



# magazine

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## Technology Incubators

incubating technology  
in the north sea

underbalanced,  
coiled tubing  
provides boost for  
mature algerian field

drilling with casing:  
better ways to  
get to bottom

pursuing the  
pristine core

avoiding costly  
workovers with  
safety valves

extreme software  
extends engineering  
capabilities

economical intervention  
technology in nigeria



# Getting to the Root Cause

Seven-step approach promotes process and product excellence and prevents recurring incidents.



Keith Morley, Vice President, Operations Support and Chief Safety and Compliance Officer

Weatherford's Enterprise Excellence Process (EEP) is driving the company's commitment to eliminating recurring incidents for our clients. The Root Cause Analysis (RCA) process is one of the primary tools being used to achieve this objective. Although the concept of root cause analysis is nothing new, the process that Weatherford has developed around its core principles is unique. Grounded in best practices from various industries, the company's RCA process includes a Corrective/Preventive Action Request methodology that extends far beyond problem identification, providing a channel for both short-term and long-term prevention.

## Two Processes, One Result

The five-step Problem Elimination process works in conjunction with the RCA process to ensure that an incident does not recur. Here is where the short-term and long-term solutions come into play and specific, measurable, achievable, responsible and timely (SMART) corrective actions are chosen based on the situation.

When effectively applied, RCA improves the processes through which work is done and ensures closure of gaps or missing controls. In many cases the impact on human and capital resources can be critical.

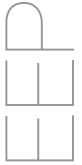
## RCA at Work in the Gulf of Mexico

Two years ago a hydraulic-control oil leak was observed on a blowout preventer (BOP) in the Gulf of Mexico during a routine weekly pressure test on a wellhead stack assembly. This was the top BOP and one of four in the assembly. It was the first installation of the BOP equipment since the original equipment manufacturer remanufactured it, and the equipment had passed seven consecutive weeks of testing. But the BOP failed the pressure test during the eighth week, and well operations were suspended until the problem could be resolved.

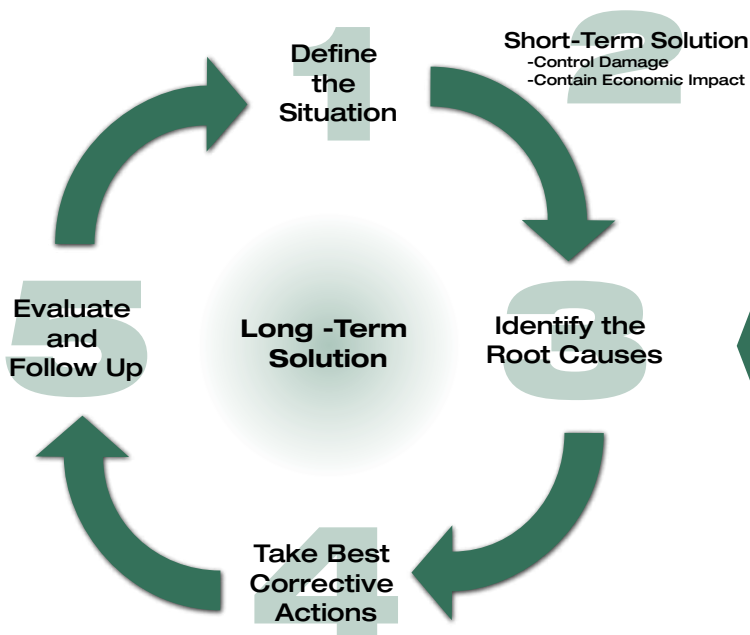
"Once this happened we were forced to take the short-term corrective action, which was to fix the leak quickly, avoid any environmental contamination and get the well back in operation," says Rakesh Agarwal, Manager of Reliability for Weatherford's EEP group. With a PhD in mechanical engineering, Agarwal is responsible for overseeing the RCA process.

Once the equipment was returned, the manufacturer ran pressure tests and disassembled it for detailed inspection; however, no defect was found. Weatherford followed up with a request that the BOP be shipped back to its wellhead technical support team for further analysis.

