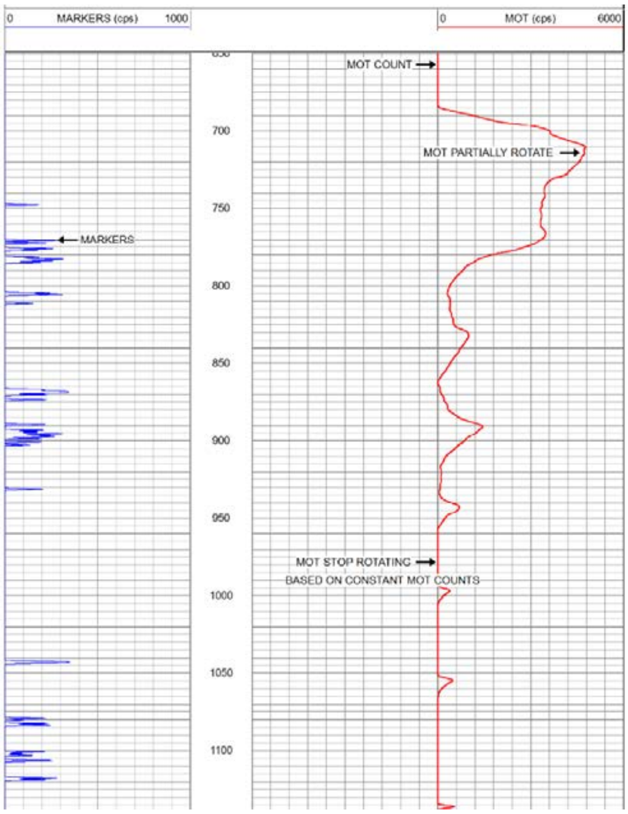
Rotation Log  and picture of MOT panel as below:





**Incident #2: MOT partially rotating downhole**

On 5th gun run (backup MOT), FE initiated MOT rotating sequence. Observed MOT CPS count remain constant despite stable current consumption by motor. Early indication from log shows that the MOT was partially rotating, then stopped rotating afterwards. Rotation log as below:

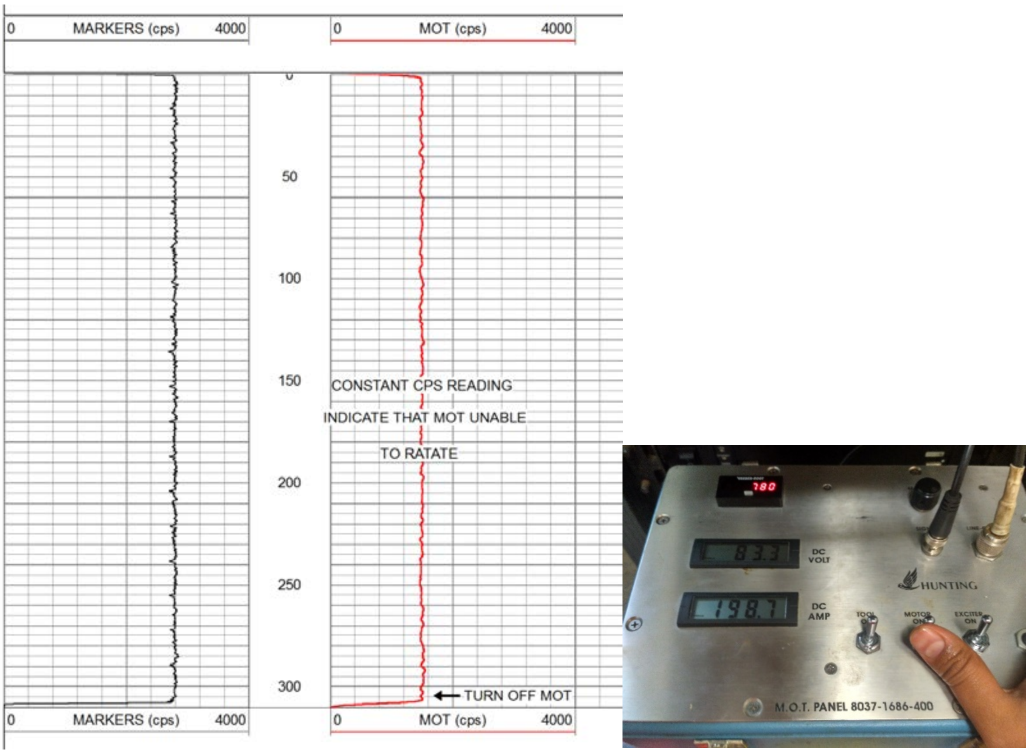



***Lesson Learnt: To mitigate shock from large guns by adding perforating shock absorber (PSA) on top of MOT shock sub in future MOT toolstrings***

