EXTREME EQUIPMENT SALES & RENTALS

PowerDrive Managing Low Flow Rates Revision 3.0

Date: October 24, 2022

Applicability: All sizes and configurations

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BACKGROUND INFORMATION

The PowerDrive Control Unit maintains a geostationary position in the assembly by alternatively drawing power from the upper and lower torquers as necessary. When the tool is turned off abruptly by quickly lowering flow rate below the minimum 'tool turn on' flow rate, large amounts of electrical energy can be released into the components in line with the torquers. Diodes, IGBT's, PSPD boards, and even the torquers themselves can be at risk by an uncontrolled release.

Positive pulse MWD can instantaneously reduce downhole flow rate through the PowerDrive assembly by up to 40% during pulse events, depending on size and configuration.

PowerDrive takes time to boot and start recording data after the flow is raised above minimum turn on flow rate. With most positive pulse MWD tools interrupting flow more frequently than this, there are potential scenarios where the tool sees multiple releases of electrical energy without recording any data to memory. These periods can also fatigue power components, causing failure later after exposure.

Many of these 'low flow' exposures happen during high-risk operations identified in previous bulletins. Filling pipe during trips, reaming, or other off-bottom activity are often where it is advised to keep flow to a minimum to avoid rotational energy off bottom with a motor-driven assembly.

When the MWD tool pulses, there is a significant drop in the flow rate seen by the torquers and the RPMs drop. During these drops, the flow can briefly fall below the minimum drilling flow, or the tool turn on flow at each pulse. Dropping below the minimum drilling flow can result in reduced steering capability of the tool.

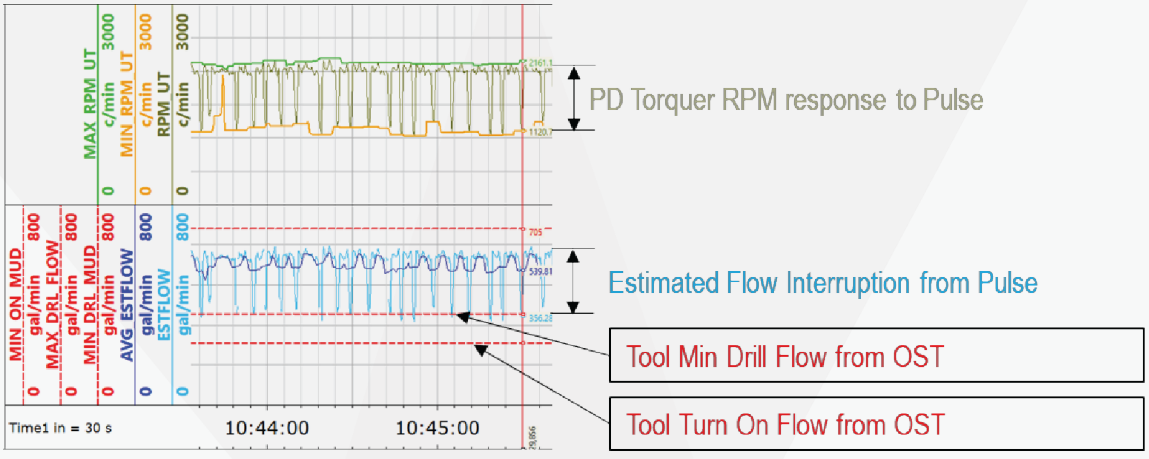

Figure 1: Flow response to Positive Pulse MWD

During low flow operation, the flow rate can drop below the tool turn on threshold and the tool can experience repeated power resets that can cause stress and lead to failure of these components.

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RECOMMENDED ACTIONS

PowerDrive should be kept at least 10% above the minimum turn on flow (listed on the outgoing systems test paperwork) at all times to avoid unwanted releases of electrical energy as discussed above. This includes accounting for motor bearing leakage and downhole flow variations caused by positive pulse MWD tools.

EXAMPLE CALCULATION

FLTurnOn = Turn on Flow listed on OST – Example =300 gpm

Motor Loss% = Expected motor bearing losses (%) – Example = 5%

MWD Pulse % = Positive pulse MWD losses (from offset applications) as percentage of average flow rate through PD – Example = 30%

Margin% = Margin to stay above tool turn on flow listed in OST – Example = 10%

FLMinSurf = Advised minimum surface flow rate for low flow operations – Output from the Calculation

$FL_{MinSurf} = FL_{TurnOn} + \text{Motor Loss\%}(FL_{TurnOn} + \text{MWD Pulse\%}(FL_{TurnON}) + \text{Margin\%}(FL_{TurnOn})$

