METROLINX

Metrolinx
RCA (Root Cause Analysis) Process

RAMS-4

Revision 0
Date: 28/07/2020

RCA (Root Cause Analysis) Process
RAMS-4

Publication Date: July 2020

Preface

This is the first edition of the Root Cause Analysis process published as part of Metrolinx RAMS (Reliability, Availability, Maintainability and Safety) Standards. It describes the Root Cause Analysis process as a problem solving tool to be used by Asset Class Teams to investigate the repetitive and major asset failures that are affecting the asset level of service ALOS and customer level of service CLOS, the tool helps revealing and addressing the root causes as well as identifying measures to prevent the failure recurrence.

The purpose of Metrolinx RAMS Standards is to formalize the framework to adequately manage RAMS performance of all Metrolinx assets for the entire life cycle starting from concept, through risk assessments, stage gate approvals, design and specifications, construction, systems integration, validation, acceptance, operation, maintenance, performance monitoring and decommissioning. Metrolinx RAMS standards, which are built as an adaptation of European Standard EN 50126-1:2017, provide internal Metrolinx staff and external stakeholders involved in design, construction, operation and maintenance of Metrolinx assets with a common understanding and a systematic process for RAMS management. Ultimately, they provide a systematic approach for specifying RAMS requirements and demonstrating that these requirements are achieved.

This document was developed by the Engineering Reliability and Performance Office, Engineering and Asset Management Division, Capital Projects Group, Metrolinx.

Suggestions for revision or improvements can be sent to the Metrolinx Engineering Reliability and Performance office, Attention: Director of Engineering Reliability and Performance who shall introduce the proposed changes to the Metrolinx Engineering Reliability and Performance office. The Director of the Engineering Reliability and Performance office ultimately authorizes the changes. Be sure to include a description of the proposed change, background of the application and any other useful rationale or justification. Be sure to include your name, company affiliation (if applicable), e-mail address, and phone number.

July 2020

Amendment Record

Revision	Date (DD/MM/YYYY)	Description of changes

Contents

Appendices

Figures

Tables

Documents

TABLE 0-1 SUPPORTING DOCUMENTS

Document Number	Document Title	Relation
BS EN 50126-1:2017	Railway Applications – The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) (PHASE 1: Adoption of European Standard EN 50126-1:2017)	Parent Standard
CPG-QAT-FRM-106	CPG Terms Glossary	Reference
RAMS-1	FRACAS (Failure Reporting, Analysis and Corrective Action System) Process	Reference
RAMS-2	FMECA (Failure Modes, Effects and Criticality Analysis) Process	Reference

Acronyms and Abbreviations

TABLE 0-2 ACRONYMS AND ABBREVIATIONS

Acronym	Full Name
BU	Business Unit
CAPA	Corrective Action Preventive Action
CAPEX	Capital Expenditure
CLOS	Customer Level of Service
CPG	Capital Projects Group
CSAT	Customer Satisfaction
FMECA	Failure Modes, Effects and Criticality Analysis
FRACAS	Failure Reporting, Analysis and Corrective Action System
FRB	Failure Review Board
KPI	Key Performance Indicator
MTBF *	Meantime between failures
MTTR	Meantime to repair
OPEX	Operational Expenditure
OTP	On Time Performance
PM	Preventive Maintenance
RAM	Reliability Availability Maintainability
RAMS	Reliability Availability Maintainability and Safety
RCA	Root Cause Analysis
SME	Subject Matter Expert
WO	Work Order

***Note:** "T" and "Time" may be substituted for other utilization measures as appropriate (i.e. Mean Distance Between Failures as MDBF, etc.).

