

A Hidden Risk: How Creeping Changes Threaten Process Safety

Primatech Inc.

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In the complex world of industrial operations, large-scale modifications, such as new equipment installations, major design overhauls, or new process lines, are rigorously evaluated and controlled through formal MOC systems. Yet, some of the most serious hazards arise not from these significant changes but from small, incremental adjustments that slowly accumulate over time. These are known as creeping changes, and their subtle nature makes them a serious threat to process safety.

Nature of Creeping Changes

Creeping changes refer to small, often undocumented or poorly documented, modifications that gradually alter the design, operating conditions, or safety parameters of a process. Often, they go unnoticed, unrecognized, or are not considered consequential. Collectively, they gradually move a process away from its original design basis and safe operating envelope. Examples include:

- Minor adjustments to operating setpoints to improve production.
- Gradual increases in material feed rates beyond design to increase throughput
- Control system tuning adjustments that erode protective margins.
- Incremental increases in alarm setpoints or widening of alarm deadbands to reduce the incidence of nuisance alarms that reduce operator awareness and delay critical responses to abnormal situations.
- Operating procedure shortcuts becoming the norm.
- Replacement of spare parts with similar but not identical components.
- Degradation in equipment performance or control system accuracy.
- Informal workarounds or temporary fixes that become permanent.
- Bypass or deactivation of safety interlocks to continue production during troubleshooting or to avoid nuisance trips that are left in place as an informal practice.

These cases highlight a common thread. Each change was considered small or "temporary" and seemed justified in the moment as it was intended to solve immediate operational issues or optimize performance. However, when these incremental changes accumulate without formal MOC review, they systematically undermine process safety.

The impact of creeping changes is often underestimated because each individual change appears harmless, but, over time, they can cumulatively move a process away from its safe operating envelope. This slow drift toward unsafe conditions can remain undetected until a near miss or an actual incident occurs. For example, a slightly higher temperature setpoint might increase production yield but, if operators gradually raise it repeatedly without review, the process can approach conditions where a runaway reaction becomes likely.

Creeping Changes in Real-World Incidents

Several major industrial accidents have been attributed, at least in part, to creeping changes. A prominent example is the 2005 BP Texas City refinery explosion. During startup of an isomerization unit, operators overfilled the raffinate splitter tower causing a massive hydrocarbon release and subsequent explosion. Over time, alarm systems had been poorly maintained, with critical high-level alarms disabled or malfunctioning. Operators had become accustomed to compensating for these deficiencies using sight glasses and manual checks. Incremental drift in alarm reliability, procedural shortcuts, and a culture of complacency combined to create a dangerous new "normal" that ultimately contributed to the catastrophic event.

Another example is the 1989 Phillips 66 Houston Chemical Complex explosion. While performing maintenance on a polyethylene reactor, a valve was inadvertently opened releasing a large volume of highly flammable gas. Over the years, operators had introduced informal practices during line breaks, and temporary procedural changes became normalized. These small, incremental deviations gradually eroded safety barriers, ultimately leading to a catastrophic event.

Detection of Creeping Changes

Creeping changes are hard to detect for several reasons. They evade detection because they often bypass formal MOC processes, especially if considered "minor". Documentation of creeping changes may be nonexistent, incomplete or scattered. Over time, facility personnel may accept the "new normal" without realizing how far conditions have drifted. Also, the cumulative effect of creeping changes is often only visible when looking at trends or the bigger picture.

Here are some ways that creeping changes that have occurred in a process can be identified:

- Perform Thorough Field Verifications and Inspections

Conduct walk-downs and compare actual field conditions to P&IDs, control diagrams, and operating procedures. Look for temporary fixes that became permanent, equipment modifications, and "as-found" deviations where conditions or configurations are discovered to be different from what is documented, designed, or expected. Check for bypassed alarms, overridden safety systems, or valves in unexpected positions.

- Review Historical Process Data and Trends

Analyze process historian data (e.g. pressures, temperatures, flows) for gradual drift in operating conditions. Identify subtle changes in setpoints or alarm limits and look at maintenance logs for recurring issues or workarounds.

- Audit and Reconcile Documentation

Compare current P&IDs, cause and effect diagrams, and procedures to the original design. Check for discrepancies in equipment specs, control logic, or safety system descriptions. Reconcile equipment tag numbers, calibration records, and loop diagrams.

- Engage with Experienced Operators and Maintenance Staff

Conduct interviews or structured workshops. Ask about informal practices, unrecorded modifications, or "tribal knowledge". Inquire about steps operators take that are not in procedures, e.g. "workarounds".

- Review Past Temporary Changes and MOCs

Check that temporary changes were properly closed out and, as applicable, reversed. Notably, temporary bypasses often remain in place. Audit older MOCs to ensure they were implemented as documented.

- Use Advanced Analytics or AI Tools

AI-based pattern recognition tools can detect subtle operational drifts, and predictive maintenance data can reveal component degradations that contribute to creeping changes.

Identifying creeping changes requires a combination of document and field audits, data analysis, and engaging frontline personnel. It is not a one-time activity but requires ongoing vigilance.

Managing and Mitigating Creeping Changes

Companies can adopt several strategies to control the insidious risk of creeping changes:

- Strengthen MOC Processes

Encourage a culture where even small changes are formally reviewed. Emphasize that MOC is not just for large modifications but also for routine operational adjustments.

- Conduct Regular Design Basis Reviews

Periodically, revisit original design assumptions and operating envelopes to ensure they remain valid. Compare current conditions to design intent to detect deviations.

- Monitor Performance and Trends

Use data analytics and advanced monitoring tools to track incremental changes in operating parameters, safety system activations, and near misses.

- Enhance Operator Training and Awareness

Educate operators and maintenance teams on the risks of creeping changes and the importance of adhering to established procedures.

- Foster a Strong Safety Culture

Promote an environment where employees feel responsible for maintaining process integrity and are encouraged to report deviations or informal changes.

- Ensure PHA revalidations address creeping changes

Address deviations or new hazards that might have emerged through small changes and revisit assumptions made in previous PHAs.

Creeping changes are often invisible, but their impact can be catastrophic. Recognizing and proactively managing these gradual shifts is critical to maintaining process safety and protecting people, assets, and the environment. By strengthening MOC, revisiting design intent, and cultivating

a vigilant safety culture, organizations can stay ahead of these hidden threats and ensure safer, more reliable operations.