FREEPORT-
MCMORAN

STUDENT GUIDE

SFT FCX1025C
Control of Hazardous Energy

September / 2019
VERSION 1

"Your good work, dedication to your jobs, and commitment to our company is what makes Freeport-McMoRan strong."

Richard C. Adkerson

President and CEO, Freeport-McMoRan[1]

1 Richard C. Adkerson to company, memorandum, 1 January 2019, "Richard Adkerson New Year's Message", https://fmwebhome.fmi.com/locations/nola/Announcements/190101_RCA%20New%20Year%20Message_2019.pdf#search=richard%20adkerson.

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LEARNING OBJECTIVES

The provided learning objectives establish guidance and focus throughout the course.

MODULE 1: SOURCES OF ENERGY

Upon completion of this module, students will be able to:

- Identify sources of energy, given a scenario or image

MODULE 2: CONTROL OF ENERGY SOURCES

Upon completion of this module, students will be able to:

- Select the correct energy control device/type, given a scenario

MODULE 3: ROLES AND RESPONSIBILITIES

Upon completion of this module, students will be able to:

- Determine the responsibilities of each individual, given a simple or complex lockout job

MODULE 4: PROCESSES

Upon completion of this module, students will be able to:

- Demonstrate the actions to stay safe, given a scenario

MODULE 5: ENERGY CONTROL IN PRACTICE

Upon completion of this module, students will be able to:

- Demonstrate the application of hazardous energy control principles to various sources, given different examples

INTRODUCTION

Through the following pages, you will see our commitment to you and to a safe working environment here at Freeport-McMoRan. As stated by our Board of Directors in our Corporate Safety and Health Policy:

"No job will be considered so important, and no schedule so urgent, that time cannot be taken to perform work in a safe manner."

By ensuring that no production need is more important than the safety of you or your coworker, we can be sure that everyone makes it home safely. Working safely is more than a condition of employment; it is our livelihood. All of us must strive to achieve our goal of eliminating workplace injuries, illnesses, and fatalities.

The Freeport-McMoRan Control of Hazardous Energy Policy (FCX-HS04) intends to address the practices and procedures necessary to disable machinery or equipment and to prevent the release of hazardous energy while employees perform service and maintenance activities. The Control of Hazardous Energy Policy (FCX-HS04) establishes minimum, acceptable requirements to protect employees and contractors from injury. The policy requires that each site establish a written program for hazardous energy control. Additionally, the policy specifies minimum requirements for identifying and developing controls for all hazardous energy types.

The Control of Hazardous Energy Policy (FCX-HS04), site Hazardous Energy Control Programs, and equipment specific procedures differ in the specific details of each component of the hierarchy. The **Control of Hazardous Energy Policy** (FCX-HS04) is a broad, all-encompassing policy that outlines the minimum requirements on how to protect workers against the release of hazardous energy and is the foundation for worker protection

Sites develop more detailed **Hazardous Energy Control Programs** to meet the unique needs of each site. These programs are still somewhat broad in scope but outline more specific requirements on how each site will implement the Control of Hazardous Energy Policy and Technical Supplement (FCX-HS04).

Equipment specific **procedures** are very detailed and outline the specific energy control steps that workers will perform when working on a specific piece of equipment to ensure compliance with the policy. Sites develop these procedures in conjunction with Standard Operating Procedures (SOPs) and are specific only to one task/job/equipment.

Sites will train and qualify employees so that they can follow the appropriate requirements of the Control of Hazardous Energy Policy (FCX-HS04). Each employee must have an understanding of the overall hazardous energy control procedures and the elements of the energy control procedures that are directly related to his/her work duties.

This intent of this training is to satisfy the minimum training requirements for Energy Control Coordinators (ECC), Authorized/Qualified Individuals, and Affected Individuals. Module 3 explains the roles and responsibilities of these individuals. In addition to this training, your site will provide you with equipment or machinery-specific training before performing Lockout/Tagout/Tryout.

If at any time you have a question, in this class or while you are working in the field, it is your responsibility to stop and seek clarification.

FATAL RISKS AND CRITICAL CONTROLS

Fatal Risk Management is a continuation of the Fatality Prevention Program. Focus is placed on identifying Fatal Risks and Critical Controls in an attempt to safeguard all employees within the Company. The Fatal Risk Management Program standardizes communication for twenty-three Fatal Risks by implementing icons, definitions, and Critical Controls.

Fatal Risks are based on safety issues that have resulted in catastrophic events such as severe injury or death. While all risks have a degree of danger, Fatal Risks are those risks that, when left uncontrolled, will kill you.

For each identified Fatal Risk, a list of necessary Critical Controls was developed to prevent or mitigate the most serious consequences of these risks. Once the Fatal Risk is identified, applying the most effective Critical Control is crucial. A Critical Control is a device, system, or process implemented to eliminate or reduce the risk for a task/job, and if missing or overlooked has the potential to lead to catastrophic outcomes such as serious injury or death. These Critical Controls are considered the most impactful on preventing a fatality or injury and have been previously established based on data. The absence or failure of a Critical Control significantly increases the risk of severe injury or death despite the existence of other controls. The Fatal Risk(s) and Critical Controls relevant to this course are provided below.

UNCONTROLLED RELEASE OF ENERGY

The Uncontrolled Release of Energy Fatal Risk is defined as exposure to stored energy from pressure (e.g., pneumatic systems, hydraulic systems, steam, tires, etc.); Items under tension or compression (e.g., mooring lines, springs, counterweights, etc.).

CRITICAL CONTROLS

- Energy Isolation/LOTOTO
- Guards, Barriers, and Barricades
- Hose Coupling Lock System
- Pipe Management
- Piping Hoses and Equipment Mechanical Integrity
- Relief Valves
- Tensioned Lines Management
- Tire Management

ENTANGLEMENT AND CRUSHING

The Entanglement and Crushing Fatal Risk is defined as contact with machinery/moving parts (entanglement, crushing, pinching, penetrating, and cutting forces).

CRITICAL CONTROLS

- Blocking for Maintenance Work
- Energy Isolation/LOTOTO
- Guards, Barriers and Barricades

EXPOSURE TO ELECTRICAL HAZARDS

The Contact with Electricity Fatal Risk is defined as exposure to electrical shock or arc flash.

CRITICAL CONTROLS

- Access Control
- Barriers and Segregation
- Drawings and Labels
- Electrical PPE
- Energized Electrical Work Permit Execution
- Energy Isolation/LOTOTO

EXPOSURE TO HAZARDOUS SUBSTANCES - ACUTE

The Exposure to Hazardous Substances Acute Fatal Risk is defined as workplace exposure to substances that are immediately toxic, asphyxiating, or corrosive (e.g. H_2S gas, NO_2 gas, CO gas, concentrated acids, caustics, etc.).

CRITICAL CONTROLS

- Access Control
- Alarm Systems
- Engineered Controls
- Handling Requirements
- Loading and Unloading Protection
- Mechanical Integrity of Storage and Distribution
- PPE

EXPOSURE TO HAZARDOUS SUBSTANCES - CHRONIC

The Exposure to Hazardous Substances Chronic Fatal Risk is defined as workplace exposure to substances that can cause lethal disease overtime (e.g. silica, arsenic, lead, welding fumes, asbestos, acid mist, etc.)

CRITICAL CONTROLS

- Access Control
- Engineered Controls
- Handling Requirements
- PPE

FALLING OBJECTS

The Falling Objects Fatal Risk is defined as exposure to falling objects (e.g. tools, material, equipment, structures, etc.).

CRITICAL CONTROLS

- Barriers and Segregation
- Integrity of Overhead Structures and Equipment
- Securing Devices
- Work Area Management

LIFTING OPERATIONS

The Lifting Operations Fatal Risk is defined as exposure to loss of control of a load suspended by a crane (fixed or mobile), hoist, forklift, boom, or other lifting equipment.

CRITICAL CONTROLS

- Barriers and Segregation
- Lifting Execution
- Mechanical Integrity of Lifting Equipment

Sources of Energy

MODULE 1

MODULE 1: SOURCES OF ENERGY

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MODULE 1 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Identify sources of energy, given a scenario or image

INTRODUCTION

Freeport-McMoRan strives to be one of the safest natural resource companies in the world by identifying and controlling hazardous energy in the workplace. This module begins by describing some of the energy types that may be present in the work environment and then discusses how to identify the sources of energy.

HAZARDOUS ENERGY CONTROL

The primary purpose of a Hazardous Energy Control Program is to protect personnel from injury. According to the Freeport-McMoRan Policy Administration Requirements (FCX-HS01), each site must establish a written program for Hazardous Energy Control. This program must ensure the protection of personnel from potentially hazardous energy when performing service or maintenance work.[2]

Maintenance or repair work may expose workers to hazardous energy sources. The Hazardous Energy Control Program requires workers to de-energize equipment and physically isolate the equipment from power sources to avoid accidental re-energization or unexpected start up while performing work. Check with your Supervisor or Health and Safety Representative for your site's specific Hazardous Energy Control Program.

Fig. 1.1: Example of a Hazardous Energy Program in use

2 FCX Department of Occupational Health and Safety, *Policy Administration Requirements, FCX-HS01*, (Corporate Safety Portal, DOHS Policies: 2019), 15.

TRAINING

All employees who may perform work on potential energized equipment/machinery are required to complete initial and annual refresher training. In addition to this course, sites must train individuals on the specific equipment, machinery, or process that they assign to the individual. This training must be to an appropriate level according to his/her duties and responsibilities.

Sites will provide retraining to all employees when one of the following occurs:

- When policy or program changes
- When there is a change in job assignment, a change in machinery, equipment, or process that presents a new hazard, or a change in energy control procedures
- If auditing indicates that there are deficiencies in the application of hazardous energy control or a lack of employee understanding of the program

HIERARCHY OF CONTROLS

One tool for use when looking for controls is the Hierarchy of Controls. When deciding on the type of controls to use, consider the effectiveness of each level. In general, controls are most effective when they do not rely on individual worker behaviors as behaviors may vary from worker to worker. Controls at the bottom (such as PPE and Administrative) are less reliable because worker behaviors play a larger role than the controls at the top. The diagram shows the five types in order from most effective (elimination) to least effective (PPE).

- Elimination – physically removing the hazard from the workplace
- Substitution – replace a chemical, substance, material, or practice with something less hazardous
- Engineering – blocks an employee's access to a hazard with a barrier so the employee cannot contact the hazard
- Administrative – implementing rules that change the way employees do their job
- Personal Protective Equipment (PPE) – offers the body a layer of protection from hazards

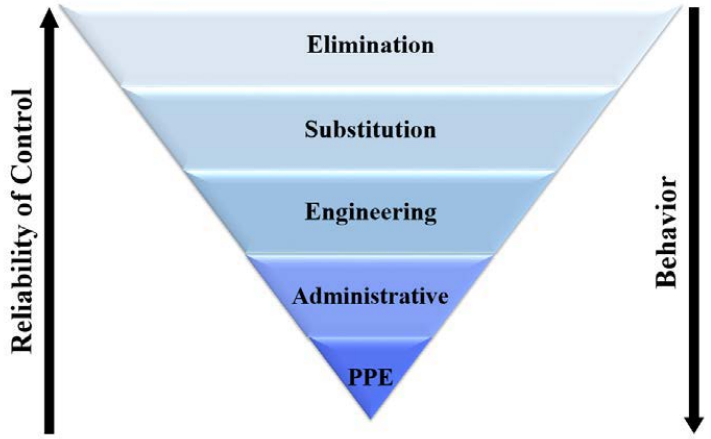

Fig. 1.2: Hierarchy of Controls Chart

Most of the hazards in our work areas come from some form of energy. Whether it is stored energy (suspended loads, pressurized lines, etc.); energy in motion (moving machine parts, vehicles, etc.); thermal energy (furnaces, boilers, roasters, etc.); electrical energy or others, all of them have one thing in common. If workers can identify a potential hazard, then workers can control it.[3]

ENERGY SOURCES

Before work begins, identify any energy that could energize, startup, or release so that personnel can lock or block them out before work begins. This course focuses on the types of energy prevalent at most of Freeport-McMoRan's operations: electrical, chemical, gravitational, hydraulic, magnetic, mechanical/kinetic, nuclear/radiation, pneumatic, and thermal. Keep in mind that this is not a complete list of all energy types.

ELECTRICAL

When people talk about energy types, they typically think of electrical energy first. When a current of electrons moves through a conductor, this generates electrical energy. People use electrical energy to create light, heat, or motion. An example of electrical energy is a switch box on an overhead crane. Recognized as a serious workplace hazard, electrical energy exposes employees to the following hazards:

- Arc flash
- Electric shock
- Burns
- Fires/Explosions

Fig. 1.3: Substation

Fig. 1.4: Overhead power lines

3 "Hierarchy of Controls", *Confined Space*, *v. 2.1*, (Freeport-McMoRan/Mine Training Institute: 2018), 47.

CHEMICAL

The chemical bonds of a substance stores chemical energy. When a reaction breaks the chemical bonds, it releases chemical energy. The energy can release as heat, but also can release in other forms such as pressure. A common result of a hazardous chemical reaction is fire or explosion. Many chemicals are potentially toxic, corrosive, or otherwise hazardous to your health.

Fig. 1.5: Sulfuric Acid tank

Fig. 1.6: Perchloric acid added to samples

GRAVITATIONAL

The result of an object's vertical position or height stores gravitational energy. This energy is another example of potential energy. An example of gravitational energy is a crane suspending a load over a work area or a counterweight.

Fig. 1.7: Crane suspending a haul truck bed

Fig. 1.8 Counterweight

HYDRAULIC

Hydraulic energy is energy stored in pressurized liquids frequently used to move heavy objects. Examples of hydraulic energy include automotive lifts, heavy equipment, power presses, filter presses, braking systems, rams, and jacks.

Fig. 1.9: Hydraulic cylinder

Fig. 1.10: Hydraulic filter press

MAGNETIC

Magnetic energy is the energy within a magnetic field, which results in various metals, either repelling or attracting each other. All magnetic currents create an electrical current; therefore, any moving electric charges produce magnetic fields.[4] Examples of magnetic energy include metals tools and metal detectors. Individuals with pacemakers and implantable cardioverter defibrillators (ICDs) should avoid areas with high-powered magnets as these magnets may interfere with the function of the devices.[5]

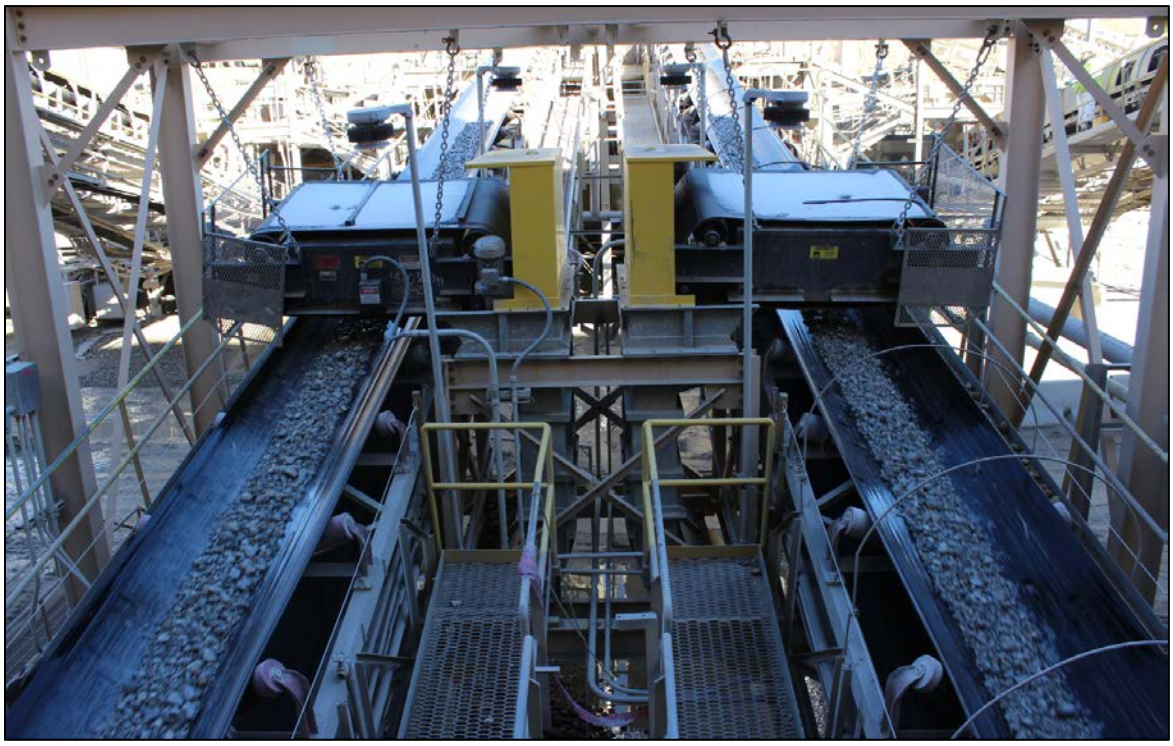

Fig. 1.11: Metal detector on conveyor belt

4 "What is Magnetic Energy?" *Reference.com*, Accessed May 30, 2019, https://www.reference.com/science/magnetic-energy-e664ea43b5ec8d8.

5 Heart Rhythm Society, "Magnets May Pose Serious Risks For Patients With Pacemakers And ICDs", *ScienceDaily.com, Accessed June 20, 2019,* www.sciencedaily.com/releases/2006/11/061130081343.htm.

MECHANICAL/KINETIC

Mechanical energy is the sum of all kinetic and potential energy in a working system. Kinetic energy is the energy of motion, and potential energy is the energy stored in an object based on its position.

It is easy to think of mechanical energy as the energy of a mechanical object in motion. Examples of mechanical energy include a running conveyor belt or a shovel loading muck. Common hazards associated with mechanical energy are people crushed or struck by a moving object.

Mechanical energy may also be present in the form of potential energy. Examples of this are a ball mill, rotating equipment, or a tensioned spring/line. While it is easy to see how kinetic energy in a mechanical system can be hazardous, it is important to be aware of the dangers associated with potential energy as well. When releasing potential energy, it becomes kinetic energy. This energy has the potential to expose workers to the same type of crush injuries mentioned above.

Fig. 1.12: Electric shovel

Fig. 1.13: Conveyor belt

NUCLEAR SOURCES / IONIZING RADIATION

Ionizing radiation is any electromagnetic or particulate radiation source with enough energy to remove electrons from an atom.

At Freeport-McMoRan, the technology centers and processing areas most frequently contain these energy types. For instance, the Technology Center has ionizing radiation equipment used in material characterization such as X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF), which is in an enclosed x-ray beam system; shielded cabinets enclose all x-rays.

