Climate Change

Climate Change — Impact on Process Safety

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What is process safety?

Process safety focuses on the control of hazards and risks associated with high-risk processes involving chemicals. Process incidents can result in fires, explosions, chemical releases and spills, structural collapses, equipment malfunctions and other impacts. These incidents can lead to environmental pollution, property damage, harmful chemical exposures, injuries, and fatalities.

What are the impacts of climate change?

Impacts of climate change include:

- Extreme heat and cold events
- Forest fires and wildfires

- Floods, heavy rain and snow
- Severe winds, hurricanes, and tornadoes
- Air pollution and smog
- Other extreme weather events

What are some key considerations for reducing the impact of climate change on process safety?

It is important to make sure that:

- The significant variability and severity of environmental conditions are considered when processes are designed and operated
- Climate-related hazards are included as part of your process safety management
- Hazards and risks of climate-related events are assessed, and control measures are implemented to protect worker health and safety
- Increases in risk to your processes due to changing climate conditions are assessed
- Systems are in place to continually evaluate process controls and to identify new threats posed by climate events and weather conditions
- Infrastructure is adapted to improve resiliency to extreme weather and climate events
- Emergency preparedness and response plans are developed to safely respond to extreme weather events

How can process safety help address the impact of climate change?

Process safety can be used to address workplace hazards and the associated risks from climate change. Risk management strategies can be used to identify environmental hazards, such as wildfires, floods and extreme heat, and the associated risks specific to your workplace and processes.

The safe operation of a process requires considering the significant variability and severity of environmental conditions. Workplaces need to consider how extreme weather can impact processes and people. For example, climate change and worsening weather events may increase the risk of:

- Infrastructure damage
- Loss of power and other utilities

- Changes in process temperatures
- Chemical releases and exposures
- Unintentional mixing of incompatible materials

Extreme weather can also affect worker health and safety due to heat or cold stress, exposure to harmful airborne contaminants, process failures, and other hazardous conditions.

When reviewing process safety, it is important to seek input from individuals who know the impacts of climate change, extreme weather events and the process safety system itself. Collaborating with other organizations with similar processes is also recommended to make sure all hazards and risks are identified, and adequate controls are in place.

How can workplaces identify and assess potential process hazards due to climate events?

It is important to identify the potential sources of harm or failure associated with a process throughout its lifecycle. These include chemical, fire and explosion hazards, and climate-related hazards, such as wildfires, flooding, severe winds, high temperatures, and storms. It is also important to consider worst-case situations and scenarios (e.g., extreme weather events) to identify all potential hazards.

Risk assessments for each of the hazards identified need to be done to help determine appropriate control measures and prioritize the order in which the hazards need to be addressed. The hazards may not be new, but the risk of the hazards may have incrementally increased due to climate change. Since climate events are becoming more severe and frequent, a greater emphasis on assessing the potential impacts of extreme weather on process safety is needed. Workplaces need to assess the potential severity of the consequences of climate events (e.g., fire, explosion, flooding, chemical releases, injuries, exposures, and death) and the likelihood that those consequences could occur. When assessing the risks, consider your geographical location, future weather trends, changes in flood and wildfire risks, extreme temperatures, changes in tornado and storm risks, and risks posed by other extreme weather events.

How can workplaces better understand climate risks?

Engineers Canada published guidance based on a National Guideline (2018) which includes:

- Understanding future climate conditions requires extensive knowledge of historical and current climate conditions and how these have evolved.

- Relying only on historical climate trends for projecting future climate conditions, however, is becoming less reliable for engineering planning, design, operations, and infrastructure maintenance.
- Working with climate scientists and experts to ensure appropriate and current climate and weather considerations are used in professional practice.
- Using advanced modelling and analysis to project and incorporate climate change scenarios into process engineering design.

Climate experts might not have extensive knowledge of the engineer's area of practice and vice versa. Collaboration will be needed to ensure meaningful climate information and the impact on the process will be obtained.

What are examples of climate-related hazards?

Below are examples of hazards that may be more likely to occur or have more severe impacts due to climate events:

- Fires, flooding, heavy winds, lightning, changes in temperatures, storms, tornadoes, etc., caused by climate events
- Impacts and damage to critical infrastructure such as buildings, roads, pipelines, equipment, and critical process components.
- Loss of power, backup power, water, gas, communication, and other utilities (e.g., due to flooding, storms, wildfires, extreme temperatures). These losses could lead to:
- Spills and releases that may result in exposures and unintentional mixing of incompatible chemicals
- Response to emergency situations caused by extreme weather events and process failures
- Impacts on worker health and safety
    - Heat or cold-related illness
    - Fatigue
    - Injuries, illness, or death from exposure to chemicals
    - Psychological stress

Be aware of cascading effects, where the occurrence of one event can lead to another. For example, an extreme weather event may cause a loss of power, which may lead to an inability to maintain process cooling, which may result in a thermal reaction that could cause a fire, explosion, infrastructure damage and chemical releases.

How can a workplace control the hazards?