### Case 2: High Deviation restricted MOT to rotate downhole

| | |
|---|---|
| Date | 3rd August 2018 |
| Platform | PMO/Dulang |
| Well | B19S |
| Job | Oriented Perforation |
| BHA | CH + 1.69SWB + 1.69TWB + 2.0SWB + MOT CENT + MOT + MOT SHOCK SUB + ADAPTOR + FH ASSY + 1-WHEEL (INT) + 2'' SPENT GUN (3M) + IWHEEL GUIDE |

FE attempted to rotate MOT at bottom perf zone (CCL Stop depth 1717mMDRKB). Constant MOT CPS observed with high motor current at MOT panel. Repeated same process at top perf zone (CCL Stop depth 1711mMDRKB) with same results. Rotation log and picture of MOT panel as below:




***Lesson Learnt: For future high angle orientating jobs, to use DC-MOT coupled with roller conveyance tool such as I-wheel for better rotating capabilities at high angles.***

## 5.4 Best Practices & Precautions

### Dummy Run

Perform 2 correlation passes:

a. 1st using CCL as per standard procedure.
b. 2nd using CWT to help identify additional jewelry on the backside of the casing or tubing which may interfere with MMS reading

It is advisable to perform rotation log at all target CCL stop depths. Additional stops just above or below the target depths may also give helpful data.

Take note of areas where there could be interference with MMS reading. It may be suggested to include a spacer such as weight bar to be placed between the MOT and the gun to allow MMS sensor to rotate at a higher depth.

### Actual Run

For each run, to give confidence on MOT performance at target depth, it is recommended to perform MOT rotation log at least once after passing safe depth (before angle kick-off depth).

## 5.5 Different Environments

### O-ring Seals

Fluorocarbon elastomers (Viton®) exhibit very good thermal and hydrocarbon resistance but can be attacked by a number of commonly encountered oilfield media. Corrosion inhibitors will cause embrittlement, while sour wells containing Hydrogen Sulphide ($H_2S$) and Carbon Dioxide ($CO_2$) may cause softening with consequent reduction in the elastomer's mechanical properties.

Hydrogenated Nitrile Rubbers (HNBR) have proven invaluable in extending the boundaries of elastomeric seals in aggressive environments. These materials display superior resistance to aggressive fluids such as sour crude oil or gas, lubricating oil additives and amine corrosion inhibitors where fluorocarbon (Viton®) seals are less effective.

Hence the type of O-ring used will depend on the environment. Under normal conditions Viton® can be used, however, in harsher environments, such as in sour wells, HNBR will be more reliable.

The required O-rings sizes can be cross checked with the O-ring tables in the next section.

*O-Ring Cross Check Table*

| | |
|---|---|
| TOOL | MOT-DC |
| TOOL CODE | MOT-B |

| | | | O-RING SIZE (STANDARD: AS568B) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO | SUBSECTION | PART | 010 | 012 | 013 | 014 | 111 | 114 | 118 | 123 | 125 | 211 | 219 | 317 |
| 1 | MOT-DC CCL | 8037-1686-100 | 1 | 2 | | | | | | | 4 | 3 | | 4 |
| 2 | MOT-DC ANCHOR BOW SPRING CENTRALIZER | 8037-1686-200 | | | | | 4 | | | | | 2 | | |
| 3 | MOT-DC TOOL | 8037-17551EC075-12-06 | | 2 | | | | 1 | | 1 | 6 | 2 | | |
| 4 | MOT-DC SHOCK SUB | 3100-168-S600 | | | 2 | 2 | | | 2 | | | 2 | 4 | |
| 5 | MOT-DC BOW ADJUSTABLE SPRING CENTRALIZER | 8071-168-200 | | | | | 4 | | | | | 2 | | |