Example

$FL_{MinSurf} = 300gpm + 0.05(300gpm) + 0.1(300gpm) + 0.1(300gpm) = 435gpm$

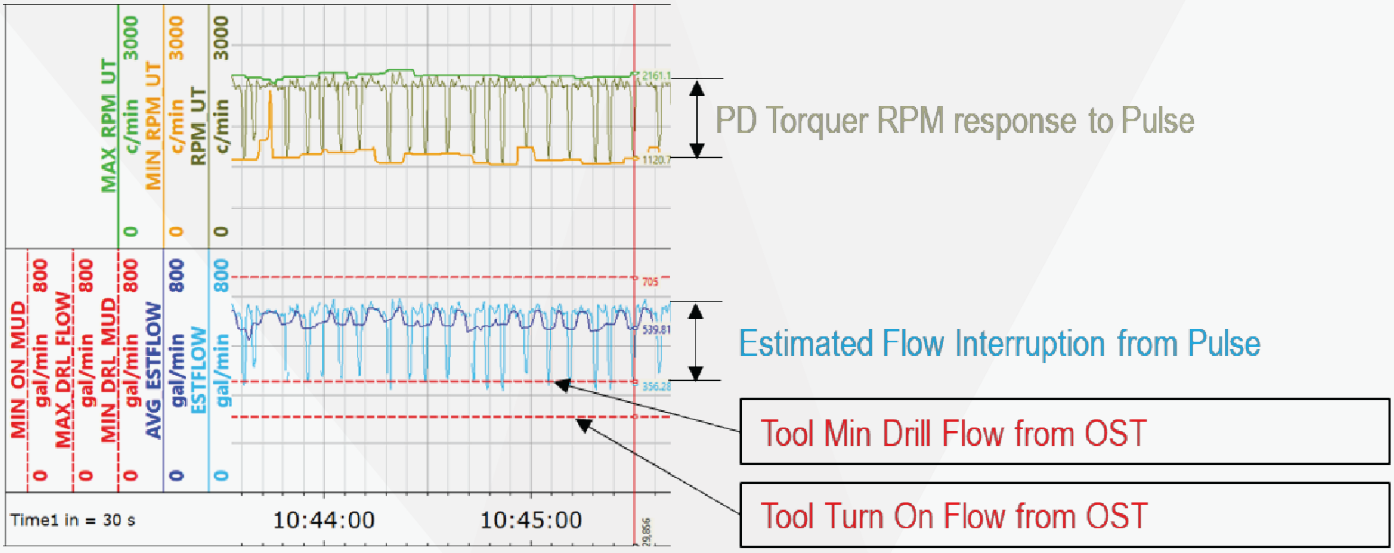

Figure 2: Example of high risk combination of low flow with positive pulse MW.

EXTREME EQUIPMENT SALES & RENTALS CHARGES

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EXAMPLE OST AND NOTES

All PowerDrive tools are tested over their full flow range before leaving the maintenance facility. Tests are performed in water, but may be corrected for expected mud weight. Results of this test are included in the paperwork provided with all tools.

Minimum Turn On flow rates are listed from the test in water. Calculated data corrected from water to 11ppg mud weight is also presented for reference. A chart is also included that can be used for correction to other anticipated mud weights.

PowerDrive Flow Loop Analysis

Tool/Processing Information

MfgCode/ToolName:	PDX6B/PDCU-CA	Processed Date:	Nov/05/2022
Tool Version:	32	Processed Time:	10:33:50 AM
ToolScope Version:	2019.0.2.21c	Processor Name:	S.Miller
CU Serial Number:	04167	Location Name:	USL
Flow Kit:	PD675_MF_8_blades	SU/Tool Type:	Orbit
Tool Dump File:	C:\TOOLDATA\CA32\PDX6_04167\Temp\2022_11_05_04167_FL-2022-11-05-09-21-08\ControlUnitTests\PDCU-CA_04167_ControlUnitTest_2022110		

Test Summary

In Water:

Maximum drilling flow rate (GPM):	718
Minimum drilling flow rate (GPM):	318
Minimum tool turn on flow rate (GPM):	245

In Drilling Mud:

Mud weight (ppg):	11
Maximum drilling flow rate (GPM):	718
Density corrected minimum drilling flow rate (GPM):	290
Density corrected minimum tool turn on flow rate (GPM):	223

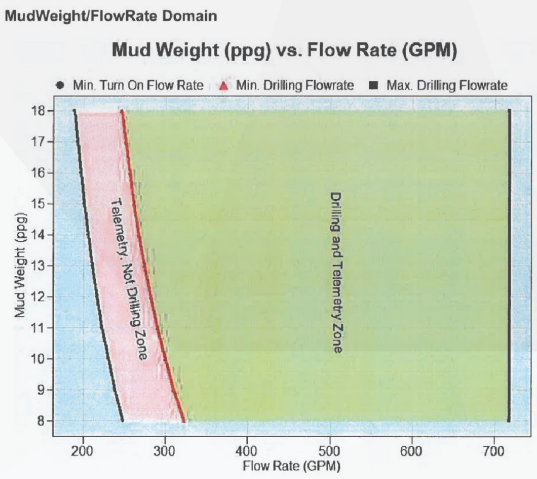

Figure 3: PowerDrive Outgoing Systems test paperwork – listing minimum turn on flow rates and density correction chart.