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Power to Prevent SIF

Field Guide to Controlling High-Energy Hazards

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Introduction

Serious injuries and fatalities (SIFs) have proven stubborn. Even as traditional efforts have reduced minor injuries across the industry, the most severe events have not followed the same downward trend. This guide exists because we have an urgent opportunity to change that trajectory.

Energy-Based Safety (EBS®) gives us a clearer focus: **SIFs happen when high energy isn't adequately controlled.** By paying close attention to the physical forces at work such as electricity, heat, pressure, motion, and others, we can better understand where people are exposed and whether the safeguards in place are strong enough to prevent serious harm, even when things don't go as planned.

This flip guide is built for the field. Inside, you'll find:

- A quick overview of the EBS principles
- Common high-energy hazards and real utility-work examples
- Practical, strong safeguards called Direct Controls that keep energy where it belongs

It applies across electric power work: generation, transmission, distribution, gas operations, vegetation management, warehouses, and support functions. Whether you're planning a job, walking a site, or helping a crew solve a problem, this guide helps you focus on what matters most.

You don't need to be a safety expert or engineer, just ask three simple questions:

- Where are the sources of energy in this task?
- Which ones have enough energy to cause a SIF?
- Are the controls strong enough to protect us if someone makes a mistake?

By seeing the energy and verifying its controls, we ensure the right defenses are in place before something goes wrong. That's how we make real progress against the SIF plateau.

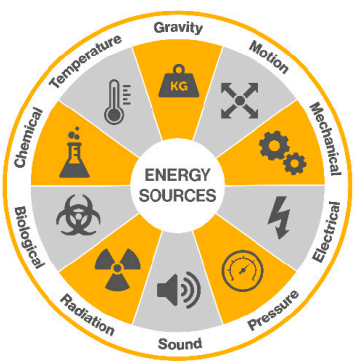
Principle 1: Energy Causes Harm and the Energy Wheel Helps Us Spot 30% More Hazards

Every serious injury or fatality on the job happens because energy released in a way that hurt someone. A worker might fall from a ladder because of gravity. Someone might get burned by hot steam or shocked by an energized wire. A pipe might rupture and explode because of pressure. These events may seem different, but they all have one thing in common. Energy was released or transferred to the body with enough force to cause serious harm.

That is why energy is the starting point for safety. If there is no energy, there is no serious injury. But most jobs in the electric utility industry involve energy. Electricity, heat, pressure, motion, weight, or chemical reactions are all examples. These are sources of energy, and when they are not properly controlled, they become hazards.

To help crews recognize hazards more consistently, we use a tool called the Energy Wheel. It shows common types of energy that can cause harm on the job. The idea is simple. When you plan a task or walk a job site, scan the wheel and ask what types of energy are present. Is there something that could fall? Is anything hot, pressurized, or moving fast? Are we working near high voltage?

Research shows that using the Energy Wheel helps crews identify about 30 percent more hazards. It helps us look at the job differently and have better conversations about risk. When we see the energy, we can control it. And when energy is controlled, people stay safe.



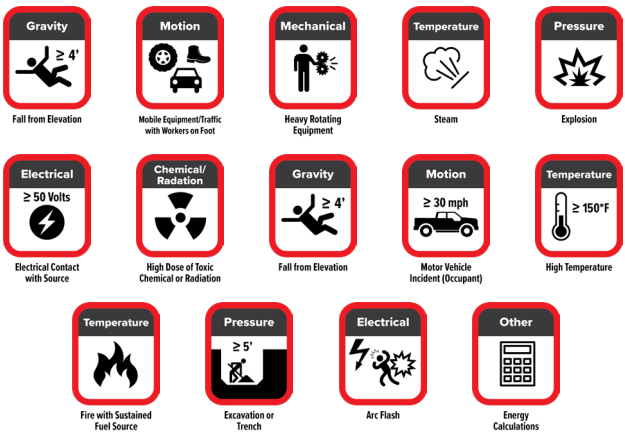
Principle 2: More Energy Causes More Harm and High-Energy Hazards Lead to Serious Injuries

Not all hazards are equal. A trip on flat ground might result in a scraped knee. But a fall from a bucket truck or an elevated platform can cause broken bones or worse. The difference is the amount of energy involved. The more energy that is present, the more serious the consequences when something goes wrong. When we have enough energy (1500 Joules to be exact) a SIF is not only possible, it's the most likely outcome.