*O-Ring Quantity Table*

| NO | O-RING SIZE | TOOL REF | QTY PER NO. OF RUNS | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1 | 5 | 10 | 15 | 20 |
| 1 | O-RING SZ-010 | 1 | 1 | 5 | 10 | 15 | 20 |
| 2 | O-RING SZ-012 | 1, 3 | 4 | 20 | 40 | 60 | 80 |
| 3 | O-RING-SZ-013 | 4 | 2 | 10 | 20 | 30 | 40 |
| 4 | O-RING SZ-111 | 2, 5 | 8 | 40 | 80 | 120 | 160 |
| 5 | O-RING SZ-114 | 3 | 1 | 5 | 10 | 15 | 20 |
| 6 | O-RING SZ-118 | 4 | 2 | 10 | 20 | 30 | 40 |
| 7 | O-RING SZ-123 | 3 | 1 | 5 | 10 | 15 | 20 |
| 8 | O-RING SZ-125 | 1, 3 | 10 | 50 | 100 | 150 | 200 |
| 9 | O-RING SZ-211 | 1, 2, 3, 4, 5 | 11 | 55 | 110 | 165 | 220 |
| 10 | O-RING SZ-219 | 4 | 4 | 20 | 40 | 60 | 80 |
| 11 | O-RING SZ-317 | 1 | 4 | 20 | 40 | 60 | 80 |

## Conveyance

### *In Vertical Wells*

Use of centralizers above and below the MOT helps to centralize and reduce the resistance of the motor while performing orientation.

### *In Deviated Wells*

As wells become more highly deviated, or their profiles become more challenging, it is increasingly difficult to reach the targeted depths. Frictional resistance caused by the toolstring lying on the low side of the well can inhibit the operation from reaching lower depths.

Roller conveyance tools lift and support the toolstring off the low side of the well. Large rollers eliminate tool contact friction, making it easier to convey the toolstring to target depth and achieve the results expected.

Removal of the lower centralizer may also help to reduce friction.

## 5.6 References

Cased Hole Services, Dimension Bid Sdn Bhd. (2018). *Magnetic Orienting Tool, MOT unable to rotate downhole.* Kemaman.

Cased Hole Services, Dimension Bid Sdn Bhd. (2018). *Problem Investigation Report - MOT Unable to Rotate at High Deviation Well.* Kemaman.

Hunting Titan. (2016). *Technical Manual & Maintenance 1-11/16" Perforating Shock Absorber Assemblies.* Pampa, TX.

Hunting Titan. (2016). *Technical Manual & Maintenance 1-3/4" DC-MOT Rev A.* Pampa, TX.

PEXS, CHS, Dimension Bid Sdn Bhd. (2018). MOT-DC O-RING X-CHECK TABLE. Kemaman.

# DC-MOT SSP CHECKLIST

## At Base: Design & Prepare

| | | |
|---|---|---|
| Design | Client has provided the well information, confirmed final perforation interval and signed the work program. | ☐ |
| | Confirm the operation is within tool specifications. | ☐ |
| | Client has already been informed on the limitation of the tools, equipment, well condition and etc. | ☐ |
| | Ensure availability of the standard tool configurations. | ☐ |
| Prepare | Consider the following requirements when combining the MOT-DC with other CCL. Specific CCL for MOT-DC need to be used. | ☐ |
| | Discussed with FSM and HO PEXS on the availability of the equipment: CCL, Centralizer, Adaptor, Shock Sub, and Eline/Ballistic Conveyance Rollers | ☐ |
| | Prepare all the tools and accessories as per maintenance manual. Verify with lab team on the maintenance. | ☐ |
| | Ensure all consumables and spare parts are ready in the package. | ☐ |
| | Prepare Acquisition Software (Warrior 8) as per SSP. Refer to opcheck checklist. | ☐ |
| | Perform MOT Opcheck. (Refer to Opcheck checklist) | ☐ |
| | Perform CCL & Hotcheck. (Refer to Opcheck checklist) | ☐ |
| | Backup all Warrior config files after complete Opcheck. | ☐ |