Definitions

TABLE 0-3 TABLE OF DEFINITIONS

Term	Definition	Source
Asset	Any physical or tangible item that has potential or actual value to Metrolinx (excluding intellectual property, inventory to be sold, human resources, and financial instruments), as well as IT systems and software.	CKH-ASMT-PRC-001 Asset Data and Information Standards Note: refer to CKH-ASMT-PRC-001 Asset Data and Information Standards for additional asset-related definitions.
Asset Class Teams	Metrolinx business units who have been designated as being accountable for the completeness and accuracy of information about a given class of assets.	CKH-ASMT-PRC-001 Asset Data and Information Standards
Cause	Circumstance or set of circumstances that leads to failure or success.	*CPG-QAT-FRM-106*, *CPG Terms Glossary*
Corrective Action	A documented design, process, procedure, or materials change implemented and validated to correct the cause of failure or design deficiency.	MIL-STD-721
Defects	Something that has failed to meet specification.	*CPG-QAT-FRM-106*, *CPG Terms Glossary*
Failure	[1] Loss of ability to perform as required [2] The event, or inoperable state, in which any item or part of an item does not, or would not, perform as previously specified	1] BS EN 50126-1:2017 [2] MIL-STD-721
Root Cause	Factor with no predecessor that is relevant for the purpose of the analysis	
Root Cause Analysis (RCA)	Systematic process to identify the causes of a focus event.	

1. Overview

1.2 Purpose

1.2.1 The purpose of the root cause analysis (RCA) process is to introduce a systematic approach for identifying and addressing the root cause of asset failures and non-compliance with CLOS targets and/or RAMS requirements. (Including CSAT and OTP)

1.2.2 The intended audience for this process are:

a) Asset Class Team (typically operations and maintenance departments)

b) RCA Requestor (can be attendees from OTP meetings, CSAT meetings, FRB meetings, trades, supervisors, contractors etc. who wish to request the root cause of a problem)

1.3 Scope

1.3.1 Root cause analysis (RCA) is a step-by-step problem solving process that identifies the factors contributing to a particular event of interest. An RCA is performed with the understanding that events are addressed by identifying the root causes, rather than the immediate obvious symptoms.

1.3.2 The RCA process is centered on revealing the root cause. Often, an immediate failure symptom is mistakenly identified as the root cause. The immediate cause is simply the closest contributory symptom, which itself has deeper roots that could be revealed by a thorough RCA.

1.3.3 The RCA only applies to Metrolinx assets in the operation, maintenance, and performance monitoring lifecycle phase. It is a process for analyzing and correcting root causes of actual asset or system failures and does not apply to theoretical or potential failures.

1.3.4 The RCA process shall be initiated by the Asset Class Teams during the operation, maintenance, and performance monitoring lifecycle phase for all Metrolinx assets. To ensure that priority issues are addressed with an RCA, the failures and faults should be categorized for both safety and reliability for varying levels of severity/criticality (i.e. accident, incident, service-interrupting, non-service interrupting, etc.) as described in the FRACAS process (See RAMS Process RAMS-1.

1.3.5 There are two outcomes in RCAs when analyzing failures:

a) Outcome 1: Corrective action (CA): action taken to eliminate and/or minimize and/or reduce the failure on the affected asset.

b) Outcome 2: Preventive Action (PA): action taken to prevent the failure from recurring on any asset or containing the failure if prevention is not possible.

1.3.6 The RCA process is a valuable tool for organizations; however, it takes time and resources to conduct RCA properly. Consequently, it is important to know when and when not to use an RCA. Not all failures require a full root cause analysis.

1.2.6.1. An RCA is to be initiated if:

a) One or both outcomes (CA or PA) are not known; or

b) There is a request to do a deeper investigation into a failure. (i.e. Safety incident, major delay etc.)

1.2.6.2. Do not proceed with an RCA if:

a) The root cause is already known; and

b) Corrective action (CA) and preventive action (PA) measures for the failure already exist.

1.2.6.3. In other words, if the CA and the PA are known, then there is no need for an RCA.

1.3.7 The RCA Process applies to:

a) All Metrolinx assets in the operation, maintenance and performance monitoring lifecycle phase.

b) Actual asset failures experienced in service.

1.3.8 This process does not apply to:

a) Non-operational BUs (i.e. Finance, HR, etc.)

b) Assets currently under construction that are not in the operation, maintenance and performance monitoring phase.

1.3.9 The RCA process efficacy relies heavily on a creating an RCA database where completed RCAs are kept for future reference. Before creating a new RCA, Asset Class Teams should refer to the RCA database to build on the previously completed RCA for same or relevant assets.

