Technical Bulletin		
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Stick Slip Mitigation Through the Implementation of Electroproject Soft Torque Technology; TESCO Electric Top Drives		

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BACKGROUND INFORMATION:

"Stick-slip" is a common occurrence in drilling operations in which rotational vibrations in the drill-string, as a result of friction on the bit, bottom hole assembly (BHA) and/or drill-string itself, can cause damage to the bit and cutters, leading to decreased rate of penetration (ROP) and decreased bit life.

Electroproject of the Netherlands has developed Soft Torque Technology designed to effectively mitigate stick-slip (see attached Annex 1 and Annex 2). Mitigating stick-slip in drilling applications has been proven to save costs by:

a. increasing rate of penetration (ROP)
b. improving steerable system performance (reduced failures)
c. reduced bit damage, longer bit runs

In the 3rd quarter of 2010, Electroproject, TESCO Asia Pacific Business Unit (APBU) and TESCO Calgary Engineering implemented Electroproject Soft Torque Technology on TESCO's ECI-900 top drive operating on the SONGA VENUS rig for SHELL off the coast of Australia.

Automatic mitigation was achieved by changing the top drive speed and torque controls via software and electronics, and testing was performed in both Singapore and TESCO Calgary Manufacturing facility, prior to implementing off the coast of Australia.

AFFECTED PRODUCTS:

Informational only.

ACTION REQUIRED:

Informational only.

Better Ways to The Bottom™

Contact your local TESCO Parts and Service Center for further information regarding this bulletin and or supply of affected components noted above.

Version	Date (D/M/Y)	ECN	Description of changes
Rev 0	18/10/2010	127-0267	Initial release of document

Annex 1. Stick-Slip mitigation

1.1. What is “Stick-Slip”?

“Stick-slip” is a common occurrence in drilling operations that can result in harmful rotational vibrations in the drill-string. Although the drill-string is continuously rotating at surface during the drilling operation, friction on the bit, bottom hole assembly (BHA) and/or drill-string itself can cause it to “stick” down hole. As rotation at surface continues and torque in the drill-string builds up, this ‘stick’ friction is suddenly overcome causing a sudden increase in speed ("slip") as the drill-string 'unwinds' itself. When fully developed, stick-slip can cause the bit and BHA rotation to completely stop and accelerate up to 5-6 times the surface r.p.m.

“Stick-slip” can cause:

- **damage to the bit;**
- **broken cutters;**
- **decreased rate of penetration (ROP)**
- **decreased bit life.**

Furthermore, it can also damage other down hole components such as rotary steerable systems, and Measurement While Drilling devices (MWD). It can even cause down-hole motors to stall.

1.2. Recognizing when “Stick-Slip” is occurring

There are two clear stick-slip indicators for the driller:

1. **Large variations in surface torque.**
2. **Large variations in downhole RPM.**

The torque variations can be accompanied by “groaning” noise coming from the top drive. Characteristic for the slip-stick behaviour is the saw-tooth behaviour of the torque, which can go up to 50% torque variation. In Figure 1 is an example of the characteristic saw-tooth torque variations. This behaviour can only be seen clearly when using data with at least 1-second sample time.

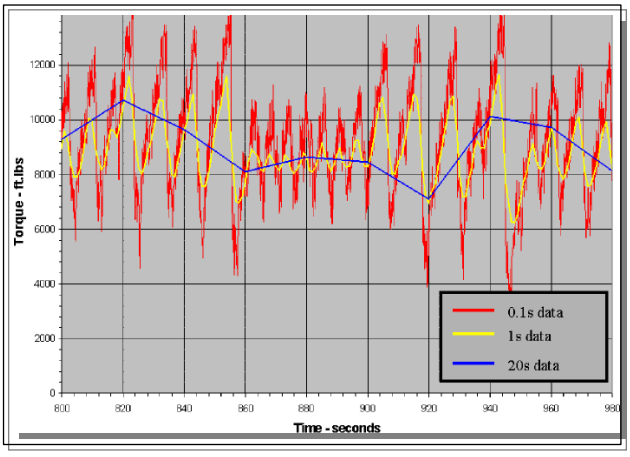

Figure 1: Torque variations due to stick-slip

1.3. How to reduce “Stick-slip”

Stick-Slip occurs at a rotary speed below a certain threshold value. The threshold value depends on system parameters such as design of the drill-string, mud, bit, BHA and weight on bit (WOB). The driller can reduce stick-slip by:

1. Increasing the rotary speed (RPM);
2. Reducing the weight on bit (WOB);
3. Add lubricants to the mud system;
4. **Install Electroproject soft torque system (EPST) to reduce Stick slip.**

Please note that EPST, is the first soft torque system specifically developed for AC top drives and modern DC drives. EPST technology has been in use since the early ‘90’s.

