

Course ID
RCFA5
Course Duration
5 days

Course Title
Root Cause Failure Analysis: Workshop and Simulation

Related Courses

- Root Cause Analysis of Systems Failure: A Comprehensive Five Day Workshop (RCFA, 5 days)
- Root Cause Analysis of Systems Failure: A Comprehensive Course (RCFA4D, 4 days)
- Root Cause Analysis of Component Failure: Understanding Human and Engineering Factors for Improved Product Performance (RCFA-ME, 2-4 days)
- Root Cause Analysis of Systems Failure (RCFA2D, 2 days)
- Systems Engineering: An Intermediate Tutorial and Workshop (SYSENG, 2 days)
- Succeeding at Technical Management: Do's and Don'ts for the Technical Manager (DOS&DONTs, 1 day)

Aimed At

Engineers, technicians, operators, managers and others concerned with finding causes of failure in complex systems. We have several different versions of this course to address the varied needs of industries such as manufacturing, chemical, semiconductor, aerospace, water treatment plants, power generation, nuclear reactors, weapons systems, and others.

Group Size

5-25

Prerequisites

While there are no formal prerequisites, the course does assume on-the-job experience in an industrial or military setting.

Course in a Nutshell

This action-learning program, one of the most comprehensive in the industry, teaches both the theory and practice of root cause failure analysis. It includes numerous exercises, several case studies, and one major case study that simulates in-class the workings of an actual RCFA investigation including the team dynamics and interpersonal communications aspects.

We will discuss brainstorming, Ishikawa diagrams, mind mapping, flow charting, fault tree analysis, event and causal factors analysis, barrier and change analysis, MORT analysis, critical incident approach, and several other techniques for defining potential causes of the problem. We go on to discuss failed hardware evaluation technologies, design of experiments, and other technologies for converging on the

actual cause of the failure. We will then discuss potential corrective actions, including guidance for selecting the best solution. Throughout the course, you will learn how to apply the techniques taught to your own on-the-job RCFA investigations through a series of industry failure analysis case studies that highlight the investigative techniques, roles played by key characters in the analysis activity, the analytical approach, and the types of failure causes that can contribute to the failure. The class will also undertake a comprehensive simulation of a real-life root cause failure investigation, working in teams to analyze a relatively complex case scenario, conduct role plays and interviews, develop a root cause failure report, and present it before the class.

Customize It!

Do your failures involve products, processes, or complex incidents chains? Whether you work in manufacturing or nuclear plant operation, we have case studies to help tailor the course to the unique needs of your industry. We can also include in the course case scenarios derived specifically from your own work. The RCFA investigation techniques taught in the course are also customized to your industry. A comprehensive final examination can be optionally included as well. We encourage you to schedule post-class follow-up consultation to help you further your root cause failure analysis activity by engaging our RCFA expert with your team on the job and in real time.

Learn How To

- Objectively identify all potential failure causes using fault tree analysis, event and causal factor analysis, barrier and change analysis, MORT analysis, critical incident technique, design of experiments, and other technologies.
- Objectively assess the likelihood of each potential failure cause.
- Identify the most likely failure causes.
- Proactively eliminate additional potential failure causes before they occur.
- Work together in teams to conduct complex root cause failure investigations, engaging in interviews, analyzing data, writing a root cause failure analysis report, and presenting it to the class.

Course Outline

Day 1: Root Cause Failure Analysis

- Introductory Concepts
 - Root cause failure analysis philosophy
 - The four-step problem solving approach
 - The importance of a priori failure cause identification
 - ***Mast Mounted Sight group exercise***
- Pareto analysis
 - Vilfredo Pareto and the 80/20 concept
 - Pareto analysis approaches and perspectives

- Pareto analysis data sources
 - Using Pareto statistics to target root cause analysis efforts
- Identifying potential root causes
 - Brainstorming
 - Mind-mapping
 - Ishikawa diagrams
 - The 5-Whys technique and the Why staircase
 - Fault tree analysis
- Why analysis
 - The Why analysis approach
 - Staircase graphical format
 - Why analysis limitations
 - Why analysis example
 - **Why analysis group exercise**
- Blending root cause analysis approaches
 - Pareto analysis
 - Fault tree analysis (FTA)
 - Event and causal factor analysis (ECFA)
 - Barrier analysis
 - Management oversight and risk tree analysis (MORT)
 - Change analysis
 - Critical incident technique (CIT)
 - The 5-Whys technique
 - **Group exercise using different analyses (light bulb fails to illuminate)**
- Fault tree analysis introduction
 - Fault tree analysis history
 - Fault tree analysis applications
 - Fault tree analysis capabilities
 - Fault tree analysis construction introduction
 - Fault tree analysis example
 - **Fault tree analysis group exercise (light bulb fails to illuminate)**
- **Group discussion:** Different analysis approach advantages and disadvantages
- **Case study homework assignment:** The Uranium Water Treatment System Case Study (*this major case study, running throughout the course, can be replaced by a case study specific to your industry*).