1.4 Key Responsibilities

1.4.1 The **RCA Requestor** is responsible for the following tasks:

a) Requesting the **Asset Class Team** to conduct RCA following observation of a potential or actual non-compliance with CLOS targets and/or RAMS requirements. Please note, non-compliance observation(s) are potentially to be made through various huddles (OTP Huddle, CSAT huddle, etc.) or through FRACAS and FMECA processes or through FRB and Asset Class Team meetings.

b) Creating a clear definition of the non-compliance or failure observed ('**RCA Request'**) and sharing with **Asset Class Team** along with all relevant data and information (If available).

c) Tracking due dates for submitting RCA findings and corrective actions and preventive actions (collectively CAPA) by each Asset Class Team.

d) Tracking due dates for implementing CAPA.

1.4.2 The **Asset Class Team** is responsible for the following tasks:

a) Assigning an **RCA Leader** following the receipt of an **RCA Request**.

b) Ensuring continuous and adequate communication of information relevant to the RCA to the **RCA Requestor** and **RCA Leader**.

c) Following up the RCA findings and CAPA outcome with the **RCA Leader**.

d) Following up the implementation on the CAPA action with **RCA Leader**.

e) Initiating RCA for BU related failures.

1.4.3 The **RCA Leader** is responsible for the following tasks:

a) Creating and closing RCA standard work orders in INFOR if applicable.

b) Forming an **RCA Team** with relevant experience to the failure in question and initiating the process of filling **RCA Template.** (Appendix B.1)

c) Conducting root cause analysis with the **RCA Team** through **RCA Team** meeting sessions, and site visits by using sound data analysis techniques.

d) Reporting RCA findings and outcome CAPA to the **RCA Requestor**.

e) Reporting CAPA implementation to the **RCA Requestor**.

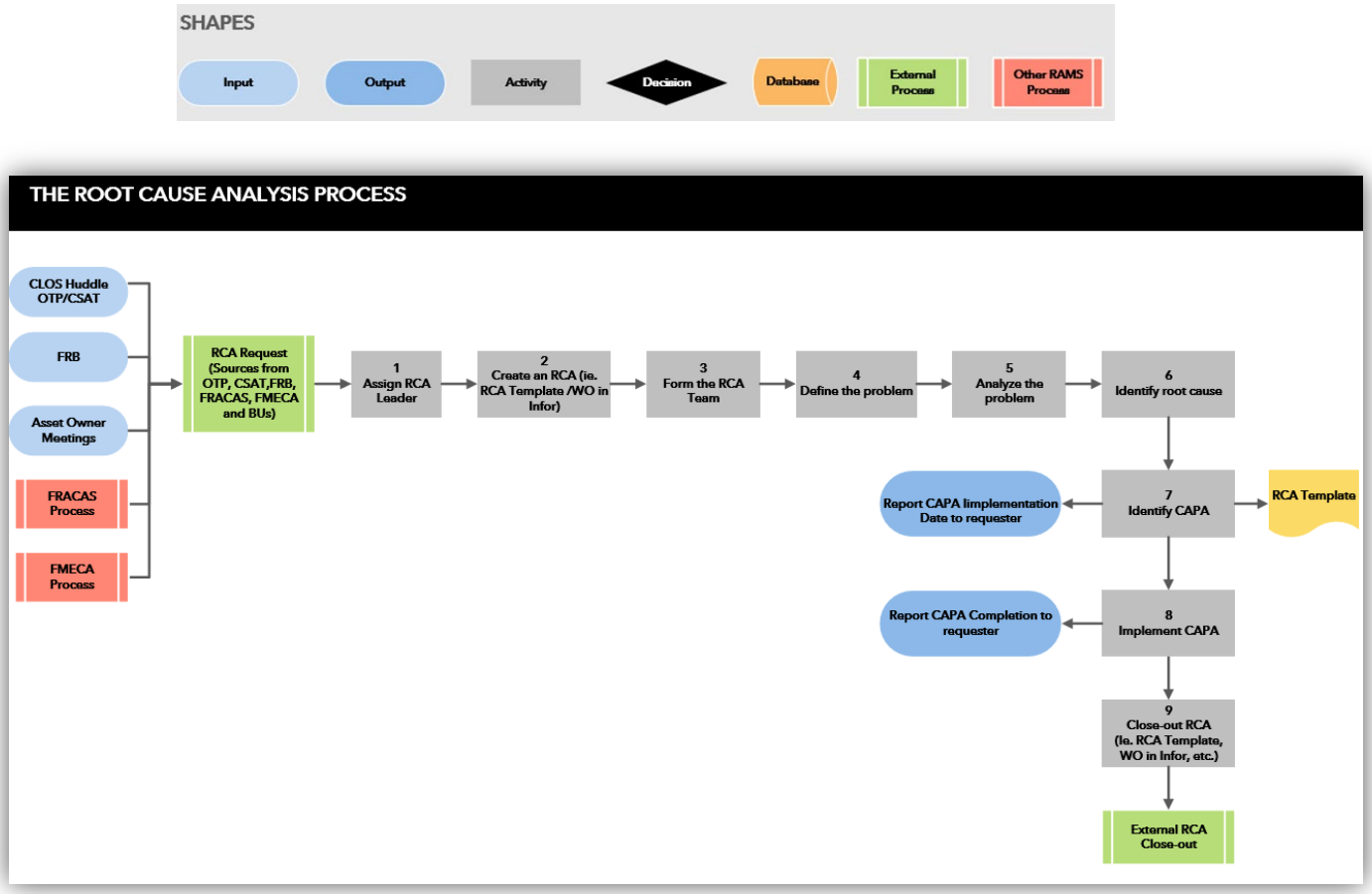
f) Keeping the completed **RCA Template** after closure in RCA Database for future reference.

