

Using Safe Work Practices to Prevent Workplace Fatalities (CCPS Project 276)

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Outline for Today's Discussion

- Overview CCPS Organization & Mission
- Establish the “Case for Change”
- Overview the Risk Based Process Safety (RBPS) Model
- Introduce CCPS Project 276
- Overview Safe Work Practices Portal
- Describe the Opportunity for Community Input, including Key Contact Information
- Additional CCPS Resources
- Questions & Discussion

CCPS Vision



“To protect people, property, and the environment by bringing the best process safety knowledge and practices to industry, academia, governments, and the public around the world through collective wisdom, tools, training, and expertise”

Website: www.aiche.org/ccps

CCPS Mission

- **Eliminate catastrophic process incidents globally by:**
 - Advancing global Process Safety technologies, culture, and management practices
 - Establishing Process Safety as a foundation for responsible operations
 - Serving as the premier worldwide resource for Process Safety
 - Fostering knowledge and understanding of Process Safety
 - Promoting Process Safety as a key societal value and expectation

US Chemical Safety Board's Drivers of Critical Chemical Safety Change

- Key focus areas of CSB Recommendations & Improvement Needs
- 5 Targeted Areas
 - Combustible Dust
 - Process Safety Management for the 21st Century
 - Emergency Planning and Response
 - Preventative Maintenance
 - Safe Hot Work Practices
- Each area “Championed” by CSB Board Member
- Web Information: www.csb.gov/mostwanted

CSB'S DRIVERS OF CRITICAL CHEMICAL SAFETY CHANGE
 U.S. Chemical Safety and Hazard Investigation Board

Safe Hot Work Practices

Hot work is defined as burning, welding, or similar operations that can ignite fires or explosions. Hot work incidents occur throughout many industries in the United States, including food processing, pulp and paper manufacturing, oil production, fuel storage, and waste treatment. Most hot work incidents result in the ignition of combustible materials, e.g., a roofing fire, or the ignition of structures or debris near the hot work.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) has found that the most common causes of worker death due to hot work are explosions and fires due to flammable atmospheres in confined spaces. The table of hot work investigations below demonstrates that the CSB continues to see these types of hot work incidents involving tanks or containers containing flammables, especially at high hazard facilities like refineries and chemical plants. These incidents often result in injuries and fatalities and have the potential to result in a major catastrophic incident.

In February 2010, the CSB published the Safety Bulletin, *Seven Key Lessons to Prevent Worker Deaths during Hot Work in and around Tanks*. These items have since been incorporated into the International Code Council 2015 International Fire Code, in a new Section 3510, Hot Work On Flammable And Combustible Liquid Storage Tanks. The CSB provides the following summary of the seven key lessons from the bulletin:

- 1. Use Alternatives** - Whenever possible, avoid hot work and consider alternative methods.
- 2. Analyze the Hazards** - Prior to the initiation of hot work, perform a hazard assessment that identifies the scope of the work, potential hazards, and methods of hazard control.
- 3. Monitor the Atmosphere** - Conduct effective gas monitoring in the work area using a properly-calibrated combustible gas detector prior to and during hot work activities, even in areas where a flammable atmosphere is not anticipated.

The CSB has found that explosions and fires caused by hot work are among the most common incidents it investigates. These incidents typically result in injuries and fatalities and have the potential to result in a major catastrophic incident.

CSB MAR 07 Investigation, 2008

Failure to Properly Execute Hot Work Procedures (July 17, 2001)



