ROOT CAUSE ANALYSIS (RCA)

DEFINITION

RCA is a structured, team-based and streamlined approach for solving chronic failure problems in a process, product, or service. RCA applies practical, systematic methods for analyzing performance problems to uncover root causes. It prioritizes which problems should be analyzed first, and then explores effective ways of gathering data for root cause determination. Finally, RCA resolves to the primary root cause where the problem is found and fixed.

The Value of RCA:

- *Prioritizes which problems to tackle first utilizing the 80/20 concept*
- *Facilitates a concise RCA agenda to effectively brainstorm potential causes*
- *Drills down to the Root Cause by implementing the "5 Whys" technique*
- *Implements an immediate short-term fix, and the long-term Corrective Action*

OBJECTIVE

To effectively implement RCA methods to improve product and equipment quality that positively impacts overall Reliability, Serviceability, and Availability (RAS).

SITUATION

It is a common practice that equipment and system failures are often investigated at a superficial level. As a result, maintainers and operators keep running unreliable equipment, causing repeated losses. Also, they become experts at fixing rather than preventing the problems. What is left is a very reactive method of fixing equipment rather than a pro-active method of solving problems

WHO SHOULD ATTEND

RCA is intended for those involved in performing Root Cause Analysis on any type of issue — product or process — from engineering to operations, finance to service, or sales and marketing.

OUTLINE

Introduction and Objectives

- Importance of Root Cause Analysis
- Areas and uses for Root Cause Analysis
- 7-Step Process
  1. Define the problem.
  2. Gather data/evidence.
  3. Ask why and identify the causal relationships associated with the defined problem.
  4. Identify which causes if removed or changed will prevent recurrence.
  5. Identify effective solutions that prevent recurrence, are within your control, meet your goals and objectives and do not cause other problems. The solution should not just address the problem at hand, but should assure that similar problems also do not occur
  6. Implement the recommendations.
  7. Observe the recommended solutions to ensure effectiveness.

Identifying/Defining Problems

- Developing and testing a hypothesis
- The need for data
- Collecting data for problem solving

Analyzing Data for Root Cause

- Identifying contributing events (brainstorming)
- Event charting
- Available tools
    - Fault Tree Analysis (FTA)
    - Stress-Strength Analysis
    - Design of Experiments (DOE)
    - Material Analysis
    - Finite Element Analysis (FEA)
    - Dynamic Load Analysis
    - Thermal Analysis
    - Computational Fluid Dynamics (CFD)
    - Probabilistic Evaluations

Identifying Root Causes

- Pareto Analysis and Ishikawa (fishbone) diagrams
- Finite Element Analysis
- The 5 Whys technique
- Workshop - applying the 5 Whys technique

Environmental Considerations and Their Role in Accelerating Failures

- Temperature
- Vibration
- Humidity
- Drop/Shock

RCA Across Different Disciplines

- Electrical
- Mechanical
- Chemical
- Materials
- Optical
- Software
- Manufacturing

Introduce the concept of multidisciplinary solutions

Electrical RCA: Typical Failure Modes for Different Types of Components

- Printed Circuit Boards
    - Manufacturing Defects
    - Handling Issues
    - ESD Effects
    - Conductive Anodic Filaments
    - Plated through hole fatigue
    - Electrochemical migration
- Interconnects
    - Solderability Issues
    - Overstress
    - Intermetallic Formation
    - Wearout (Thermal Cycling, Vibration)
- Die-Level
    - Passivation Cracking
    - Die Cracking
    - ESD/EOS
    - Electromigration
    - Dielectric Breakdown
    - Hot Carrier Injection
    - MMIC and Hybrid Processes
- Passive Parts
    - Resistors
    - Capacitors
    - Inductors
    - Attenuators
    - Crystals
    - Microwave Components

Mechanical RCA
- Stress Analysis
- Fatigue
- Fracture Mechanics and Creep degradation
- Nonlinear Finite Element Analysis (FEA)
- Computational Fluid Dynamics (CFD)
- Probabilistic Evaluations

Electrical and Mechanical RCA Component Level Tools
- Radiography
- Cross-Sectioning
- Decapsulation
- Optical Microscopy
- Electron Microscopy
- Ion Chromatography
- Surface Analysis Techniques (FTIR, EDS, XRF, etc.)
- Material Analysis Techniques (DSC, TMA, TGA, etc.)
- Mechanical Analysis Techniques (Microtester, Bend Testing, Pull Testing, etc.)
- Chemical and Electrochemical Processes (Etching, Defect Enhancement, Liquid Crystal Techniques, etc.)

Software RCA
- Understanding similarities and differences between Software RCA and Hardware RCA.
- Tools employed for Software RCA
  - Software FMEA
  - Software FTA
  - Targeted Code Reviews
  - Implementation of Phase Containment metrics

Root Cause Analysis Programs
- Guidelines on conducting individual analyses
- Resolving recommendations
- Trending analysis results (plotting a timeline)

Creating a Root Cause Analysis Program
- Integrating root cause analysis with other programs
- Different Software Packages available vs. developing a "home-grown" system
- Workshop - Creating a root cause analysis program

Wrap-Up
- Course Summary/Question and Answer Session