

# A Systematic Approach to Plant Trip Investigation in Industrial Operations

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**Abstract:** Alarm rationalization is a structured and systematic process used to evaluate alarms within an Industrial Automation system to ensure that each alarm is meaningful, actionable, and properly justified. The objective is to confirm that every alarm has a valid reason to exist, that it alerts the operator to a real operating condition requiring attention, and that its setpoint, priority, and response timing are appropriately defined. Plant trips, defined as unplanned shutdowns of equipment or process systems, can significantly affect operational continuity, reliability, and process safety. A disciplined investigation process is essential to determine the initiating event, contributing factors, and root causes, and to ensure effective corrective actions are implemented. This article presents a structured approach to plant trip investigation, covering incident reporting, investigation team formation, data collection, sequence-of-events analysis, root cause analysis, corrective action development, report preparation, implementation, and knowledge sharing. The article argues that plant trip investigation is not merely a troubleshooting activity but a systematic learning process that strengthens reliability and continuous improvement in industrial operations.

**Keywords:** Plant Trip, Incident Investigation, Root Cause Analysis, Process Safety, Reliability Engineering, Corrective Actions.

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## I. INTRODUCTION

Industrial plants are designed to operate continuously and efficiently under complex operating conditions. In this environment, a plant trip represents an unplanned interruption to normal operation caused by equipment malfunction, process deviation, protective shutdown, or an external disturbance. While some trips are protective in nature and prevent more serious damage or hazards, they also indicate a need to understand weaknesses in design, maintenance, instrumentation, control systems, operating practices, or human performance.

A trip investigation is therefore a critical part of reliability and process safety management. The objective is not only to restore operation, but also to determine why the event occurred and what must be changed to prevent recurrence. In large industrial organizations, this work typically requires collaboration among operations, maintenance, reliability, instrumentation & control, and engineering personnel.

## II. INCIDENT REPORTING & INITIAL RESPONSE

The investigation begins immediately after the trip occurs. Operators or field personnel record the time, affected equipment, alarm conditions, and initial symptoms. This early documentation is important because it preserves the condition of the event before data is overwritten or operating conditions change.

Safety remains the first priority. If the trip creates a hazard, the affected equipment is isolated and secured. Lockout or shutdown procedures may be initiated as necessary. If the unit is critical to production continuity, standby equipment may be started while the fault is investigated.

### III. INVESTIGATION TEAM FORMATION

A multidisciplinary team is then assembled. The team commonly includes a chairperson, often a senior engineer or

superintendent, a team leader, and representatives from operations, instrumentation and control, mechanical maintenance, reliability, and technical support.

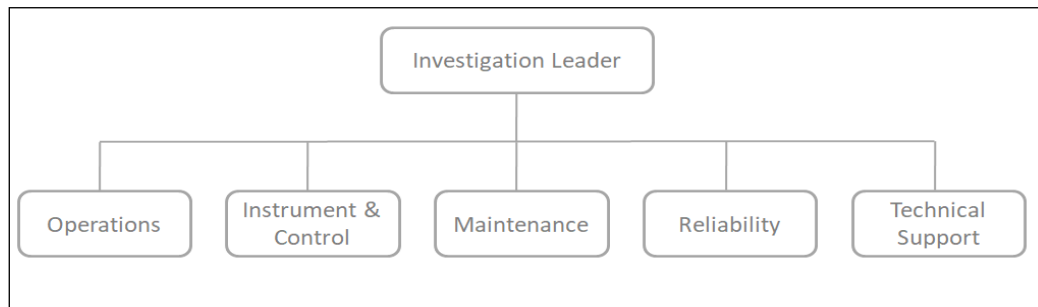


Fig 1: Investigation team

This collaborative structure ensures that the event is examined from multiple perspectives. Operators provide direct operating observations, maintenance staff contribute equipment history, and engineers interpret process and control behavior. Management support is also important because investigation findings must translate into action.

### IV. DATA COLLECTION AND REVIEW

The next stage is comprehensive data collection. Relevant sources typically include:

- DCS or SCADA alarm logs
- Historical trends of pressure, temperature, flow, and vibration
- Maintenance and inspection records
- Operator and technician interviews
- Event logs and trip protection records
- Procedure manuals and operating instructions

Alarm Priority	Date&Time	Tag Name	Tag Description	Unit	Alarm Trip value	Live value
Emergency	16/04/2026 20:00	TI101	R-001 Temperature High	DEGF	1200	1205
High	16/04/2026 19:58	PI101	C-102 Pressure Low	PSIG	30	28
Medium	16/04/2026 19:57	LI101	D-101 Level High	%	80	82
Low	16/04/2026 19:56	FI101	C-101 Flow Low	MBD	20	19.5

Fig 2: DCS Alarm Log

The purpose of this phase is to build a factual record. Trends and alarms may show the first abnormal condition, while maintenance records may reveal recurring defects or overdue work. Interviews provide context that may not be visible in system logs.

### V. SEQUENCE OF EVENTS ANALYSIS

A sequence of events analysis reconstructs the timeline leading to the trip. Alarm sequences, control actions, operator responses, and equipment behavior are arranged chronologically to identify the first deviation from normal operation.