## At Well Site: Execute

| | | |
|---|---|---|
| Rigup | Confirm well and hole properties with Wireline Supervisor (LS and SS Shut In, Gas lift closed, etc). | ☐ |
| | Check continuity and isolation for cable, collector, and head. | ☐ |
| | Perform FIT on tools and equipment. (Refer to FIT checklist) | ☐ |
| | Verify all tool measurements with Wireline Supervisor. | ☐ |
| | Make up MOT toolstring as per program. | ☐ |
| | Zero toolstring at center of CCL on main deck. | ☐ |
| | Perform MOT Opcheck. (Refer to Opcheck checklist) | ☐ |
| | Perform CCL & Hotcheck. (Refer to Opcheck checklist) | ☐ |
| Dummy MOT | Perform Dummy MOT as per procedure mentioned in SSP. | ☐ |
| | Perform CCL correlation pass. | ☐ |
| | Perform CWT correlation pass. | ☐ |
| | Perform MOT rotation log at bottom and top targeted CCL stop depths. | ☐ |
| | Confirm log is good before POOH. | ☐ |
| Actual MOT Perforation | Perform Actual MOT Perforation run as per SSP. | ☐ |
| | Ensure to take all safety precautions as per DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD. | ☐ |
| | Use the locking nut on the pin end of the Shock Sub to align the charges to the MOT alignment notch. | ☐ |
| | Physically measure the distance from the centre CCL to the top shot of the gun. | ☐ |
| | Verify the CCL stop depth and shooting interval. | ☐ |
| | Perform correlation pass and verify with client on depth shift. | ☐ |
| | Receive Greenlight from client rep to proceed to CCL-Stop depth for MOT rotation log. | ☐ |
| | Perform MOT rotation log minimum 3 cycles before stopping at high peak. Verify with client rep on MOT rotation log. | ☐ |
| | Receive Greenlight from client rep to proceed shooting sequence. | ☐ |
| | Take note of pre-fire hanging weight, SITHP of LS and SS. | ☐ |
| | Perform shooting sequence and observe for current/voltage deflection and cable vibration. | ☐ |
| | Monitor post-fire SITHP of LS and SS, hanging weight and cable vibration. REPEAT the shooting sequence if needed. | ☐ |
| | If the gun successfully detonated, wait for 3 minutes for debris to settle down. | ☐ |
| | POOH to surface, not exceeding 30 m/min. | ☐ |
| | Ensure to follow all procedures as per DB EXPLOSIVE SERVICE SAFE OPERATIONS PLACARD. | ☐ |
| Post Job | Clean the tool during rig down while it hangs out from the lubricator. | ☐ |
| | Rig down toolstring and report any anomalies found. | ☐ |

## Return to Base: Close

| | | |
|---|---|---|
| Close | Generate the wellsite product as per contract. Organize the field print as per client SOP. | ☐ |
| | Arrange de-mobilization of the equipment back to base. | ☐ |
| | Complete Post Job Maintenance and Reporting. | ☐ |
| | Submit any lessons learnt and improvement suggestion to FSM. | ☐ |
| | Attend debriefing with FSM. | ☐ |

| | | | |
|---|---|---|---|
| **Name:** | *write your name here* | | |
| **Date:** | *dd/mm/yyyy* | **Signature:** | *sign here* |

# DC-MOT OPCHECK CHECKLIST

## Warrior 8

| | | |
|---|---|---|
| Software & Toolstring | Warrior 8, 32 bit version used. | ☐ |
| | DC MOT 16-BIT service file is selected. | ☐ |
| | Service settings and SDS Tool Interface Panel Configurations have been set correctly. | ☐ |
| | Toolstring has been properly declared. | ☐ |
| | Tool lengths have been verified. | ☐ |
| | Toolstring zero is at CCL. | ☐ |