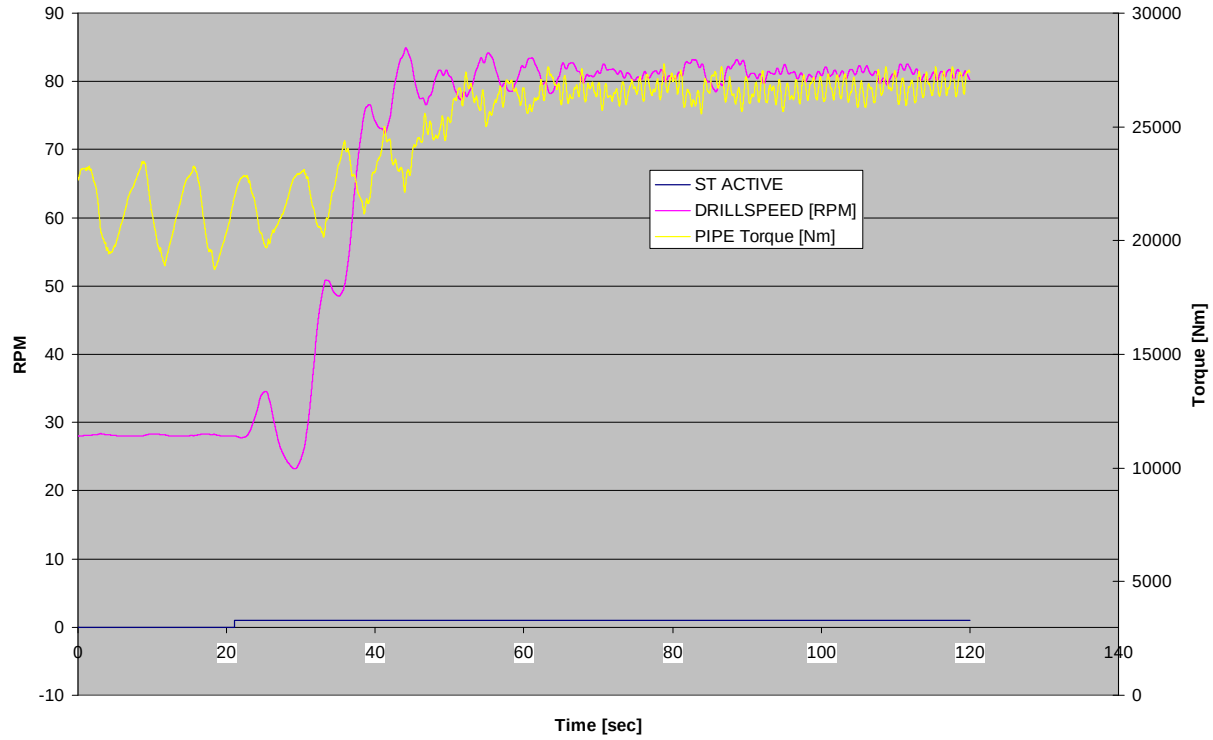

Figure 2: Activating soft torque

In Figure 2 at 21 seconds soft torque is switched on. Torque becomes smoother and speed variations are greater. This is typical when soft torque is active.

Annex 2. Electroproject Soft Torque.

In general the EPST is described below.
Depending on implemented drive system and the used controls for top drive, the functionality of the EPST system and the used components could differ.

2.1. General System overview

The EPST system is designed to be easily implemented in modern drive systems.
The EPST controller is a standalone but RIG specific µ-processor based controller. It can operate without any interface with the RIG-controls.

To implement the system the following hardware is required:

1. Touch panel to operate the system.
2. Industrial PC (IPC). The Soft Torque controller.
3. Additional PROFIBUS communication interface with variable frequency drive (VFD)
4. Ethernet communication between touch panel and IPC
5. If not already present, speed encoder at TOP DRIVE motor.

