SH&E 101
Reducing Safety, Health, and Environmental Costs

In this course:

Overview

Safety is a never-ending pursuit for everyone in the process industry. Many feeds and products are volatile, toxic, explosive, or otherwise harmful. The high temperatures and pressures involved in many processes carry their own risks.

In addition, abnormal conditions that cause problems can be hard to detect until they result in a process upset or equipment failure. What you don't know *can* hurt you—and your employees, your business, your community, and the environment.

The main reasons for improving process safety are to protect human life while meeting corporate, public, and regulatory pressures for cleaner and safer plants—as well as reducing operating costs and protecting plant assets. Every facility strives to be as safe and environmentally responsible as possible, which means constantly looking for cost-effective ways to improve.

The principles of process-safety management are well established in most countries, often through some form of process safety regulation. These principles are often defined in terms of safety protection "layers." This course covers the Control and Monitoring layer or, more specifically, how basic process control can improve the safety, health, and environment (SH&E) of your plant. It does not cover Safety Instrumented Systems (SIS) and the new Smart SIS solutions, which will be addressed in other PlantWeb University courses.

Many safety, health, and environment improvements can be made in the Control and Monitoring layer—possibly avoiding the need to ever invoke the other protection layers.

SH&E is also called Health, Safety and Environment (HS&E) or Environment, Health, and Safety (EH&S). Regardless of their order, for a typical process company these three areas are defined as follows:

- **Safety**: Design and maintain facilities, establish management systems, provide training, and conduct operations in a manner that safeguards people and property.
- **Health**: Identify and evaluate health risks related to operations that potentially affect employees, contractors, or the public.
- **Environment**: Comply with all applicable environmental laws and regulations and apply responsible standards where laws and regulations do not exist.

This course shows how a digital basic process control architecture can help improve SH&E by enabling you to **predict** and **prevent abnormal situations** instead of simply reacting to them.

Hint

As you go through the topics in this course, watch for answers to these questions:

- What causes an abnormal situation?
- How can an automation system impact safety?
- What steps can I take to reduce human factors associated with safety, health, or the environment?

Abnormal Situations

An abnormal situation is a disturbance in a process that causes plant operations to **deviate from their normal operating state**. It is likely to impact the safety, health, and environment of a plant.

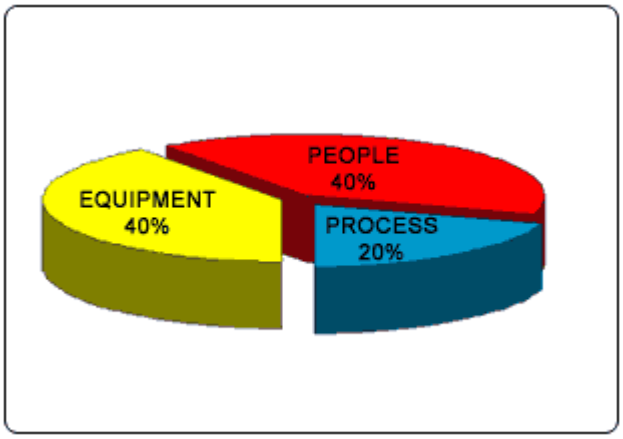
The costs associated with abnormal situations are staggering:

- The U.S. petrochemical industry estimated losses at approximately $108 billion per year.
  Source: ASM Consortium 1999

- The automation industry claims equipment damage exceeds $2.2 billion per year.
  Source: Insurance company estimates

- Plant surveys indicate that
  - Incidents are frequent.
  - Typical costs are $100,000 -$1 million.
  - Refineries average a major incident once per three years, costing an average of $80 million.
    Source: British Health and Safety Executive research report #166

The sources of abnormal situations fall into three main categories: **equipment**, **people**, and **process**.



Sources of abnormal situations.
Source: Established in literature ; confirmed by 7 plant studies - US, Canada, & Europe

Equipment factors include degradation and failures in the process equipment, such as pumps, compressors, and furnaces, as well as failures in the control equipment, such as sensors, valves, and controllers.

Factors related to **people** are the training, skill, and experience levels of the operations teams and their stress levels when situations reach alarm conditions. Organizational structure, communications, environment, and documented procedures and practices (or lack thereof) also play a role in operator response.

Process factors include process complexity, types of materials and manufacturing (batch vs. continuous), and state of operation—steady state vs. startups, shutdowns, and transitions.

All three of these factors can impact safety, health, and environment. You will now study the first two factors in more detail.