Fig. 1.14 On-Stream Analyzer (OSA)

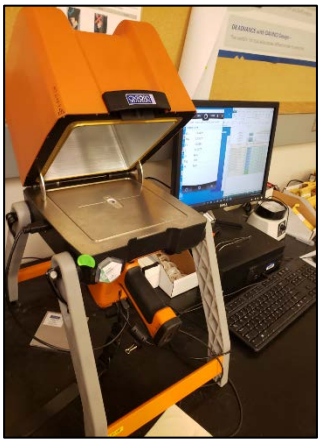

Fig. 1.15: XRF machine

PNEUMATIC

Pneumatic energy is energy stored in pressurized or compressed air, as well as stored in a vacuum. At Freeport-McMoRan sites, spraying devices, compressed air/gas cylinders, and tanks all have pneumatic energy.

Fig. 1.16: Stationary compressed airline

Fig. 1.17: Air compressor

THERMAL

Thermal energy, commonly thought of as heat, is the energy of a system due to the movement of molecules. The greater the amount of thermal energy, the faster the molecules move. People feel this increased movement of molecules in the form of released heat. Conversely, a lack of thermal energy is something cold to the touch.

Table 1.1: Examples of thermal energy

High levels	Low levels
Heat felt from an electrical cord	Ice
Hot liquids or steam	Liquid propane
Surface of a motor	Liquid oxygen
	Liquid nitrogen

Fig. 1.18: Furnace/Skim Basin

The thermal energy of a system can be the result of directly applied energy such as combustion, radiant heat applied by an outside force such as the sun, or friction between two moving objects in contact with each other. High and low levels of thermal energy can cause burns to a person or damage a piece of equipment that can harm a person in the event of a failure. Any liquid that is normally a gas at room temperature (nitrogen, oxygen, etc.) can cause severe burns upon contact.

Fig. 1.19: Roaster

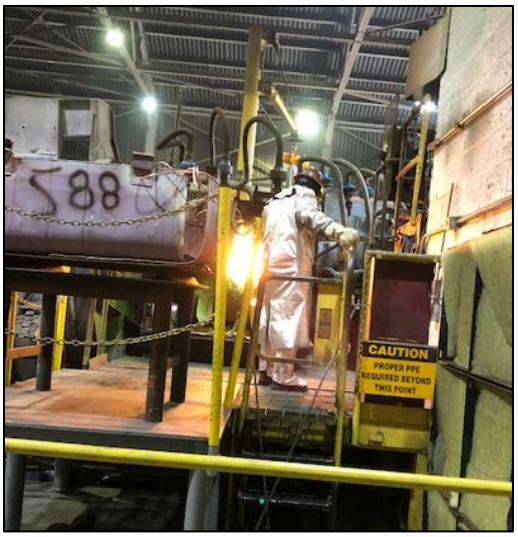

Fig. 1.20: Rod Mill

ENERGY OVERVIEW

The following table summarizes the various sources of energy. Keep in mind; this is not an all-encompassing list.

Table 1.2: Summary of energy sources

Energy Source	Example	Definition
Chemical	• Pregnated leach solution • Sulfuric acid	The energy released by breaking chemical bonds.
Electrical	• Switch box • Overhead power lines	The current generated by the movement of electrons through a conductor.
Gravitational	• Suspended load • Counterweight	The energy stored in an object as the result of its vertical position or height.
Hydraulic	• Pressure washers • Braking systems • Automotive lifts • Power press	The energy stored in pressurized liquids.
Magnetic	• Metal detector • Tramp metal magnet	The energy within a magnetic field, which results in various metals, either repelling or attracting each other.
Mechanical/Kinetic	• Crusher • Conveyor belt • Mills	The sum of all kinetic and potential energy in a system. The energy generated by moving equipment.
Nuclear Sources / Ionizing Radiation	• X-Ray diffraction • X-Ray fluorescence	Electromagnetic or particulate radiation with enough energy to remove electrons from an atom.
Pneumatic	• Air compressors • Compressed gas cylinders	The energy stored in pressurized air.
Thermal	• Steam • Hot surfaces • Cold	The energy in a system resulting from the internal movement of molecules.

EQUIPMENT EXCLUDED FROM THE STANDARDS

Equipment excluded from the standards includes cord and plug equipment if the plug is under the direct control of the employee.[6] "Direct control" includes plugs that are within sight and reach during the duration of the work.[7] Whenever using electrical equipment, ensure that appropriate personnel perform a continuity test or ground check before using the equipment. Always check with site Health and Safety or leadership before performing work using this type of equipment.

Fig. 1.21: Drill with cord

HOW TO IDENTIFY ENERGY SOURCES

Each Freeport-McMoRan site shall conduct a Hazardous Energy Survey that identifies all potential energy that is present on equipment, machinery, or processes during service or maintenance.

The Energy Survey serves two main functions. The first is to determine all sources of energy that employees may be exposed to during service or maintenance activities. This determination includes all sources of electrical, chemical, gravitational, hydraulic, magnetic, mechanical/kinetic, nuclear/radiation, pneumatic, and thermal energy. Also, remember to consider internal energy sources such as charged capacitors, batteries, wound springs, and raised loads. The second function of the Energy Survey is to determine how workers can isolate or control each source of energy and the location of the isolation points or devices. Be aware that many processes/pieces of equipment have multiple energy sources, all of which workers will need to identify in the Energy Survey.

6 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

7 "The Control of Hazardous Energy (Lockout/Tagout)-OSHA 1910.147," *Osha.gov*, Accessed May 29, 2019, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9804&p_table=STANDARDS.

ACTIVITY 3: IDENTIFYING SOURCES OF ENERGY

Directions: With your group, choose 2 energy sources and create an infographic poster for each energy source. Include the following on the posters:

- Name of the energy source
- Any associated FRM icons
- An image showing the energy source
- Examples of where would you encounter the energy source

Use this page to take notes before creating the poster. Be prepared to present your posters to the class.

ENERGY SOURCE:

FRM icon(s): _____

Image/example to draw:

_____

Where would you encounter this energy source?

_____

_____

ENERGY SOURCE:

FRM icon(s): _____

Image/example to draw:

_____

Where would you encounter this energy source?

_____

_____

MODULE 1 QUIZ

Complete the following quiz. Some questions may have more than one answer.

1. Name the potential energy source(s) when using a crane to suspend a load over a work area.
    a. Hydraulic
    b. Pneumatic
    c. Gravitational
    d. Mechanical/Kinetic

2. Name the potential energy source(s) when using compressed gas cylinders.
    a. Thermal
    b. Hydraulic
    c. Pneumatic
    d. Mechanical/Kinetic

3. Name the potential energy source(s) when adding perchloric acid to samples in a lab.
    a. Thermal
    b. Chemical
    c. Magnetic
    d. Pneumatic

4. Name the potential energy source(s) when working around a conveyor belt.
    a. Magnetic
    b. Electrical
    c. Mechanical/Kinetic
    d. Nuclear Source/Ionizing Radiation

5. All processes or pieces of equipment only have a single source of energy.
    a. True
    b. False

Control of Energy Sources

MODULE 2

MODULE 2: CONTROL OF ENERGY SOURCES

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MODULE 2 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Select the correct energy control device/type, given a scenario

INTRODUCTION

The control of hazardous energy is the process of identifying and isolating potential sources of energy when there is the possibility of exposure while performing work; eliminating or controlling the sources of energy; and verifying that controls are effective.[8] This module discusses the various types of controls used at Freeport-McMoRan properties and the verification process.

TYPES OF CONTROLS

An energy-isolating device is a mechanical device that prevents the transmission or release of energy. Some examples of these devices include circuit breakers, disconnect switches, line valves, and blocks.

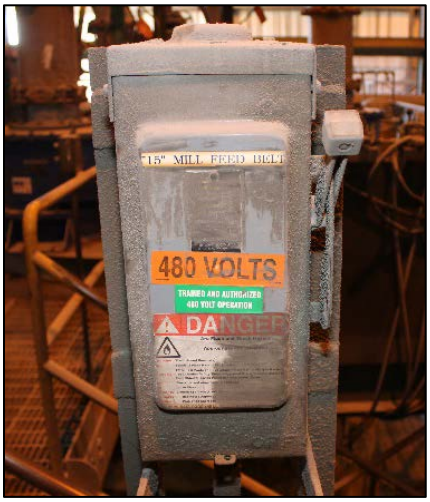

Fig. 2.1: Disconnect switch

Each site must develop and document detailed energy isolation procedures for each unique piece of equipment, system, or process during service and maintenance activities. The detailed procedure must clearly outline the requirements for energy isolation for machines, equipment, or processes.

These procedures must include the following:

- Identification of the machine, equipment, or process
- Listing of all energy isolation devices and their locations
- Specific procedural steps for shutting down, isolating, blocking, securing, and relieving stored or residual energy
- Specific procedural steps for placement and removal of energy isolation devices
- Specific procedural steps for verifying isolation and if a device has been properly de-energized

8 FCX Department of Occupational Health and Safety, Control of Hazardous Energy, FCX-HS04, (Corporate Safety Portal, DOHS Policies: 2019), 1.

ENERGY CONTROL

After identifying the potential sources of hazardous energy, use appropriate methods and devices for controlling the energy source. This section describes the use of procedures, techniques, designs, and methods to protect personnel from injury from the unplanned release of energy.

AIR GAP/LINE BREAK

The air gap or line break method puts a space or gap in the system carrying the energy (e.g., wires, lines, or pipes). Examples include removing a section of pipe or completely removing the fuses out of a power line system.

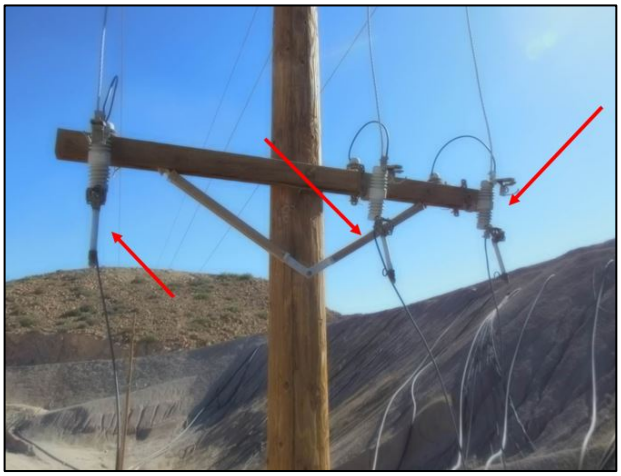

Fig. 2.2: Air gap

Line breaking removes a spool section (an expansion joint) of a pipe/duct. Close and lock all upstream valves per the Control of Hazardous Energy Policy (FCX-HS04). If the valve fails, removal of the joint ensures that the material does not flow into whatever the line was attached to, such as a tank or pump. To ensure that this control functions properly, place a lock through a bolt hole to prevent accidental re-sectioning.[9]

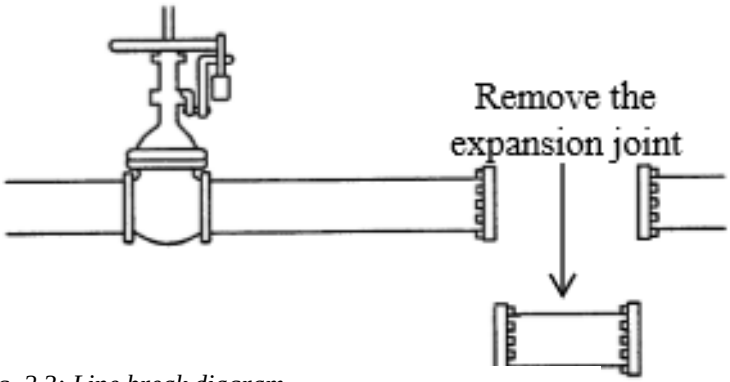

Fig. 2.3: Line break diagram

9 "Line Breaking", *Confined Space*, *v. 2.1*, (Freeport-McMoRan/Mine Training Institute: 2018), 63.

BELT CLAMPS

Belt clamps and ratchet lever hoists physically restrain the belt by securing it to a substantial member of the conveyor's structure. Keep in mind that the belt may move in either direction based on the conditions present at the time of the work. Not all belts may include a backstop that would prevent them from rolling backwards so it is important to secure the belt in both directions. Also, keep in mind that these conditions can and do change as the work progresses.

Even if properly locking out and tagging out the belt conveyor, there is a potential for accidents or fatalities. Locked out and tagged out belt conveyors have still harmed employees.[10]

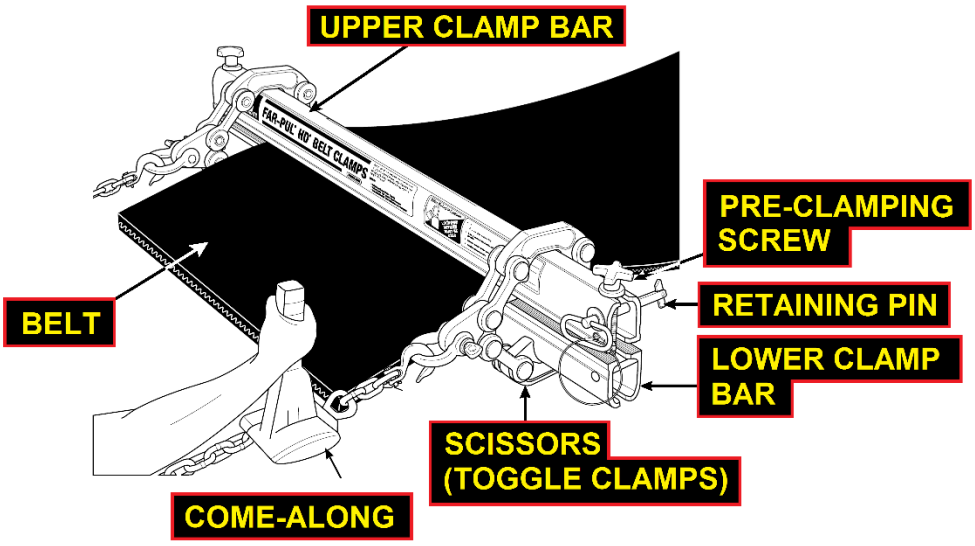

Fig. 2.4: Belt conveyor diagram

10 "Safety Controls", *Bulk Material Handling Repair*, *v. 1*, (Freeport-McMoRan/Mine Training Institute: 2016), 22.

BLOCKING, CRIBBING, AND CHOCKING

Blocking, cribbing, and chocking all work to prevent movement of objects. Cribbing is when workers stack material (normally wood) for stability, which helps to prevent movement. Blocking protects the worker from potential energy inadvertently becoming kinetic energy.[11] Chocking prevents vehicles, rail cars, and rolling stock from moving unexpectedly.[12]

Fig. 2.5: Cribbing

Fig. 2.6: Blocking

Fig. 2.7: Chocks on a wheel

11 "Engineering", *Fundamentals of Safety, v. 2*, (Freeport-McMoRan/Mine Training Institute: 2017), 167.
12 "Wheel Chocks", *Fundamentals of Safety, v. 2*, (Freeport-McMoRan/Mine Training Institute: 2017), 127.

CLAM SHELLS, CHAINS, AND VALVE LOCKS

Clam shells, chains, and valve locks prevent valve movement after de-energizing a system. A valve lockout device allows the placement of a personal lock and tag on a valve handle after de-energizing a system. Due to the wide variety of valves found on Freeport-McMoRan properties, workers can use many valve lockout devices. Use a lockout device that does not allow the valve to be moved or reopened without removal of the personal lock and tag. If the lockout device allows for valve movement, danger still exists.

Fig. 2.8: Valve lock

Fig. 2.9: Valve lock

Fig. 2.10: Clam shell

Fig. 2.11: Chains

DOUBLE BLOCK/BLANK AND BLEED

"Double block and bleed" involves the use of a three-valve system when closing a line, duct, or pipe leading to the isolation. First, close and lock the two in-line valves; then, open and lock the drain valve in between the two closed valves. This method prevents the material from flowing and drains in case of a valve leak.

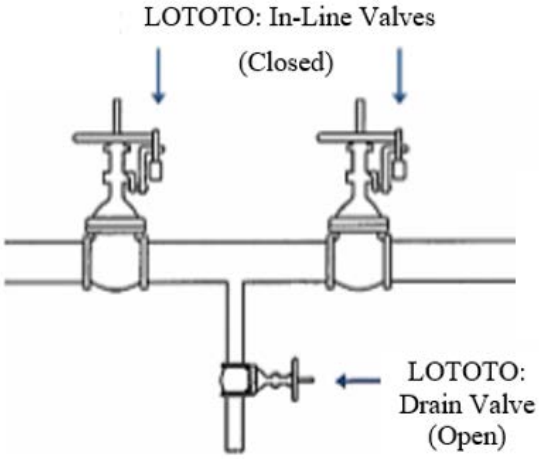

Fig. 2.12: Double block and bleed diagram

"When used, a double block-and-bleed must be situated directly upstream of the work area." [13] Therefore, if flow in the pipe can come from more than one direction, then set up a double block-and-bleed on each upstream side. Remember to lock out the valves, either opened or closed.[14]

The blank or blind is the block put into the line or pipe at a joint. This stops whatever material is in the line from entering the area. First, bleed the pipeline to relieve any pressure. Then, remove the flange bolts to separate the pipes. Insert the blank or slip blind between the two pipes and bolt the blank. Ensure that the blanks fit tightly with all bolts in place. They must be strong enough to withstand four times the pressure in the line. When locking out the valve, make sure it does not move more than a one-quarter turn (tryout). Once a worker blanks a line, lock out the blank to inform other workers not to remove it. Blanked or blinded piping must be clearly marked to indicate the presence of the blank or blind.[15]

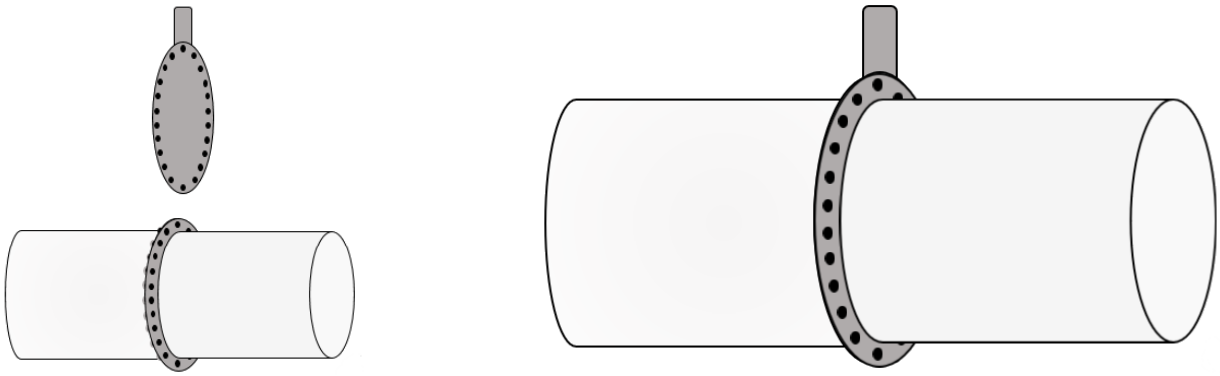

Fig. 2.13: Left image – pipe and blank; Right image – line blanked

13 Section 215.4 Isolating piping - Alberta Labour, http://work.alberta.ca/SearchAARC/639.html (accessed March 24, 2016).

