Although we may develop detailed project plans that are intended to prevent problems, we are still likely to encounter problems. Project planning allows us to anticipate problems and take steps to prevent them from occurring. And should problems occur, our plans provide a framework for addressing them quickly and efficiently. Nonetheless, some problems arise from systemic failures that need detailed analysis to identify the root cause of the problem.

### Root Cause Analysis

Although any structured approach that objectively characterizes the problem can be used to determine its root cause, many find the “Five Whys” approach both easy and effective. The first step in the process is to collect the facts and then define the problem. Once the problem is defined, the investigator, using an iterative process, asks why the problem occurred, focusing on operations, processes, behaviors, and policies. The goal is to identify the fundamental system or process that failed, thereby creating the problem. The model uses five iterations to drill down to the problem; however, more or less iterations may be appropriate for some problems. Once the root cause is identified, corrective actions can be identified and implemented.

To illustrate this approach to root cause analysis, consider the following case where repair work on a compressor motor resulted in a production shutdown at a manufacturing facility. Importantly, this compressor provided compressed air to a part of the facility that was subject to process safety management (PSM). Accordingly, the repair work was planned, scheduled, and managed as a project. The incident investigation yielded the following details:

1. Production was unexpectedly terminated when an air compressor was being repaired.
2. The electrician incorrectly wired the motor when attempting the repair.
3. When the electrician closed the breaker to re-energize the compressor, it created a major fault.
4. The main breaker in the substation opened, shutting down power to the air compressor plant. This shut down some production areas, including some covered by the facility’s PSM program.

### The Whys Approach

Now let’s use the Five Whys approach to determine the root cause of the problem:

1. **Why did the unexpected production shutdown occur?** Because circuit breakers serving production equipment tripped.
2. **Why did the circuit breakers trip?** Because a motor on the circuit had been rewired.
improperly resulting in a short.

3. **Why was the motor wired improperly?** Because this motor had a wiring configuration that differed from other motors in the plant and the electrician re-wired the motor based on his familiarity with other motors.

4. **Why was the electrician not familiar with the specialized wiring requirements for this motor?** Because the motor required infrequent and non-routine service preventing the electrician from properly preparing for this repair task.

5. **Why was the electrician not properly prepared for the task?** Because procedures for addressing non-routine repairs on production critical motors did not exist.

Thus the root cause of the production failure was determined to be a lack of procedures for addressing non-routine repairs on production critical motors. It is important to note that this facility used a sophisticated maintenance management program that was supported with standard operating procedures, work instructions, and recordkeeping systems. In this particular instance, specialized equipment, with infrequent service intervals and wiring configurations that differed from similar equipment, had been overlooked.

**A Corrective Action Plan**

Once the root cause had been determined, a corrective action plan was developed that included the following elements:

1. Facility management engineers would identify “mission critical” motors. Mission critical motors were defined as those that would shut down production if they failed.

2. For these motors, two electricians would be assigned to the repair work. The electricians would not be required to work together for the entire repair operation; however, they would have to work together during the disassembly phase and the post-repair check phase that occurs before the motor is restarted.

3. The lead electrician would be required to make a sketch of the wiring connection for the motor and the second electrician would be required to verify it. This sketch would have to be made before disconnecting the wiring. Repair work would then have to be checked against this sketch by both electricians assigned to the repair before the equipment could be restarted.

4. A standard operating procedure would be developed to identify mission critical motors and provides a checklist incorporating the foregoing tasks.

5. Additional preventative maintenance requirements would be developed for these motors to reduce the potential for failure, and hence, the need for complex repair operations.

Although the above tasks may be appropriate corrective actions, it is important to note that an effective corrective action plan will go beyond merely identifying corrective actions. An effective corrective action plan will clearly identify who is responsible for completing the tasks, as well as a schedule for completing the tasks, and will include training requirements to ensure that corrective action requirements are fully understood. Finally, an effective corrective action plan will include follow-up monitoring to establish that the corrective actions are being implemented as required and producing the intended results.

**A Change in Enforcement**

Interestingly, recently proposed U.S. Environmental Protection Agency (EPA) regulations that would require fenceline monitoring for refineries (Federal Register 79, 336879, 6/30/2014) establish requirements for a root cause analysis and development of a corrective action plan if established fenceline limits for benzene concentrations are exceeded. The facility would not be deemed out of compliance with fenceline limits, provided that the appropriate corrective action measures are taken according to the time-frame detailed in the corrective action plan. This approach signals a change in enforcement that holds the facility accountable for proper root cause analysis and effective corrective action plan development and implementation. We’re likely to find that root cause analyses and corrective action planning will become projects for all environment, health, and safety project managers in the near future. em

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