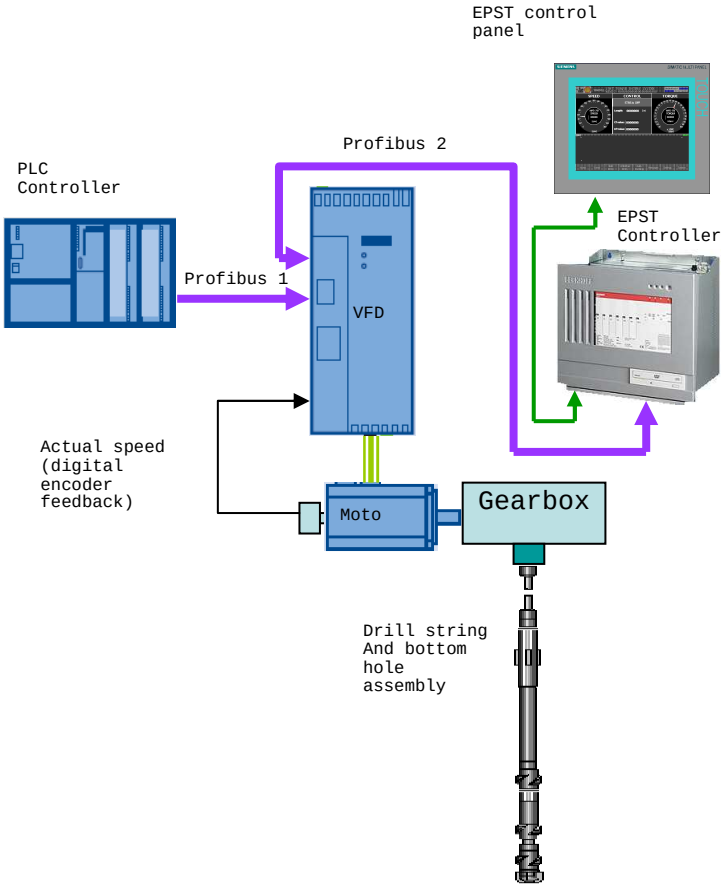

Figure 3: EPST System overview

2.2. Principle of operation

An oil-rig's top-drive is a multi-purpose controllable high power drive. During drilling the drill-pipe is the intermediate between a drill and the top-drive. A practical problem is so called `stick-slip' while drilling. Experience shows that a relatively constant speed of the drill is optimal for effective penetration, low drill wear and good steering conditions.
At certain depths and depending on drill conditions, among others: friction on bit, drill speed and weight on bit, the drill bit can “stick” down hole while the drill-string keeps rotating. The drill-pipe acts as a torsional spring. Since the Top Drive does not recognize the “stick” of the drill bit, the rotation of the drill pipe continuous and the drill-pipe will wind up. As a result the torque in the pipe builds up. At a certain torque value the “stick” friction is overcome and the drill-bit suddenly increase in speed while the drill pipe “unwinds” itself. This suddenly increase in speed can damage the bit. Also steering rotary drilling operation is very difficult under “stick-slip” conditions.

The EPST system is designed to mitigate the stick-slip behaviour. The EPST controller is a speed controller tuned with the Kf (drive stiffness in Nm/rad) and Cf (drive damping in Nms/rad) values. Depending on the drill string and BHA configuration the tuning parameters Kf and Cf are calculated. EPST will be able to improve damping of stick-slip when the two tuning parameters Kf and Cf are on target or not too far from ideal values. Also drill speed needs to be above a critical value. Compared to normal operation (EPST is off) the critical speed value is lower when soft torque is on.

There are two ways to specify Kf and Cf.

1. Manually input of Kf and Cf (Home screen)
2. Calculation with integrated BHA and drill string configuration.
   (BHA and Drill pipe entry screen)

2.3. EPST control and input

With the touch panel the EPST controller can be operated and speed and torque variables can be monitored.

The EPST controls consist of:

1. Switching Soft Torque (ST) ON and OFF.
2. Entering the right settings for the tuning parameters Kf and Cf.
3. Calculation of Kf and Cf depending on BHA and Drill pipe specifications

2.4. Speed and torque monitoring

On the touch panel, actual values of speed and torque can be monitored in real-time.
These values can also be monitored graphically in a trend display of 100 seconds.

2.5. Advanced data logging

The EPST controller is programmed in an IPC (Industrial PC). The operating system is Linux.
The IPC also function as a data server for logging purposes, the EPST-server.