2. The Root Cause Analysis (RCA) Process

2.2 The Root Cause Analysis (RCA) Flow Chart

2.2.1 Figure 2-1 illustrates the Root Cause Analysis Process.

FIGURE 2-1 ROOT CAUSE ANALYSIS PROCESS



2.3 The Root Cause Analysis (RCA) Process Narrative

2.3.1 The following steps describe the Root Cause Analysis (RCA) Process:

1) An RCA may be triggered by a deviation in performance or underperformance of an asset in comparison to CLOS and/or RAMS targets defined, or a specific failure, the RCA should be requested through the specific channels
   a) RCA request channels:
      i. CLOS Huddles:
         A. On Time Performance OTP Huddle
         B. Customer Satisfaction CSAT Huddle
         C. Other Huddles
      ii. FRACAS Reviews [ref FRACAS process RAMS-1].
      iii. FMECA Reviews [ref FR process RAMS-2].
      iv. Failure Review Board (FRB) meetings.
      v. Asset Class Team Lead. (i.e. Manager, supervisor, superintendent within the business unit)
   b) RCA triggers including, but not limited to:
      i. **Customer Level of Service CLOS Triggers:**
         A. Safety Triggers: Injury - Effluent Exceedances- Spills.
         B. Customer Satisfaction (CSAT) Triggers: Comfort related complaints, Presto ease of payment complaints.
         C. On Time Performance (OTP) (Rail service, Interrupting failures and rail OTP)
         D. Other CLOS and/or RAMS targets.
      ii. **Asset Levels of Service Triggers:**
         A. Reliability Parameters such as MTBF (Meantime between failures).
         B. Maintainability Parameters such as MTTR (Mean Time to Restore).
         C. Availability Parameters such as Asset Availability.
2) The affected Asset Class Team shall assign an RCA Leader with relevant experience and influence on the asset in question to conduct an RCA.
3) The RCA Leader shall create an RCA by using the RCA Template (Appendix B.1) and should maintain an RCA database. The RCA filled template could be kept as a standard work order in INFOR (or other RCA database) with the RCA WO allocated to the asset in question (as applicable).
4) The RCA Leader shall form an RCA team, the team members should be selected based on the specific expertise needed to analyze the focus event and implement the outcome (CAPA).

Note: An efficient RCA Team should include the following members:

a) **Frontline Operator/ witness:** To describe the failure symptoms.

b) **Maintainer/Trade/Contractor:** To give inputs on preventive maintenance and repairs of the system.

c) **Supervisor/ Specialist** with knowledge of asset and focus event.