14 "Double Block and Bleed", *Confined Space*, *v. 2.1*, (Freeport-McMoRan/Mine Training Institute: 2018), 63.

15 "Blanked/Blinded", *Confined Space*, *v. 2.1*, (Freeport-McMoRan/Mine Training Institute: 2018), 62.

LOCKOUT/TAGOUT/TRYOUT (LOTOTO)

Lockout/Tagout/Tryout (LOTOTO) is the primary method used for hazardous energy control at Freeport-McMoRan and is required when performing service, maintenance, modification, or installation work. LOTOTO requires the placement of a personal lock and tag on an energy isolation device using an established procedure. The lock and tag are physical barriers that stop others from using the equipment/machine until the completion of work. Before re-energizing the equipment/machine, the person who placed them must remove the lock and tag.

Fig. 2.14: Example of LOTOTO in use

In a survey of recently injured workers, 80 percent failed to turn off the equipment before performing their work. Of the 20 percent of workers who did turn off the machinery, half of the injuries occurred when someone (usually a coworker) reactivated the equipment, unaware that a coworker was servicing the machine.[16]

Lockout/Tagout is the placement of a lock and tag on an energy-isolating device. Place the lock to prevent others from restarting the piece of equipment while workers perform the work. Use a tag in combination with a lockout device to identify the person who placed the lock and to warn others of the hazards of attempting to energize the equipment/machinery.

Fig. 2.15: Simple lockout on a switch

16 United States Department of Labor, "Fatal Underground Coal Mine Electrical Accident", *Msha.gov*, Accessed July 2, 2015. http://www.msha.gov/FATALS/2008/FTL08c09.asp).

Before beginning work, release or dissipate any stored energy and then try out the machine or equipment to ensure that all energy sources were effectively isolated. Accomplish this verification or tryout by attempting to start or re-energize the locked-out system by normal means.

Fig. 2.16: Control panel for an electrical device

Incidents have occurred when workers took the necessary steps of disconnecting the main power source, but failed to perform a crucial step for a complete lockout; they failed to test the equipment to make sure the machinery was de-energized. The residual energy caused equipment to move, resulting in injuries or fatalities.

HASP

Lockout hasps allow multiple Authorized Individuals to place a personal lock and tag on an energy-isolating device that can only accept a single lock. Each Authorized Individual places his/her personal lock on one of the lock points on the hasp. Removal of the hasp requires the removal of every personal lock first.

Fig. 2.17: Hasp

LOCKBOX

You can use a lockbox when two or more Authorized Individuals need to perform service or maintenance and when the energy isolation devices cannot accept multiple locks. Additionally, use a lockbox when service or maintenance work contains multiple energy isolation devices. Lockboxes come in different sizes and varieties including portable, heavy-duty, and wall mountable.

Fig. 2.18: Lockbox

Group lockboxes securely hold multiple keys. After placing a lock(s) on the energy isolation device, place the key(s) inside the lockbox. All Authorized Individuals working in the affected area place their personal locks and tags on the lockbox. This procedure ensures that others cannot re-energize the system/equipment until the removal of the final personal lock from the lockbox. The only way to remove the keys contained inside the box is if each worker removes his/her personal lock from the lockbox. Once the final worker removes his/her personal lock, the key inside becomes available to unlock the energy isolation device.

ENERGY CONTROL COORDINATOR (ECC) LOCK AND TAG

The Energy Control Coordinator's locks and tags meet the same standardized requirements as personal locks and tags. The ECC tag also includes a method to identify ownership and has an ECC label. The Control of Hazardous Energy LOTOTO – Technical Supplement states that "ECC locks will be single keyed."[17]

Fig. 2.19: ECC lock and tag

17 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

PERSONAL LOCKS AND TAGS

Freeport-McMoRan issues personal locks and tags to Authorized Individuals per the Control for Hazardous Energy - LOTOTO Technical Supplement (FCX-HS04). Use the following standards for all issued locks and tags. Facilities standardize locks based on the needs of their facility.

Table 2.1: Requirements for locks and tags

Locks	Tags
Uniquely identifiable for energy control	Withstand 50 pounds (23 kilograms) of force
Singled-keyed (for both personal and ECC)	Identify the individual by first and last name
Only used for energy control	Include appropriate contact information/method
Standardized within the facility	Include “ECC” on ECC tag
Not easily defeated	Legible
	Withstand exposure to conditions (e.g., acid, weather, etc.)
	Include a warning statement
	Standardized within the facility

The individual receives a personal lock keyed for him/herself. While a worker may have multiple personal locks keyed alike, he/she will be the only person with a key. Only one key exists that can unlock a personal lock. A single key unlocks all multiple personal locks keyed alike. The single key is under the exclusive control of the employee performing the service or maintenance. Only the owner of the personal lock can place and remove the lock.

An approved personal tag accompanies each lock and includes a method of identifying the individual who placed the lockout device. Tags are standardized (across facilities) in color, shape, size, or specific markings, as well as print and format. Tags have a means of attachment that is substantial enough to prevent inadvertent or accidental removal and withstands 50 pounds (23 kilograms) of pulling force as well as the surrounding environment.

Fig. 2.20: Personal tag

SHOPS LOCKS VS. OUT-OF-SERVICE LOCKS VS. OPERATION LOCKS

While working at FCX, you may come across locks and tags that this training does not outline. These locks can include but are not limited to, the following: Out-of-Service Locks and Tags, Shop Locks, Care and Custody Locks, and Department Locks. While Freeport-McMoRan properties may have these devices, it is important to note that workers cannot use these locks during Lockout/Tagout/Tryout applications. Remember, only Authorized Individuals using personal locks and tags may perform LOTOTO. Do not use any other types of locks to perform LOTOTO.

Never use out-of-service locks and tags for the control of hazardous energy. Apply these locks and tags to unsafe equipment to protect the machines and equipment from damage due to accidental start-up. When using these locks, ensure that the tag includes "Out of service" or a similar message and that they are visibly different from LOTOTO locks and tags.[18]

Fig. 2.21: Out-of-Service tags

18 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

EXPOSURE CONTROL

When unable to eliminate the hazardous energy source completely, use appropriate controls to minimize or eliminate the exposure to the energy source. When workers cannot eliminate a hazardous energy, it may be necessary to complete an Energized Work Permit. The following examples are not all inclusive.

CHICKEN SWITCHES/REMOTE RACKING

Chicken switches[19] are remotely operated devices that can operate various electrical switches using a control motor operator externally applied to the switch. These switches have the capability of providing distance from operating switch. Remote racking is a system used to remotely rack in a breaker, which eliminates exposure to the breaker due to distance.

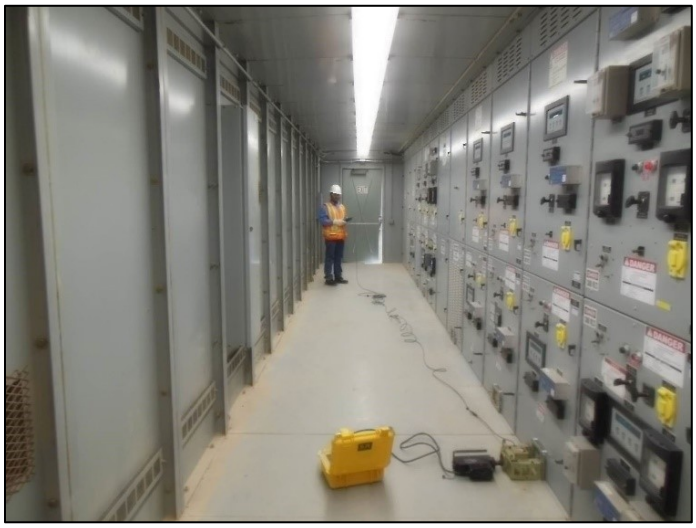

Fig. 2.22: Remote racking

Fig. 2.23: Chicken switch

19 Chicken switch image credit: CBS ArcSafe, "Chicken Switch Joins the CBS ArcSafe Family", *cbsarcsafe.com*, Accessed July 9, 2019, https://cbsarcsafe.com/chicken-switch/.

DERAILER

A derailer is a device installed on railroad tracks, which, upon activation, causes the train to derail and prevents the train from advancing on the railroad.

Fig. 2.24: Derailer

Operators use this device to stop the advancement of the train in the event of non-compliance with the site's Standard Operating Procedures (SOPs). This device also stops the advancement should there be any mechanical failure in the derailer or train machinery.

DESCALING

Descaling removes material build-up from equipment. In boilers and heat exchangers, layers of calcium can accumulate on the surface and hinder function. In chutes, material build-up can collect on the walls. Workers must remove the material to prevent clogs and jams that not only can damage the machinery, but also could pose a hazard to employees who enter into the spaces for cleaning purposes. Workers descale equipment chemically or mechanically by scraping the walls of chutes

For example, Freeport-McMoRan operations may use the descaling process to remove tightly adhered layers of oxide formed by hot rolling, heat treatment, welding, and other high-temperature operations. These activities remove the layers by using sulfuric, nitric, and hydrofluoric acid.[20]

20 FIMA, *Surface Passivation*, *FIMA-PDC-IN-014*, (2009), 1. https://fmpartners.fmi.com/epms/CV_Expansion/Project%20Documents%20%20All/5-0014-00060.pdf#search=descaling

FLAGGING AND BARRICADING

Knowing which flagging, tagging, or barricading to install is critical when it comes to safeguarding an area. Whether marking an unsafe area or preparing for a task, understand the purpose and limits to the specific method selected, as well as the hazard in the restricted area.[21]

Fig. 2.25: MCC bucket racked out and locked out (electrically safe), with flagging and barricading

Install any flagging or barricading in conjunction with proper communication to any affected parties, including your supervisor, health and safety professional, and any groups working in the area. These individuals need to be aware of the hazard and the reason for the installation of the flagging or barricading. Consult your site-specific SOP for further details.[22]

GROUNDING

As an exposure control, workers place and arrange grounding equipment in a manner to prevent employees from exposure to a shock hazard. There are three types of grounding:

1. Structural grounding installs ground bonds to buildings, conveyors, fences, and other structures to provide a safe path to ground for residual electrical energy.
2. Equipment grounding installs ground bonds to equipment like welding machines, generators, or portable light plants to provide a safe path to ground for residual electrical energy.

Fig. 2.26: Structural grounding example

21 "Module 3 Introduction", *Flagging and Barricading, v. 1.1*, (Freeport-McMoRan/Mine Training Institute: 2019), 31.

22 "Communication Plan", *Flagging and Barricading, v. 1.1*, (Freeport-McMoRan/Mine Training Institute: 2019), 32.

Substation gate grounding image credit: AVO Program, "Figure 12 Substation Gate Grounding", In *Module 8 Permanent System Grounding* PowerPoint Presentation, (2017), slide 63.

3. Personal protective grounding is an evaluated part of the planning process for control of hazardous energy. Workers install personal protective grounding on equipment such as grounding clusters when working on electrical power systems that have a chance of inducing energy onto wire or while working on an electrical bus. For example, when working on power lines, workers install grounding clusters to remove any chance of induced energy. A second example involves employees working on a Motor Control Center (MCC) bus where there are energized electrical sources near the work area. In this case, grounding removes any stored energy and prevents any induced energy from injuring an employee working.

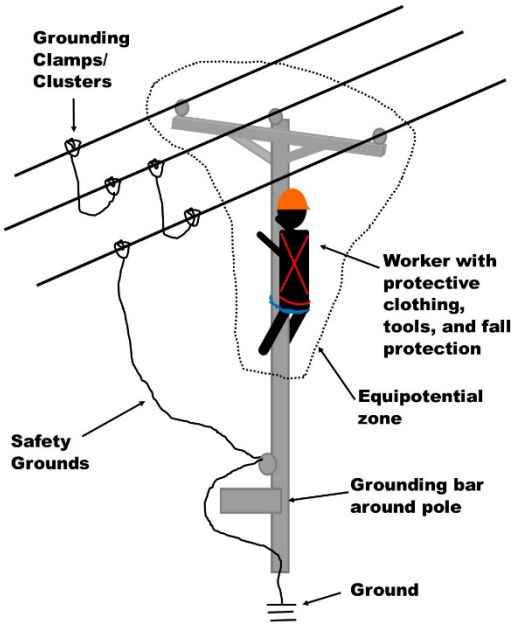

Fig. 2.27: Personal protective grounding example

GUARDING

Guards are objects placed between personnel and hazards. Guarding keeps any portion of the body from contact (intentional or inadvertent) with a hazard. Guarding designs include shielding, fencing, or enclosing hazards with covers, casings, shields, troughs, spillways, or railings. Examples of guarding methods are guarding by location (positioning hazards so they are inaccessible to employees) and point of operation guarding (using barrier guards, electronic safety devices, or other such devices).[23]

Fig. 2.28: Belt guard

23 "Glossary", *Workplace Examinations, v. 1.1*, (Freeport-McMoRan/Mine Training Institute: 2018), 43.

INSULATORS

Some materials resist the flow of electricity better than others do. An insulator is a material that has a very high resistance to the flow of electrons and is non-absorbing. Insulators are not good conductors of electricity.[24] For example, use an insulating blanket when working near an energized power line.

Fig. 2.29: Insulating blanket over power line

MAINTENANCE SWITCHES

Maintenance switches are devices that take power away from whatever type of load they are currently controlling.

Fig. 2.30: Maintenance switch

24 "Insulators", *Core Standard: Switching for Non-Electricians, v. 2*, (Freeport-McMoRan/Mine Training Institute: 2019), 14.

"Insulating Blanket" image credit: "Insulating Blanket, Orange, 3 Ft x 3 Ft", *grainger.com.* Accessed July 17, 2019. https://www.grainger.com/product/SALISBURY-Insulating-Blanket-5ZV86.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal Protective Equipment (PPE) are items used to help protect workers from items or situations that could cause bodily harm during their job performance. Inspect or test all PPE before use according to that equipment's specific requirements, such as specific requirements for Cal suits or inspecting face shields, gloves, etc. for hot work. Remember only to use serviceable PPE that is free from modifications.

Fig. 2.31: 40 CAL flash suit

Fig. 2.32: Glove

WHIP CHECKS

Whip checks connect air hoses across the coupling to prevent the hoses from flying around if the connection inadvertently separates. Air hoses ¾ inches (2 centimeters) or larger require a whip check.[25]

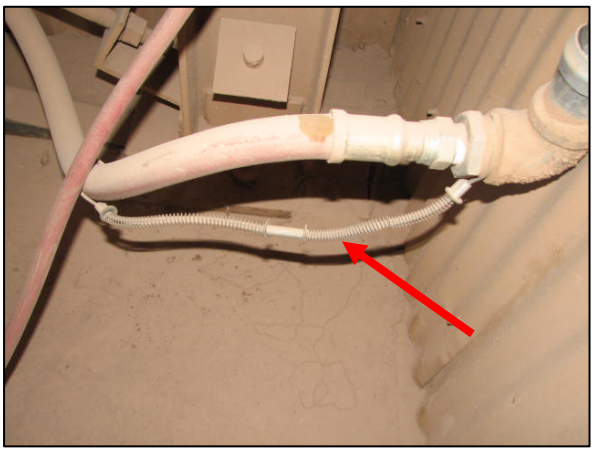

Fig. 2.33: Whip Check

"Glove" image credit: AVO Program, "Glove Air Test", In *Module 6: Personal Protective Equipment* PowerPoint Presentation, (2014), slide 20.

25 FCX Department of Occupational Health and Safety, *Standard Safety Requirements Policy, FCX-HS29*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

PREVENTATIVE MAINTENANCE (PM)

Preventative Maintenance (PM) ensures that all systems and equipment are in good working order and that regular preventative maintenance procedures are in place. Maintaining equipment ensures that systems and equipment meet and follow all manufacturer recommendations and engineering requirements.[26]

Troubleshooting is a systematic way of problem-solving that looks at data, signs, and symptoms to determine what is happening to processes or equipment. Workers then make changes based on the analysis to remedy any problems or constraints in the processes or equipment.[27]

SOP OR WORK INSTRUCTIONS

Before performing a hazardous energy control job, review any written procedures for the job. When installing or upgrading new processes or systems, review any written procedures and amend the procedures as necessary for the job.

Procedures include identification of the machine, equipment, or process, listing of all required energy-isolating devices and their locations, and specific procedural steps for shutting down, isolating, blocking, securing, and relieving stored or residual energy. There are also specific procedural steps for the placement and removal of lockout devices and specific requirements for verifying the accomplishment of isolation and de-energization.

Sites also have written programs detailing the requirements for Lockout/Tagout/Tryout, which include surveying all hazardous energy sources and identifying complex or multiple source energy-isolating devices.[28]

26 FCX Department of Occupational Health and Safety, *Policy Administration Requirements, FCX-HS01*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

27 "Troubleshooting", *Bulk Material Handling Repair, v. 1*, (Freeport-McMoRan/Mine Training Institute: 2016), 74.

28 FCX Department of Occupational Health and Safety, *Policy Administration Requirements, FCX-HS01*, (Corporate Safety Portal, DOHS Policies: 2019), 15.

CONTROL OVERVIEW

The following tables summarize the various control devices/types. Keep in mind; this is not an all-encompassing list.