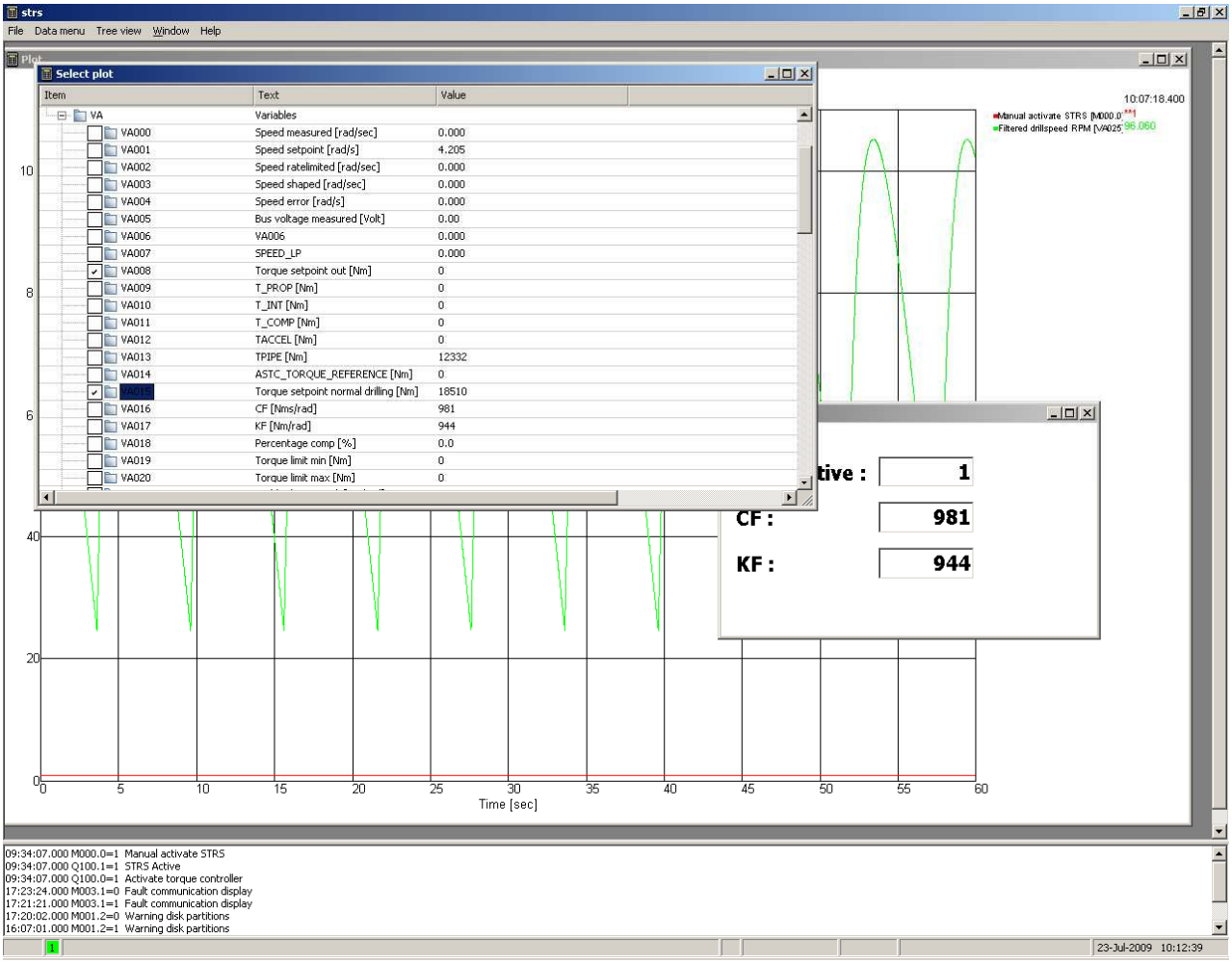

Figure 4: Screenshot ST log-data view program

The EPST-server, stores the actual values of all inputs, outputs, variables, markers and parameters to hard disk. When the VFD is operating, the resolution of this log data is 5ms. Depending on the size of the applied hard disk(s), log data can be hold for months.

The log data can be viewed, exported and analyzed with a special EPST data-log view program.
The EPST data-log viewer can be installed on a Windows based PC.

2.6. Remote access

If the IPC is connected to a WAN network, logdata and status of the IPC can be remotely accessed.
Even remote assistance and updates are possible.

If a connection has to be made between the EPST network (IPC and touch panel) and another network, a specific TCP/IP setting has to be made. These settings can only be changed by Electroproject personal. The standard IPC TCP/IP configuration is stand alone but RIG specific with a DHCP server enabled.
Please contact us for other configurations.

2.7. EPST off-line

Since the EPST system is designed as a standalone but RIG specific controller the drill operation can continue if the EPST system is off-line.
Drill operation can continue with disconnected EPST system. If the EPST is turned off, the original control of the VFD is restored.