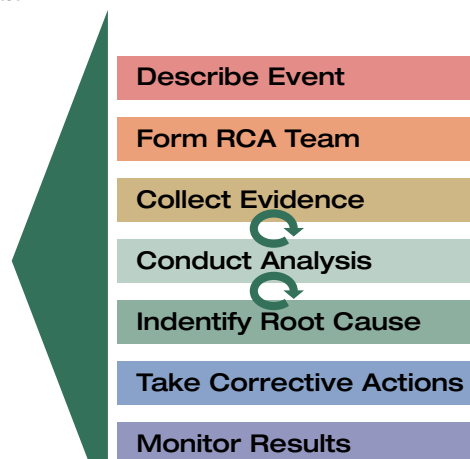
"And that's where things got interesting," says Agarwal. "Our team found a pit in the dynamic O-ring groove that was approximately 1/8 inch (3 millimeters) deep, scar marks on the

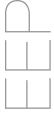


## 5-Step Problem Elimination Process



## 7-Step Root Cause Analysis Process





## Narrowing Possible Causes

Weatherford's structured RCA process has been integrated into the company's culture. With regard to managing product and process incident investigations, it helps narrow a host of possible causes. The process consists of seven steps:

- 1. Describe the event.** This step involves determining what happened by tracing the system failure to the most basic component or part.
- 2. Form an RCA team.** The team proposes viable hypotheses for factors contributing to the incident. Focus is placed on process gaps versus human error.
- 3. Collect evidence.** A key benefit of this step is that all hypotheses about the incident that cannot be supported by evidence are rejected.
- 4. Conduct analysis.** All hypotheses that are supported by evidence are further analyzed, and contributing factors are determined.
- 5. Identify root cause.** The current process is reviewed to identify ineffective or missing controls for each of the contributing factors of the validated hypotheses. Gaps in the controls lead to the true root causes.
- 6. Implement corrective actions.** Corrective actions that focus on effective and economical management of the contributing factors by process are determined and implemented.
- 7. Monitor results.** Effectiveness of the actions and their implementation is determined by measuring performance improvement over a specified period of time. Monitoring and measuring continue until it has been demonstrated with a high degree of confidence that recurrences of the incident and its symptoms have been eliminated.



Rakesh Agarwal, Manager of Reliability for Weatherford's EEP group, is the leading expert in the Root Cause Analysis (RCA) process. RCA is one of the primary tools used in driving the company's commitment to eliminating recurring incidents for our clients.

piston surface, and a hairline crack on the surface of the static O-ring. We had to evaluate these defects against the product and material specifications and workmanship standards.”

In the end it was concluded that the pitting, the scars and the O-ring condition were beyond the acceptable limits set forth in the standards. Typically this is where most root-cause investigations end. The critical event in the problem's cause and effect is determined, and a fix is applied. But Weatherford's RCA process ensures that the root cause that lies deep within the process is identified and that specific corrective actions are implemented to remove the cause of the failure from the assembly process and prevent the incident from recurring.

“So we began to review the process to find out how these defects had escaped detection,” adds Agarwal.

Weatherford's processes that control avoidance of defects include detailed equipment specifications, incoming inspection and a client-approved test plan. Each of these processes were reviewed, and the gaps that led to the critical defects in the equipment were identified. Because these components are assembled by the supplier before Weatherford receives them, specifications now require that

inspections of O-rings and the surrounding surfaces be conducted and documented in the inspection checklist and that a copy of the completed checklist be shipped along with the equipment. In the future, these changes will help ensure a much higher integrity level of all critical components.

“Previously, undue reliance of the process on the client's approved test plan led to compromised product integrity,” says Agarwal. “If a tool met the approved test plan requirements, it was considered a good piece of equipment. But the RCA process helped us understand that the pressure test alone was not enough to ensure equipment quality. We had to put in place procedures and controls that ensured conformance to requirements of materials and processes resulting in quality products before we move on to the pressure testing.”

So far the product performance results have been error free, with zero failures since the original incident in the Gulf of Mexico occurred. The implementation of the RCA process as a part of our standard incident investigation process has also contributed to elevated confidence in Weatherford's capabilities to ensure the highest standard of product integrity, every time. ♥