Table 2.2: Summary of energy controls

Device/Type	Example	Control
Air Gap/Line Break	• Remove a section of pipe • Remove fuses from the power line system	Puts a space or gap in the system carrying the energy
Belt Clamps	• Conveyor belt	Physically restrains the belt by securing it to the conveyor's structure
Blocking, Cribbing, and Chocking	• Stack material (usually wood) • Chock tires	Prevents unexpected movement of objects
Clam Shells, Chains, and Valve Locks	• Piping	Prevents valve movement after de-energizing a system
Double Block/Blank and Bleed	• Line, duct, or pipe	Prevents material from flowing and drains in case of a valve leak
Lockout/Tagout/Tryout (LOTOTO)	• Switch boxes • Electrical systems	Prevents use of equipment/machine by placing a personal lock and tag on an energy isolation device using an established procedure

Table 2.3: Summary of exposure controls

Device/Type	Example	Control
Chicken Switches/ Remote Racking	• Electrical switches • Breakers	Operates various electrical switches using a remote controlled device externally applied to the switch
Derailer	• Railroad tracks	Causes the train to derail and prevents the train from advancing on the railroad
Descaling	• Abrasive blast equipment to remove substances	Removes substances from surfaces using chemicals or tools

Table 2.3: Summary of exposure controls (continued)

Device/Type	Example	Control
Flagging and Barricading	• Spills • Overhead work • Open holes	Prevents employees from entering areas with potential hazards
Grounding	• Substation gate grounding	Place and arrange grounding equipment in a manner to prevent employees from exposure to a shock hazard
Guarding	• Barrier guards • Electronic safety devices	Places object between personnel and hazard to keep any portion of the body from contact (intentional or inadvertent) with a hazard
Insulators	• Power line cover-ups • Insulating blankets	Prevents electricity from traveling by resisting the flow of electrons
Maintenance Switches	• Breaker boxes	Takes power away from whatever type of load they are currently controlling
Personal Protective Equipment (PPE)	• Cal suits • Face shields • Gloves	Protects workers from items or situations that could cause bodily harm during job performance
Whip Checks	• Air hoses ¾ inches (2 centimeters) or larger	Prevents hoses from flying around if connection separates by connecting air hoses across the coupling
Preventative Maintenance (PM)	• PM schedule	Ensures all systems and equipment are in good working order
SOP or Work Instructions	• Shut down, isolate, block, secure, and relieve stored or residual energy • Placement and removal of lockout devices • Verify isolation and de-energization	Identifies the machine, equipment, or process and lists all required energy-isolating devices and their locations

LABELING STANDARDS

Proper labeling of all electrical panels is critical to the safety of personnel. Improper or nonexistent labeling can contribute to major injuries or death during maintenance or emergencies.

Fig. 2.34: Labeling difficult to read

When inspecting the labeling of electrical panels, verify that all operational fuses are marked appropriately and accurately. If labels are damaged, missing, or not legible, notify the appropriate personnel so that they can take immediate corrective action. Only authorized and qualified individuals should open any panels. Additionally, note whether adequate lighting is in place to read all labeling. Any items labeled "spare" or something similar, must remain in the open position.[29]

According to the FCX-HS03 Electrical Safety Policy, electrical gear (breakers, cabinets, switches, panels, etc.) must have labels that indicate the following:

- Voltage
- Equipment being powered or fed[30]

Remember to properly label and identify all lines, breakers, valves, etc. If needed, contact responsible parties or consult the relevant documentation for more information.[31] Label lines to include contents, direction of flow, and rate of flow/pressure if necessary.

Fig. 2.35: Proper labeling of lines

29 "Improperly Labeled/Illegible Panels", *Workplace Examinations, v. 1.1*, (Freeport-McMoRan/Mine Training Institute: 2018, 20.

30 FCX Department of Occupational Health and Safety, *Electrical Safety Policy, FCX-HS03*, (Corporate Safety Portal, DOHS Policies: 2018), 1.

31 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

VERIFICATION OF ZERO ENERGY

Before starting maintenance work, ensure that there is zero energy and attempt to restart the equipment. Do not confuse process interlocks with energy isolation or use for a tryout.[32]

Zero energy refers to the state of equipment verified by various methods. The equipment does not have any hazardous energy, and employees may begin to perform service on the equipment safely. Tryout is one method to verify that there is zero energy. During tryout, employees attempt to restart the equipment. When the equipment does not restart, this verifies zero energy in the equipment. It is important to understand that while energy control devices or methods result in zero energy of the equipment, exposure control devices or methods do not result in zero energy.

VERIFICATION OF THE EFFECTIVENESS OF CONTROLS

When verifying the effectiveness of energy control, verify the isolation of the correct isolation points for each type of hazardous energy identified. Verifying that the energy control is effective is an important action to stay safe while working around potential energy hazards. Use appropriate verification devices and the verification process to maintain safe working conditions. The list below is not-all encompassing. Follow all written procedures for de-energization.

- Single line drawings
- Process diagrams
- Piping and Instrumentation Drawings (P&IDs)
- Pressure gauges
- Flow meters/indicators
- OHM/volt meter readings
- Temperature
- Tank levels
- Atmospheric monitoring
- Tryout

32 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy*, *FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

VERIFICATION DEVICES

The National Fire Protection Association (NFPA) requires the verification of zero-energy state and specifically requires voltage measurements of both phase-to-phase and phase-to-ground to ensure the removal of all power from the circuit. The NFPA 70E standard gives no voltage range for when this requirement starts or stops.[33] Freeport-McMoRan follows the NFPA's guidelines, and therefore compliance with NFPA 70E standards requires sites to use devices to verify zero-energy state. Follow the live-dead-live test described in the Electrical Safety Policy, FCX-HS03.

PROXIMITY SENSORS/TESTERS

Proximity detectors are the industry-accepted method for detecting the presence of voltages above 600 volts (electrical pressure) of alternating current (VAC). Manufacturers design these detectors to withstand the electrical "pressure" exerted on them up to the rated voltage.[34]

Fig. 2.36: Proximity sensor

VISUAL INSPECTION

After isolating the energy source and before beginning work, visually confirm the use of energy or exposure control devices. For non-routine energy isolation, such as during emergency work or in the absence of Standard Operating Procedures (SOPs), complete a field verification of the application of the control devices before performing work.[35]

33 "Why Are Proximity Detectors Ok To Detect Voltage Absence", *e-hazard.com*. Accessed May 22, 2019. https://www.e-hazard.com/blog/burning-question-why-are-proximity-detectors-ok-to-detect-voltage-absence-above-1kv-and-not-below/.

34 "Why Are Proximity Detectors Ok To Detect Voltage Absence", *e-hazard.com*. Accessed May 22, 2019. https://www.e-hazard.com/blog/burning-question-why-are-proximity-detectors-ok-to-detect-voltage-absence-above-1kv-and-not-below/.

35 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

ENERGIZED WORK PERMIT

Any time employees perform work on energized equipment and circuits, they must make every effort to de-energize the power to perform the necessary tasks. However, there are times when de-energizing the circuit is not possible. These instances require appropriate justifications and must follow the processes and procedures defined in the Electrical Safety Policy – Energized Electrical Work Technical Supplement (FCX-HS03) document. [36]

Complete an Energized Work Permit when possible exposure to hazardous energy exists and the equipment must remain energized to perform work. For routine work and where a Standard Operating Procedure (SOP) exists, the Energized Work Permit is valid for one year and kept with the SOP as part of the record. Review the SOP prior to performing work. Electrical troubleshooting and testing does not require a permit – refer to the Electrical Safety Policy Technical Supplement for Energized Electrical work. If there is no Superintendent on site, the delegate may authorize the work in his/her place.[37]

See the following page for the Energized Work Permit form.

36 FCX Department of Occupational Health and Safety, *Electrical Safety Policy – Energized Electrical Work Technical Supplement, FCX-HS03*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

37 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

FREEPORT-
MCMORAN

Energized Work Permit
Control of Hazardous Energy FCX-HS04

JOB/WORK ORDER #		DATE	
REQUESTOR NAME/TITLE			

PART I: TO BE COMPLETED BY THE REQUESTER	
ITEM	**COMMENTS**
Description of equipment/job location	
Description of work to be done	
Justification for why the equipment cannot be de-energized or the work deferred until the next scheduled outage	

PART II: TO BE COMPLETED BY THE QUALIFIED PERSONS PRIOR TO STARTING THE WORK	
ITEM	**COMMENTS** **Use the back of this form or attach additional information if necessary.**
Detailed job description/procedure to be used in performing the above detailed work	
Description of the safe work practices to be used	
Necessary personal protective equipment to safely perform the assigned task (list)	
List controls used to restrict the access of unqualified persons from the work area	
Evidence of completion of a job briefing including discussion of any job-related hazard	
Do you agree the above described work can be done safely?	

PART III: ADDITIONAL REQUIREMENTS TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED	
Result of the shock hazard analysis	
Determination of shock protection boundaries	
Result of the arc flash hazard analysis	
Determination of the arc flash protection boundary	
Do you have a 2nd electrically qualified person or trained attendant? Name:	
*** NOTE: If any of the above answers are no, return to requester. ***	

PART IV: APPROVAL TO PERFORM THE WORK WHILE ENERGIZED			
Qualified Person(s)		**Qualified Person(s)/Trained Attendant (electrical work only)**	
Operations/Maintenance Supervisor		**Electrical Supervisor (electrical work only)**	
APPROVER'S NAME & SIGNATURE			

NOTE: Approval is only granted by the relevant superintendent or delegate. All requests for energized electrical work must be approved by an electrical superintendent or delegate.

This printed document is uncontrolled. Visit DOHS SharePoint site for current version and full policy details. *1 of 1*

Fig. 2.37: Energized Work Permit

ACTIVITY 4: IDENTIFYING ENERGY CONTROL DEVICES/TYPES

Directions: With your group, choose 2 different infographic posters created during Activity 3. For the each energy source, write down how you would control the energy source.

Use this page to take notes before creating the poster. Be prepared to present your posters to the class.

ENERGY SOURCE:

Controls: _____

_____

_____

_____

ENERGY SOURCE:

Controls: _____

_____

_____

_____

MODULE 2 QUIZ

Complete the following quiz.

1. Which hazardous energy control device/method requires the placement of a personal lock and tag on an energy isolation device using an established procedure?
    a. Emergency-Stop
    b. Flagging and Barricading
    c. Maintenance Switches
    d. Lockout/Tagout/Tryout (LOTOTO)

2. Which hazardous energy control device/method keeps any portion of the body from contact (intentional or inadvertent) with a hazard?
    a. Guarding
    b. Insulators
    c. Grounding
    d. Chicken Switches

3. Which of the following do sites include in written procedures for the job? Circle all that apply.
    a. Identification of the machine, equipment, or process
    b. List of all required energy-isolating devices and their locations
    c. Specific procedural steps for shutting down, isolating, blocking, securing, and relieving stored or residual energy and for placement and removal of lockout devices
    d. Specific requirements for verifying the accomplishment of isolation and de-energization

4. Which form is required when repairing energized equipment?
    a. ECC form
    b. Variance Request form
    c. Energized Work Permit form
    d. Non-Routine Lock Removal form

5. _____ control devices or methods result in zero energy of the equipment.
    a. Energy
    b. Exposure

Roles and Responsibilities

MODULE 3

MODULE 3: ROLES AND RESPONSIBILITIES

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MODULE 3 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Determine the responsibilities of each individual, given a simple or complex lockout job

INTRODUCTION

It is essential to understand the various roles and responsibilities that come with controlling hazardous energy. The role of the employee determines the responsibilities during the job. This module discusses the various roles and responsibilities of individuals involved with the job.

ROLES

When controlling hazardous energy, the following roles may apply to the job or task.

AFFECTED INDIVIDUALS

An Affected Individual is an employee whose job requires them to operate or use a machine or piece of equipment where controlling a hazardous energy source is required to perform service or maintenance. This definition includes personnel in the area who are not performing work on the equipment.[38]

AUTHORIZED INDIVIDUALS

An Authorized Individual locks and tags the isolation device for equipment to perform service or maintenance. This individual then performs work on the locked-out equipment. The Authorized Individual must place their own locks and tags and must maintain control of the key to their lock. The individual is also responsible for returning the equipment to the serviceable condition before removing any energy isolation device or lock.[39]

Note the differences between an Affected and an Authorized Individual. If performing maintenance is the responsibility of the Affected Individual, then that person becomes the Authorized Individual and he/she must place a personal lock and tag on the energy-isolating device or use an appropriate alternative device to control the energy source.

The Affected Individual, as opposed to an Authorized Individual, does not directly perform servicing or maintenance work and does not implement lockout procedures or other hazardous energy controls. Rather, Affected Individuals have jobs that require them to perform tasks such as operating, cleaning, setting up, adjusting, monitoring, or otherwise interacting with or directly around systems and equipment that are under hazardous energy control. Due to the nature of their job duties, Affected Individuals must be aware of the purpose and use of hazardous energy control procedures, even though they are not performing work as Authorized Individuals.

38 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

39 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

QUALIFIED INDIVIDUAL/PERSONNEL

Qualified Individuals/Personnel have the qualifications to perform energy isolation to de-energize the specific system, but they may or may not work on the lockout. These individuals ensure workers follow safe procedures for the shutdown, isolation, and energy release and are responsible for verifying the effectiveness of energy isolation and conducting tryout.[40] An example is an electrician that operates a switchgear to de-energize a piece of equipment for mechanics to perform service.

Qualified Personnel are capable of recognizing hazards associated with the work and of avoiding hazards associated with the work. They have the approval to perform energy isolation and dissipation and to perform energy measurement/testing or tryout.

ENERGY CONTROL COORDINATOR (ECC)

When an Authorized Individual is unable to place his/her lock and tag directly on the energy-isolating device(s) or is unable to use another control device directly, Supervision assigns an Energy Control Coordinator (ECC). The ECC is an individual that has a technical and working knowledge of the equipment needing energy isolation. Once designated, the ECC, with the support of the qualified and authorized individuals, has the responsibility of the energy isolation to ensure the identification, control, and tryout of energy sources from start to finish. ECCs have their own specific and distinguishable locks and tags. ECCs have the responsibility of completing the ECC form. Keep the ECC form with the lockbox.

Supervision may also assign the ECC to coordinate hazardous energy control when one of the following occurs:

- Use of multiple energy-isolating devices
- Involvement of multiple Authorized Individuals
- Extension of the period of energy isolation
- Relatively inaccessible energy-isolating device(s)
- Dependently connected multiple system components

See the following pages for the ECC form.

40 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

Energy Control Coordinator (ECC) Form

Control of Hazardous Energy | FCX-HS04

FREEPORT-McMoRan

This form must stay with the job for the duration of the job and can only be removed during ECC transfer or after the job is complete. Replace only the ***Individual Lockout Roster*** after each shift.

ECC NAME	PRIMARY SYSTEM
ECC CONTACT INFO	START DATE / END DATE
ECC SUPERVISOR	LOCK BOX IDENTFIER
REASON FOR LOTOTO	

* * * * * * WARNING: If the equipment is NOT listed here, it is not locked out! * * * * * *

EQUIPMENT

List all Equipment Secured by the ECC device(s) including ID numbers	Isolated & Verified (ECC Initials)	Name of the Qualified Individual who ISOLATED the energy source(s)	Date Lock APPLIED	Name of the Qualified Individual who RELEASED/DISSIPATED the energy source(s)	Date Lock REMOVED
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /
			/ /		/ /

ECC TRANSFER (IF APPLICABLE. SEE PAGE 2 FOR DETAILS)

ECC Name	Shift	Date		ECC Name	Shift	Date
1.		/ /		6.		/ /
2.		/ /		7.		/ /
3.		/ /		8.		/ /
4.		/ /		9.		/ /
5.		/ /		10.		/ /

ECC LOCKOUT RESPONSIBILITIES

When utilizing an ECC/lock box each step below must be completed and initialed by the original ECC during the equipment lockout process. Initial below.

	Does the ECC understand the scope of work to be completed?
	Have all of the hazardous energy sources, related to the work being conducted, been identified and isolated or controlled according to proper procedures?
	Has a lock and ECC tag been placed on all the energy isolation points and is there a legible name printed on each one?
	Has all stored/residual energy been released?
	Has the Qualified Individual/ECC verified the effectiveness of controls (Try Out) on the equipment and ensured all stored energy is released?
	Have ALL the energy isolation keys been placed in the lock box?
	Has the ECC placed a lock and tag indicating their name and labeled as ECC on the lock box?

INDIVIDUAL LOCKOUT RESPONSIBILITIES

Only after the above steps have been completed shall any individual attempt to join the LOTOTO. This includes the ECC's personal lock if the ECC is going to perform work. An individual must apply their personal lock and tag to the group lockout device and read and understand the ECC form. Make contact with the ECC or project supervisor/lead before placing locks. Before signing read the form to ensure that the equipment you are working on is identified.

This printed form is an uncontrolled document. Visit DOHS SharePoint site for current policy documents. 1 of 4

Fig. 3.1a: ECC form

ECC TRANSFER (IF APPLICABLE)
ECC Transfer signature area is on page 1.
The incoming ECC will place their name on the ECC Transfer only after Outgoing and Incoming ECC have verbally confirm details of the work and lockout, and conduct a walk-down of the lockout devices in use if necessary.
Incoming ECC will assume responsibility for the lockout process once they take possession of the key and put their correct information on the form. The Outgoing ECC will remove their personal lock from the group lockout device before leaving the area.
The ECC form will be kept at the lock box unless ECC is actively being transferred. No new Authorized Individuals will join the LOTOTO in process until the ECC transfer is complete and form has been returned.
Work can continue by Authorized Individuals who have already signed the Individual Lockout Roster while ECC transfer is in process.

ECC RETURN TO SERVICE RESPONSIBILITIES	
When utilizing an ECC each step below must be completed and initialed by the current ECC during the equipment release process. Initial below.	
	Prior to returning to service, inspect the area for persons, tools and equipment that must be removed. Ensure all guards and safety devices have been installed and equipment is operationally intact.
	All personal lock(s) have been removed from the lockbox.
	Operations and Affected Individuals have been notified by the ECC that the equipment is to be released for service.
	The ECC locks removed and Qualified Individuals have restored energy to the equipment.

INDIVIDUAL LOCKOUT ROSTER

WARNING: If the equipment is NOT listed on the first page of the ECC Form, it is not locked out!

Printed Name	Date	Time Personal Lock APPLIED	Signature (upon lock REMOVAL)	Time Personal Lock REMOVED
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm
	/ /	: am/pm		: am/pm

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Fig. 3.1b: ECC form

RESPONSIBILITIES AROUND THE JOB

When performing jobs or tasks, there are many responsibilities around the processes involved with the job.

PLANNING THE JOB

Before beginning any work, create a plan for the job or task. It is important to understand the full scope of the work and all associated tasks. In the plan, identify all personnel roles and responsibilities, tools, hazards, isolation points, and isolation devices. Remember to consult relevant Standard Operating Procedures (SOPs) and Job Safety Analyses (JSAs) before performing work.[41]

ROUTINE VS. NON-ROUTINE

Any non-routine job requires a Job Safety Analysis (JSA). This part of the job preparation allows the team to think forward and identify any potential hazards along with the critical controls that will assist them in completing their work safely.[42]

When a Standard Operating Procedure (SOP) is not available and during emergency work, planning for the energy control must include the following:

- An inventory of identified hazardous energy sources
- Determination of isolation/control devices
- Assignment of responsible persons, including Qualified Individuals and ECC if necessary
- Field verification of the application of the control devices

Document this information and evidence of the verification. If there is no existing documentation in place, document this information by using a JSA before starting the job.[43]

41 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04,* (Corporate Safety Portal, DOHS Policies: 2019), 1.

