Reliability Improvement using Defect Elimination

A Three-Prong Approach

The Keystone to Safe, Reliable, Profitable Production

Michael Voigt
Introduction

Michael Voigt

• 19 Years Experience
  – Petrochemical and Chemical
  – Mining

• Reliability and Maintenance Process Applications
  – Assessment
  – Engineering
  – CMMS
  – Routine & Turnaround Maintenance
  – Management System
  – Equipment Care and Condition Monitoring
Outline

- Identification and Elimination
- Implementation
- Typical Program Results
- Summary
Three Pronged Approach Methodology

- Risk Assessment
- Three Prong Approach
  - Root Cause Analysis
  - Failure Analysis
  - Troubleshooting
- Approach Selection
- Basic Steps
- Human Performance and Reliability
Why Risk Assessment

- Takes aim at the “critical few” problems
- Optimizes the use of resources to quickly reduce Risk
- Provides a clear, consistent selection process
- Matches and integrates with other processes at the site
- Consistent with other approaches (e.g. RBI, SIS/LOPA,...)
Risk Assessment

<table>
<thead>
<tr>
<th>Financial Credits</th>
<th>Health Safety Business Impact</th>
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<tbody>
<tr>
<td>1000 : 1</td>
<td>A - Catastrophic</td>
</tr>
<tr>
<td>100 : 1</td>
<td>B - Very Serious</td>
</tr>
<tr>
<td>50 : 1</td>
<td>C - Serious</td>
</tr>
<tr>
<td>5 : 1</td>
<td>D - Not So Serious</td>
</tr>
<tr>
<td>2 : 1</td>
<td>E - Not Serious</td>
</tr>
</tbody>
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PROBABILITY:
- 5 Extremely Unlikely < 0.1%
- 4 Unlikely 0.1% - 1.0%
- 3 Possible 1% - 10%
- 2 Somewhat Likely 10% - 80%
- 1 Very Likely 80% - 100%

CONSEQUENCE:
- A - Catastrophic
- B - Very Serious
- C - Serious
- D - Not So Serious
- E - Not Serious

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Three Prong Approach

- **Root Cause Analysis**
  - Very detailed investigation, used for major events or those items that cannot be resolved by normal failure analysis methods. Usually a team.

- **Failure Analysis**
  - General use for routine reliability issues, such as moderate equipment or process losses, or bad actors. Usually led by one investigator.

- **Troubleshooting**
  - Individualized problem troubleshooting; a day to day activity among operators and technical personnel. Mostly an individual effort on items like process deviations or lesser bad actors.
Three Prong Approach

- **Approach**
  - **Root Cause Analysis**
    - Start immediately
    - Initial data gathering within 24 hours
  - **Failure Analysis**
    - As assigned
  - **Troubleshooting**
    - As assigned

- **Participants**
  - Lead Investigators with Subject Matter Expert support
  - Process, Maintenance, and Reliability Engineers
  - Operators, Artisans, Process and Maintenance Engineers
Approach Selection

Input Areas for Monthly Review of Top Reliability Issues

- Lost Profit Opportunity Data
- Process Issues
- Maintenance Issues
- HSE Issues
- System Defects
- Troubleshooting / Failure Analysis
- Risk Assessment
- Incidents
- Top Problem List
- Failure/Root Cause Analysis
- Active Corrective Actions
- Archive Database
- Identify System Defects

Risk Levels:
- Very Low
- Low
- Medium
- Most Medium
- High

Risk Management Process:
1. Identify System Defects
2. Incidents
3. Risk Assessment
4. Troubleshooting / Failure Analysis
5. Lost Profit Opportunity Data
6. Process Issues
7. Maintenance Issues
8. HSE Issues
9. System Defects
10. Top Problem List
11. Failure/Root Cause Analysis
12. Active Corrective Actions
13. Archive Database
14. Identify System Defects
Basic Steps for Troubleshooting

1. Define the problem
2. Assess the situation (data collection)
3. Identify potential causes (brainstorming)
4. Select most probable cause (analysis)
5. Validate most probable cause
6. Take Corrective Action
7. Document Problem and Solution

An iterative process
Troubleshooting

- **Failure Types:**
  - Process deviations
  - Equipment repairs
  - Bad Actors

- **Level of Effort:**
  - Typically, 10 – 30% of operator and technician routine work activity