In most SIFs, a large amount of energy is released. This might be electrical, mechanical, thermal, or chemical energy. For example, a suspended load falling from a crane can strike a worker with the force of a small car crash. An arc flash from energized equipment can release more heat than a blast furnace. Steam under high pressure can cause severe burns or cut through skin. Heavy rotating equipment can pull in loose clothing or limbs in a fraction of a second.

These are examples of what we call **high-energy hazards**. They are not just dangerous. They are life-threatening if not properly controlled. Energy-based safety focuses on these types of hazards because they are the ones most likely to result in a serious injury or fatality.

To help identify these situations, we group high-energy hazards into thirteen types. Each type represents a category of energy that can reach dangerous levels. They include the following:



Each of these hazards involves a type of energy that can do serious harm. The exact source may vary by task or job site, but the risk comes from the same principle. When high energy is present and not controlled, it can be deadly.

That is why the next step in energy-based safety is understanding how to control that energy in a way that protects people even when things go wrong. This is where the idea of **Direct Controls** becomes critical.

Principle 3: Direct Controls Save Lives

Once we recognize high-energy hazards, the next step is making sure they are properly controlled. That is where Direct Controls come in.

A Direct Control is a specific type of safeguard with a clear purpose. It is designed to prevent serious harm by keeping high energy from reaching the human body. But not all controls qualify. To be considered a Direct Control, three rules must be met:

Rule 1: The control must be targeted.

Focuses directly on the specific source of high energy in the task. Not all general safety practices count. The control must be aimed at the hazard that could cause a SIF.

Rule 2: The control must be strong.

The control must mitigate the energy by physically stopping, isolating, containing, or reducing the amount of energy that can reach a worker. If the energy can still harm someone, the control needs to be improved.

Rule 3: The control must be forgiving.

Continues to protect even if someone makes a mistake. A good control does not rely on perfect human behavior; it has your back when things don't go as planned.

Targeted

Specifically targeted to the source of high energy

Strong

Effectively mitigates the amount of energy present when it's installed properly

Forgiving

Remains effective, even if unintentional human error occurs after installation

In addition to meeting these three rules, a Direct Control must be installed, verified, and used correctly. A control that is not in place, not functioning, or not applied properly does not count.

These rules are the foundation for energy-based safety and SIF prevention. They ensure we are not just doing something but doing something that works, especially when it matters most.

High-Energy Hazards and their Direct Controls

The next sections of this guide show how Energy-Based Safety (EBS) principles can be applied during Energy-Based Observations (EBO®).

For each of the thirteen high-energy hazards, you will find two types of information:

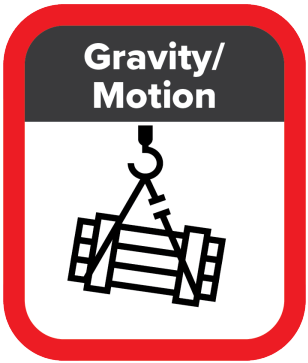
- A list of example tasks where that type of energy is commonly present
- A set of example Direct Controls that can help mitigate the hazard

These are not complete or exhaustive lists. They are meant to show realistic situations and practical solutions. They are everyday jobs where high energy may be present and where serious injuries can occur if energy is not properly controlled.

The examples show what it looks like to apply the rules of Direct Controls in the field. They are included to support planning, coaching, and decision-making. Not every control fits every task. Not every task will have a perfect answer. The goal is not to check a box. The goal is to improve how we see energy, how we assess risk, and how we protect people from serious harm.

1

Suspended Load



Most suspended loads require specialty equipment to lift massive objects off the ground. In such a case, suspended loads are over the high-energy threshold. Suspended loads typically have gravitational energy from the vertical height and kinetic energy from the lateral movement. These two energy sources should be treated separately as they require different types of protection.