42 "Hazard Recognition", *Blue Stake, v. 2,* (Freeport-McMoRan/Mine Training Institute: 2019), 19.

43 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04,* (Corporate Safety Portal, DOHS Policies: 2019), 2.

ACCESS AND VERIFICATION

If an Authorized Individual joins after verification of isolation has taken place, they must contact the other Authorized Individuals or the ECC (if used) to confirm isolation of equipment and completion of verification/testing. All Authorized Individuals retain the right to verify isolation by clearing the area and attempting to start the equipment. When access to isolation devices is limited (e.g., inside a restricted area), a Qualified Individual will escort the Authorized Individuals or the group will use the ECC process.[44]

ELECTRICAL SWITCHING

Most site policies state that only qualified and authorized personnel can perform switching responsibilities and require personnel to receive electrical safety training and task training. Site policies may differ by defining labeled devices only (e.g., switches, disconnects, breakers, etc.), the thresholds of voltage and current limit, and required PPE.[45] Reference the Electrical Safety Policy (FCX-HS03).

44 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2

45 "Site-Specific Policies", *Core Standard: Switching for Non-Electricians, v. 2*, (Freeport-McMoRan/Mine Training Institute: 2019), 40.

REMOTE LOCATIONS

Some work environments may have the isolation devices located in remote areas, or areas that are not easily accessible. For example, some properties have equipment located miles from the energy isolation device. Freeport-McMoRan requires any site with remote areas to provide equivalent protection for any Authorized Individual as he/she had placed his/her personal lock and tag under LOTOTO. This activity may require a variance.

Fig. 3.2: A remote location of an isolation device

When the work environment places the isolation device in a remote location, follow these steps:

1. An ECC at the remote location of an energy isolation device has a Qualified Individual perform the energy isolation and verify zero energy state of the equipment.
2. The ECC places an ECC lock and tag on the energy isolation device, and the ECC places the key to that lock in a group lockbox.
3. Authorized Individuals performing service or maintenance place representative personal locks and tags on the group lockbox. Use the ECC form.
4. Once all Authorized Individuals have a personal lock and tag placed on the group lockbox, they may begin servicing or performing maintenance on the equipment/process.

VARIANCE PROCESS

The controls specified in Control of Hazardous Energy Policy (FCX-HS04) are the minimum requirements for hazardous energy control based on industry regulations, site best practices, expert reviews, and past experiences. While Freeport-McMoRan does not usually allow for performance of work outside of this policy, the company recognizes that due to the diversity of operating conditions at each site, strict compliance with this policy may not always be feasible. Therefore, Freeport-McMoRan has established a process to allow for justifiable variances from the Control of Hazardous Energy Policy (FCX-HS04).

When workers cannot meet the Control of Hazardous Energy Policy (FCX-HS04), complete a variance request. Site leadership and Health and Safety must then review and approve the variance request. The Department of Occupational Health and Safety (DOHS) must also approve any long-term variances to ensure acceptable control of the risks.

In the variance request, specify the reason why the work requirements cannot meet the Control of Hazardous Energy Policy (FCX-HS04). Additionally, outline the alternative controls that workers will implement to ensure the establishment of an equivalent level of protection for employees or contractors. Document the variance in the Management of Change (MOC) system located in the Site Ops Call Center. The Site Ops Call Center is the archive for the MOC ticket and associated documents.[46]

46 FCX Department of Occupational Health and Safety, *Policy Administration Requirements, FCX-HS01*, (Corporate Safety Portal, DOHS Policies: 2019), 10.

RESPONSIBILITIES AROUND PERSONNEL

Responsibilities around personnel include performing yearly audits for each control of hazardous energy procedure in use and specific responsibilities around shift changes, Energy Control Coordinator (ECC) transfers, joining a job already in progress, and interacting with contractors.

AUDITS

A Qualified Individual must perform a documented audit at least annually for every control of hazardous energy procedure in use. The site management determines who the Qualified Individual(s) are that conduct the audit.

The Qualified Individual must witness the performance of at least one control of hazardous energy procedure with the procedural details. Sites must design the audit to correct deficiencies in the established control of hazardous energy procedure or in employee understanding through retraining.

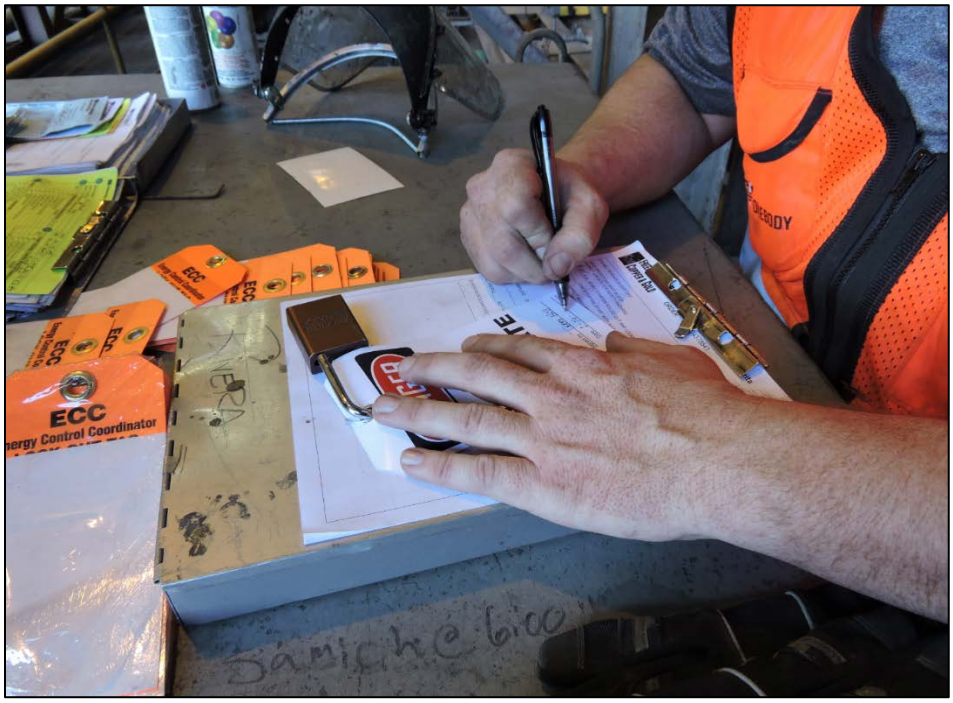

Fig. 3.3: Employee filling out tag during lockout procedure

SHIFT CHANGE

When the Authorized Individual either receives another task assignment, leaves at the end of the shift, or completes the work, he/she should ensure the removal of personal locks. The exception to this is when the removal of the lock exposes others to a hazard.

Shift changes include the following procedures:

- Document the procedures for shift changes
- Ensure integrity of isolation devices before turnover
- Use the ECC procedures if necessary
- Remove personal locks and tags if work is complete and equipment is in a safe condition[47]

Maintenance of hazardous energy control integrity and orderly shift/personnel transfers include the following examples:

- On-coming employees apply their personal locks before the off-going employees remove their locks.
- The lockout sequence repeats for the on-coming shift.
- An ECC lock remains on the energy isolation device until completion of the job.
- Transfer of ECC locks or lock custody during shift change.

Before commencing work at the beginning of each shift, each Authorized Individual has the right to verify the effectiveness of the hazardous energy control.

47 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy*, *FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

ECC TRANSFERS

If the job requires an ECC and there is a shift change, the incoming ECC adds their information to the ECC form. Then, the outgoing and incoming ECC verbally confirm the details of the work and lockout, and may visually confirm lockout devices in use. The incoming ECC assumes responsibility of the lockout process once they take possession of the key, and they put their contact information on the ECC tag. The outgoing ECC removes their personal lock from the group lockout device before leaving the area.

Fig. 3.4: ECC lockout device

Keep the ECC form with the lockbox unless there is an active transfer of the ECC. During the ECC transfer, no new Authorized individuals can join the LOTOTO in process until the completion of the ECC transfer and the return of the form. Work can continue by Authorized Individuals who have already signed the Individual Lockout Roster while the ECC transfer is in process.[48]

JOINING JOB IN PROGRESS

When joining a lockout or energy control job in progress, read the Job Safety Analysis (JSA) and any relevant Standard Operating Procedures (SOPs). Remember to notify the lead personnel or ECC. It is an employee's right to verify all lockout points for the potential hazardous energies involved with the job. After completing the verification of all lockout points, the employee places their lock in the lockout control device and completes necessary documents.

INTERACTION WITH CONTRACTORS

There may be projects when contractors and FCX employees are working together on complex lockout jobs. Before performing work, contractors must evaluate the full scope of work to ensure job planning adequately covers project specific procedures so that all parties are informed.

48 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

RESPONSIBILITIES AROUND EQUIPMENT

Responsibilities around equipment include the commissioning, testing, calibrating, and troubleshooting of equipment. Remember to complete an Energized Work Permit when possible exposure to hazardous energy exists and the equipment must remain energized to perform work. Even though hazardous energy control may not apply, workers must complete a safety analysis or risk assessment. During the safety analysis or risk assessment, first, understand the process for the start-up of the equipment and the potential for exposure to self and others. Then, develop a communication plan for these activities, evaluate new controls, and verify existing controls.

When completing the safety analysis or risk assessment, keep in mind the following points:

- When removing guards and barriers (or bypassing interlocks) for troubleshooting/testing and calibration, put in place other controls to prevent exposure.
- When performing work on energized equipment, follow specific documented guidelines and procedures.
- When installing other bypass devices and while performing work on energized equipment, follow specific documented guidelines and procedures for installation, use, and removal of bypass devices.

Always conduct a pre-operational inspection before starting up the equipment.

When testing or positioning machines or equipment, complete the following steps:

1. Clear the area of unnecessary personnel, tools, and materials
2. Install flagging or barricading (refer to FCX-HS19)
3. Remove energy control devices as specified in procedures
4. Energize and proceed with testing or positioning

Before performing additional maintenance, de-energize, isolate from potential sources, and reapply energy control devices.[49]

49 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy, FCX-HS04,* (Corporate Safety Portal, DOHS Policies: 2019), 2.

MODULE 3 QUIZ

Complete the following quiz.

1. An Affected Individual can also be an Authorized Individual when:
    a. He/she performs a safe de-energization of a system
    b. He/she performs a hazard assessment for an SOP
    c. He/she is also servicing the de-energized equipment
    d. All of the above

2. Who assigns an ECC to a lockout job?
    a. Supervision
    b. Qualified Individual
    c. Authorized Individual
    d. Health and Safety Department

3. If an Authorized Individual joins after verification of isolation has taken place, they have the right to verify isolation by clearing the area and attempting to start the equipment.
    a. True
    b. False

4. If a Standard Operating Procedure (SOP) is not available during emergency work, workers must complete a Job Safety Analysis (JSA).
    a. True
    b. False

5. When there is a shift change that involves the ECC, the outgoing ECC can leave their personal lock in the group lockout device and exit the area.
    a. True
    b. False

Processes

MODULE 4

MODULE 4: PROCESSES

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MODULE 4 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Demonstrate the actions to stay safe, given a scenario

INTRODUCTION

According to the Control of Hazardous Energy Policy (FCX-HS04), actions to stay safe when there is the possibility of exposure to hazardous energies while performing work include planning the activity; identifying the potential sources of hazardous energy; eliminating, isolating, or controlling each energy source; dissipating residual energy; and verifying controls are effective and try out the equipment. This module discusses various processes that help workers to stay safe when performing work that involves potential exposure to hazardous energies. Remember to follow hazardous energy control procedures for each piece of equipment, system, or process. Procedures must include steps for verification of control. Stop the job when the scope of work changes or controls are ineffective. Isolate at the source whenever possible, or use other methods to ensure zero energy. [50]

PLANNING AND EXECUTING

Planning for the job involves reviewing the appropriate Standard Operating Procedures (SOPs). All sites must have a written process for energy control for each unique piece of equipment that incorporates equipment lockouts into the process. During planning, ensure that everyone knows the task and that individuals have the correct equipment for the task. During planning, identify all potential hazardous energies and identify how to control those energies or exposure to those energies.

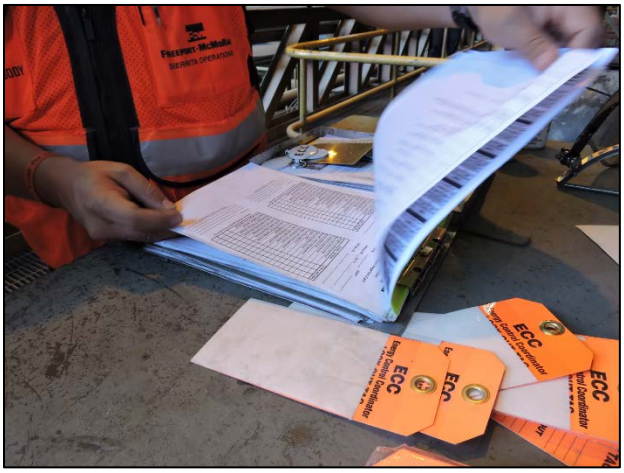

Fig. 4.1: Employee reviewing documents

Executing the job involves locking out at the correct points and controlling or isolating all potential hazardous energies.

50 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy*, *FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

FORMAL VERIFICATION OF THE PROCESS

For routine jobs, first, go over the pre-job document and associated Standard Operating Procedures. The pre-job document identifies the potential hazardous energies involved with the job, necessary safety equipment, and all lockout points. Before beginning work, ensure proper communication with anyone working in the area.

Fig. 4.2: Employee filling out documents

For non-routine jobs or processes, perform a walk-down of the job. During the walk-down, ensure that everyone knows the tasks involved for the job and the work that each person will perform. Ensure that each individual understands the potential hazardous energies involved with the job and has the proper training (e.g., working at heights, confined space). Verify the lockout points involved in the job. Before beginning work, complete the Job Safety Analysis (JSA).

LOTOTO PROCEDURES

All Freeport-McMoRan LOTOTO procedures must address seven critical steps that safeguard employees from the unexpected startup or release of hazardous energy during service or maintenance activities. This course outlines the MINIMUM requirements for LOTOTO procedures. While individual properties may have additional requirements beyond the requirements contained in this course, all LOTOTO procedures will include the following seven steps:

1. Plan the work
2. Notify
3. Shutdown equipment/systems by Qualified Individual
4. Isolate/eliminate hazardous energy sources
5. Lock and tag
6. Release stored/residual energy
7. Verify the effectiveness of controls

1. PLAN THE WORK

Authorized Individuals must understand the scope of the work, identify sources of hazardous energy, identify Qualified Individuals, and select appropriate controls.

2. NOTIFY

Notify the equipment/system owner and individuals affected by a shutdown of a machine, piece of equipment, or process before the application and after the removal of any lockout/tagout devices.

3. SHUTDOWN EQUIPMENT/SYSTEMS BY QUALIFIED INDIVIDUAL

A Qualified Individual(s) performs the shutdown of the equipment/systems using the established hazardous energy control procedures.

4. ISOLATE/ELIMINATE HAZARDOUS ENERGY SOURCES

A Qualified Individual(s) operates the switch, valve, or other energy-isolating devices to disconnect or isolate the energy source(s) from the equipment.

5. LOCK AND TAG

Each Authorized Individual or Energy Control Coordinator places his/her personal lock and tag on each energy-isolating device that controls the energy source(s) to the area in which the individual is working. An approved tag accompanies each lock.

6. RELEASE STORED/RESIDUAL ENERGY

Relieve, disconnect, restrain, or otherwise control all potentially hazardous stored, residual, or potential energy.

7. VERIFY EFFECTIVENESS OF CONTROLS

Prior to working on a machine, piece of equipment, or process, the Authorized Individual or Energy Control Coordinator verifies zero energy from all sources and tryouts the machine or piece of equipment. Tryout refers to attempting to restart all locked aspects of the equipment.[51]

51 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 2.

SAFELY RELEASE ENERGY

Even if the equipment is de-energized, there is a potential for stored energy including kinetic, pressure, residual, electrical, and fluid that the system has not released. Follow the manufacturer's recommendations and the site's written procedures to carefully release and remove this stored energy from the system.

EMERGENCY-STOPS (E-STOPS)/PULL CORDS

Emergency-stops (e-stops), pull cords, or kill switches are safety mechanisms used to shut down or disable machines immediately when operators cannot shut down the machine properly.[52] Keep in mind that moving systems do not immediately stop. Sites mount safety switches and pull cords along both sides of the conveyor. **Operators use these devices to stop the equipment in an emergency.[53] These devices are not substitutes for a proper energy isolation.** Some examples include pumps, conveyors, rectifiers, and fuel stations.

Fig. 4.3: E-Stop

Fig. 4.4: Pull Cord

Fig. 4.5: E-Stop on piece of equipment

52 Rouse, Margaret, "Kill switch", Whatis.techtarget.com, Accessed May 28, 2019. https://whatis.techtarget.com/definition/kill-switch.

53 "Pull Cords", *Conveyor Operation II, v. 2*, (Freeport-McMoRan/Mine Training Institute: 2013), 14.

SIMPLE VS. COMPLEX

The seven steps previously described are required to ensure the safe de-energization of equipment and protection against accidental start-up before performing any work. These same seven steps are an integral part of every LOTOTO procedure, and workers must follow these steps regardless of the type of LOTOTO performed. In general, there are three types of LOTOTO situations encountered on a routine basis: Simple LOTOTO, Complex LOTOTO, and ECC LOTOTO.

SIMPLE LOTOTO

A simple LOTOTO is an Authorized Individual(s) performing service or maintenance on a piece of equipment having one energy source. The Authorized Individual is responsible for following the specific procedural steps to safely de-energize and isolate the equipment they will be servicing.

Fig. 4.6: A simple lockout with a single lock

COMPLEX LOTOTO

A group, or complex, LOTOTO is any LOTOTO procedure that involves more than one energy source. Since every Authorized Individual must place his/her personal lock on the energy-isolating device, typically workers use some form of group lockout device, such as a hasp or lockbox.

Fig. 4.7: A group lockout with multiple locks

ECC LOTOTO

Workers perform an ECC LOTOTO when multiple Authorized Individuals are not able to place their personal locks and tags directly to the energy-isolating device(s). The primary reason to use an ECC is to provide full protection to all Authorized Individuals working on the same project. The use of a lockbox for storing the ECC lock's key allows all Authorized Individuals to place a personal lock while conducting work.