Date	Time	Events
16/04/2026	15:29:31	VAH193A Vibration High Alarm reported
16/04/2026	15:30:15	VAHH193A Vibration High High Alarm reported
16/04/2026	15:30:15	Compressor K-101 Tripped
16/04/2026	15:30:16	Compressor common alarm reported
16/04/2026	15:30:20	Operator Acknowledge the alarm

Fig 3: Sequence of Events

This step is critical because the final trip signal is often the result of an earlier process upset or equipment failure. By mapping the progression of events, investigators can distinguish the trigger from the consequence and better understand system behavior.

### VI. ROOT CAUSE ANALYSIS

Root cause analysis is the core of the investigation. It examines the deeper reasons behind the event using structured methods such as:

- 5-Why analysis
- Fishbone or Ishikawa diagrams
- TapRoot or similar frameworks
- Barrier and causal factor analysis

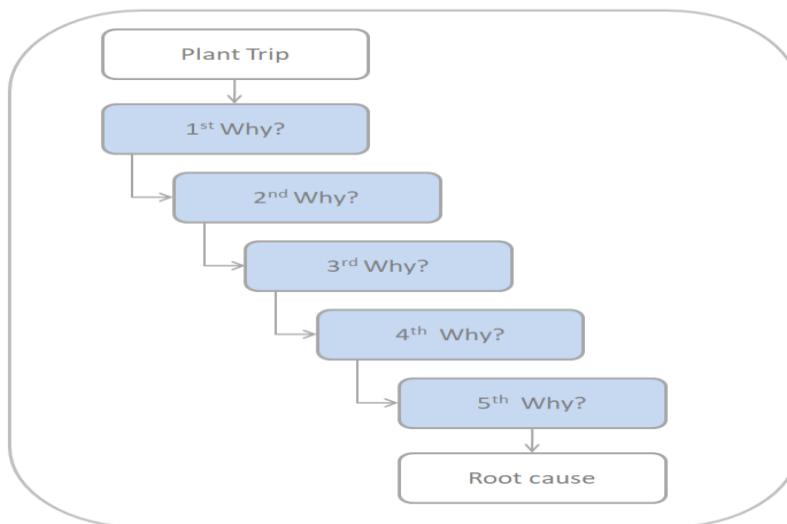


Fig 4: 5-Why Analysis

Findings are typically classified as:

**A. Direct Cause:**

The immediate reason for the trip. **B. Contributing Causes:** Conditions that increased the likelihood or severity of the event. **C. Root Cause:** The underlying issue that must be corrected to prevent recurrence.

This distinction is important because many investigations stop at the immediate fault. A stronger investigation identifies the system-level weakness that allowed the failure to occur.

### VII. CORRECTIVE ACTION DEVELOPMENT

Based on the analysis, the team develops corrective actions. These may include:

- Repairing or replacing defective components
- Calibrating instruments and control elements
- Revising operating procedures
- Adjusting alarm settings or trip thresholds
- Improving preventive maintenance schedules
- Modifying control logic or interlocks
- Enhancing training and competency

No	Action	By	ETC
1	Add 5 secs trip delay for compressor K-101 vibration high high trip	Rotating Equipment Unit	18/04/2026
2	Create Preventive maintenance for Compressor K-101 vibration	Maintenance unit	25/04/2026
3	Check the K-101 vibration probe	Maintenance unit	Immediately

Fig 5: Corrective actions

Corrective actions should be specific, practical, and assigned clear ownership and deadlines. The best actions address the root cause rather than only the symptom.

### VIII. REPORT COMPILATION AND APPROVAL

A formal investigation report documents the event, findings, and recommendations. A complete report usually includes:

➤ *Executive Summary:*

A concise overview of the trip, findings, and key recommendations. 2. *Background and Scope:* The operating context, affected equipment, and investigation boundaries. 3. *Investigation Methodology:* The process used to collect and analyze the evidence. 4. *Data and Observations:* Historical trends, maintenance history, field findings, and interview results. 5. *Sequence of Events:* A chronological reconstruction of the incident. 6. *Root Cause Analysis:* The causal chain and underlying factors. 7. *Corrective Actions and Implementation Plan:* The proposed actions, owners, and deadlines. 8. *Conclusions and Lessons Learned:* The overall findings and broader implications.

The report is reviewed and approved by relevant technical and management stakeholders to ensure accuracy and accountability.

## IX. IMPLEMENTATION AND FOLLOW-UP

The value of the investigation depends on whether corrective actions are implemented effectively. Responsibility for each action should be assigned, progress should be tracked, and completion should be verified in the field.

After implementation, the affected system should be monitored to confirm that the trip does not recur. Follow-up is essential because a documented recommendation is only effective when it is completed and proven to work.

## X. KNOWLEDGE SHARING AND CONTINUOUS IMPROVEMENT

Findings from the trip investigation should be shared across relevant teams and facilities. Lessons learned can support updates to procedures, maintenance plans, training materials, and technical standards.

This knowledge-sharing step turns a single incident into organizational learning. In large industrial systems, it helps prevent similar failures elsewhere and supports continuous improvement in reliability and process safety.

## XI. CONCLUSION

Plant trip investigation is a structured and essential process in industrial operations. It begins with immediate reporting and safe response, continues through multidisciplinary analysis and root cause identification, and ends with corrective action implementation and knowledge sharing. When executed properly, it reduces recurrence, improves reliability, and strengthens process safety.

Rather than treating a trip as an isolated event, organizations should view it as an opportunity to learn about system weaknesses and improve performance. A disciplined trip investigation process therefore supports safer, more reliable, and more effective industrial operations.

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