PENSPEN

ROOT CAUSE ANALYSIS

Achieving Operational Excellence in the Energy Industry

In the highly dynamic and competitive business landscape, effectively addressing and mitigating problems is crucial for maintaining operational efficiency, enhancing productivity, and ensuring overall success. Merely treating the symptoms often leads to temporary fixes, leaving underlying issues unresolved and prone to recurrences.

Across various industries, from manufacturing and healthcare to engineering and quality management – Root Cause Analysis (RCA) has emerged as a structured and systematic approach to dissecting complex issues, identifying the fundamental origins, and implementing targeted interventions to address them at the core.

Why Root Cause Analysis?

RCA gained substantial traction across various industries due to its ability to examine beyond surface-level symptoms and uncover the intricate web of factors contributing to specific problems or events. By uncovering the underlying root causes, RCA facilitates the development of tailored solutions that address immediate concerns and prevent future occurrences. This fosters a culture of continuous improvement and proactive problem-solving within organisations.

While RCA is widely used across various sectors, its application in the energy industry is particularly vital due to complex operations, stringent safety requirements and financial stakes. The energy sector faces unique challenges, including equipment failures, operational disruptions, safety incidents, environmental impacts, etc. Effective RCA can help mitigate these challenges, enhancing operational reliability, safety, and profitability.

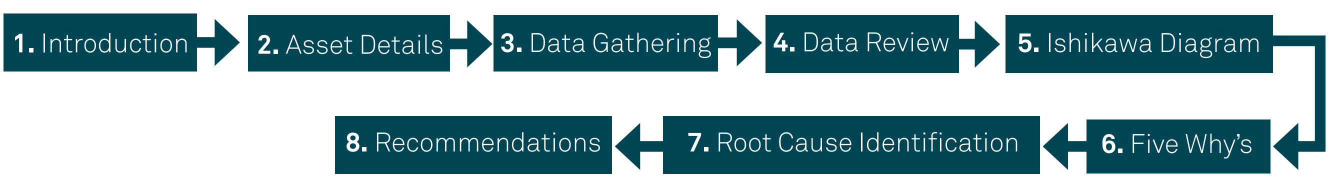

Figure 1: Steps for RCA

Introduction

The introduction sets the step for the RCA process by defining the problem/issue that needs analysis. It provides context and background information to understand the problem clearly. Effective RCA starts with a clear problem statement and well-defined objectives. The initial step of RCA is to set a foundation for a structured and focused problem analysis, where precision is paramount. The problem statement should at least cover the following:

- Clearly articulate the problem that requires investigation. Ensure the problem statement is specific, measurable, and actionable.
- Define the scope and boundaries of the problem statement.
- Descrive the impact and consequence of the problem.

Asset Details

This phase underlines in-depth asset understanding. Gathering information about the asset or system related to the problem includes details such as equipment specifications, maintenance records, operational history, and relevant documentation that provides insight into the asset, its function and performance. Asset details shall account for the following:

- Asset details should be able to determine the asset associated with the RCA Scope.
- Detailed information about the asset description and specification.Descrive the impact and consequence of the problem.
- Cross-referencing asset details reveals dependencies or interactions that might contribute to failures.
- Asset Operational status at the time of failure.
- Thorough maintenance history, including records of past repairs and upgrades.

Data Gathering

Collecting relevant data and information from diverse sources is critical. The data collection related to the problem involves observational data, historical records, operational logs, maintenance logs, incident reports, equipment manuals, interviews with personnel, and other sources that provide insight into the problem's occurrence and nature. The data is then organised in a structured format for analysis, thereby providing a comprehensive understanding of the issues.

Rigorous data gathering forms the basis for the RCA study and data can be categorised as follows:

- Data related to design, manufacture, construction, and commissioning phases.
- Data related to operating conditions and service environment.
- Data related to inspection, monitoring, and survey activities results.
- Relevant applicable specifications, procedures and recommended practices.

Data Review

A meticulous review of the collected data is essential. Analyzing and reviewing the collected data helps identify patterns, trends, and potential factors contributing to the problem, providing a comprehensive understanding of the issue leading to more accurate root cause determination. As part of the data review process, the following are to be considered:

- Organise and compile the gathered data in a structured format.
- Verify the consistency of data across different sources.
- Identify patterns and trends.
- Document key assumptions, findings, and insights.
- Assess the reliability of methods and procedures used to confirm data accuracy.

Ishikawa Diagram

The Ishikawa Diagram, or Fishbone Diagram, is a visual tool used to systematically identify potential causes of a problem. It categorises potential causes into specific groups such as people, processes, equipment, environment, materials, and measurement.