Workers may use an ECC for complex, large-scale lockout situations, such as jobs that require multiple departments, shifts, or systems.

Fig. 4.8: An ECC lockout with multiple ECC keys and personal locks applied to a lockbox

ABANDONED LOCKS

When the Authorized Individual is not available to remove a device or personnel are unable to identify the owner of a lockout device, personnel may remove that device. The removal of these lockout devices would be considered a Non-Routine Lock Removal.

The steps in a Non-Routine Lock Removal ensure that the employee protected by the device is not exposed to hazardous energy once another employee removes the lock. Removal of personal lockout/tagout devices by another person is not permitted except when following the Non-Routine Lock Removal procedure.

The Non-Routine Lock Removal Process requires all of the following:

- All reasonable efforts have been made by a member of management to contact the individual of the pending lock removal, and determine why the equipment was locked out.
- If personnel cannot notify or identify the lock's owner, the Area Supervisor, a Qualified Individual, and a Safety Representative must verify the completion of a thorough inspection and certify that the machine or equipment is safe to re-energize.
- The Area Supervisor requesting the lock removal completes the Non-Routine Lock Removal Authorization Form.
- Before resuming work at that facility, personnel informs the individual about the removal of his/her lockout/tagout device.

For abandoned locks, follow non-routine lock removal procedures and complete the non-routine lock removal form.[54]

See the following page for the Non-Routine Lock Removal form.

54 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1-2.

Non-Routine Lock Removal Form

Control of Hazardous Energy | FCX-HS04

FREEPORT-McMoRan

EQUIPMENT	DATE	TIME
	LOCK OWNER	

☐ INDIVIDUAL CONTACTED

	Checklist	Summary
☐	Check the Energy Control Coordinator Form, lock and tags for information	
☐	Perform a thorough inspection of the equipment	
☐	Verify that all grounds and blocking devices have been removed	
☐	Verify that tools and material are clear	
☐	Verify that the equipment is operable	
☐	Verify that all guards have been re-installed	
☐	Verify that all personnel are clear	

☐ INDIVIDUAL NOT CONTACTED OR LOCK NOT IDENTIFIED

	Checklist	Effort to Contact the Owner	
☐	Check the Energy Control Coordinator Form, lock and tags for information	By Whom?	
☐	Perform a thorough inspection of the equipment	When?	
☐	Verify that all grounds and blocking devices have been removed	Location of Owner	
☐	Verify that tools and material are clear		
☐	Verify that the equipment is operable		
☐	Verify that all guards have been re-installed		
☐	Verify that all personnel are clear		
Verbal authorization from the Sr. Supervisor or Superintendent		Supervisor:	Approved By:

INVESTIGATORS

Title	Name & Signature
If contact with the lock owner cannot be made, or the owner is unknown, each of the individuals below must be contacted and must ensure all of the above requirements have been met, and the equipment is safe to remove the lock.	
Area Supervisor(s)	
Qualified Individual	
Energy Control Coordinator (*if applicable)	
Health & Safety	

NOTIFICATION

☐	Employee has been notified of the removal of their lockout/tag-out device before returning to work	
	When?	By Whom?
Provide document to **Area Superintendent or Responsible Person**		

This printed document is uncontrolled. Visit DOHS SharePoint site for current version and full policy details. 1 of 1

Fig. 4.9: Non-Routine Lock Removal Form

RESTARTING EQUIPMENT/SYSTEMS

There are four basic steps to restarting the equipment/systems:

1. Inspect the area
2. Remove all locks
3. Notify
4. Qualified Individual restores energy according to procedures[55]

Fig. 4.10: Individual inspecting tag

These steps must be performed by authorized employees, using the specific control of hazardous energy procedures, before the re-energization of any equipment. The steps are in place to ensure the removal of any maintenance/service items that may impact the operation of equipment. These steps also ensure that all guarding is in place and secured properly. The most important step is to make sure all personnel are accounted for and in a safe location.

1. INSPECT THE AREA

Area and equipment inspections ensure that the workers have returned the machine/equipment to operating condition and that it is safe to re-energize after the maintenance is complete.

Before returning the machine/equipment to service, the Authorized Individual or Energy Control Coordinator (ECC) inspects the work area. Inspections ensure that workers have removed all maintenance/service items and that the machine, equipment, or process is operationally intact. These inspections also ensure the proper installation of all safety equipment.

Lastly, check the location/area. Verify that all employees were removed from the area and are in a safe position.

55 FCX Department of Occupational Health and Safety, *Control of Hazardous Energy – LOTOTO Technical Supplement, FCX-HS04*, (Corporate Safety Portal, DOHS Policies: 2019), 1.

2. REMOVE ALL LOCKS

The Authorized Individual that applied the lock and tag or other device removes each lock and tag or other device.

For a Simple or Complex control of hazardous energy, the isolated energy source is free to be unlocked once the Authorized Individual(s) has completed the task and the inspection.

Fig. 4.11: Individual inspecting ECC tag

For an ECC situation with the use of a lockbox, the ECC will not be able to access the key for the ECC lock before the removal of all Authorized Individuals' personal locks and tags from the lockbox. Once the ECC key is accessible, the ECC removes the ECC lock and tag from the energy isolation device.

3. NOTIFY

The Authorized Individual or ECC notifies the equipment/system owner and any Affected Individuals that they have released the equipment for service. The equipment/process is now ready to begin the start-up process using the SOP.

4. QUALIFIED INDIVIDUAL RESTORES ENERGY ACCORDING TO PROCEDURES

Before start-up, the Qualified Individual needs to verify that all energy sources are connected to the equipment and no longer isolated and that all gaurds are properly in place. Pressurized systems may need to be charged to accomplish this.

The isolated energy sources can now be re-energized by a Qualified Individual. Start the equipment by using the standard start-up procedures and best management practices. A systematic start-up procedure must be utilized to avoid any additional or increased hazards to employees as a result of the machine or equipment start-up.

ACTIVITY 7: CREATING A PLAN

Directions: With your group, choose 2 different infographic posters created during Activity 3. For the each energy source, create a plan on how you would prepare to work safely with the energy source.

Use this page to take notes on your discussion. Be prepared to discuss your ideas with the class.

ENERGY SOURCE:

How would you prepare to work safely with this energy source?

_____

_____

_____

_____

ENERGY SOURCE:

How would you prepare to work safely with this energy source?

_____

_____

_____

_____

MODULE 4 QUIZ

Complete the following quiz.

1. Which of the following do workers identify when planning a job? Circle all that apply.
    a. All potential sources of energy
    b. Correct equipment needed for the job
    c. Responsibilities of each individual working on the job
    d. How to control the energies or exposure to the energies

2. What do workers need to complete for non-routine jobs? Circle all that apply.
    a. ECC form
    b. Variance Request form
    c. Job Safety Analysis (JSA)
    d. Walk-down of the application of the control devices

3. Which form must workers complete for abandoned locks?
    a. ECC form
    b. Variance Request form
    c. Energized Work Permit form
    d. Non-Routine Lock Removal form

4. Before restoring energy to equipment/systems, what does the Authorized Individual or Energy Control Coordinator (ECC) need to inspect? Circle all that apply.
    a. The work area
    b. Removal of all maintenance/service items
    c. Proper installation of all safety equipment
    d. The machine, equipment, or process is operationally intact

5. When restoring equipment to service, who notifies the equipment/system owner and any Affected Individuals that they have released the equipment for service? Circle all that apply.
    a. ECC
    b. Supervisor
    c. Qualified Individual
    d. Authorized Individual

Energy Control in Practice

MODULE 5

MODULE 5: ENERGY CONTROL IN PRACTICE

Introduction 89
Releasing Energy in Hydraulics 89
Overall Process Example 90
Events of Failures 90
False Sense of Security for Tryout 90
Activity 8: Preventing Incidents 91
Module 5 Quiz 93

MODULE 5 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Demonstrate the application of hazardous energy control principles to various sources, given different examples

INTRODUCTION

This module discusses an incident where an employee was unable to verify zero energy of the system, resulting in an injury to the employee. Verifying zero energy of the equipment or system before tryout is an important step in ensuring the safety of employees when performing work that involves potential exposure to hazardous energies.

RELEASING ENERGY IN HYDRAULICS

Before beginning work on hydraulic systems, first review the equipment manuals and all chemical Safety Data Sheets (SDS). While working on hydraulic systems, maintain a clean work area free of slipping hazards and debris and use all required safety equipment. Block, secure, or lower to the ground any components that may move, rotate, or fall. Use test equipment designed for higher pressures than the system in repair. Use of gauges, lines, connectors, or other equipment designed for lower pressures can result in bursting or equipment damage. A good rule of thumb is to start with higher gauges and work down. For example, start with using equipment rated at twice the expectation.

Do not use fingers or hands to find leaks. Always use safety glasses and use extreme caution when disconnecting hydraulic lines. Severe burns can result from hot fluids unintentionally released from the lines. Avoid heating near pressurized fluid lines. Remember to clean up any spills immediately, as hydraulic fluid can cause slips or falls and result in injuries.

Do not work under equipment supported by hydraulics. Place stops, safety pins, or other safety devices before beginning repairs.[56]

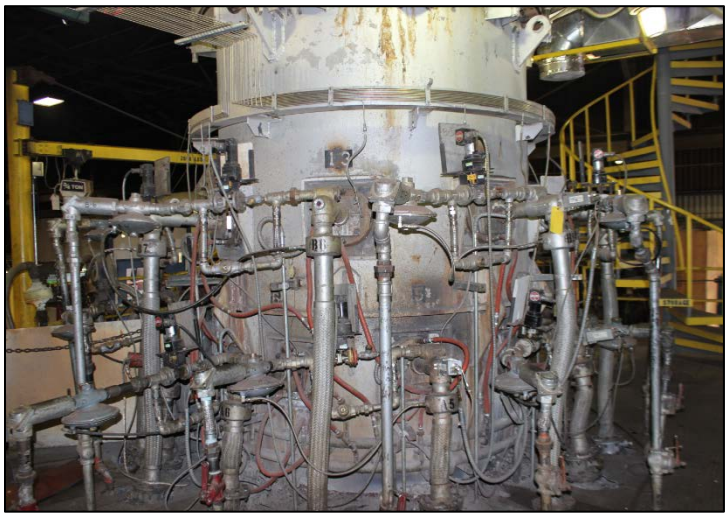

Fig. 5.1: Hydraulic system

56 "Hydraulic Safety", *Hydraulic Basics for Operations, v. 2*, (Freeport-McMoRan/Mine Training Institute: 2013), 16.

OVERALL PROCESS EXAMPLE

An injury occurred when a mill maintenance technician was unable to verify if the hydraulic system he was working on was at "zero energy state." The employee needed to remove the cylinder from the machine to replace the gland seals. The employee found the cylinder mounted in the vertical position, and the rod-end connected to a relatively heavy structure. In preparation for the cylinder removal, the employee started the pump and lowered the load (retracted the cylinder rod) to the rested position to remove the pressure. There was no means of verifying the depletion of the pressure. The employee locked the power unit out in accordance with his company's lockout protocol and proceeded with the task of removing the cylinder. When he loosened the connector, a "jet" of oil unexpectedly discharged from the connector, struck him in the face, and caused the injury.[57]

EVENTS OF FAILURES

The incident in the overall process example described above occurred when the employee was in the process of removing a hydraulic cylinder from a production machine to replace leaking gland seals. When he loosened the hose-end connector to remove the hose from the closed-end of the cylinder, a stream of oil unexpectedly discharged from the connector at extreme velocity and struck him in the face. The oil penetrated his cheek and spilled into his mouth. The employee continued to work and did not report the incident to his supervisor. He later reported that the taste of the hydraulic oil remained in his mouth for approximately three days after the accident, as it secreted into his mouth from the pinhole-sized wound in his cheek.[58]

FALSE SENSE OF SECURITY FOR TRYOUT

The employee in the overall process example was surprised that the oil discharged from the connector with such intensity when he loosened it. He was certain that there would be no pressure in the transmission line/system because he had lowered the cylinder to the rested position. This thinking is where many people make an error in judgment, and why hydraulic system de-energization and verification are critical. Hydraulic hoses are flexible and can expand with pressure. Additionally, hydraulic oil is compressible to a limited degree. Combining flexible hydraulic hoses with compressible hydraulic oil creates an accumulator or a device that stores energy.[59]

57 Fluid Power Safety Institute, "Fluid Power Safety Alert #10", *Fluidpowersafety.com*, 2008, Accessed June 11, 2019, http://fluidpowersafety.com/fpsi_alert-10.html.

58 Fluid Power Safety Institute, "Fluid Power Safety Alert #10", *Fluidpowersafety.com*, 2008, Accessed June 11, 2019, http://fluidpowersafety.com/fpsi_alert-10.html.

59 Fluid Power Safety Institute, "Fluid Power Safety Alert #10", *Fluidpowersafety.com*, 2008, Accessed June 11, 2019, http://fluidpowersafety.com/fpsi_alert-10.html.

ACTIVITY 8: PREVENTING INCIDENTS

Directions: For each scenario, identify the potential energy source and determine any missing energy controls. What would you have done differently to prevent the incident from happening?

INCIDENT #1

On May 12, 2008, at the Aracoma Alma #1 Mine in Stollings, West Virginia, a 24-year-old electrician with four years of experience cut into an energized 480-volt phase lead on a shuttle car. The resulting shock killed him. The worker was aware of proper Lockout/Tagout procedures and had properly de-energized a different shuttle car before the fatal incident.

Potential energy source(s): _____

Missing energy control(s): _____

_____

What would you have done differently to prevent the incident from happening?

_____

_____

_____

_____

INCIDENT #2

On January 2, 2007, a 37-year-old Instrument Technician with 2 ½ years of experience sustained a fatal injury when he opened a valve in the piping system of a vacuum monitoring line, and hydrogen fluoride discharged into his face. He was not wearing a respirator and died from chemical inhalation.

Potential energy source(s): _____

_____

Missing energy control(s): _____

_____

What would you have done differently to prevent the incident from happening?

_____

_____

_____

_____

INCIDENT #3

A Mine Maintenance employee was looking at the air conditioning on haul truck. The employee put his lockout lock on the transmission lockout and left the truck running for troubleshooting purposes. Once the employee locked out the truck, he retrieved a ladder from his service truck and placed it under the right front of the truck. While inspecting the a/c compressor, the employee slipped, and his left pinkie finger slid between the alternator guarding and contacted the alternator cooling fan. The operator called a Mayday and emergency personnel sent the injured employee for X-rays for a possible broken or dislocated pinkie finger and treatment for a laceration.

Potential energy source(s): _____

Missing energy control(s): _____

_____

What would you have done differently to prevent the incident from happening?

_____

_____

_____

_____

INCIDENT #4

On January 9, 2015, a Freeport-McMoRan contracted mechanic performed service to a skid steer. The mechanic properly de-energized the skid steer while performing maintenance. After completing the service, the mechanic removed the lock and tag and restarted the engine.

The mechanic noticed a diagnostic tool left inside the engine compartment. With the equipment running, the employee reached into the engine compartment to retrieve the tool. He entangled his gloved hand in a rotating component of the engine, resulting in lacerations to his ring and index fingers.

Potential energy source(s): _____

Missing energy control(s): _____

_____

What would you have done differently to prevent the incident from happening?

_____

_____

_____

_____

MODULE 5 QUIZ

Complete the following quiz.

1. Workers should use their hands to check for leaks?
    a. True
    b. False

2. When releasing energies in hydraulics, which of the following are possible hazards? Circle all that apply.
    a. Bursting or equipment damage from over-pressurized lines
    b. Severe burns from the release of hot fluids
    c. Puncture wounds from the discharge of fluids
    d. Slips or trips from spilled fluids

3. In the example with the mill maintenance technician (on page 90), what was the cause of the injury?
    a. He did not pre-plan the job well.
    b. He forgot to lock out the energy source.
    c. He removed the cylinder at the incorrect time.
    d. He did not verify if the hydraulic system he was working on was at "zero energy state."

4. In the example with the mill maintenance technician (on page 90), the employee had correctly locked out the power unit out in accordance with his company's lockout protocol, which had created a "false sense security" that it was safe to begin work on the machine.
    a. True
    b. False

5. It is important to de-energize and verify zero energy in hydraulic systems because the combination of flexible hydraulic hoses and compressible hydraulic oil can store energy.
    a. True
    b. False

CONCLUSION

There is no shortcut worth your life or the lives of your coworkers. Freeport-McMoRan designed the rules, regulations, equipment, and guidelines to keep you safe and ensure that you return home in the same way you reported to work.

Maintaining an awareness of your surroundings, as well as being knowledgeable about current policies and procedures, is an integral part of your job. Freeport-McMoRan developed the Control of Hazardous Energy Policy (FCX-HS04) as a means to protect employees and contractors by establishing minimum, acceptable requirements for the practices and procedures necessary to disable machinery or equipment. These requirements prevent the release of hazardous energy while employees perform service and maintenance activities.

The Control of Hazardous Energy Policy (FCX-HS04) also specifies that each site establishes a written program for hazardous energy control. This written program allows the sites to create guidelines with more detail and to develop guidelines to meet the unique needs of their site and further ensure employee safety.

Remember, you are a valuable asset to this company. As displayed throughout this course, measures exist to protect you and allow you to work with minimal exposure to risk. FCX Department of Occupational Health and Safety policies are available online and in print. Speak with your supervisors and health and safety representatives to ensure you know and understand how these policies apply to you and your work areas.

Failure to follow regulations can result in termination, but more importantly, it can result in you or your coworker’s death. No production deadline is more important than any one of our lives.

Resources

RESOURCES

Glossary 101
FCX-HS04 Control of Hazardous Energy Policy 104
FCX-HS04 Lockout Tagout Tryout Technical Supplement 106
Piping and Instrumentation Diagram (P&ID) Example 108
Single Line Drawing Example 110
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GLOSSARY

The glossary provides an alphabetical list of words, acronyms, terms, and phrases found in this course.

Entry	Definition
Affected Individual	An employee whose job requires them to operate or use a machine or piece of equipment on which performance of servicing or maintenance is under lockout/tagout/tryout (LOTOTO), or whose job requires them to work in an area during such performance of servicing or maintenance.
Authorized Individual	A qualified person who has the permissions, need, and knowledge to perform a specific task in a specific area. This person is accountable for the safety of the work they are performing.
Competent Person	One who has demonstrated the capability of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them.
Contractor	A third party provider, its employees, and all subcontractors and their employees who perform services for FCX and its subsidiaries. General or Prime Contractor, Subcontractor, or supplier on the FCX site.
Critical Control	A device, system, or process implemented to eliminate or reduce the risk for a task/job, and if missing or overlooked has the potential to lead to catastrophic outcomes such as serious injury or death.
Department of Occupational Health and Safety (DOHS)	Freeport-McMoRan’s corporate health and safety department.
Energy Control Coordinator (ECC)	An Authorized Individual selected by supervision having technical and working knowledge of the equipment needing energy isolation. The ECC requests the qualified craft representatives necessary to isolate energy sources. The ECC has the overall responsibility of the energy isolation to ensure the isolation, control, lock, tag, and tryout of all energy sources with the assistance of the Qualified Individual.