What Happened

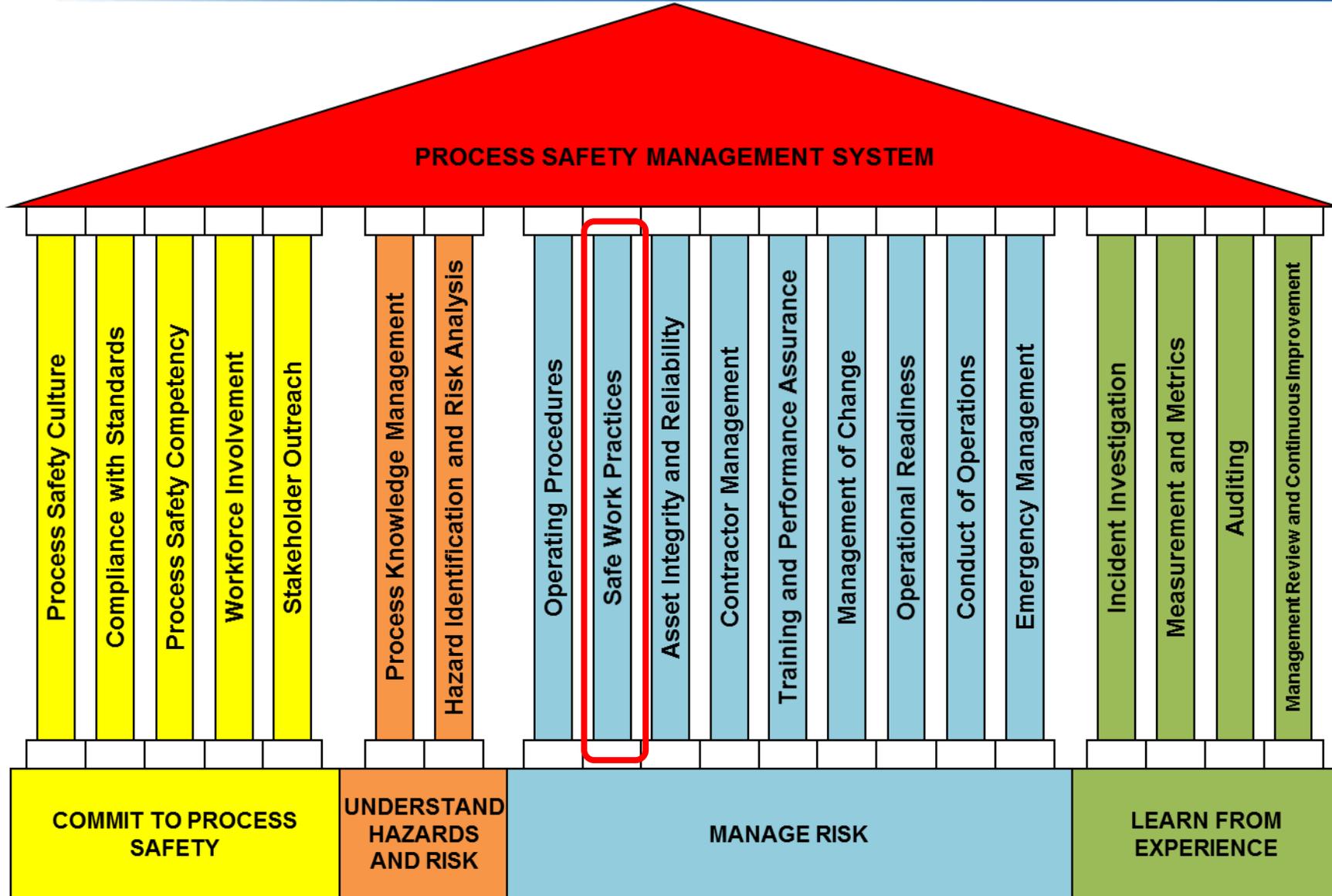
- Catwalk grating repair work was underway in a sulfuric acid storage tank farm
- Sparks from hot work ignited flammable vapors in one of the storage tanks
- The explosion lifted the tank, separating it from its floor, instantly releasing the tank contents
- Other releases in the tank farm were triggered at the same time
- One (1) worker was killed; eight (8) others were injured
- Secondary containment was breached with significant damage to aquatic life
- CSB Investigation Report:
 - <https://www.csb.gov/motiva-enterprises-sulfuric-acid-tank-explosion/>

Hot Work Failure

- Hot work was allowed in the vicinity of tanks known to have holes
- The hazards associated with the roof holes were not recognized as potential flammable vapor sources
- The Hot Work procedure did not identify the potential for flammable vapor hazards, and therefore no preventive measures were taken as part of issuing / approving the Hot Work permit

Risk Based Process Safety

<https://www.aiche.org/ccps/resources/publications/summaries/summary-guidelines-risk-based-process-safety>



Project No. 276

Essentials of Safe Work Practices

Overview

Work place fatalities continue to occur because of unsafe work practices. Through sharing safe work practice incidents and by compiling effective “best practice” elements, make safe work practices more “human failure” resistant.