Equipment

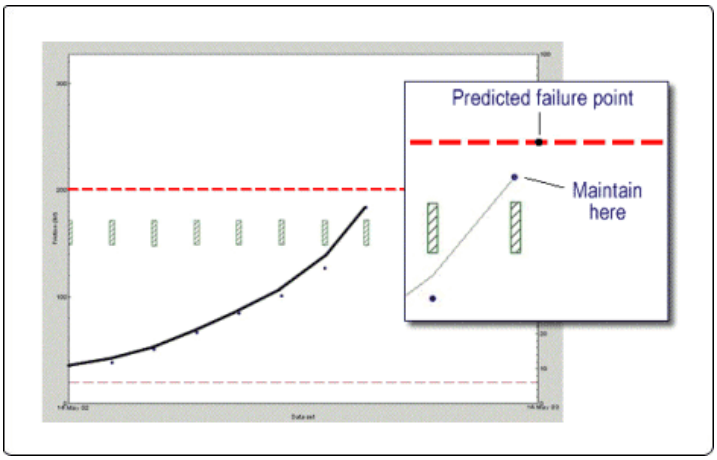
When **process equipment**, **mechanical equipment**, or **instruments** fail to perform as expected, the results can have both safety and environmental consequences, especially if the problem isn't discovered quickly.

Most mechanical failures result from damage or wear initiated by specific, random events, rather than from steady "wear-out" over the life of the equipment. This highlights the shortcomings of typical preventive maintenance programs. Because these programs are typically based on calendar or runtime schedules rather than actual equipment condition, two situations can occur:

- Service may take place too late, after damage that can lead to safety, health, or environmental problems has already begun.
- The work may be done too early, when it's not needed. Maintenance errors at this point can even create new problems or SH&E incidents.

Both situations increase costs—by performing maintenance that's not needed yet, or by allowing problems to grow until more expensive repairs are required.

To reduce these costs as well as the risk of failures, plants need to make greater use of predictive maintenance that's based on actual equipment condition. Equipment monitoring and diagnostic technology can detect potential problems—from a worn pump bearing to a sticking valve, from a fouled sensor to a failing heat exchanger—before they affect process operations or safety. As a result, maintenance teams can prioritize repairs for the equipment that needs it, when it needs it.



Digital predictive intelligence provides early warning of potential problems. This valve diagnostic, for example, indicates that friction will exceed the recommended limit in one month, enabling you to schedule replacement of the valve packing before deteriorating performance affects safety, health, or environmental protection.

Continuous monitoring will also tell you which devices and equipment are working properly, saving you the trouble of performing unnecessary maintenance that can increase costs as well as increase the risk of accidents or spills. Knowing that equipment is working properly will eliminate the need to send technicians into hazardous areas for routine checks that often reveal no problems.

A digital control system architecture can help ensure the mechanical integrity of your plant by:

- ***Predicting*** the events
- ***Messaging*** these predictions to appropriate plant personnel
- ***Guiding*** personnel on how to mitigate the event.

The PlantWeb Advantage

DeltaV Inspect software monitors both device performance and overall loop performance. It automatically flags any degradation or abnormal condition in a measurement, actuator, or control function block. This includes "advisory alerts" for equipment that is currently healthy but may need attention soon, before it affects safety or performance.

AMS Suite: Equipment Performance Monitor reports performance deviations in a wide range of process equipment, enabling early detection of potential catastrophic failures in key pieces of equipment, such as back pressure steam turbines. PlantWeb diagnostics have also shown their ability to detect conditions leading to a catalyst circulation upset in a fluidized catalytic cracker (FCC) unit—30 minutes in advance.

AMS Suite: Machinery Health Manager software combines online monitoring information with data from a wide range of analytical tools. These include the ability to detect and identify the very high-frequency noise associated with the earliest stages of bearing wear. You get maximum warning of future problems, before increasing damage significantly increases the risk of pump or motor failure.

People

Human error is another cause of abnormal situations that have an impact on SH&E. Some of these are simple slip-ups, but others may be caused by system design or by insufficient or ineffective training, procedures, and work practices.

Control systems are typically designed, programmed, and tuned for **normal** or near-normal operation. It's therefore particularly important that operators and other personnel have easy access to the information they need to manage the process when it deviates into **abnormal** situations.

The benefits are even greater, however, if you can move from abnormal situation management to **abnormal situation prevention** by enabling your team to spot potential problems and take corrective action before they grow.

The problem is that the typical control system can't show you more than the process variable and any associated trends or alarms. It doesn't know (and can't tell you) when equipment conditions indicate a potential problem.

For example, most traditional systems assume that any instrument signal between 4 and 20 mA is good, when in fact such a "good" signal could be hiding a sticking valve, a fouled pH sensor, or a plugged impulse line to a pressure transmitter. Or a bearing in a critical pump or motor may be deteriorating, but the control system has no way of knowing.

What's needed is a way to get a better view of what's happening throughout the operation, detect conditions that can lead to problems, and deliver the information where it's needed for corrective action—before those conditions turn into safety, health, or environmental incidents.