High-Energy Hazard Examples

- Placing generator components using a crane
- Lifting reactor vessel internals with specialized rigging
- Installing transmission tower sections with slings and a crane
- Hoisting conductor bundles into place using bucket trucks and rope blocks
- Placing pad-mounted transformers with rigging and boom truck
- Setting utility poles with digger derrick and slings
- Lowering gas regulator stations into vaults using a chain hoist
- Installing gas compressor skids with crane and rigging during station upgrades
- Clearing large fallen trees using rigging and crane in storm restoration work
- Staging large cable reels using forklift and overhead hoist

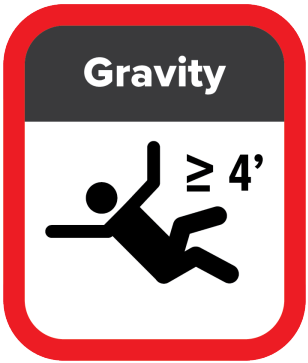
Direct Control Examples

- Engineered ratchet straps or tie downs
- Tool tethers
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

2

Fall from Elevation

(Greater than 4 Feet)



Considering the average weight of a human is approximately 200 lbs (90 kg), 4 feet (1.22 m) measured from the ground surface to the bottom of the feet exceeds the high-energy threshold. The approximate center of gravity at this elevation is roughly 7 feet (2 m), which is over the 1500-Joule threshold.

High-Energy Hazard Examples

- Performing maintenance on boiler tubes while standing on scaffolding
- Inspecting spent fuel pool area from elevated work platform
- Stringing shield wire while working from a transmission tower cathead
- Installing line hardware while positioned in an elevated bucket truck
- Connecting secondary conductors while working from a ladder
- Changing crossarms while operating from a distribution aerial lift
- Inspecting relief valves on top of a natural gas separator skid
- Installing regulators on elevated pipe racks
- Trimming limbs near energized lines while working from a bucket truck
- Picking inventory from high storage racks using a rolling ladder

Direct Control Examples

- Fall arrest system
- Fall restraint system
- Covers over holes
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

3

Mobile Equipment or Traffic with Workers on Foot

Because of the mass, most mobile equipment including motor vehicles exceeds the high-energy threshold when the equipment or vehicle is in motion. For this icon, the energy exposure is taken from the point of view of the worker on foot and not the equipment operator or vehicle driver.

High-Energy Hazard Examples

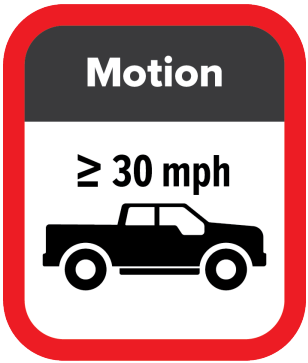
- Transporting turbine parts through a generating station yard while workers guide the movement
- Positioning fuel casks using heavy haulers while spotters assist
- Pulling conductor with tensioner and pulling rig while ground crew manages wire clearance
- Setting poles with digger derrick while crew members position and level base
- Unloading pad-mounted transformers with forklift while workers stabilize the load
- Trenching for secondary service while mini excavator operates near ground crew
- Lowering pipe segments into trench using side boom while workers check alignment
- Hauling excavated soil from worksite while laborers manage spoils
- Chipping limbs with workers feeding brush as traffic passes nearby
- Moving pallets with forklift while workers stage materials for delivery

Direct Control Examples

- Automatic shutoff system to avoid collision between equipment and workers
- Hard physical barriers that stop progression of equipment into unsafe areas
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

4

Motor Vehicle Operation Over 30 mph (Vehicle Occupant)



Estimations of the motor vehicle speed typically involved in serious or fatal crashes vary greatly. The team selected a conservative estimate of 30 miles per hour as the high-energy threshold. This energy exposure is taken from the point of view of the vehicle occupants including the driver, but not workers on foot.