Target Audience (3-Tiered)

- Operators and Maintenance Technicians
- Supervisors
- Managers

Simplicity

- Scalable and Universal
- Broadly Applicable (regardless of industry, facility size, geographical location, etc.)
- Establish New Program and/or Optimize Existing Program
- Establish Linkages with Programs/References from other Int'l Organizations

- **First Work Practices:**

- Hot Work
- Line Opening
- Energy Isolation
- Confined Space Entry
- Hot Tapping
- Equipment Filling and Mixing
- Field Review of Permits
- Temporary Bypass of Instrumentation and Controls

- **Work Product Elements:**

- Fundamental Intent
- Need/Call to Action
- Potential Hazardous Consequences
- Strategies & Effective Practices to Manage & Mitigate Hazards
- Possible Work Flow
- Common Program Practices
- Incidents
- Reference Materials

- **Website:** <https://www.aiche.org/ccps/resources/tools/safe-work-practices>



- Fundamental Intent
- Potential Hazards
- Incidents
- Effective Practices
- Reference Materials
- Workflows
- Call to Action
- Common Practices



An integrated set of policies, procedures, permits, and other systems that are designed to manage risks associated with non-routine activities such as performing hot work, opening process vessels or lines, or entering a confined space.

Control Hazards & Protect Personnel

1. [Hot work authorization](#)
2. [Line breaking / isolation \(and opening and blinding of process equipment\)](#)
3. [Lockout / tagout \(and control of energy hazards\)](#)
4. [Confined space entry](#)
5. [Access to process areas by unauthorized personnel](#)
6. [Access to hazardous areas during normal/routine operation](#)
7. [Roof access permits \(vents, PSV's, etc.\)](#)
8. [Elevated work and fall protection](#)

Protect Against Mishaps and Secondary Effects

9. [Excavation in or around process areas](#)
10. [Operation of vehicles in process areas](#)
11. [Lifting and hoisting over process equipment](#)
12. [Use of other heavy construction equipment in or around process areas](#)
13. [Hot tapping lines and equipment](#)

Control Special Hazards

14. [Radiation source handling \(e.g., mechanical integrity inspection\)](#)
15. [Electrical safe work](#)

Impairment of Safety Systems

16. Fire system impairment
17. Temporary isolation of relief devices
18. Temporary bypassing or jumpering of interlocks

Others

19. [Sampling](#)
20. [Shutdown / Safing equipment and processes](#)
21. [Water pressure and blasting](#)
22. [Equipment identification](#)
23. [Equipment filling and mixing](#)
24. [Field review of permits \(vs. "armchair" permitting\)](#)
25. [Permits for simultaneous operations \(SIMOPS\)](#)
26. [Scaffolding permits](#)
27. [Temporary buildings and/or structures](#)
28. [Extending permits over shifts/days](#)
29. [Temporary repairs / leak sealing and clamping](#)

- Line Break
- LOTO
- Confined Space
- Hot Work**
- Excavation
- Lifting
- Hot Tap
- Work at Height
- Temp. Bypass
- Scaffolding

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Fundamental Intent define the fundamental intent of the safe work practice, the purpose it can serve, and the benefits intended to provide. Draw veterans back-to-basics and provide a solid foundation for those in the developmental stages of their program.



Potential Hazards identify potential hazards that exist with performing work related to the safe work practice. Enable users to understand potential pitfalls and challenges so that pertinent incidents and effective practices may be better appreciated and understood.