The approach to controlling climate-related hazards is not that much different than for other hazards. The main difference will involve accounting for the increased risk of climate-related events and impacts. This approach will require making sure controls implemented or already in place will be effective given the significant changes in climate conditions and increased risk of extreme weather events.

After the climate-related hazards have been identified and the risks assessed, appropriate control measures can be implemented, or existing controls can be modified as needed. It is important to consider worst-case scenarios and have redundancies in place if a control measure fails or is breached. One approach is to implement layers of controls. The hierarchy of controls, which is a step-by-step approach to eliminate or reduce the risk of workplace hazards, should be considered. The hierarchy of controls prioritizes controls from the most effective level of protection to the least effective level of protection.

Elimination: For new construction, these controls could involve making sure the location is not in a high-risk area for flooding or extreme weather (e.g., wildfires, tornadoes).

Substitution: For example, replacing chemicals that are highly susceptible to thermal reactions with safer alternatives.

Engineering Controls: For example, ventilation and cooling systems appropriate for higher ambient temperatures. It also includes making sure critical infrastructure, such as power and backup power supply, is properly protected during an event (e.g., located in elevated areas, enclosed, etc.).

Administrative Controls: includes training and educating workers, and developing or improving work policies, practices, and procedures. Examples include emergency response plans and business continuity plans.

Personal Protective Equipment (PPE): includes making sure workers responsible for responding to emergencies have access to the required PPE to perform their duties safely. This may include respiratory protection, skin protection, firefighting equipment, rescue equipment, etc.

Examples of climate-specific control measures include:

Flood mitigation measures

- Maintain and enhance stormwater management infrastructure and capacity
- Move critical infrastructure to elevations above expected flood levels (e.g., electrical transformers, ventilation systems, backup generators)
- Have backup power generators and fuel to provide electricity to critical infrastructure (e.g., cooling systems, heat pumps, sump pumps, fire protection systems, ventilation, and emergency lighting).

- Install sump pumps and backwater valves
- Strategically place water sensors to detect flooding
- Have flood barriers available to use (e.g., dikes, berms, sandbags)
- Seal the building envelope and make sure grading and drainage are appropriate
- Store hazardous chemicals in sealed containers, above flood levels, and in areas with floor drains

Wildfire management – minimize the impacts of wildfires

- Move flammable products stored outside to a safer location, or place them in sealed containers or enclosures made of flame-resistant material
- Use building materials with increased flame-resistant properties (e.g., metal and concrete)
- Install external sprinkler systems connected to a dedicated water and power source
- Maintain property and landscaping to remove flammable materials and vegetation around the perimeter of the workplace
- Add screens to vents and building openings to prevent embers from entering, as appropriate
- Maintain ventilation systems and determine if higher efficiency filters can be used without exceeding the design specifications (to capture air contaminants generated from wildfires). Consider using portable fans with a HEPA filter

Extreme heat

- Develop a heat stress plan for workers.
- Make sure ventilation and cooling systems are adequate, as initial design parameters may not have accounted for the increases in ambient temperatures.
    - Potential for higher temperatures and increased vapour generation of chemicals inside storage containers
- Backup power supply for ventilation, cooling systems, and other critical infrastructure
- Review preventative maintenance schedules as higher temperatures may increase the deterioration and wear on process components, equipment, and infrastructure

Extreme cold

- Develop a cold stress plan for workers

- Review and update winterization plans, including procedures to prevent the freezing of lines, equipment, and critical infrastructure.
- Use of heating systems on equipment and piping where appropriate
- Review the temperature design specifications of equipment and process components
- Review safe shutdown procedures in the event a process cannot operate in extreme cold temperatures, including procedures for draining residual water and other fluids that could freeze.

How do workplaces verify the effectiveness of controls?

Hazards driven by climate change can evolve, and it is important to re-assess hazards and risks at regular intervals. Appropriate modifications need to be made when deficits or unacceptable levels of risk are identified. Regular audits of your processes by competent individuals (internal or external) are valuable and help with continuously assessing risks over time. Climate-related criteria should be incorporated into the audit and revised as necessary.

How do workplaces protect the health and safety of workers?

When implementing controls or changes to address the impacts of climate events on a process, it is important to analyze the impacts on worker health and safety. Any changes should also be reviewed from an occupational risk prevention point of view. It is important to identify hazards, not only for the process, but also for workers who operate and maintain the process and for other workers that could be impacted. For example, consider changes associated with the operation, cleaning, maintenance, construction, demolition, and other activities where a worker could encounter a hazardous situation. Based on the hazards and risks, appropriate controls need to be in place and continuously monitored to protect workers.

How can workplaces prepare for emergencies?

Although efforts and control measures may be in place to prevent emergencies, as climate events are becoming more unpredictable, it is important to have plans and redundancies in place. Emergency response plans need to incorporate procedures on how to safely monitor, shut down or continually operate critical processes that may cause injuries, damage, or releases in the event of a power failure or malfunction. For more information, please see our OSH Answer on Extreme Weather - Preparing for Climate-Related Emergencies.

Workplaces may also have resources and personnel that can help their local community with an overall response to climate-related emergencies. Businesses may be able to collaborate with local government and emergency services to determine what services or resources they can provide during a climate-related emergency.

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