The Ishikawa Diagram is typically created with a cross-functional team to identify potential causes of a problem systematically. The team collaboratively generates ideas and populates the diagram with potential causes under each category. This structured approach helps ensure a comprehensive consideration of all potential factors contributing to the problem.

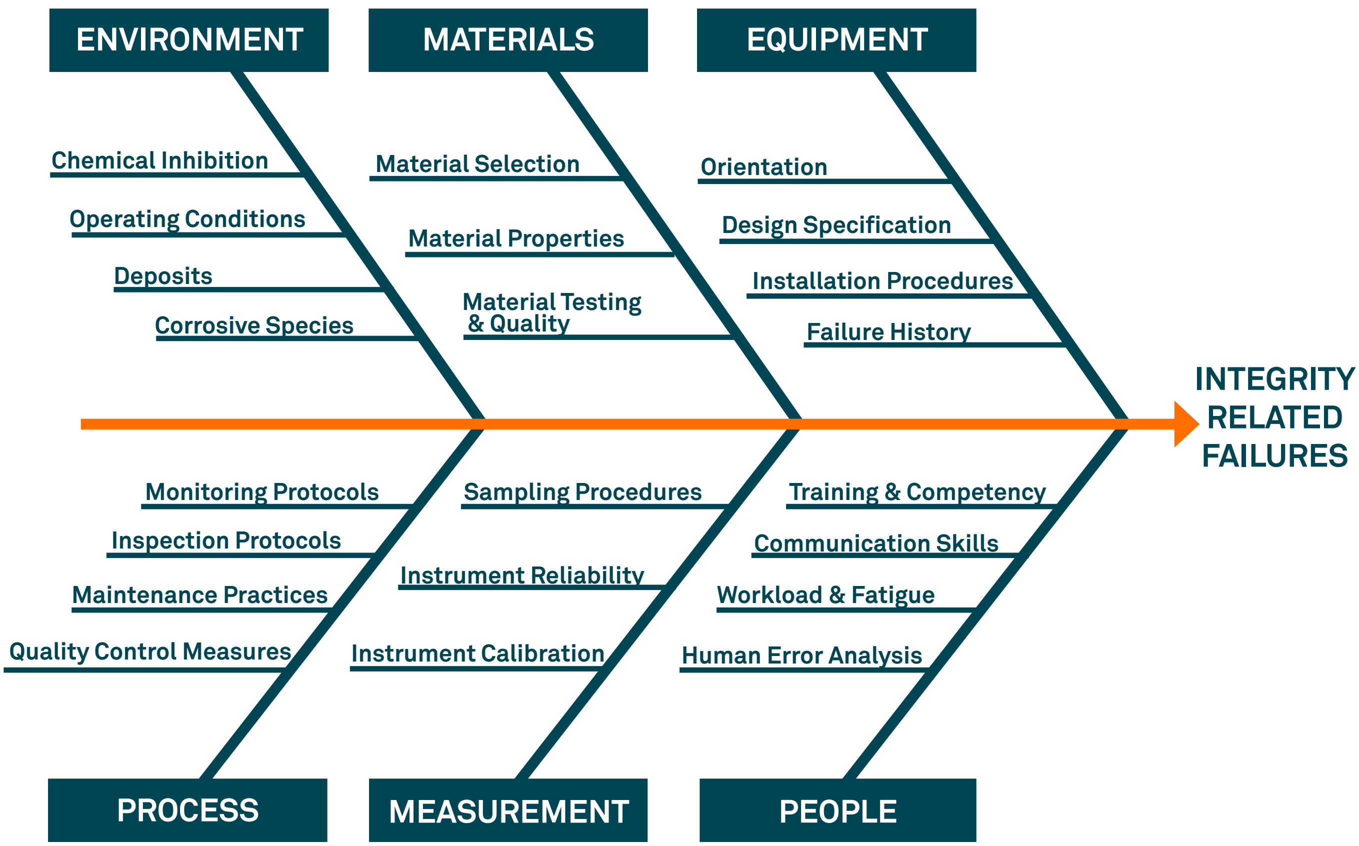

Figure 2: Ishikawa Diagram

ENVIRONMENT

- **Chemical Inhibition:** Insights into the effectiveness and application of chemicals related to the specific failure and system reliability.
- **Operating Conditions:** Temperatures, pressue, flowrates etc. to be studied to observe any possible impact on the high corrosion rate observed.
- **Deposits:** Under deposit corrosion occues beneath debris and scale adherent to the pipe.
- **Corrosion Species:** Evaluate the corrosive substances within the system along with their respective concentrations and compare against the design phase thresholds. Assess the interaction and compatability with construction materials and examine the adequency of chemical management and maintenance protocols. Also, analyse the interplay between corrosive species such as Sulphur, H2S, and Oxygen.