Incidents – provide a listing of incidents that have identified root and contributing causes associated to each safe work practice. Briefly describe the incident and provide detailed insight into the safe work practice issues



Effective Practices – provide information and details regarding effective practices developed and implemented within industry to strengthen safe work practices and minimize related issues.



Reference Materials – provide a listing of related materials and information sources that readers can refer to in order to gain further information and insight into intent, incidents, and effective practices.



Workflows – Example of a typical workflow for managing hot work on the plant

Line Break

LOTO

Confined Space

Hot Work

Excavation

Lifting

Hot Tap

Work at Height

Temp. Bypass

Scaffolding

Potential Hazardous Consequences

Fundamental Intent

Potential Hazards

Incidents

Effective Practices

Reference Materials

Workflows

Call to Action

Common Practices

Property Damage (Fire / Explosion)

- Creating an ignition source (flame, heat, sparks, non-intrinsically safe equipment, molten metal or direct flames) in a combustible atmosphere (flammable materials/vapors) leading to fire or explosion.
 - Caution must be taken when working near openings or cracks in walls, flooring, open doorways and windows.
- Impinging heat to surrounding process equipment, causing possible thermal expansion resulting in the release of hydrocarbons,
- Arc from welding, possibly setting off fire detection / mitigation systems (i.e., deluge systems, alarms resulting in possible unit shut downs, etc.)
- Interference with other simultaneous work in close proximity (e.g., work involving breaking containment and potential release of combustible gases while hot work is present.)
- Hazards associated with welding equipment:
 - Damage and defective parts, if not replaced prior to start of the job
 - Improper grounding
 - Oxy-fuel equipment
 - If oxy-acetylene cylinders do not have sufficient material in the cylinders prior to start of the job, backflow can happen if one cylinder goes empty during operation which can cause:
 - A system pressure imbalance.
 - Mixing of oxy and fuel inside the hose.
 - Flashback caused by reverse flow of gas through the torch and back through to the hose, regulator and/or cylinder, potentially causing an explosion
 - Hose rupture leading to gas escape
- Fire or explosion caused by ignition of flammable/combustible vapors/materials present in processing equipment such as tanks, vessels and piping, etc., that have void spaces or liners (i.e., double-walled tanks and piping, double-bottom tanks)
- Cutting or welding on a line which has not been properly isolated, depressurized, drained, or purged

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Strategies and effective practices to manage and mitigate hazards

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Hazardous Consequences to be considered in planning the work	Strategies to Manage and Mitigate Hazards	Effective Practices to Manage and Mitigate Hazards
<ul style="list-style-type: none"> Unintended / unexpected release of hazardous materials Potential ignition (in the case of flammable material) or exposure (in the case of toxic material) 	<ul style="list-style-type: none"> Reduce risk by elimination or substitution; move in-situ work to a less hazardous location. 	<ul style="list-style-type: none"> Fabrication and modification outside hazardous areas is preferable with minimal hook up activities in situ. Consider deferring hot work to a future turnaround or outage when inventories of flammable materials is the plant at a minimum or totally eliminated. Move spark potential equipment such as air compressors outside hazardous areas and use long hoses.
<ul style="list-style-type: none"> Residual material not completely removed / cleared from the equipment, e.g. pockets, pores / pitted areas. 	<ul style="list-style-type: none"> Use alternative methods to welding or gas cutting. Use a non-sparking / minimal heat generating approach to the initial equipment / line penetration; follow-up with check that the system is 'clear of hazards' 	<ul style="list-style-type: none"> Consider bolted connections vs welding , mechanical cutting equipment vs gas cutting, use of plastic materials and adhesives rather than metals which rely on welding for installation
<ul style="list-style-type: none"> Propagation / transfer of potential ignition source to another location 	<ul style="list-style-type: none"> Create a safe working environment. 	<ul style="list-style-type: none"> If welding cannot be avoided in a hazardous area consider building a working enclosure with continuous positive pressure to prevent fugitive gas entry
<ul style="list-style-type: none"> Proximity of equipment and piping containing hazardous materials that could be impacted by nearby work. Consideration of occupied buildings / structure locations relative to the work 	<ul style="list-style-type: none"> Defer hot work to a future turnaround or outage. 	<ul style="list-style-type: none"> When the risk of hot work is considered unacceptable, consideration should be made to defer it until the plant is in a safer condition