5) The RCA leader shall then lead the RCA team through the analysis steps using the RCA template as follows.
   a) Define the Problem (5 W-1 How) at the physical location where the failure took place. (where possible)
   b) Use RCA Tools (Appendix A) to analyze the failure causes and narrow down the main causes starting with the Fishbone diagram, followed by 5 Whys. This will initiate a deep dive into the root cause.
   c) Identify top contributing factors and root causes.
   d) Develop (CAPA -Corrective Action Preventive Action, identifying the owners and the corrective/preventative implementation timelines.
   e) Follow up on the CAPA implementation until closure.
6) The RCA Requestor shall record the RCA completion due date and CAPA implementation due date on the meeting board or minutes of meeting (if applicable) and follow up with the RCA leader when the action items are due. This follow up continues until the action is completed.
7) The RCA Leader shall report the outcome of the RCA in terms of findings, CAPA and CAPA implementation dates to the RCA Requestor respectively:
   a) CLOS Huddles:
      i. On Time Performance OTP Huddle
      i. Customer Satisfaction CSAT Huddle
      ii. Other Huddles
   b) FRACAS Reviews [ref FRACAS process RAMS-1].
   c) FMECA Reviews [ref FR process RAMS-2].
   d) Failure Review Board (FRB) meetings.
   e) Asset Class Team Lead. (i.e. Manager, supervisor, superintendent within the business unit)
8) The RCA Leader shall close the RCA work order created (e.g., INFOR as applicable) and attach the completed RCA template to the WO (as applicable). The RCA work order is only to be closed when the CAPA is implemented.
9) The RCA Leader shall keep a copy of the completed RCA template in the RCA database. (i.e. EDMRS, RCA database or the BU shared drive as applicable)

END: The process ends here.

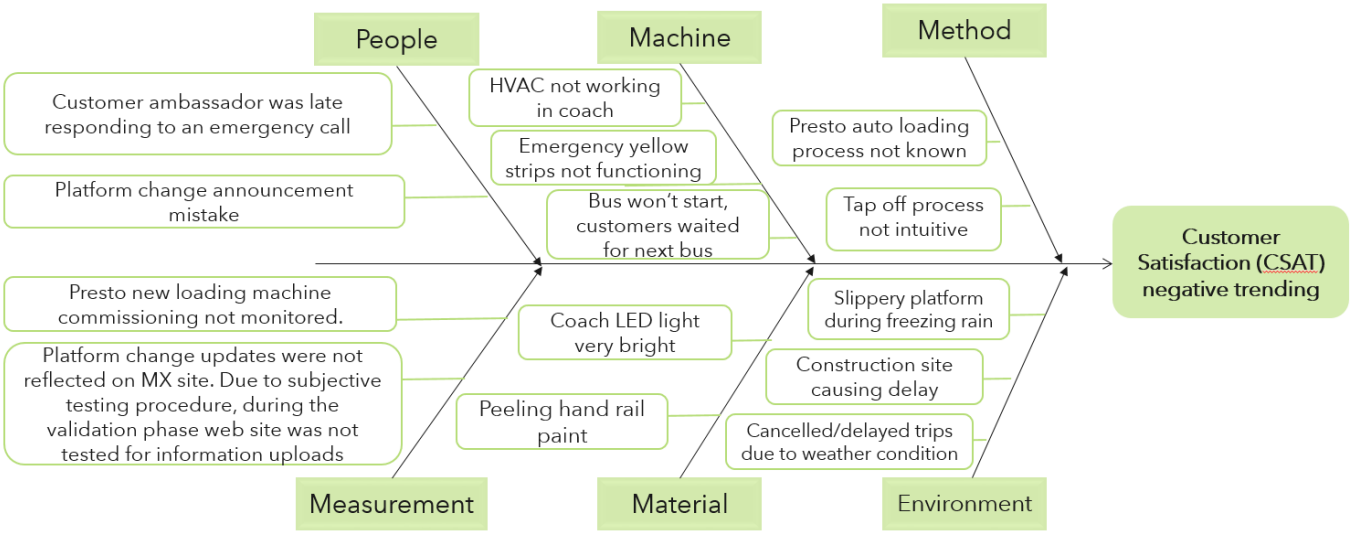
Appendix A- Root Cause Analysis (RCA) Tools