High-Energy Hazard Examples

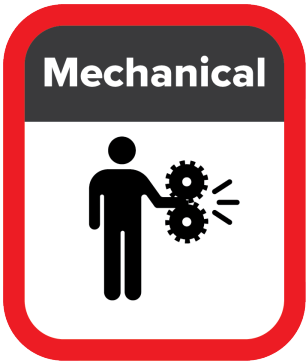
- Driving in a pickup truck on a major highway
- Transporting technicians between sites in a van on rural roads
- Driving a line truck on highways
- Operating a bucket truck between substations and pole replacement sites
- Transporting materials in a flatbed truck
- Driving a small utility vehicle between jobs
- Conducting leak survey patrols using a pickup truck
- Hauling equipment for gas meter upgrades
- Accessing remote line corridors via UTV for vegetation patrols
- Delivering materials from central warehouse to field sites using a service truck

Direct Control Examples

- Automatic collision avoidance or shutoff system
- Highway-rated vehicle (includes steel frame, seat belts, airbags, etc.)
- Non-highway-rated vehicles with rollover protection and seat belts

5

Heavy Rotating Equipment



All heavy rotating equipment beyond powered hand tools typically exceeds the high-energy threshold and most rotating equipment or tools exceeding 100 rotations per minute (rpm) should be considered high energy. The following tools are considered high-energy in almost every condition: chainsaw, concrete saw, outriggers, powder actuated tools, augers, and capstans.

High-Energy Hazard Examples

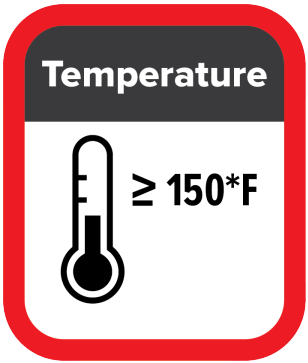
- Performing maintenance near a generator turbine rotor
- Inspecting coolant pumps with high-speed impellers
- Working near energized phase rotation equipment
- Servicing hydraulic tensioners used for pulling a conductor
- Repairing capacitor bank cooling fans with exposed rotating elements
- Maintaining cable reel spools with rotating drive mechanisms
- Servicing rotating blower units on gas compressor skids
- Inspecting rotating impellers
- Clearing brush near rotating chippers
- Operating a rotating convey or belt system

Direct Control Examples

- De-energization with lock-out tag-out (LOTO)
- Energy isolation where LOTO is not required
- Interlocks
- Machine guards
- Outriggers to prevent machinery from tipping
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

6

High Surface Temperatures
(Greater than 150° Fahrenheit)



Solid surfaces over 150°F are considered high energy if contact is possible with a surface area of 100 square inches or larger. Contact with any surface at or above 150°F can cause third-degree burns within at least 2 seconds, reflecting typical human reaction time.

High-Energy Hazard Examples

- Welding steam piping during turbine maintenance
- Removing insulation near reactor coolant piping
- Cutting seized connectors with a torch
- Heating conductor ends for compression fittings
- Performing hot work on service risers
- Grinding metal enclosures during vault equipment repair
- Conducting hot tap installation
- Maintaining gas-fired heater systems
- Chipping limbs around recently run chainsaw mufflers in summer heat
- Handling hot mechanical components after extended forklift use

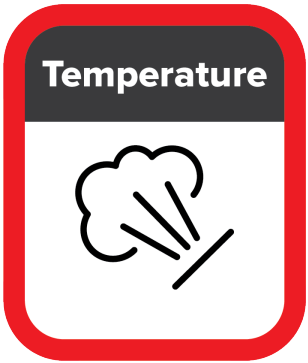
Direct Control Examples

- Automatic shutoff system
- Interlocks
- Specialized PPE: Rated heat-resistant clothing with no skin exposed
- Temperature control device
- Thermal surface insulation
- Tool that forces a safe distance
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

7

Steam

Industrial exposures to steam almost always exceed the high-energy threshold.



High-Energy Hazard Examples

- Opening isolation valves on steam headers during turbine startup
- Replacing steam flange gaskets
- Inspecting live steam lines for leaks
- Working near high-pressure steam relief vents
- Removing insulation from steam supply lines
- Draining residual steam from service entrance piping
- Repairing steam-driven turbine equipment
- Blowing down steam traps

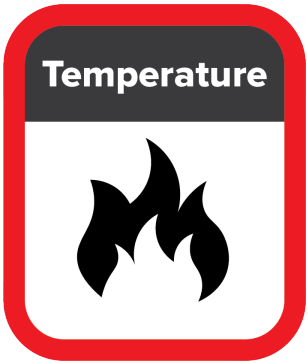
- Clearing overgrowth around venting steam lines in vegetation-prone areas
- Inspecting high-temperature steam traps used in warehouse heating systems

Direct Control Examples

- Automatic shutoff system
- De-energization with lock-out tag-out (LOTO) applied
- Energy isolation (e.g., squeezing and blocking; closing valves) where LOTO is not required
- Specialized PPE: Rated steam suits with no skin exposed
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

8

Fire with a Sustained Fuel Source



A lightly combustible material like paper burns at approximately 700 degrees Fahrenheit, far exceeding the temperature threshold. Fire with a sustained source of fuel exceeds the high-energy threshold.