## MOT

| | | |
|---|---|---|
| Telemetry | From 0V, the STIP voltage is increased to 105V to turn on electronics, then slowly to 120V. | ☐ |
| | The exciter starts and current jumps while voltage drops. The voltage is increased back until stable at approximately 120V (120 mA). | ☐ |
| | Aux gain on the slider bar has been adjusted so that the digital data fills the telemetry window from top to bottom. | ☐ |
| | Positive threshold (Red line) and negative threshold (Blue line) have been adjusted correctly. | ☐ |
| | Green light is on and Red Light is off in Titan Telemetry Monitor. | ☐ |
| Monitor Outputs | Angular Metal Mass (MMS) reads a number but does not change since the motor is not on. | ☐ |
| | Markers (MKSW) reads 0 or 1000, but does not change since the motor is not on. | ☐ |
| | Deviation (BHINCL) reads within +- 2 deg of the actual deviation if the test stand is tilted. | ☐ |
| | Gravity Tool Face (GTF) reads the degrees that the tool is facing in relation to the high side of the pipe. This will be at 0 Degrees if the notch in the tool is facing the high side of the pipe. | ☐ |
| Motor | Voltage is increased slowly to 150V, starting the motor. | ☐ |
| | Current jumps and voltage drops. Voltage is increased back slowly until LineV is 140V. | ☐ |
| Rotation Log & Notch Alignment | Rotation log is started with vertical scale set to 75 seconds per inch. | ☐ |
| | MMS curve records a series of high and low peaks. One full rotation takes approximately 2 minutes and 45 seconds. | ☐ |
| | Markers (MKSW) have 11 marks and then a gap that occurs at the same spot in relation to the MMS curve. | ☐ |
| | Gravity Tool Face (GTF) curve crosses the 0 deg line at low peak if adjacent tubing at low side, and at high peak if adjacent tubing at high side. | ☐ |
| | After 3 complete rotations, the tool is stopped on the high peak by powering down the tool. Rotation pass is stopped. | ☐ |
| | DC-MOT is removed from the test fixture while not allowing it to rotate from last stop position. | ☐ |
| | Position of alignment notch is observed to be facing the adjacent tubing. | ☐ |

## CCL & Hot Check

| | | |
|---|---|---|
| CCL | Simulate CCL signal and perform several collar checks. | ☐ |
| Hot Check | Tool is powered up with multimeter checking voltage between tool lower electrical contact and body. | ☐ |
| | No AC/DC voltage is present while MOT is powered up/rotating. | ☐ |
| | Tool is powered down and safety and shooting panels are set to Fire on Negative. | ☐ |
| | Negative voltages of -100VDC, -200VDC, and -250VDC are fired from panel while checking with multimeter at tool lower electrical contact. | ☐ |
| Post Check | Repeat MOT and CCL opchecks after Hot Check. | ☐ |

| | | | |
|---|---|---|---|
| **Name:** | *write your name here* | | |
| **Date:** | *dd/mm/yyyy* | **Signature:** | *sign here* |

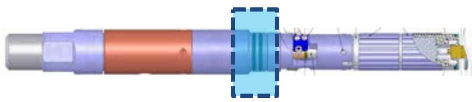
# DC-MOT FIT CHECKLIST

| OBJECTIVE |
|---|
| i - To conduct Fast Inspection of Tools (FIT) prior to performing job. |
| ii - To identify any anomalies/possible damage after run. |

## DC-MOT

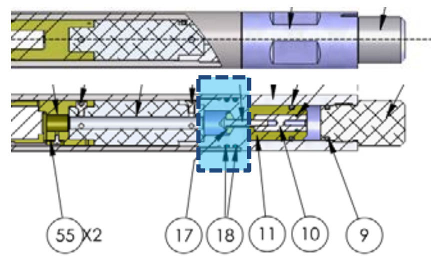
### TOOL DIAGRAMS

**O-ring 125 at Top Sub (Motor Section)**



**Grease Motor Bearings**

**O-ring 125 at Bottom Sub (Notch)**

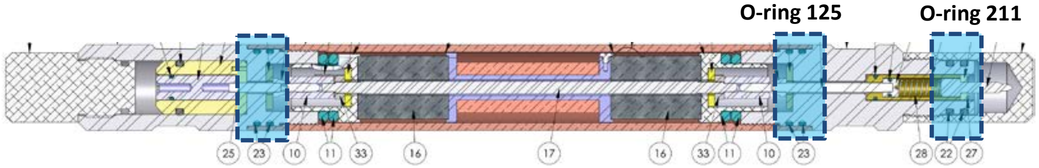



| PRE JOB | | |
|---|---|---|
| 1. Check O-ring 125 condition at Top and Bottom subs and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done | |
| 2. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done | |
| 3. Grease the motor bearings with high temp grease. | ☐ Tick if done | |
| 4. Ensure all screws and connections have been tightened. | ☐ Tick if done | |

