Suggested Changes in Seismic Data Acquisition Based on the DST Seismic Trace Characterization

During Downhole Seismic Testing (DST) data acquisition the operator would like to have feedback how to obtain the most reliable results. BCE has developed a characterization method of the acquired data (the so-called Seismic Trace Characterization (STC)) that is based upon various independent parameters or trace metrics of the acquired DST data at a particular depth. Currently, BCE has indentified five trace metrics:

- Parameter 1: the linearity estimates (LIN) from polarization analysis. The LIN trace metric quantifies the correlation between X, Y and Z axis responses.
- Parameter 2: the Cross Correlation Coefficient (CCC) of the full waveforms at the particular depth and the preceding depth. The CCC trace metric gives an indication of the similarity between the two waves being correlated when deriving relative arrival times.
- Parameter 3: the Signal Shape Parameter (SSP). The SSP trace metric quantifies the deviation of the shape of the frequency spectrum from an ideal bell shape
- Parameter 4: the Peak Symmetry Differential (PSD) trace metric facilitates the identification of traces whose peak source wave responses have been significantly skewed due to measurement noise or source wave reflection interference.
- Parameter 5: Signal to Noise Ratio (SNR). The SNR trace metric is solely provided to quantify what portion of the spectral content of the recorded seismogram resides within the desired source frequency spectrum irrespective of source wave distortions such as near-field effects, reflections, refractions, and “dirty sources”.

These parameters are described in more detail in Technical notes 15, and this note provides possible reasons why a parameter can drop below the trigger value and for each reason possible corrective action is indicated.

Cross Correlation Coefficient		**Trigger value = 0.79**
Description	**Possible reason(s) for flagging**	**Possible corrective action**
This parameter gives an indication of the similarity between the current seismic trace and the trace for the same polarization at the previous depth	The site conditions have changed (e.g. construction activities have started nearby)	• If possible reduce background noise sources (e.g. turn off a water pump or vehicle engine) • Increase data gain
	The data collection conditions have changed (e.g. SH source plate-ground coupling has changed, mechanism of hammer impact has changes, a different hammer is used to generate the last seismic wave)	• Confirm that the source plates are still level and do not slip or move upon impact • Use a consistent wave source (e.g. a pendulum hammer).
Linearity		**Trigger value = 0.78**
Description	**Possible reason(s) for flagging**	**Possible corrective action**
this parameter gives an indication of the similarity between the X-axis and Y-axis responses of the seismic trace	The site is noisy (the recorded trace reflects the seismic wave generation, and also other sources)	• If possible reduce background noise sources (e.g. turn off a water pump or vehicle engine) • Increase data gain
	The source wave generation is poor	• Confirm that the source plates are still level and do not slip or move upon impact • Consider increasing the radial source offset from seismic probe • Use a consistent wave source (e.g. a pendulum hammer).
	The seismic waves are reflected	• Investigate the presence of nearby foundations or stone columns, and note their presence in the Site Information • Investigate the presence of surface materials such as gravel, loose sand or very soft clay, and note their presence in the Site Information

Signal Shape Parameter		**Trigger value = 0.59**
Description	**Possible reason(s) for flagging**	**Possible corrective action**
this parameter gives an indication of how well the frequency spectrum of the acquired trace matches the ideal bell curve shape	The source wave generation is poor	• Confirm that the source plates are still level and do not slip or move upon impact • Place more absorbent material on top of the source plate • Consider increasing the radial source offset from seismic probe • Increase data gain • Use a consistent wave source (e.g. a pendulum hammer).
	The seismic waves are reflected	• Investigate the presence of nearby foundations or stone columns, and note their presence in the Site Information • Investigate the presence of surface materials such as gravel, loose sand or very soft clay, and note their presence in the Site Information
Signal-Noise Ratio		**Trigger value = 0.80**
Description	**Possible reason(s) for flagging**	**Possible corrective action**
this parameter gives an indication of the noisiness of a seismic wave by comparing the seismic wave before and after filtration	The power supply causes excessive background noise in the signal	• Use a different power source
	The recorded signals reflect the presence of rod noise or near field waves	• Increase radial source offset from seismic probe
	The site is noisy (the recorded trace reflects the seismic wave generation, and also other sources)	• If possible reduce background noise sources (e.g. turn off a water pump or vehicle engine
	The seismic wave generation is inadequate for the test depth	• Increase the impact energy for the source wave generation (e.g. use a heavier hammer or a greater drop height) • Increase data gain

Peak Symmetry Differential		**Trigger value = 0.6**
Description	**Possible reason(s) for flagging**	**Possible corrective action**
this parameter gives an indication of the symmetry of the peak response	The source wave generation is poor	• Confirm that the source plates are still level and do not slip or move upon impact • Place more absorbent material on top of the source plate
	Excessive source wave reflections generated or near field effects	• Increase the radial source offset from seismic probe • Investigate the presence of nearby foundations or stone columns, and note their presence in the Site Information • Investigate the presence of surface materials such as gravel, loose sand or very soft clay, and note their presence in the Site Information