MATERIALS

- **Material Selection:** Evaluating the material based on the temperature and corrosion resistance, etc.
- **Material Properties:** Evaluation based on the physical, mechanical, and chemical properties of the materials.
- **Material Testing & Quality:** The evaluation of materials, based on testing and quality control during manufacturing and procurement, as well as material certification and traceability. is crucial.

EQUIPMENT

- **Orientation:** Accumulation of liquid or solid debris on horizontal piping sections.
- **Design Specification:** Assess whether the design adequacy accounts for factors like stress, pressure, and thermal conditions.
- **Installation Procedures:** Verify alignment, anchoring, and any other installation requirements to ensure optimal performance.
- **Failure History:** Explore the equipments failure history, if applicable. Determine whether there were prior incidents or recurring issues and analyse previous corrective actions implemented and their potential effect.

PROCESS

- **Monitoring Protocols:** Effectiveness , frequency, procedure, and accuracy of monitoring.
- **Inspection Protocols:** The effectiveness , frequency of inspection, inspection documentation, and evaluation of Risk-Based Inspection (RBI) programs are key elements to consider.
- **Maintenance Protocols:** Maintenance schedule and techniques to be considered.
- **Quality Control Measures:** Effectiveness of the quality control and the techniques adopted.

MEASUREMENT

- **Sampling Procedures:** Examine the procedures for collecting samples for measurements. Proper sampling techniques are crticial for obtaining representative data that reflects the actual conditons.
- **Instrumental Reliability:** Assess the reliability of measurement instruments. Instruments that are prone to malfunctions or drift can introduce errors in data collection. Effective detection range should also be considered and assessed.
- **Instrument Calibration:** Verify whether measurement instruments are regularly calibrated. Inaccurate measuremens can result from instruments that are not properly calibrated, leading to misinterpretation of data.

PEOPLE

- **Training & Competency:** The adequacy of the training has to be evaluated.
- **Communication Skills:** The evaluation of verbal and written communication skills.
- **Workload & Fatigue:** Evaluating the workload and fatigue levels of individuals.
- **Human Error Analysis:** Evaluation of the type and cause of errors.

Five Whys

The 5 Whys methodology developed by Sakichi Toyoda is a simple yet powerful technique used to explore the root cause of a problem by asking "Why" a number of times, starting with the initial problem statement. The answer to one question forms the basis for the next question. The method is called five whys as the root cause is typically determined within five questions.