## MOT CCL

### TOOL DIAGRAMS

**O-ring 125** **O-ring 211**

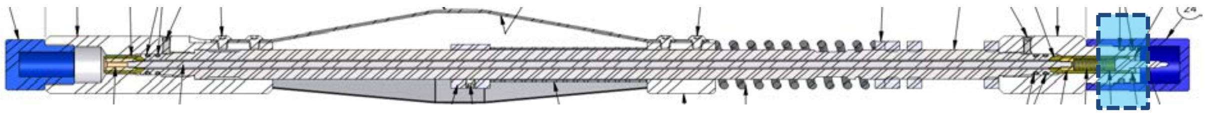



| PRE JOB | |
|---|---|
| 1. Check O-ring 211 condition at head connector and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 1. Check O-ring 125 condition at Top and Bottom subs and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 2. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 4. Ensure all connections are tightened. | ☐ Tick if done |

# MOT CENTRALIZERS

## TOOL DIAGRAMS

**MOT Anchor Bow Spring Centralizer**



**MOT Bow Spring Centralizer**

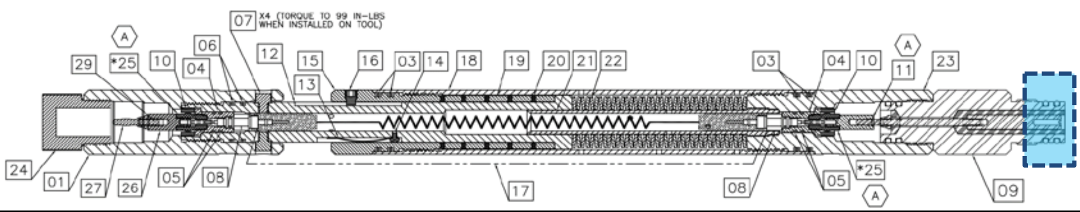

## PRE JOB

| | |
|---|---|
| 1. Check O-ring 211 condition at head connector and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 2. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 3. Check upper to lower pin resistance with multimeter to be not more than 5 ohms.<br>i. If greater than than 5 ohms rework assembly. | ☐ Tick if done |
| 4. Using a Meggar meter set to 500 Vdc, check insulation leakage between contact and body to be greather 10Mohms.<br>i. If less than 10Mohms, rework assembly. | ☐ Tick if done |
| 5. Ensure bowspring is 10-20% larger than tubing size. | ☐ Tick if done |
| 6. Ensure all screws and connections are tightened. | ☐ Tick if done |

# SHOCK ABSORBER

☐ **Tick if done**

## TOOL DIAGRAMS




## PRE JOB

| | |
|---|---|
| 1. Perform visual inspection for deformed or damaged parts, such as belled housing or galled threads.<br>i. If any damage found, replace shock absorber and tag for repair | ☐ Tick if done |
| 2. Inspect movement of the mandrel with respect to the remainder of the tool when placed under tension or compression.<br>i. If movement greater than 1/8" is seen, rework assembly and verify free movement has been eliminated. | ☐ Tick if done |
| 3. Check O-ring 211 condition at head connector and replace if necessary. Ensure to use HNBR O-rings for Sour Wells. | ☐ Tick if done |
| 4. Confirm that the upper and lower electrical connectors are clean, dry, and undamaged. | ☐ Tick if done |
| 5. Check upper to lower pin resistance with multimeter to be not more than 5 ohms.<br>i. If greater than than 5 ohms, inspect cable & boot assembly and replace if necessary. | ☐ Tick if done |
| 6. Using a Meggar meter set to 500 Vdc, check insulation leakage between contact and body to be greather 10Mohms.<br>i. If less than 10Mohms, rework assembly. Inspect the Cable & Boot Assembly, Vespel Insulators and Feedthru Bulkheads for leakage. Replace if broken or damaged. | ☐ Tick if done |
| 7. Ensure all screws and connections are tightened. | ☐ Tick if done |

# POST JOB

## POST JOB

| | |
|---|---|
| 1. Clean the tool before disconnecting toolstring. Observe for any anomalies/possible damage. | ☐ Tick if done |
| 2. Ensure there is no well fluid entry at upper and lower electrical connectors. | ☐ Tick if done |
| 3. Refit thread protectors. | ☐ Tick if done |