Entry	Definition
Energy-Isolating Device	A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following: a manually operated circuit breaker; a disconnect switch; a manually operated switch by which employees can disconnect the conductors of a circuit from all ungrounded supply conductors; a line valve; a block; and any similar device used to block or isolate energy. Push buttons, emergency stop buttons, selector switches, control circuit type devices, and disconnect switches where employees can operate poles independently are not energy-isolating devices.
Energy Source	Origination/isolation point for control of hazardous energies. Can include electrical (residual), mechanical, hydraulic, pneumatic, chemical, thermal, or other potential energies capable of causing harm to employees, damage to property, and process loss.
Fatal Risk	A risk that if not controlled has the potential to lead to catastrophic outcomes such as serious injury or death.
Hazardous Energy	Any electrical, chemical, gravitational, hydraulic, magnetic, mechanical/kinetic, nuclear/radiation, pneumatic, thermal energy, or other energy that could cause injury to personnel.
Job Safety Analysis (JSA)	A systematic process to identify hazards to health and safety and the potential for incidents. The analysis helps to determine appropriate controls for eliminating or reducing the hazards as low as reasonably practical.
Lockout/Tagout/Tryout (LOTOTO)	An approved method of isolating potentially hazardous energy sources required whenever performing service, maintenance, modification, or installation activities on de-energized equipment, machines, or processes in which unexpected energizing, start-up, or release of stored energy has the potential of causing injury to people, damage to property, or loss to process.
Lockout Device	A device that utilizes a positive means such as a lock that secures an energy-isolating device in a safe position that prevents the energization of a machine, equipment, or process.
National Fire Protection Association (NFPA)	A global, nonprofit organization devoted to eliminating death, injury, property, and economic loss due to fire, electrical, and related hazards.
Occupational Health and Safety Administration (OSHA)	Part of the United States Department of Labor. The mission is to assure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance.

Entry	Definition
Personal Protective Equipment (PPE)	Items used to help protect workers from items or situations that could cause bodily harm during their job performance.
Preventative Maintenance (PM)	Ensures that all systems and equipment are in good working order and that regular preventative maintenance procedures are in place. Maintaining equipment ensures that systems and equipment meet and follow all manufacturer recommendations and engineering requirements.
Qualified Individual/ Personnel	One who, by possession of a recognized degree, certificate, or professional standing or who by knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.
Servicing or Maintenance	Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining or servicing machines or equipment. These activities include lubrication, cleaning or unjamming of machines or equipment, and making adjustments or tool changes, where the unexpected exposure of energy to the employee could occur from the unexpected energization or startup of the equipment or release of hazardous energy.
Standard Operating Procedure (SOP)	Set of systematic instructions to achieve a predictable, standardized, desired result often within the context of a longer overall process.

FREEPORT-McMoRan

Control of Hazardous Energy Policy

Health and Safety FCX-HS04 | Release Date 8/5/2019

POTENTIAL FATAL RISKS

Uncontrolled Release of Energy

CRITICAL CONTROLS

Blocking for Maintenance Work
Guards, Barriers and Barricades
Energy Isolation/LOTOTO
Pipe Management
Hose Coupling Locking Systems
Pipe/Hose/Equip. Mechanical Integrity
Relief Valves
Tensioned Lines Management
Tire Management

POTENTIAL ENERGY SOURCES

Atmospheric	Chemical
Electrical	Electromagnetic
Gravitational	Hydraulic
Kinetic	Mechanical
Pneumatic	Residual
Stored	Thermal

FORMS AND SUPPLEMENTS

LOTOTO Technical Supplement
ECC Form
Energized Work Permit
Non-Routine Lock Removal form

TRAINING REQUIREMENTS

Initial
Annual Refresher
Task training to written procedures
New equipment/processes
Remedial as necessary

POLICY

OVERVIEW

Identify and isolate, eliminate or control all potential sources of energy when there is the possibility of exposure while performing work (i.e. inspection, installation, calibration, maintenance, etc.). Verify that controls are effective. This policy applies to all employees and contractors on FCX operating sites.

ACTIONS TO STAY SAFE

1. Plan the activity to be performed
2. Identify the potential sources of hazardous energy
3. Eliminate, isolate or control each source
4. Dissipate residual energy
5. Verify controls are effective and tryout

Follow hazardous energy control procedures for each piece of equipment, system or process. Procedures must include steps for verification of control.
Stop the job when scope of work changes or controls are ineffective.
Isolate at the source whenever possible, or use other methods to ensure zero energy (i.e. double block/bleed, blind, air gap, blocking, etc.)

Plan:

- Understand the full scope of the work and all tasks associated.
- Identify all personnel roles and responsibilities, tools, hazards, isolation points, isolation devices, prior to starting work.
- Consult SOPs or JSAs prior to performing work.

Identify Sources:

- Use most recent drawings, prints, etc. for identifying sources of hazardous energy.
- Ensure lines/breakers/valves etc. are properly labeled/identified; contact responsible parties or consult relevant documentation.

Eliminate, Isolate and Control:

- Verify that the correct isolation points are isolated for each type of hazardous energy identified.
- Use appropriate devices for the source.
- Follow de-energization procedures in FCX-HS03 Electrical Safety for electrical de-energization.

Dissipate Residual Energy:

- When zero energy cannot be accomplished, install controls to reduce ot eliminate exposure to the energy source. Complete Energized Work Permit.

Verify Controls and Tryout:

- Ensure zero energy and attempt to restart the equipment.
- Do not confuse process interlocks with energy isolation or use for tryout.
- ECC or Authorized Individual and Project Manager or delegate must visually confirm non-routine energy isolation prior to performing work in the absence of SOPs.

Energized Work (Commissioning, Testing, Calibrating, Troubleshooting, etc.)

- Hazardous energy control procedures may not apply, but complete a documented safety analysis/risk assessment.
- Understand the process for start-up and potential for exposure to self and others.
- Develop a communication plan for these activities.
- Evaluate new controls and verify existing controls.
- When guards and barriers are removed (or interlocks bypassed) for troubleshooting/testing and calibration, other controls must be in place to prevent exposure.
- When work is performed on energized equipment, follow specific documented guidelines and procedures.
- When other bypass devices are installed, and equipment is energized while performing work, follow specific documented guidelines and procedures for installation, use and removal of bypass devices.
- Conduct pre-operational inspections prior to start up.
- When testing or positioning machines or equipment:
    - Clear the area of unnecessary personnel, tools and materials
    - Install flagging or barricading, reference FCX-HS19
    - Remove energy control devices as specified in procedures
    - Energize and proceed with testing or positioning
- Prior to performing additional maintenance, de-energize, isolate from potential sources and reapply energy control devices

ENERGIZED WORK PERMIT

- When possible exposure to hazardous energy exists, but the equipment must remain energized to perform work, complete an Energized Work Permit.
- For routine work, where an SOP exists, the Energized Work Permit is valid for one year, and should be kept with the SOP as a part of the record. The SOP must be reviewed prior to performing the work.
- Electrical troubleshooting and testing is excluded from the permit requirements, reference the Electrical Safety Policy TS for Energized Electrical Work.
- If there is no Superintendent on site, the delegate may authorize the work in his/her place.

Shift Change

- Procedures for shift change must be documented.
- Ensure integrity of isolation devices prior to turn-over.
- Use ECC procedures if necessary.
- Remove personal locks and tags if work is complete and equipment is in a safe condition.

Access and Verification

- If an Authorized Individual joins after verification of isolation has taken place, they must contact the other Authorized Individuals or ECC (if used) to confirm equipment is isolated and has been verified/tested.
- All Authorized Individuals retain the right to verify isolation by clearing the area and attempting to start the equipment.
- When access to isolation devices is limited (e.g. inside a restricted area), Authorized Individuals will be escorted by a Qualified Individual, or the ECC process will be used.

Non-Routine/Emergency Work

- During emergency work and when an SOP is not available, planning for energy control must include:
    - an inventory of identified hazardous energy sources,
    - determination of isolation/control devices,
    - assignment of responsible persons, including Qualified Individuals and ECC if necessary,
    - field verification of the application of the control devices.
- Document this information and evidence of the verification. *Documentation may be a JSA if there is not existing documentation in place.*

FREEPORT-McMoRan

Technical Supplement

Control of Hazardous Energy – LOTOTO | FCX-HSX04 | Release Date 08/05/2019

OVERVIEW

Lockout Tagout Tryout (LOTOTO) is the preferred method of energy control in most situations.
Only Qualified Individuals may perform hazardous energy isolation.
Each Authorized Individual will place their personal lock on each energy isolation device or group lockout device.
When Authorized Individuals are not able to apply locks and tag to the energy-isolating device, an (Energy Control Coordinator/Process) ECC will be used.
Cord and plug equipment is excluded if plug is under direct control.
Follow non-routine lock removal procedures for abandoned locks.
Reference FCX-HS03 Electrical Safety, for de-energization and grounding information.

EFFECTIVE LOTOTO

LOTOTO Process

1. Plan the work
   - Understand the scope of work
   - Identify sources of hazardous energy
   - Identify Qualified Individuals
   - Select appropriate controls
2. Notify
   - Equipment/system owner
   - Affected individuals
3. Qualified Individual shutdown equipment/systems
4. Isolate/Eliminate hazardous energy sources
5. Lock and Tag
   - Individual/Group
   - ECC process
6. Release stored/residual energy
7. Verify effectiveness of controls
   - Verify zero energy from all sources **and**
   - Tryout- attempt to restart all locked aspects of the equipment

Restarting Equipment/Systems

1. Inspect the area
   - Persons, tools and equipment have been removed
   - Guards and other safety devices have been reinstalled
   - Equipment is operationally intact
2. Remove all locks
3. Notify
   - Equipment/system owner
   - Affected individuals
4. Qualified Individual restore energy according to procedures

LOCKS AND TAGS

Locks (LOTOTO)

- Uniquely identifiable for energy control
- Single keyed
- Only used for energy control
- Standardized within the facility
- Not easily defeated
- ECC locks will be single keyed

Tags

- Withstand 50lbs (23 kg) of force
- Identify the individual by first and last name
- Include appropriate contact info/method
- ECC tags will say ECC
- Legible
- Withstand exposure to conditions (acid, weather, etc.)
- Include a warning statement
- Standardized within the facility

Out of Service Locks and Tags

- Never used for the control of hazardous energy
- Applied when equipment is deemed unsafe
- Used to protect machines and equipment from damage due to accidental start-up
- Visibly different from LOTOTO
- Tags will have "out of service" or similar message

ROLES AND RESPONSIBILITIES

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1 of 2

Authorized Individual	Affected Individual	Qualified Individual
• Individual who locks and tags isolation devices for equipment to perform service or maintenance. • Performs work on the equipment that is locked out. • Must place their own locks and tags. • Must maintain control of the key to their lock. • Responsible for returning equipment to serviceable condition prior to removing any energy isolation device or lock. • Support ECC as needed.	• Individual whose job requires them to use equipment that is being serviced or maintained under LOTOTO. • Do not perform work on the equipment that is locked out. • Includes personnel in the area who are not performing work on the equipment.	• Individual who may or may not be working on the lock out, but has the qualifications to perform energy isolation for the specific system being de-energized. • Ensure safe procedures for shutdown, isolation, and energy release are followed. • Responsible for verifying effectiveness of energy isolation and conducting tryout. • Support ECC as needed.

Energy Control Coordinator (ECC) Process

Each person has the right and responsibility to verify control of hazardous energy with ECC, Qualified Individuals or supervision.
When an Authorized Individual joins a group lockout in process, they must apply their personal locks and tags to the group lockout device and read and understand the ECC form and make contact with the ECC.
The ECC, along with the Qualified Individual isolates and locks all hazardous energy sources using ECC locks and tags.
ECC keys are placed in a group lockout device, along with another ECC lock and tag.
Only the ECC key for the group lockout device may be handed over using specific procedures for shift changes.
The ECC lock is not the same as the personal lock and the ECC must still apply their personal lock and tag to the group lockout device if they are performing work on the system/equipment.
Multiple ECCs may be necessary for complex work.

Energy Control Coordinator Will:

Be assigned by supervision and have full responsibility for the lockout process.
Be trained and competent in the ECC process and have a working knowledge of the system being isolated.
Lead hazardous energy source identification process with support from Qualified and Authorized Individuals.
Understand the plan for the shutdown and hazardous energy control.
Manage interactions with other affected groups/individuals.
Identify Qualified Individuals to conduct Control of Hazardous Energy, and understand the role of the ECC and others.
Maintain a list of energy control points and responsible parties, Qualified and Authorized Individuals.
Maintain integrity of hazardous energy control with support from Qualified and Authorized Individuals
Manage shift changes using specific, documented procedures.
Release system back to operations with support from Qualified and Authorized Individuals.
Place the first lock on, and remove the last lock from the group lockout device.

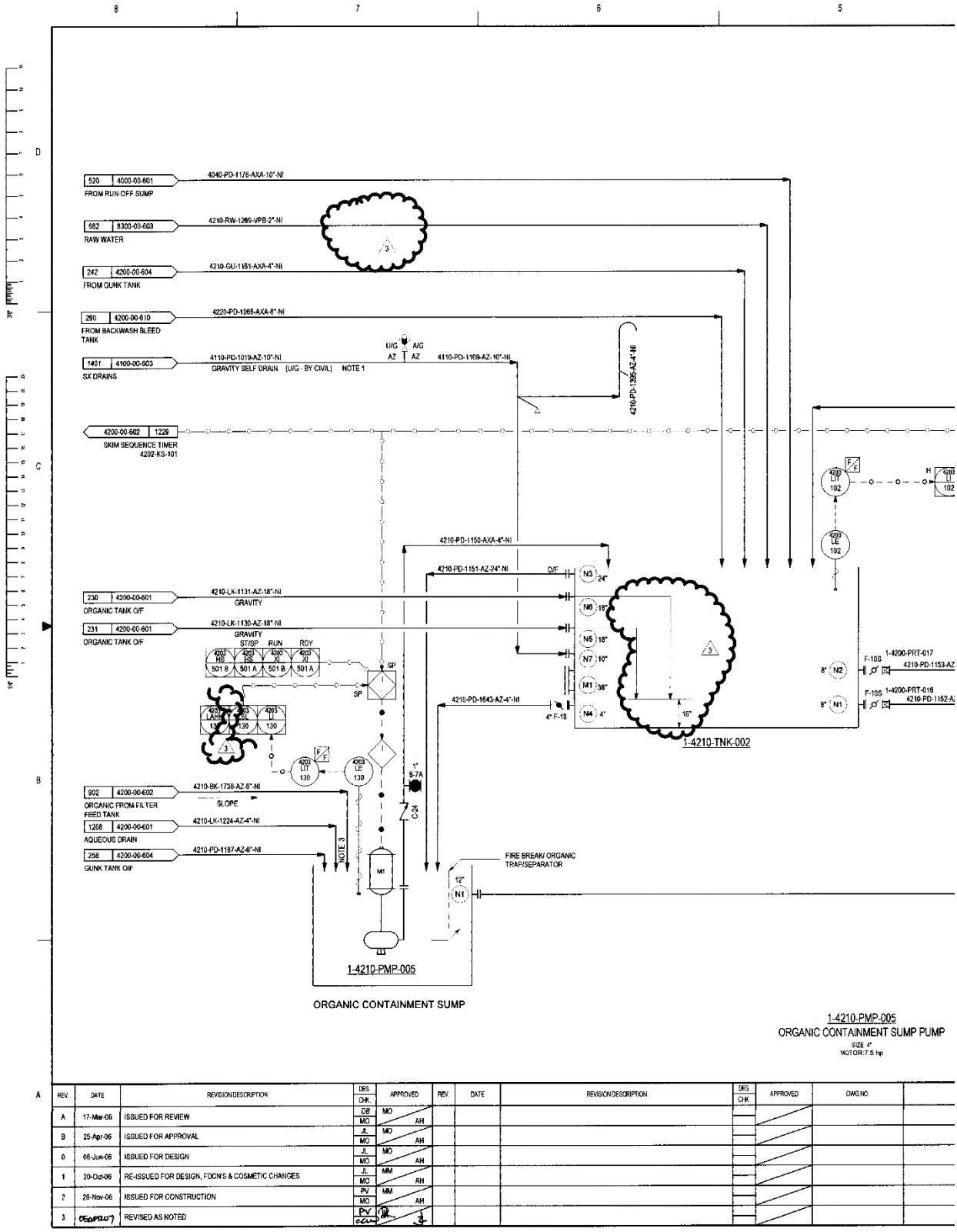
Energy Control Coordinator Transfers:

Incoming ECC will add their information to the ECC form.
Outgoing and Incoming ECC will verbally confirm details of the work and lockout, and may visually confirm lockout devices in use.
Incoming ECC will assume responsibility of the lockout process once they take possession of the key, and put their contact information on the ECC tag.
Outgoing ECC will remove their personal lock from the group lockout device before leaving the area.
The ECC form will be kept with the lockbox unless ECC is actively being transferred.
No new Authorized individuals will join the LOTOTO in process until the ECC transfer is complete and form has been returned.
Work can continue by Authorized Individuals who have already signed the Individual Lockout Roster while ECC transfer is in process.