A.1 Fishbone Diagram

A.1.1 The fishbone diagram, created by Kaoru Ishikawa, is the tool that captures the cause-and-effect relationship of failures. The fundamental idea is that failures are typically driven by process variations. To facilitate the root-cause analysis process, the sources of variation are placed into six categories: **people, methods, machines, material, measurements, and environment.**

A.1.2 Metrolinx Lean Centre of Excellence Team provides a detailed training on this tool. (Ref. Lean Team Training Course)

FIGURE A- 1 EXAMPLE OF A FISHBONE DIAGRAM

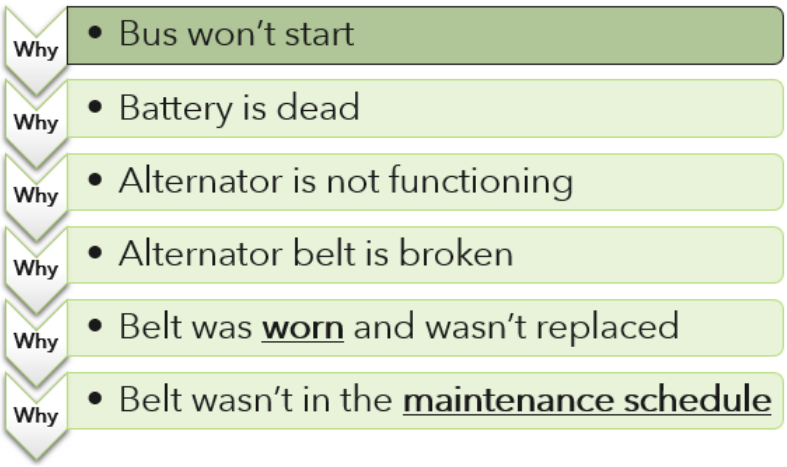


A.2 5-WHYS

A.2.1 5-Whys is a simplistic approach which exhausts the question "Why?" to help determine the root cause of a failure. The 5-Whys tool was created by Japanese inventor Sakichi Toyoda. The effectiveness of the model became apparent in the Japanese automotive industry. Toyota became a big proponent of the 5-Whys model, which ultimately became a critical component of the company's problem-solving training.

A.2.2 Metrolinx Lean Centre of Excellence Team provides a detailed training on this tool. (Ref. Lean Team Training Course)

FIGURE A- 2 EXAMPLE OF A 5-WHYS



Appendix B- Root Cause Analysis (RCA) Template

B.1 Root Cause Analysis (RCA) Template

Root Cause Analysis Template Page 1. To be used as a guideline for the RCA.

Root Cause Analysis (RCA)

Author: _____

Business Unit: _____

Steps:	YYYY-MM-DD
1st Recognition of Problem	
Start Problem Solving Activity	
Action Plan Approval (CAPA)	
Solution(s) implemented	

Root Cause Analysis (RCA) Trigger(s)

Safety Accident/Injury/Near miss	☐	OTP Delays	☐	Environmental Impact/Spills	☐
Mean Time Between Failures (MTBF) below Targets	☐	Frequent Failures	☐	Asset Availability below	☐
C-SAT Impact	☐	One time significant event	☐	Others	☐
High Impact Initial Priority $ (IPN)	☐	Mean time to restore (MTTR)	☐		

0. Emergency Response Action

References /High Impact Initial Priority IPN (If Applicable)	Problem statement

1. Form a team - assign responsibilities

Sponsor:	Department	Front Line Witness/Operator:	Department
Problem Owner:	Department	Team Member:	Department
RCA Leader:	Department	Team Member:	Department

2. Breakdown of the problem

Location	_____	Date of last known failure:	____
WO $ (if applicable)	_____	Time of last known failure	____
Asset Name/Number	_____	Shift No.(if applicable)	____

