

## Failure Analysis – Failure Simulation

*Doug Lehr, P.E.*

This is the 5<sup>th</sup> in a series of six articles on Failure Analysis for downhole tools.



With the Storm Packer [Root Cause Analysis](#) complete, the probable RCs will be known. The next step is to confirm causation of the failure. In Failure Simulation (FS) the goal is to confirm cause and effect. When more than one probable RC has been identified, the FS will consist of multiple simulation tasks. How extensive will the Storm Packer's FS program be?

Simple failures may not require an FS because the root cause is easily confirmed. An example would a straight thread connection loosening under torsional load. The RC may be the absence of set screws which may be confirmed by an SME. But complex failures require investigation of multiple RCs using methods such as laboratory testing, numerical analysis, PCB simulations, and process investigation.

Full-scale laboratory testing is frequently used for FS of exploration and production equipment to assess equipment response to static and dynamic loads, changes in temperature, and orientation (horizontal vs. vertical). CFD is used to simulate component response to fluid flow, and FEA is used to assess local response to mechanical loads. If electronics failures are suspected, simulation software can be used to study PCB response to thermal inputs over time. Lab testing is usually used to confirm the numerical analysis.



Each FS is different, but these recommendations will help ensure success:

- Not all RCs require simulation; for some, the RCA findings will be sufficient.
- Complete numerical analysis prior to lab testing
- Decide which probable RCs will require simulation, and which simulation to use.
- Assess suspect components, based on analytical results, during the lab test program.
  - Human factors, as probable RCs, can be part of a full-scale equipment lab test program.
  - Equipment testing should always include the accessories in use at the time of the failure.
  - The reported sequence of events must be part of any equipment test procedure.

The storm packer failure has more than one probable RC, so the FS program will consist of full-scale lab testing, process investigations, and possibly numerical analysis.

**TRUTH: There is no substitute for simulating a failure and confirming its root cause.**

[Integris Technology Services LLC](#) provides failure analysis services. Send your inquiry to [info@integris-llc.com](mailto:info@integris-llc.com).

Copyright © (2021) Integris Technology Services LLC

(713) 449-2246 | [info@integris-llc.com](mailto:info@integris-llc.com) | [integris-llc.com](http://integris-llc.com) | The Woodlands, Texas USA 77381