- **Personnel:**
  - All employees, particularly operators and technicians
  - Cross functional involvement as required

- **Documentation:**
  - Logbook notes
  - Repair records
Basic Steps for Failure Analysis

1. Define the problem
2. Determine what happened
3. Identify failure mechanisms and causal factors
4. Validation
5. Develop effective corrective actions
6. Write it up
7. Implement the corrective actions
8. Audit the result

An iterative process
Failure Analysis

- **Failure Types:**
  - Minor HSE incidents
  - Upsets or failures resulting in moderate consequence
  - Unresolved Bad Actors

- **Level of Effort:**
  - Widely variable depending on availability of data and problem complexity
  - Typically less than 40 hours

- **Personnel:**
  - Conducted by Process, Maintenance, or Reliability Engineers
  - Cross functional involvement as required

- **Documentation:**
  - Formal or informal incident report to RCA database
  - Corrective Action Details
Basic Steps for Root Cause Analysis

1. Define the problem
2. Determine what happened
3. Identify failure mechanisms and causal factors
4. Validation
5. Identify underlying or root cause(s)
6. Develop effective corrective actions
7. Write it up
8. Implement the corrective actions
9. Audit the result

An iterative process
Root Cause Analysis

Failure Types:
- Significant HSE incidents
- Upsets, outages or failures resulting in unacceptable consequence or risk
- More complex problems

Level of Effort:
- Widely variable depending on availability of data and problem complexity
- Typically less than 120 hours

Personnel:
- Led by trained facilitator
- Cross functional involvement required throughout

Documentation
- Formal incident report to RCA database
- Root Causes by category
- Corrective Action Recommendations
Human Performance and Reliability

Consider the following:

- The primary driver of site reliability is Human Reliability
  - 60% - 80% of the causes of unreliability are related to Human Behavior

- Organizational and Management Systems are the primary drivers of Human Behavior

- If these show up, the approach immediately becomes a Root Cause Analysis
Identify systems that allowed causal factors and human error to exist. Examples include:

- Knowledge and skills
- Procedural issues
- Management directives and policies
- Information systems
- Decision making practices

**Validate conclusions with detailed analysis**

- How often does it happen?
- How widespread is the problem?
- What was unique about this situation?
- Other?
Typical Program Implementation

- Introduce the concept of Unreliability and Continuous Improvement through Risk Reduction
- Identify client specific program design expectations
- Identify gaps and what is working well
- Adapt work processes to meet client requirements
  - Agree on work process specifics
  - Define roles and accountabilities
  - Define performance indicators for managing the process
  - Develop KPIs to track performance
Typical Program Implementation

- Provide training on Effective Troubleshooting, and High Quality Failure Analysis and Root Cause Analysis
- Communicate and continuously inform work force of the program and its results
- Provide on-going training and support to increase Problem Solving Skills
- Provide support to:
  - Manage the process
  - Identify and eliminate system defects
- Audit periodically to evaluate progress and make changes as needed
Results

Typical results show a 50% reduction in the Cost of Unreliability within 12 – 18 months of program implementation

Actual Results at a US Refinery
Results

Results at a European Petrochemical Plant

Monthly Cost of Unreliability

Program Kickoff Date

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Sources of Risk exist in all areas of Manufacturing, Equipment, Technology, Human Activity

Using Defect Elimination to reduce Risk is the process of identifying and eliminating or mitigating concerns through Troubleshooting, Failure Analysis, and Root Cause Analysis

Responsibility for problem analysis and mitigation rests with every individual whenever abnormal situations are encountered (Troubleshooting)

Increasingly severe problems are given greater attention by individuals with greater problem solving skills (Failure Analysis and Root Cause Analysis)
Summary

- High consequence problem situations occur when system safeguards fail (System Defects)
- Root Cause Analysis of these problems provides insight into systemic defects which can then be efficiently mitigated, thereby reducing the risk of entire classes of future problems
- Root Cause Analysis is most efficient when conducted by a highly skilled analyst with the support of cross-functional resources
- Substantial reductions in Risk are achievable through a consistently applied Defect Elimination process
Questions?

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Thank You for Attending

Enjoy Lunch!

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