

## CORING ROD OPERATIONS CHECKLIST

### BEFORE DRILLING

1. Check drill rig anchoring and alignment of drill rig and borehole collar.
2. Check drill rig and rod handler clamp jaws and replace worn or mis-aligned grippers.
  - a. When using W-Wall™ drill rods, ensure that clamping will avoid reduced wall thickness sections in the midbody. Do not use roller-style clamps or handlers.
3. Check borehole plan and ensure any planned deviations are within recommended guidelines.

## DEVIATION GUIDELINES

Limit borehole deviations & maximize spacing between deviations to avoid opening joints, fatigue, heat-check, wear, & midbody twisting.

| Rod Joint           | *Maximum Deviation<br>Degrees per Rod Length (deg/3m) |
|---------------------|---|
| BXQ™ / BRQ™ / BRQTK | 1.5   |
| BQ™                 | 1.2   |
| NXQ™ / NRQ™         | 1.0   |
| NQ™                 | 0.8   |
| HXQ™ / HRQ™         | 0.8   |
| HQ / PHD            | Not Recommended                                       |

\*Deviation is the total change in both azimuth & inclination ("dog-legs"), measured per rod length (3m survey interval).

\*Maximum deviation is limited by material fatigue strength, i.e. fatigue failures occur in less than 3,000min @ 1,000rpm.

\*W-Wall™ rods have equivalent deviation ratings as reduced weight compensates for reduced stiffness.

\*Increase make-up torque to compensate for deviation bend stress. Grout & redrill to correct excessive deviations.

\*Lateral loads are increased through the deviation entry & exit. Continuous rod-string lubrication by drilling fluid additives is recommended. Manually applied greases are quickly worn away and will not provide reliable stress-corrosion protection.

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4. Clean and inspect used rod strings, discarding any worn-out, damaged, or twisted rods:
  - a. Check rod box wear using OD shoulder wear gauge. The box shoulder should have at least 60% of its original thickness at its thinnest point. The midbody wear always extends over the box but will be less than the box shoulder wear.
  - b. Check thread wear on reverse flank threads, RQ/XQ, using the thread profile “finger” gauge. The gauge should not be removable without unthreading.
  - c. Straightness (Twisting) can be visually inspected by slowly rotating a suspect rod, i.e. The rod should be straighter than 1mm in 1000mm length (0.04”/39”). Twisting or a loss of straightness will become visible when rotated as excessive movement or “run-out” compared to a straight rod which appears to turn “true”.
5. Apply a generous amount of thread compound (50% zinc particulate recommended) on pin and box threads and shoulders to both clean, used rods and new rods before first make-up. Do not use low-friction greases or thread compounds without 50% metal particulate (zinc or copper), as the particulates help transfer torque and reduce galling.
6. Check Rod Make-up
  - a. Make up joint to a “wrench-snug” condition. The standoff gap should be 0.8 - 2.0mm (1/32” - 5/64”).
  - b. Make up rod joint using wrenches to confirm the external shoulders close. Do not confuse the pin shoulder chamfer as a gap.
  - c. Verify that make-up feed & rotation rates are correct before rig make-up. The make-up settings need to match the thread pitch (8.5mm 3 threads per inch Q/RQ, 12.7mm or 2 threads per inch XQ), maintaining light compression on the joint to ensure wear occurs on the stab flank (edge on rod end side), and to avoid wear to the thread load flank (edge on mid-body side). If there is a visible raised burr or “riser” developing along the box thread load flank, then there is insufficient feed or excessive rotation.
  - d. Make-up every rod joint using the drill rig to achieve the recommended make-up torque value which increases with depth and for borehole deviations, e.g. use the 1,000m make-up torque value as minimum for joints traversing a deviation. Where actual make-up torque values are unavailable, consult the drill rig OEM literature to convert and correct the hydraulic pressure setting to the required make-up torque, i.e. torque values are in units of N-m (ft-lb). Do not rely on drilling torque for make-up because drilling thrust, or pullback may prevent make-up.