One solution is **digital remote monitoring**, which can provide reliable process and equipment information **when** and, more importantly, **where** it's needed. It can be predictive, solving problems before they become safety issues. It also helps you reduce the risk of problems introduced by human error. Operators and maintenance personnel gain the data, the tools, and the confidence to respond quickly and safely.

For example, when it comes to workers' health, keeping them from being exposed to hazardous areas is common sense. Remote monitoring reduces this exposure through its on-line diagnostic knowledge, without requiring you to send personnel out into the plant to locate the devices or plug in handheld communicators.

Remote diagnostics can keep personnel from exposure to extreme or hazardous environments.

The next two segments of this course explain how "people-based" problems can also be reduced by improving **alarms** and **training**.

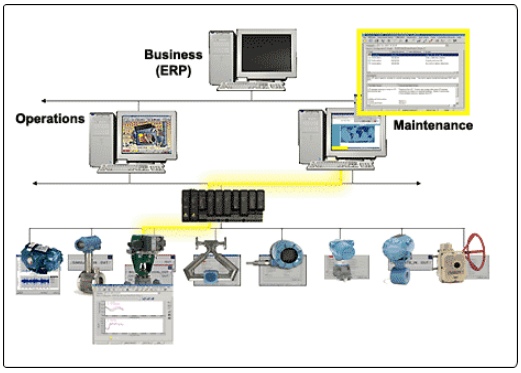
Alarms

One of the top issues in reducing human error is **the manner in which alarms are handled**. Typical plants today have too many alarms, and alarms that go to the wrong person.

According to Britain's Health and Safety Executive (HSE) contract research report 166, the performance of many alarm systems in normal steady operation leaves much to be desired:

- Around 50% of alarms are repeats of alarms activated in the last five minutes.
- Even excluding these repeat annunciations, perhaps 50% of alarms could be eliminated with little loss to the operator.
- There are strong indications that this high alarm load, coupled with the high number of nuisance alarms, adversely affects operator performance.

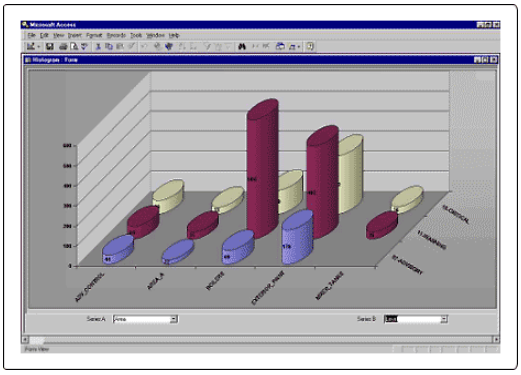
The root cause of unnecessary alarms can often be traced back to faulty plant instrumentation or inadequate instrumentation design. Good engineering of instrumentation is fundamental to a good alarm system, while good diagnostics help ensure that the instruments continue to deliver the expected performance.



Diagnostics at the valve are continually monitoring the drive signal of the I/P and are able to detect when dirty air **starts** to clog the I/P. The valve is still operating correctly, so there is no need to notify the operator. This predictive situation is sent to the Maintenance department for a solution.

"Out of service" alarms can be relatively easy to manage so that they don't distract the operator unnecessarily. For example, you can eliminate nuisance alarms by disabling a low flow alarm when the pump is OFF as well as the high flow alarm when the pump is initially turned ON. Modern digital systems make this conditional alarming easy and practical.

Alarm systems should be designed to ensure prompt, reliable, and effective operator response. Alarms lists should be carefully designed to ensure that high priority alarms are readily identified, that low priority alarms are not overlooked, and that the list remains readable even during times of high alarm activity or with repeat alarms.



Viewing alarm priorities by area helps locate trouble spots. This graph shows the number of alarms (the height of each bar) for five process areas (across the front) and three priority levels (also distinguished by different colors).

A key part of improving the alarm system is to use consistent performance measures to assess the current performance of the alarm system. Alarm activity should be regularly monitored and analyzed, and improvements implemented and documented.

In addition, it helps to have a specific person responsible for ensuring effectiveness of the alarm system within each operating area.