Who found out the problem? Who observed the problem? (is there a relation with skill set?)	
What Is the problem ? What malfunction was observed (Noise, misalignment, leak, etc...)? What happened prior to and during the problem/breakdown? What components were involved? What is the observed pattern? (cyclical, random, progressive)	
Where does the problem appear ? (e.g. physical location on the corridor/station/equipment/machine/line)	
When does the problem happen? (in which moment of the operation process, e.g. following Shift change, after a PM , Asset overhall, etc... include date/time and state weather conditions if known)	
Why is this a problem?	
How does the problem show up? (detailed technical description of HOW the problem happened)	
How many due to this problem? (Min delay, cascading delays)	

3. Interim Containment

Number	What	When	Who	Status
1				◑
2				
3				
4				
5				
6				

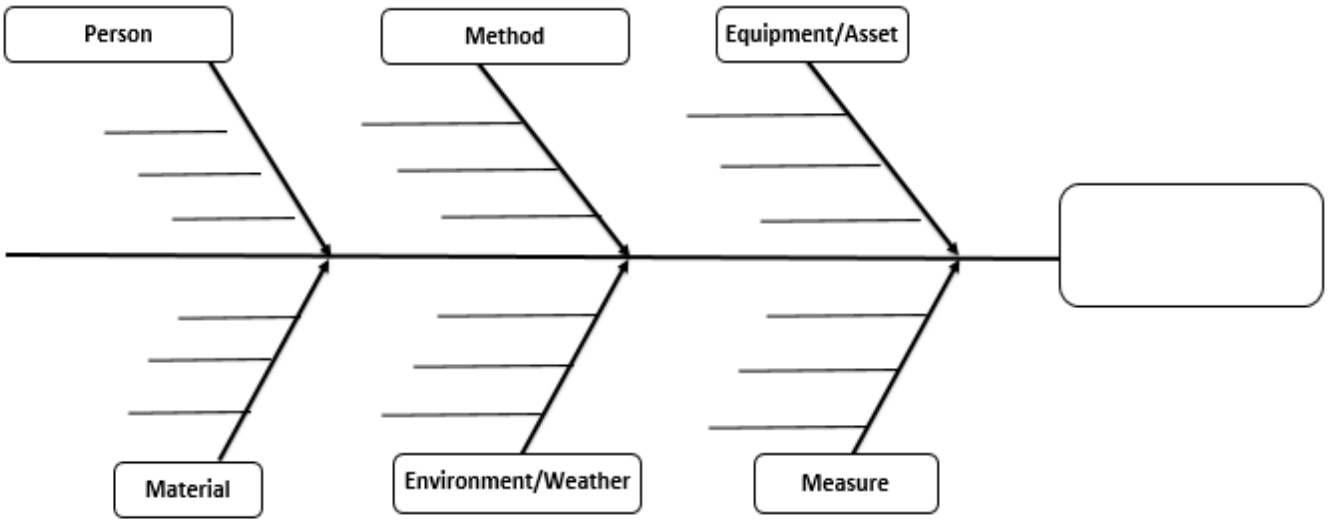
4. Understand Current Condition

Current Conditions Analysis	Yes	No	Notes
Is the situation clear? Do people understand the differences from a normal and an abnormal situation?			
Is the standard operatoring procuedure (SOP) or specifications/standards clear, known and available for this area? Are people are trained to them? (if applicable)			
Is there enough data available for the problem analysis? Is the target to be attained is clear to the the business			
Are PMs in place and performed in a timely manner? When were the last 3 PMs performed ?			
Is the problem caused due to shortcuts or lack of adherence to the standards/specifications?			
Is the area organized and easy to access information, tools and materials?			

Root Cause Analysis Template Page 2

5. Root Cause Analysis

Fishbone Diagram



Prioritize the 4 most probable causes to identify the root cause(s)

5 WHY Analysis

	Description of the Problem	→ 1.Why?	→ 2. Why?	→ 3. Why?	→ 4. Why?	→ 5. Why? (Real Root cause)
1						
2						
3						
4						

6. Develop, Implement Validate

CAPA (Corrective Action / Preventive Action)

Action Item	Due Date	Owner	WO No. (if applicable

7. Standardize

Standard	Applicable?		Description of the Action Item	Owner	Due Date	Status
Modify/Create SOP	YES	NO				
Modify/Create PM	YES	NO				
Decrease/ Increase PM Frequency	YES	NO				
Could improvement be expanded for other assets?	YES	NO				
OTHER:____	YES	NO				
OTHER:____	YES	NO				

Appendix C - Detailed description of the Root Cause Analysis (RCA) Template

The following details are the minimum requirements for an RCA template:

C.1 Root Cause Analysis (RCA) Trigger(s)

C.1.1 It is important to know what triggered the RCA before starting the RCA process. Identify the trigger(s) that qualified this problem to be analysed. This could be an important clue in determining the real root cause.