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Example Workflow for Hot Work

Key Actions	Person in Charge (Supervisor)	Area Authority (Supervisor / Operator)	Isolating Authority (Operator)	Performing Authority (Planner / Contractor)
<ul style="list-style-type: none"> Look for alternatives to Hot Work in hazardous areas whenever possible Two types of Hot Work: Naked Flame / Spark Potential 				Identify need for Hot Work
<ul style="list-style-type: none"> Full work scope, materials used, work location Visit work site to identify Task, Process, Operational hazards and means of control Ensure equipment to be worked on is clearly identified 				Clearly define work scope
<ul style="list-style-type: none"> Specify controls to manage identified hazards Identify need for isolation / LOTO to reduce risk of gas escape 				Complete HW permit & JSA
<ul style="list-style-type: none"> Review permit content, Hazards and Controls Consider SimOps and Authorise Permit 	Approve Permit			
<ul style="list-style-type: none"> Remove all flammable materials which could accidentally ignite Ensure controls/ safeguards / isolations/ LOTO are in place Perform atmospheric gas testing- validate last calibration date 			Field Verifications	
<ul style="list-style-type: none"> Consideration of simultaneous operations (see practice details) Control Room Informed 				Permit Issued / Communication
<ul style="list-style-type: none"> Isolations / LOTO demonstrated to be energy free and gas free The PA will perform a tool box talk (discuss the task, Hazards and Controls) The Work Crew will sign the Tool Box Talk form / Fire watch assigned 				Work crew communication
<ul style="list-style-type: none"> Continuous gas monitoring (LEL + welding / cutting fumes) Periodic surveillance from site Operator 				Execute work / field monitoring
<ul style="list-style-type: none"> Hot surfaces & debris to be cooled / Firewatch monitors for 1 hr after work complete Area is clean and Permit is returned to be closed out 				Work Complete / site clean up
<ul style="list-style-type: none"> Site inspected, controls/ safeguards and isolations reinstated, atmosphere tested. Lessons are captured and permit completed 				Site Inspection / permit closure

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<ul style="list-style-type: none"> Full work scope, materials used, work location Visit work site to identify Task, P, control Ensure equipment to be worked 				Identify the scope
<ul style="list-style-type: none"> Specify controls to manage identified hazards Identify need for isolation / LOTO 				
<ul style="list-style-type: none"> Review permit content, Hazards Consider SimOps and Authorise 				
<ul style="list-style-type: none"> Remove all flammable materials Ensure controls/ safeguards / isolation Perform atmospheric gas testing 				
<ul style="list-style-type: none"> Consideration of simultaneous operations Control Room Informed 				
<ul style="list-style-type: none"> Isolations / LOTO demonstrated The PA will perform a tool box talk The Work Crew will sign the Tool 				new section
<ul style="list-style-type: none"> Continuous gas monitoring (LEL) Periodic surveillance from site 				work / ring
<ul style="list-style-type: none"> Hot surfaces & debris to be cooled complete Area is clean and Permit is returned 				k site / n up
<ul style="list-style-type: none"> Site inspected, controls/ safeguards tested. Lessons are captured and permit completed 				

Area Authority

- Is responsible for managing a Unit or section of the Plant. This is typically the Shift Supervisor whose responsibilities include:
 - Ensuring the planned work activities are executed in a safe and timely manner.
 - Managing all permitted work in the area.
 - Ensuring an appropriate risk assessment or JSA for work is carried out and the appropriate control measures are specified and implemented.
 - Approval of isolation design and control of isolation implementation and reinstatement.
 - Ensuring worksite inspections are carried out before, during and after the performance of this task (maybe delegated)
 - Ensuring adequate handovers are carried out at shift change
 - Maintaining the long term isolation register
 - Managing all simultaneous operations in accordance with company policies.