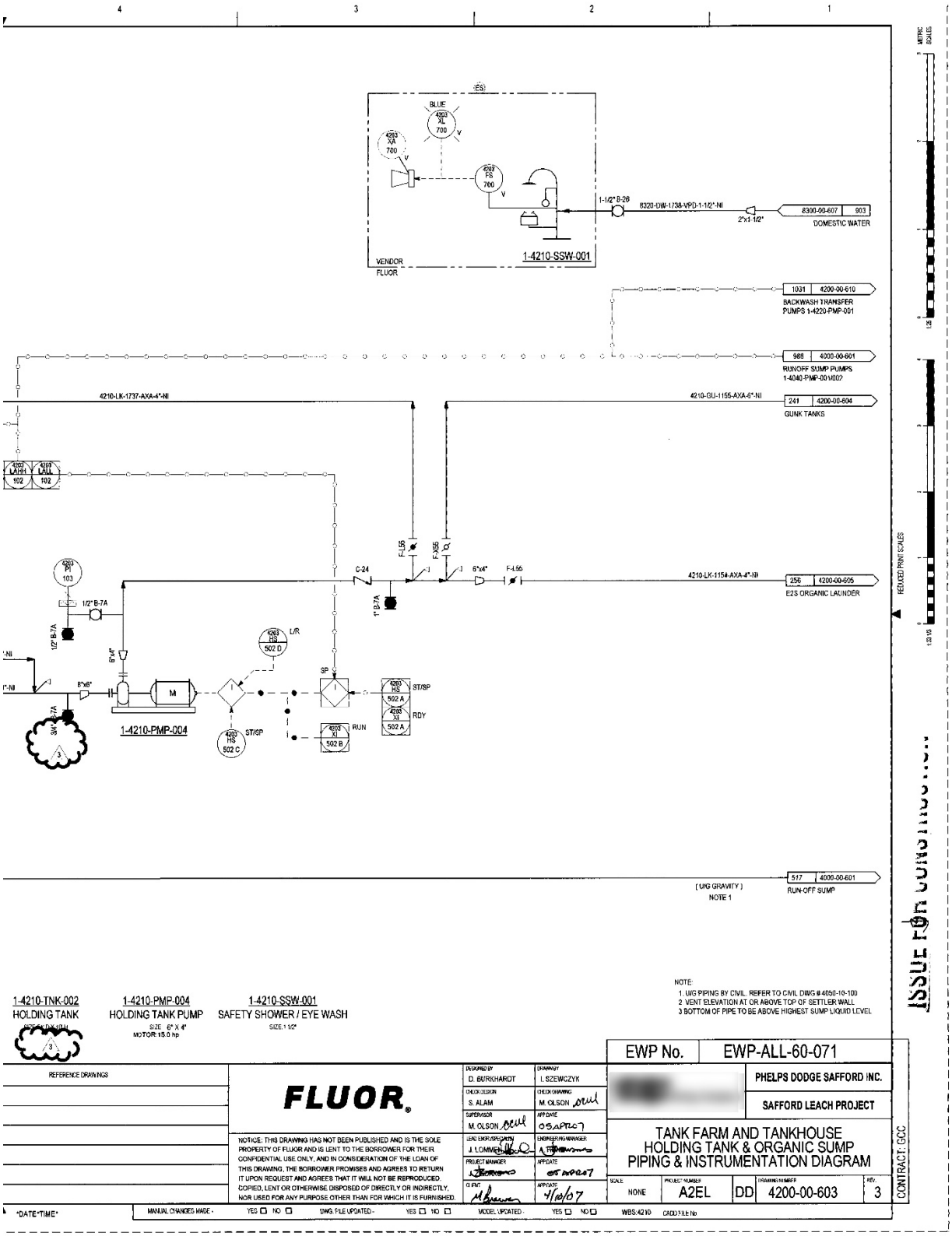
Non-Routine Lock Removal

When the Authorized Individual is not available to remove a device or the owner of a lock out device cannot be identified, that device may be removed. Always follow the non-routine lock removal form.

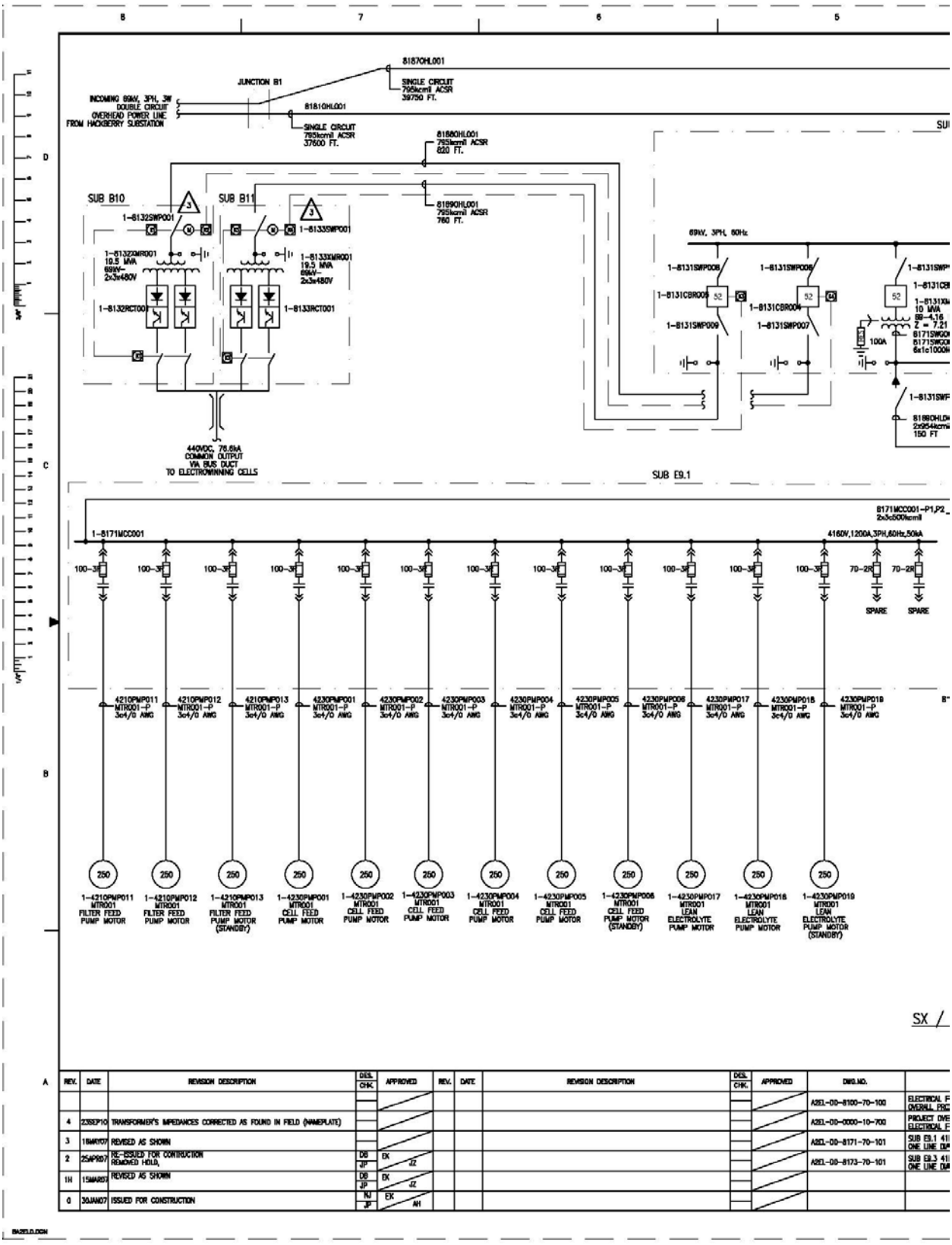
PIPING AND INSTRUMENTATION DIAGRAM (P&ID) EXAMPLE

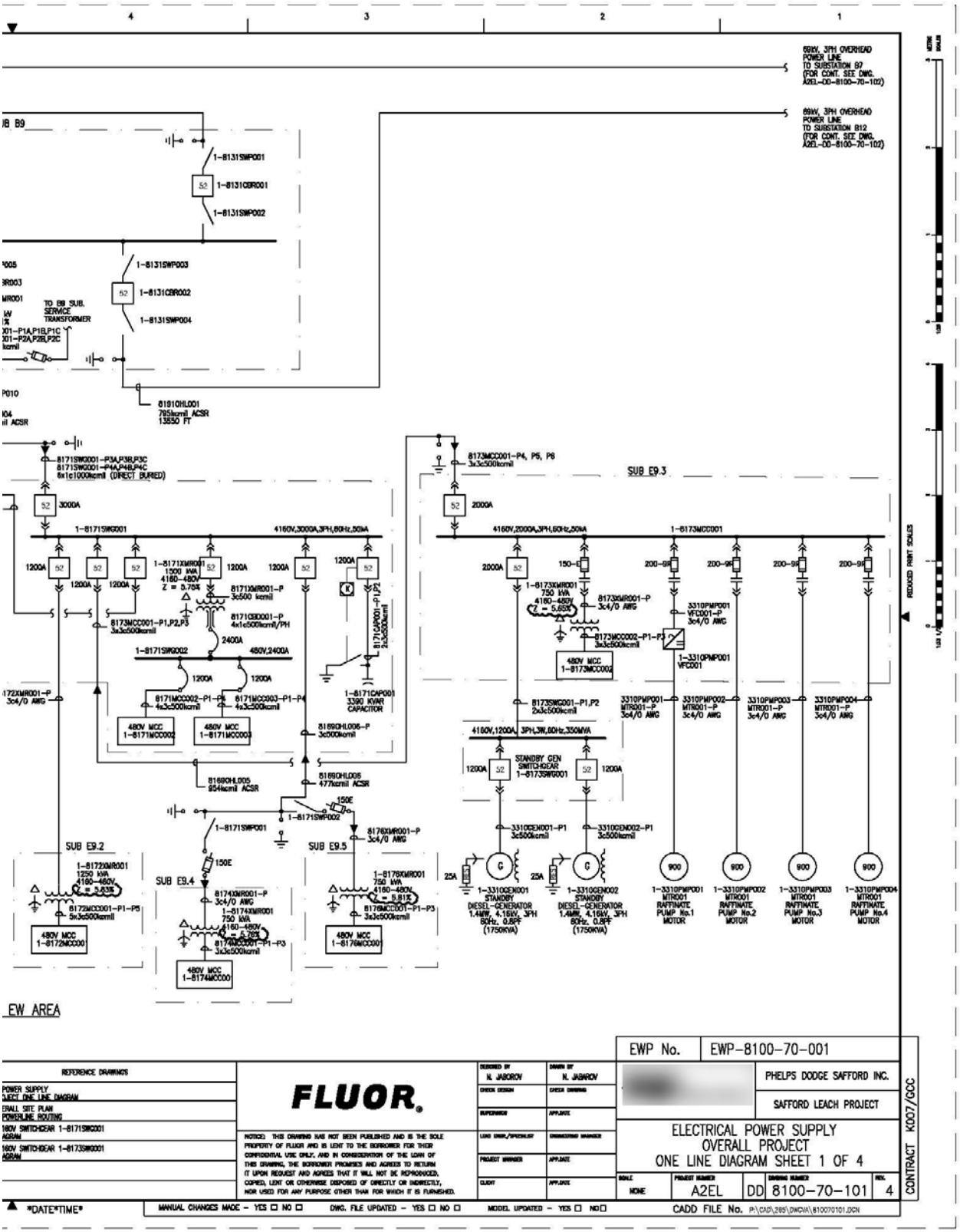


REV.	DATE	REVISION DESCRIPTION	DES.	CHK.	APPROVED
A	17-Mar-06	ISSUED FOR REVIEW	DB	MO	
B	25-Apr-06	ISSUED FOR APPROVAL	JL	MO	AH
0	06-Jun-06	ISSUED FOR DESIGN	JL	MO	AH
1	20-Oct-06	RE-ISSUED FOR DESIGN, FDCN'S & COSMETIC CHANGES	JL	MM	AH
2	28-Nov-06	ISSUED FOR CONSTRUCTION	PV	MM	AH
3	05MAR07	REVISED AS NOTED	PV	MO	AH


1-4210-SSW-001
VENDOR
FLUOR
8220-DW-1738-VPD-1-1/2"-NI
DOMESTIC WATER
BACKWASH TRANSFER PUMPS 1-4220-PMP-001
RUNOFF SUMP PUMPS 1-4040-PMP-001/002
4210-LK-1737-AXA-4"-NI
4210-GU-1155-AXA-6"-NI
GUNK TANKS
4210-LK-1154-AXA-4"-NI
E2S ORGANIC LAUNDER
1-4210-PMP-004
RUN-OFF SUMP
(U/G GRAVITY)
NOTE 1
1-4210-TNK-002
HOLDING TANK
1-4210-PMP-004
HOLDING TANK PUMP
SIZE 6" X 4"
MOTOR 15.0 hp
1-4210-SSW-001
SAFETY SHOWER / EYE WASH
SIZE 1 1/2"
NOTE:
1. U/G PIPING BY CIVIL. REFER TO CIVIL DWG # 4050-10-100
2 VENT ELEVATION AT OR ABOVE TOP OF SETTLER WALL
3 BOTTOM OF PIPE TO BE ABOVE HIGHEST SUMP LIQUID LEVEL
ISSUE FOR CONSTRUCTION
EWP No. EWP-ALL-60-071
PHELPS DODGE SAFFORD INC.
SAFFORD LEACH PROJECT
TANK FARM AND TANKHOUSE
HOLDING TANK & ORGANIC SUMP
PIPING & INSTRUMENTATION DIAGRAM
FLUOR
NOTICE: THIS DRAWING HAS NOT BEEN PUBLISHED AND IS THE SOLE PROPERTY OF FLUOR AND IS LENT TO THE BORROWER FOR THEIR CONFIDENTIAL USE ONLY, AND IN CONSIDERATION OF THE LOAN OF THIS DRAWING, THE BORROWER PROMISES AND AGREES TO RETURN IT UPON REQUEST AND AGREES THAT IT WILL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY, NOR USED FOR ANY PURPOSE OTHER THAN FOR WHICH IT IS FURNISHED.
D. BURKHARDT
I. SZEWCZYK
S. ALAM
M. OLSON
05APR07
J. LOMMEN
4/10/07
NONE
A2EL
DD
4200-00-603
3
CONTRACT: GCC

SINGLE LINE DRAWING EXAMPLE




69kV, 3PH OVERHEAD POWER LINE TO SUBSTATION B7 (FOR CONT. SEE DWG. A2EL-00-8100-70-102)
69kV, 3PH OVERHEAD POWER LINE TO SUBSTATION B12 (FOR CONT. SEE DWG. A2EL-00-8100-70-102)
1-8131SWP001
1-8131CBR001
1-8131SWP002
1-8131SWP003
1-8131CBR002
1-8131SWP004
TO B9 SUB. SERVICE TRANSFORMER
61910HL001
795kcmil ACSR
13850 FT
8171SWG001-P3A,P3B,P3C
8171SWG001-P4A,P4B,P4C
6x1c1000kcmil (DIRECT BURIED)
3000A
1-8171SWG001
4160V,3000A,3PH,60Hz,50kA
1200A
1-8171XMR001
1500 kVA
4160-480V
Z = 5.75%
8171XMR001-P
3c500 kcmil
8171CBR001-P
4x1c500kcmil/PH
2400A
1-8171SWG002
480V,2400A
8171CAP001-P1,P2
2x3c500kcmil
1-8171CAP001
3390 KVAR CAPACITOR
8171MCC002-P1-P5
4x3c500kcmil
8171MCC003-P1-P4
4x3c500kcmil
480V MCC 1-8171MCC002
480V MCC 1-8171MCC003
8169HL006-P
3c500kcmil
8169HL005
954kcmil ACSR
8169HL005
477kcmil ACSR
150E
1-8171SWP002
1-8171SWP001
8176XMR001-P
3c4/0 AWG
SUB E9.2
1-8172XMR001
1250 kVA
4160-480V
Z = 5.53%
8172MCC001-P1-P5
5x3c500kcmil
480V MCC 1-8172MCC00
SUB E9.4
81743XMR001-P
3c4/0 AWG
1-8174XMR001
750 kVA
4160-480V
Z = 5.75%
8174MCC001-P1-P3
3x3c500kcmil
480V MCC 1-8174MCC00
SUB E9.5
1-8176XMR001
750 kVA
4160-480V
Z = 5.81%
8176MCC001-P1-P3
3x3c500kcmil
480V MCC 1-8176MCC00
EW AREA
8173MCC001-P4, P5, P6
3x3c500kcmil
SUB E9.3
2000A
1-8173MCC001
4160V,2000A,3PH,60Hz,50kA
1-8173XMR001
750 kVA
4160-480V
Z = 5.69%
8173XMR001-P
3c4/0 AWG
8173MCC002-P1-P3
3x3c500kcmil
480V MCC 1-8173MCC002
3310PMP001
VFCD01-P
3c4/0 AWG
1-3310PMP001
VFCD01
8173SWG001-P1,P2
2x3c500kcmil
4160V,1200A, 3PH,3W,60Hz,350MVA
STANDBY GEN SWITCHGEAR 1-8173SWG001
3310GEN001-P1
3c500kcmil
3310GEN002-P1
3c500kcmil
1-3310GEN001 STANDBY DIESEL-GENERATOR 1.4MW, 4.16kV, 3PH 60Hz, 0.8PF (1750KVA)
1-3310GEN002 STANDBY DIESEL-GENERATOR 1.4MW, 4.16kV, 3PH 60Hz, 0.8PF (1750KVA)
3310PMP001 MTR001-P 3c4/0 AWG
3310PMP002 MTR001-P 3c4/0 AWG
3310PMP003 MTR001-P 3c4/0 AWG
3310PMP004 MTR001-P 3c4/0 AWG
1-3310PMP001 MTR001 RAFFINATE PUMP No.1 MOTOR
1-3310PMP002 MTR001 RAFFINATE PUMP No.2 MOTOR
1-3310PMP003 MTR001 RAFFINATE PUMP No.3 MOTOR
1-3310PMP004 MTR001 RAFFINATE PUMP No.4 MOTOR
EWP No.
EWP-8100-70-001
PHELPS DODGE SAFFORD INC.
SAFFORD LEACH PROJECT
ELECTRICAL POWER SUPPLY
OVERALL PROJECT
ONE LINE DIAGRAM SHEET 1 OF 4
FLUOR
N. JABROV
A2EL
DD 8100-70-101
4
CONTRACT K007/GCC
REDUCED PRINT SCALES

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STUDENT COURSE EVALUATION

Course Title Control of Hazardous Energy Site Date

Your Name (optional) Facilitator

Directions: Circle the number that best fits your level of agreement with the statement. Then complete the short answer questions.

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. The course content was relevant to my job.	1	2	3	4
2. The course materials were clear and well written.	1	2	3	4
3. The lecture, discussions, and activities improved the quality of the course.	1	2	3	4
4. The facilitator was knowledgeable about the content.	1	2	3	4
5. The facilitator created an atmosphere that enhanced my learning.	1	2	3	4
6. I am confident I can apply the course content to my job.	1	2	3	4
7. The course met my expectations.	1	2	3	4

8. What did you find valuable in the course?

9. What can be improved in the course?

10. Please clarify your responses (questions 1-8) and provide any additional comments.

Thank you for taking the time to complete this evaluation. We value your feedback.

Mail to: Mine Training Institute, Attn: Suzanne Anderson, 18550 S. La Canada Dr., Sahuarita, AZ 85629

Scan or email to: sanderso2@fmi.com