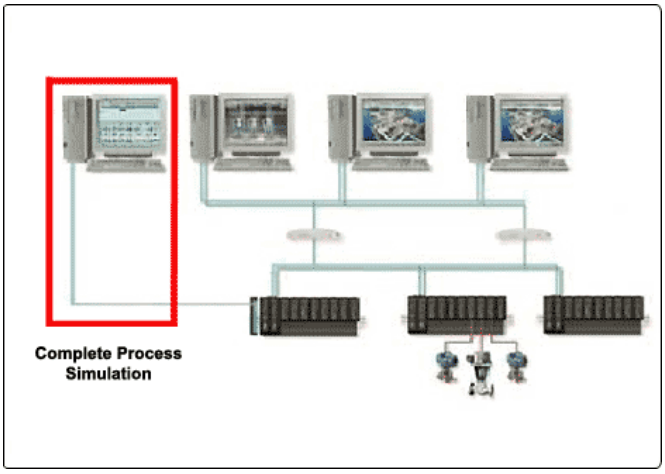
The PlantWeb Advantage

When process or equipment problems do occur, targeted **PlantWeb Alerts** help ensure that the right people get the right information right away. Instead of simply flooding operators with alarms, as many control systems do, PlantWeb software analyzes the incoming information, categorizes it by who should be told, prioritizes it by severity and time-criticality, and then not only tells the recipients what's wrong but also guides them through an appropriate response.

Training

Another "people" problem that can complicate abnormal situations is **insufficient or ineffective training**.

Operators should learn operating concepts while learning the actual process. This would prepare them to effectively handle incidents or process upsets. Training simulations can expose operators to situations they might experience in their actual control room and give them the opportunity to practice handling potential situations in a safe, off-line environment without affecting the process.



Simulation software should be non-intrusive and provide real-time process modeling. This allows you to test your control strategies without affecting your actual process.

Operator training can help:

- Reduce operator error
- Reduce/eliminate regulatory violations
- Reduce incident reporting
- Provide a better understanding of possible failure scenarios
- Improve OSHA compliance (Article 29 CFR PAR 1910.119)

The PlantWeb Advantage

Operator Training Simulation (OTS) from Emerson Educational Services exposes operators to a training environment identical to what they will experience in the actual control room. Operators will be able to learn control system operating concepts while learning their actual process at the same time.

The **DeltaV** and **Ovation simulation packages** provide an exact copy of the production control system where operators and others can safety practice dealing with both normal and abnormal events.

Regulatory Compliance

Complying with environmental, safety, and other regulations is essential and often expensive. The challenge is to find the most **cost-effective ways to meet these important requirements**.

Improved process and equipment performance helps reduce the risk of regulatory compliance problems caused by process upsets or malfunctioning equipment.

For example, frequent process changes and production rates that push equipment limits can increase risks of exceeding allowable emissions levels. While pollution prevention and abatement technologies can ease the task of compliance, so can better process measurement and control.

Tight, accurate control reduces the chance of process excursions that could increase emissions, and also reduces waste and off-spec material that must be reworked or disposed of safely.

For most operations, regulatory compliance also means documenting engineering, operating, and maintenance activities. This is especially true for processes that face validation requirements like FDA 21CFR Part 11.

In a typical plant, for example, maintenance personnel average only 30% "wrench time." The rest of their time is spent doing paperwork. Documenting process and equipment changes can also add to costs.

Automated tools for tracking and documenting changes can greatly reduce these costs, as long as all the needed information is readily available in a compatible digital form. Best-practices plants using such tools can increase "wrench time" to 50% or more.

Detailed information should be kept secure, including the device configuration, calibration, control configuration, process history, and event history. Your team's engineering efforts should be automatically chronicled and saved as part of an audit trail. This audit trail should provide you with a complete version-to-version comparison—not just who, when, where, and why the change was made, but, most importantly, **what** was changed. All actions or changes should be captured automatically to minimize costs.

The PlantWeb Advantage

AMS Suite: **Device Manager** software automatically documents all changes made through its workstation, including date, time, user, and as-found/as-left information. Available Audit Trail capabilities provide a valuable tool for meeting documentation and reporting requirements.

The **DeltaV** and **Ovation** systems' self-documenting engineering environment helps eliminate the need for separate offline or manual record keeping. Reporting tools let you easily generate reports to meet regulatory requirements. Where needed, Emerson can also draw on our extensive experience in system validation to provide documentation required by the FDA or other regulatory agency.

Summary

The top priority in any plant is maintaining operational Safety, Health, and Environmental compliance. You rely on intensive training and consistent procedures to help personnel prevent incidents. But unless you can look to your automation architecture to deliver predictive intelligence as a strategic part of your SH&E strategy, you're missing a critical advantage.

Imagine your process automation assets giving you the power to predict and prevent abnormal situations instead of simply reacting to them:

- Many incidents begin with unexpected mechanical failure. Automation architectures that have equipment monitoring and diagnostics provide an early warning of potential process and equipment problems, which enables you to take action before safety, health, or environmental problems result.
- The best way to reduce the risk of problems caused by human errors is to make it easier for operators and other personnel to get the timely, accurate information they need—and know the right way to take action based on that information, even in abnormal situations.
- Much of the effort that goes into meeting regulatory requirements takes the form of documenting engineering, operating, and maintenance activities. Make sure your automation system makes the paperwork easier and less time-consuming by doing much of the work for you.

[End of course]