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Reference Materials

Hot Work References:

OSHA Oil and Gas Well Drilling and Services e-tool: Hot Work / Welding

https://www.osha.gov/SLTC/etools/oilandgas/general_safety/hot_work_welding.html

CSB Video on Dangers of Hot Work

<http://www.csb.gov/videos/dangers-of-hot-work/>

American Petroleum Institute (API). *Safe Welding, Cutting and Hot Work Practices in the Petroleum and Petrochemical Industries*, Recommended Practice (RP) 2009, Washington, DC, 2002.

National Fire Protection Association (NFPA). *Standard for Fire Prevention During Welding, Cutting and Other Hot Work*, NFPA 51B, 2009.

NFPA. *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, NFPA 326, 2005.

Occupational Safety and Health Administration (OSHA). *General Requirements for Welding, Cutting, and Brazing*, 29 CFR 1910.252.

API RP 2009, Safe Welding, Cutting, and Hot Work Practices in the Petroleum and Petrochemical Industries.

American Welding Society Fact Sheets (#'s 6, 28, 31, 34, 36, 37, 38, 40, 41).

ANSI Z49.1:2012: *Safety in Welding, Cutting, and Allied Processes*.

General Guidance on Permit to Work (including Hot Work)

UK Health & Safety Executive: *Guidance on Permit to Work Systems*

<http://www.hse.gov.uk/pUbns/priced/hsg250.pdf>

International Association of Oil and Gas Producers: *Guidance on Permit to Work Systems*

<http://www.ogp.org.uk/pubs/189.pdf>

Norwegian O&G Association - *Recommended Guidelines for a Common Model for Work Permits*

<https://www.norskoljeoggass.no/Global/Retningslinjer/HMS/SamarbeidForSikkerhet/088%20Recommed%20guidelines%20for%20common%20model%20for%20work%20permits.pdf>

Future Procedures

(Blue Entries are In Production)



Control Hazards & Protect Personnel

1. *Hot work authorization*
2. *Line breaking / isolation (opening and blinding of process equipment)*
3. *Lockout / tagout (energy isolation)*
4. *Confined space entry*
5. Access to process areas by unauthorized personnel
6. Access to hazardous areas during normal/routine operation
7. Roof access permits (vents, PSV's, etc.)
8. Elevated work and fall protection

Protect Against Mishaps and Secondary Effects

9. Excavation in or around process areas
10. Operation of vehicles in process areas
11. Lifting and hoisting over process equipment
12. Use of other heavy construction equipment in or around process areas
13. *Hot tapping lines and equipment*

Control Special Hazards

14. Radiation source handling (e.g., mechanical integrity inspection)
15. Electrical safe work

Impairment of Safety Systems

16. Fire system impairment
17. Temporary isolation of relief devices
18. *Temporary bypassing or jumpering of interlocks*

Others

19. Sampling
20. Shutdown / Safing equipment and processes
21. Water pressure and blasting
22. Equipment identification
23. *Equipment filling and mixing*
24. *Field review of permits (vs. "armchair" permitting)*
25. Permits for simultaneous operations (SIMOPS)
26. Scaffolding permits
27. Temporary buildings and/or structures
28. Extending permits over shifts/days
29. Temporary repairs / leak sealing and clamping

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- Project Website:
 - <https://www.aiche.org/ccps/resources/tools/safe-work-practices>



Additional CCPS Resources

- **CCPS Beacon** – Free monthly one-page newsletter delivering PS message targeting manufacturing and maintenance personnel
 - (<https://www.aiche.org/ccps/resources/process-safety-beacon>)
- **Safety & Chemical Engineering Program (SACHE)** – Free Process Safety modules & certificate program for Students, Professors, and Schools
 - (<https://www.aiche.org/ccps/community/technological-communities/safety-and-chemical-engineering-education-sache/certificate-program>)
- **Risk Analysis Screening Tool (RAST) and Chemical Hazard Engineering Fundamentals (CHEF)**
 - (<https://www.aiche.org/ccps/resources/risk-analysis-screening-tool-rast-and-chemical-hazard-engineering-fundamentals-chef>)