High-Energy Hazard Examples

- Performing torch cutting during boiler tube replacement near oil residue
- Welding near insulation materials
- Using hot sticks near dry vegetation
- Grinding guy anchors during structure replacement in fire-prone transmission corridors
- Conducting hot work in an underground vault with residual cable oil
- Splicing energized conductors near combustible debris
- Hot tapping a live natural gas main during service tie-in
- Using spark-producing tools during gas meter replacement
- Clearing dry brush around energized lines
- Storing aerosol lubricants near battery chargers in a utility warehouse without ventilation

Direct Control Examples

- Automatic fire suppression system
- Automatic fuel shutoff system
- De-energization with zero voltage checks and grounding
- De-energization with lock-out tag-out (LOTO) applied
- Energy isolation (e.g., squeezing and blocking; closing valves) where LOTO is not required
- Fuel source separation
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

9

Explosion

Most incidents described as an explosion exceed the high-energy threshold.

High-Energy Hazard Examples

- Performing hot work near steam turbine lube oil systems with potential vapor accumulation
- Opening sealed containment systems near hydrogen sources
- Using non-intrinsically safe radios near gas-insulated switchgear
- Purging SF_6 gas compartments without proper venting procedures in high-voltage transmission equipment
- Charging backup batteries in unventilated underground vaults
- Splicing primary cables in manholes with possible

presence of flammable gas

- Purging natural gas mains during commissioning of new piping systems
- Opening pressure relief devices on odorizer tanks
- Using chainsaws near propane-powered equipment
- Handling flammable aerosols near exposed heating elements

Direct Control Examples

- Automatic fire suppression system
- Blast blankets
- Bonding and grounding
- De-energization with lock-out tag-out (LOTO) applied
- De-energization with zero voltage check and grounding
- Energy isolation (e.g., squeezing and blocking; closing valves) where LOTO is not required
- Fuel source separation
- Explosion suppression system
- Mechanical pressure release devices
- Rated panel enclosures
- Physical barriers to prevent equipment/vehicle strikes
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

10

Excavation or Trench with a Depth of 5 ft or Greater

An exposure to unsupported soil in a trench or excavation that exceeds 5 feet of depth (1.5 m) exceeds the high-energy threshold. Typically, for each foot of depth, soil pressure increases by about 40 pounds (2 kPa) per square foot. Thus, at 5 ft (1.5 m) of depth the pressure is approximately 200 psf (10 kPa).

High-Energy Hazard Examples

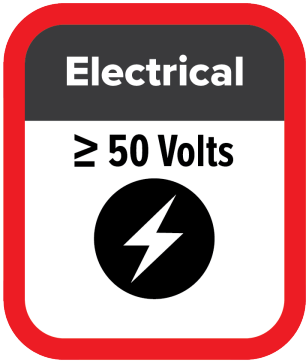
- Excavating steam line tunnels
- Installing deep intake piping for cooling systems
- Digging foundation holes for new transmission structures
- Installing grounding systems at the base of high-voltage towers using deep excavations
- Excavating vaults for large pad-mounted transformers
- Repairing underground primary cables in a trench exceeding 5 feet in depth
- Installing gas main crossings under roadways requiring deep trenching
- Performing tie-ins on high-pressure gas mains within unshored excavations
- Digging that exceeds 5 feet of depth around tree stumps during root ball removal
- Placing drainage pipe at depths of greater than 5 feet in unstable soil

Direct Control Examples

- Excavation support system
- Trench box
- Sloping or benching
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

11

Electrical Contact with 50 Volts or Greater



Electricity equal to or exceeding 50 volts typically produces current sufficient to result in serious injury or death.