Day 2: Fault Tree Analysis

- Prior material review
- **Case study discussion**
- Fault tree analysis construction

- Fault tree gate usage and interpretation
- Relationships between logic operators and events
- Fault tree gate usage and interpretation
- Fault tree analysis example
- ***Fault tree analysis group exercise***
- Inhibit gates
 - Using inhibit functions to model probability distributions
 - Inhibit gate examples
 - ***Inhibit gate group exercise***
- Fault tree analysis construction tips
 - Using a point to point approach
 - Navigating from the failure site
 - Using a sequential approach
 - State of the part events
 - State of the system events
- Using fault trees to identify redundancy-defeating failure modes
 - Approaches for identifying redundancy defeaters
 - Existing but undetected failure events
 - ***Case study discussion:*** F-16 fly-by-wire design and DC-10 engine loss
- Fault tree analysis quantification
 - Quantifying top undesired events
 - Failure rate sources
- ***Case study homework assignment:*** Prepare preliminary fault tree analyses for the Uranium Water Treatment System case study.

Day 3: Events and Causal Factor Analysis, Barrier Analysis, and Change Analysis

- Prior material review
- ***Case study discussion***
- Events and causal factors analysis (ECFA)
 - Events and causal factors analysis definitions
 - Events, conditions, causes, and terminal events
 - Verifying causal chains and event sequences
 - Integrating investigation findings
 - Communication during and after the investigation
 - Events and causal factors analysis charts
 - Assessing the safety culture from employee, management emphasis, and management practice
 - The importance of quantification
- Barrier analysis
 - Barrier concepts

- Identifying and selecting optimum barriers
- The hazard/barrier matrix
- Hazard effect pathways
- Failed countermeasures
- Missing countermeasures
- Sources of energy and tracing energy flows
- Sources of change
- Change-based characterizations
- Assessing countermeasure effectiveness
- Conducting the barrier analysis
- Change analysis
 - The pervasive nature of change in complex endeavors
 - "What's Different" analysis
 - Test and inspection data
 - Material certifications
 - Using flow charts for product performance and process evaluations
 - Interviewing techniques for field personnel
 - Customer/supplier interface issues
 - Engineering design and tolerance analysis
 - Other sources of change information
 - Words of caution: Change and correlation to the event
 - **Case study discussion: CBU-87/B detonator change analysis**
- **Case study homework assignment:** Prepare ECFA, barrier analysis, and change analysis for the Uranium Water Treatment System case study.

Day 4: MORT Analysis, Critical Incident Technique, FMA&A, and Failed Hardware Analysis

- Prior material review
- **Case study discussion**
- Management Oversight and Risk Tree (MORT) analysis
 - MORT history
 - General approach
 - MORT diagram conventions
 - MORT structure
 - Provisional and assumed risks
 - MORT as an investigational tool
 - Integrating MORT and Barrier Analysis
 - MORT analysis approach and procedures
- Critical incident techniques
 - The Critical Incident Technique
 - CIT history
 - Definitions

- The five CIT steps
- Incident reviews
- Fact finding
- Issue identification
- Decision making
- Evaluation
- Evaluating behaviors
- Interviewing techniques
- Effective versus ineffective behaviors
- Gaining interviewee trust
- **Group exercise: Interviewing operators, engineers, and others**
- Using Failure Mode Assessment and Assignment (FMA&A) matrices
 - Constructing the FMA&A
 - Using the FMA&A to guide the root cause analysis
- Failed Hardware Analysis
 - The value of failed hardware
 - Evaluating failed hardware conformance
 - Quality Assurance compliance assessment tools
 - Basic metallurgical and electronic component evaluations
 - Component failure analysis technologies, including optical microscopy, NDT methods, SEM, Composition Analysis, FTIR, EDAX, X-ray, N-ray, SIMS, Auger and FEA
 - Crack appearance in different loading geometries, including axial, bending, torsion, direct shear, and contact loading
 - Commercial failure analysis laboratories
 - Evaluating leaks
 - Testing to confirm failure causes
- **Homework assignment:** Prepare FMA&A, MORT, and CIT assessments for the Uranium Water Treatment System case study.

Day 5: DOE, Corrective Action, Reports, Procedures, Libraries, and Course Wrap-Up

- Prior material review
- **Critical incident reports homework discussion**
- Design of Experiments
 - Basic experimental design concepts
 - Hypothesis testing
 - z-tests, t-tests, ANOVA
 - Taguchi experiments
 - Selecting test parameters
 - Defining test specimen configurations
 - Strategies for minimizing test risk

- **Case study discussion: *The Navy ARS Guillotine***
- Corrective Action
 - Corrective action alternatives, including design modifications, process modifications, requirements relaxation, screening, and other corrective actions
 - Corrective action order of precedence
 - Corrective action implementation
 - Corrective action scope, including work in process, inventoried material, suppliers, and delivered equipment
 - Evaluating corrective action efficacy
 - Implementing corrective actions to address other hypothesized failure causes
 - **Group exercise**
- A suggested failure analysis procedure
- Creating a “Lessons Learned” document
- Preventing future failures
- ***Formal briefings by the class participants (organized into several teams)***
- Recap, Q/A, and evaluations

How You Will Learn

- A seasoned root cause failure analysis expert with 30 + years engineering, RCFA, and teaching experience will present this course in a highly engaging workshop/simulation format.
- Along with the lecture, we will use numerous exercises, several case studies, and one major case study/simulation to help you master the RCFA techniques and apply them on your job.
- You will learn the key concepts of root cause failure analysis from a theoretical, practical, and organizational perspective.
- You will receive a printed Participant Handbook which will help you remember and retain what you learned in class and apply it on your job.

Revised

10 March 29f