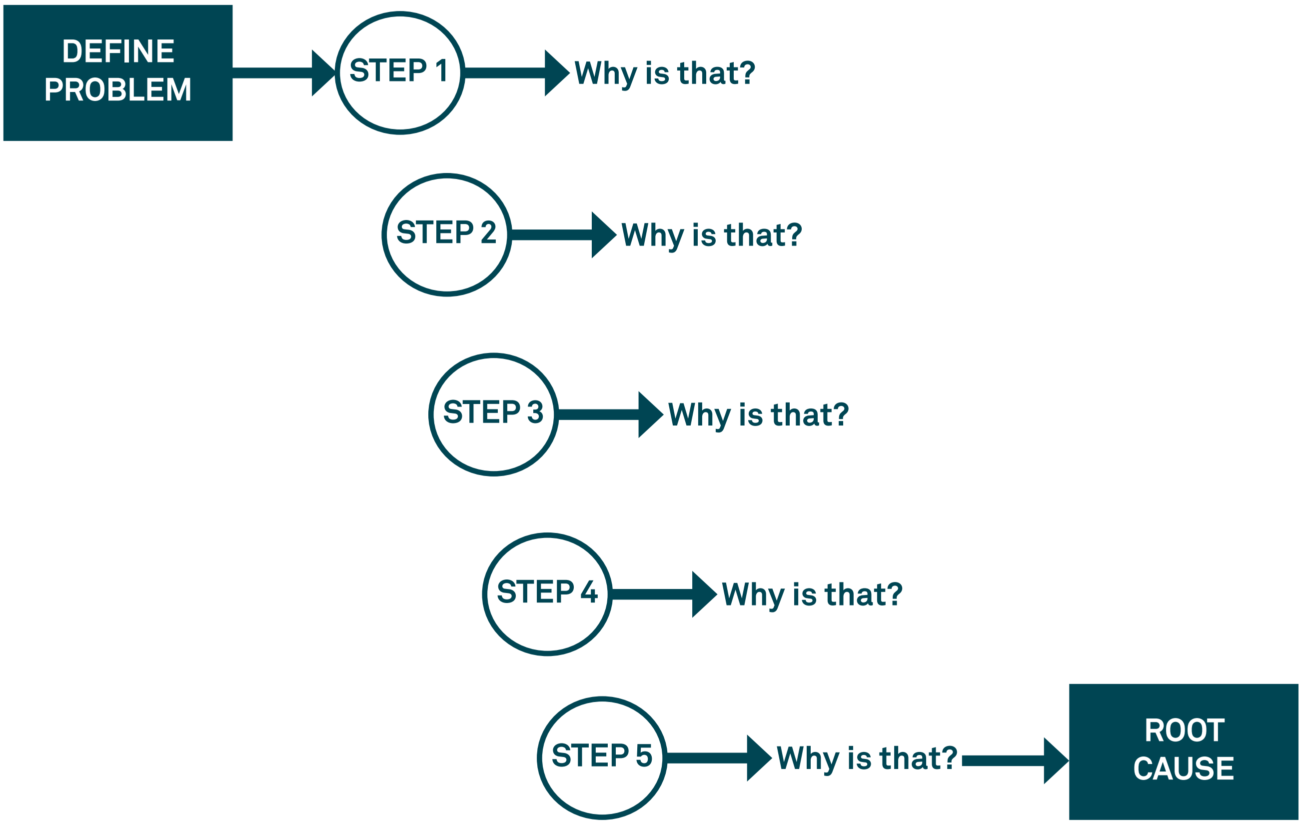

Figure 3: The Five Whys

Root Cause Indentification

Delve deep into the factors that contributed to the occurrence of the problem, formulating and testing hypotheses about the root cause(s) against available evidence and expert input. Combining insights from the Ishikawa diagram and the Five Whys, the root cause(s) of the problem is identified.

It is crucial to adopt a systemic perspective, looking beyond surface-level factors to understand broader systemic issues. Documentation of the identified root causes and supporting evidence and rationale ensures transparency and facilitates understanding. Ultimately, the root cause identification process serves as a foundation for implementing targeted corrective actions and driving continuous improvement within the organization. This step is crucial, as it prevents recurrent incidents and maintains operational integrity.

Recommen-dations

Once the root cause is established, tailored recommendations are developed. Customised recommendations directly address the identified root causes, ensuring they are practical, specific, and actionable. These recommendations also align with industry-specific standards and regulations, ensuring a holistic problem-solving approach. Characteristics examples of good recommendations are as follows.

- Directly address the root causes indentified in the analysis.
- Clear, specific, and actionable.
- Prioritise recommendations based on impact and feasibility.
- Consider the practicality and feasibility for the implementation.
- Clear communication - seek and secure support from the organisation.

Conclusion

Root Cause Analysis is a powerful tool for enhancing operational excellence in the energy industry. By systematically identifying and addressing the underlying causes of problems, RCA enables organizations to develop targeted solutions that resolve immediate issues and prevent recurrences. This fosters a culture of continuous improvement and proactive problem-solving, driving long-term resilience and success within the organisation.

At Penspen, we specialise in leveraging RCA to enhance operational efficiency and productivity in the energy sector. Our expertise and commitment to thoroughness and precision ensure that we uncover the fundamental origins of problems and implement targeted interventions to address them at their core.

About Penspen

Penspen is a global team of engineers who design, maintain, and optimise energy infrastructure to improve access to energy for communities worldwide. We help meet the world's evolving energy needs by providing consulting, project, and engineering solutions across the entire energy asset lifecycle.

For over 70 years, our teams have delivered more than 15,000 projects to in excess of 100 countries. By helping countries access lower carbon fuels and by extending the useful life of existing energy infrastructure, we help to bring cleaner energy to millions of people in thousands of communities across the Middle East, Africa, Asia, Europe, the UK, and the US.

Penspen is a proud member of SIDARA a leading, privately-owned professional services group with award-winning impact and global reach. As an engineering, architectural, and planning consultancy that values specialty expertise, Sidara is united by a commitment to providing clients with multidisciplinary solutions rooted in quality, innovation, collaboration, sustainability, and technology to deliver social and community impact

CONTACT OUR ASSET INTEGRITY TEAMS

Email: contact@penspen.com | Website: www.penspen.com