High-Energy Hazard Examples

- Installing lighting circuits without lockout
- Testing energized relay cabinets during diagnostics
- Splicing overhead transmission conductors without full clearance verification

- Working in bucket trucks near energized 230kV lines
- Replacing distribution fuses on energized transformers without confirming isolation
- Installing meters in live panels during service upgrades
- Connecting jumpers on energized gas facility instrumentation without de-energizing
- Troubleshooting cathodic protection panels without proper isolation
- Clearing vegetation near downed energized lines without verification of de-energization
- Storing and retrieving energized tools or testers in a warehouse without inspecting insulation integrity

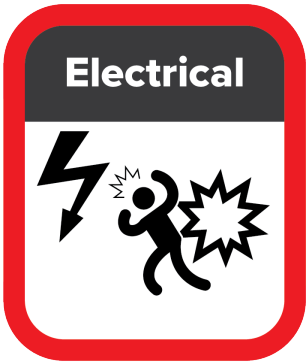
Direct Control Examples

- De-energization with lock-out tag-out (LOTO) applied
- De-energization with zero voltage check and grounding
- Energy isolation (e.g., switches) when LOTO is not required
- Equipotential zones (EPZ)
- Insulated or voltage-rated equipment and tools
- Electrical insulation barriers (e.g., rubber cover)
- Tool forcing safe distance (e.g., hot sticks)
- Specialty PPE: Full isolation such as insulating gloves, sleeves, dielectric footwear, etc.
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

12

Arc Flash

Arc flashes typically exceed the high-energy threshold because of the voltage exposure.



High-Energy Hazard Examples

- Opening energized breaker cabinets for inspection
- Testing relay systems in energized motor control centers
- Racking in circuit breakers in high-voltage transmission yard switchgear
- Performing infrared scans on energized bus work
- Replacing fuses in energized pad-mounted transformers
- Modifying wiring in a distribution panel
- Resetting breakers after a fault in instrumentation panels
- Accessing live power supplies for gas odorizer equipment

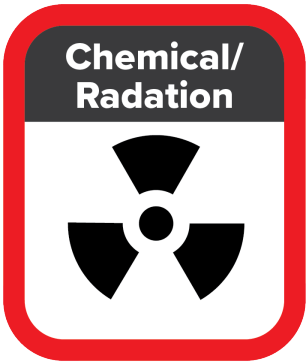
- Opening energized service equipment
- Installing temporary power panels without full arc-rated PPE

Direct Control Examples

- Blast blankets
- De-energization with lock-out tag-out (LOTO) applied
- De-energization with zero voltage check and grounding
- Energy isolation (e.g., switches) when LOTO is not required
- Equipotential zones (EPZ)
- Insulated or voltage-rated equipment and tools
- Tool forcing safe distance (e.g., hot sticks)
- Specialty arc-rated PPE
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

13

High Dose of Toxic Chemical or Radiation



Exposure to toxic chemicals, radiation, or biological agents. An industrial hygienist, chemist, toxicologist, or other competent person should be involved in the assessment of toxicity and acceptable exposure limits. The following references should be used to judge acceptable exposure limits:

- Immediately Dangerous to Life or Health (IDLH) Values
- Exposures which reduce oxygen (O2) levels below 16%
- Corrosive chemical exposures (pH <2 or >12.5)

High-Energy Hazard Examples

- Cleaning boiler components with high-concentration chemical descalers
- Handling radioactive waste shielding materials
- Applying corrosion inhibitors inside grounding systems
- Removing lead-based coatings from aging transmission structures
- Using solvent-based cleaners on energized distribution switchgear in enclosed vaults
- Spraying herbicides around pad-mounted equipment
- Purging odorant vessels or handling odorizer chemicals
- Cleaning or inspecting mercury-containing regulators
- Applying pesticides near energized lines
- Cleaning up spilled battery acid from material handling equipment

Direct Control Examples

- Automated shut-off system
- De-energization with lock-out tag-out (LOTO) applied
- Energy isolation (e.g., switches) when LOTO is not required
- Local exhaust ventilation
- Specialty chemical or radiation-rated PPE
- Radiation shielding
- Specialty rated container
- Supplied air respirator
- Hard physical barriers to prevent entry to unsafe areas
- Remote operations or automation

Power to Prevent SIF

For full definitions and more detailed information, use the QR code below to visit **powertopreventsif.com**