C.2 Emergency Response Action- RCA Template Section 0

C.2.1 Describe the failure and how crucial it is for the business. If a priority system is in place, state the priority of the problem based on its impact (if known).

C.3 Form a team - assign responsibilities- RCA Template Section 1

C.3.1 State the name and department of each participant and ensure a front line staff /witness is included on the team, include the support management (Sponsor and Problem owner) in your team to support the decision. Detail the necessary funds and approval (if applicable).

C.4 Breakdown of the problem - RCA Template Section 2

C.4.1 State the problem by answering the following questions (this is in addition to the date, time and location information) (if known).

1. **WHO** found out the problem?
   a) Who observed the problem? (is this related to skill set?)
2. **WHAT** is the problem?
   a) What happened prior to and during the problem/breakdown?
   b) What malfunction was observed (noise, misalignment, leak, etc…)?
   c) What components were involved?
   d) What is the observed pattern? (cyclical, random, progressive)
3. **WHERE** does the problem appear?
   a) (e.g. physical location on the corridor/station/equipment/machine/line)
4. **WHEN** does the problem happen?
   a) (In which moment of the operation process, i.e. following shift change, after a PM, Asset overhaul, etc. include date/time and state weather conditions.) (if known)
5. **WHY** is this a problem?
6. **HOW** does the problem show up? How did the problem happen? (detailed technical description of HOW the problem happened if known)

C.5 Interim Containment- RCA Template Section 3

C.5.1 State all your containment and short-term measures; identify when the measures will be implemented and who is responsible for the implementation. Update the progress in a timely manner.

C.6 Understand the Current Condition- RCA Template Section 4

C.6.1 To get a better and clearer understanding of the current state, find out the answers to the following questions by discussing it with the frontline staff and team members who are directly involved. A site visit is also recommended.

1- Is the situation clear? Do people understand the differences from a normal and an abnormal situation?

2- Are the standard operating procedures (SOP) or specifications/standards clear, known and available for this area? Are people are trained to them? (if applicable)

3- Is there enough data available for problem analysis? Is the target to be attained clear?

4- Are PMs in place and performed in a timely manner? When were the last 3 PMs performed?

5- Is the problem caused due to shortcuts or lack of adherence to the standards/specifications?

6- Is the area organized and is it easy to access information, tools and materials?

C.7 Analyze the Root Cause of the Deviation- RCA Template Section 5

C.7.1 (RCA): is a two-step process that should involve (where allowable) at least one site visit to where the problem occurred to seek answers using the following tools:

1) Step-1. **Fishbone Diagram**: to narrow down the main causes of the problem and feed into the next step of analysis.
   a) In order to ensure all RCA Team members' experiences are valued and heard, contributions to the discussion must be recorded in the Fishbone Diagram as much as possible.
2) Step-2. **5 Whys**: to dig deeper into the problem's main causes and lead to the reveal of the root cause.
   a) Only four (4) of the most probable causes to identify the root cause(s) should be included in the 5 Whys portion. It is not necessary to complete exactly 5 Why levels; instead, Why levels should be listed until an actionable root cause is identified.

C.8 Develop and Implement CAPA- RCA Template Section 6

C.8.1 Determine the CAPA(s). For each action item, identify the owner, implementation due date and state the work order number in INFOR or other database (if applicable).

C.9 Standardize- RCA Template Section 7

C.9.1 To ensure sustainability and standardization of the actions, examine the possibility of one of the following:

1- Modify and/or create a standard operating procedure.

2- Modify and/or create a preventive maintenance plan (PM).

3- Increase and/or decrease frequency of an existing PM.

4- Expand this improvement to similar assets within the business unit or across the organization.