## MAKE-UP RECOMMENDATIONS

Increase Make-Up Torque to maintain Box-Shoulder compression against increasing Tension with borehole Depth or Deviation.

| Rod Size | *Minimum Make-Up |       | *Deviations or 1,000m+ depth |       | *Deviations or 2,000m+ depth |       |
|----------|------------------|-------|------------------------------|-------|------------------------------|-------|
|          | N-m              | ft-lb | N-m                          | ft-lb | N-m                          | ft-lb |
| <b>B</b> | <b>400</b>       | 300   | <b>700</b>                   | 500   | <b>1,000</b>                 | 750   |
| <b>N</b> | <b>600</b>       | 450   | <b>1,000</b>                 | 750   | <b>1,400</b>                 | 1,000 |
| <b>H</b> | <b>1,000</b>     | 750   | <b>2,000</b>                 | 1,500 | <b>2,750</b>                 | 2,000 |
| <b>P</b> | <b>1,000</b>     | 750   | <b>2,200</b>                 | 1,600 | <b>3,500</b>                 | 2,500 |

\*Clean & apply generous amounts of thread compound (50% zinc) on pin & box with every make-up.

\*Consult drill-rig manual to convert & correct hydraulic pressure setting to required make-up torque value in N-m (ft-lb).

\*Always use drill-rig to apply make-up torque. Do not rely on drilling for make-up as thrust or pullback may prevent make-up.

\*Limit & correct borehole deviations within guidelines to avoid heat-check-cracking & fatigue failure.

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## 7. Check Rod Break-Out

- a. Ensure that the rig has sufficient break-out capacity. Only use rubber or plastic hammers, never metal, if needed to assist rod break out.
- b. Verify that break-out feed & rotation rates are correct (see Rod Make-up section). If there is a visible raised burr or “riser” developing along the box thread load flank (mid-body edge), then there is excessive feed or insufficient rotation, i.e., opposite to make-up adjustments.

8. Provide continuous rod string lubrication and protection against stress-corrosion with drilling fluid additives, e.g., a vegetable oil-based lubricant. Additives with sulfide and chloride neutralizers are also recommended to inhibit stress corrosion. Manually applied greases are quickly worn away and will not provide reliable corrosion protection.

## 9. Subs and Accessories

- a. Ensure all rods, subs, adapters, and accessories are threaded by the same OEM.
- b. Ensure that all lifting devices, swivels, and plugs are clearly labelled with a safe working load rating, and regularly inspect for excessive wear or damage.
- c. Use bullnose style top-drive adapter subs. Identify and track the usages of top-drive adapter subs maintained separately for drilling and rod tripping respectively, to avoid excessive make and break wear.

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## EVERY ROD TRIP

1. Swap top-drive adapter subs before tripping, to avoid wearing the sub used for drilling.
2. Inspect each rod during tripping. Retire any visibly polished, cracked, twisted, or damaged rods (e.g. visible stabbing damage to shoulders, heavy uneven wear patterns around midbody, gripper tooth indents deeper than .8mm or 1/32” on midbody, excessive midbody run-out).
3. If contaminated, clean debris from threads and reapply thread compound.
4. Consider rotating or re-ordering position of each rod in the string, to ensure the strongest joints with the least wear are positioned nearest the drill rig.

Note: Do not leave a rod string in a borehole suspended off bottom for extended periods to void stress-corrosion cracking.

## WEEKLY

1. Inspect adapters subs and accessories for damage or wear (e.g. adapter subs, water swivels, etc.). Replace as needed.
2. Inspect borehole survey for excessive deviations and correct borehole where needed.
3. Inspect box thread for a burr on the thread load flank (edge on mid-body side), and correct make-up and break-out settings as needed.
4. Inspect representative rods for visible wear, corrosion pitting and cracking, OD & ID on both ends. Discard worn, cracked or corroded rods and correct corrosion with appropriate drilling fluid additives.

## MONTHLY

1. Check rod box wear using OD wear gauges. The box shoulder should have at least 60% of its original thickness at its thinnest point. The midbody wear always extends over the box but will be less than the box shoulder wear. Discard rods that do not pass gauge check.
2. Check thread wear on reverse flank threads, RQ/XQ, using the thread profile “finger” gauge. The gauge should not be removable without unthreading. Discard any rods that fail this inspection and correct make/break settings as needed if prematurely worn.

Note: In some conditions, wear or corrosion can progress more rapidly. These recommendations do not guarantee failures will be prevented.