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**MSW Initial/Refresher
Training:
Isolation of Hazardous Energy**

Purpose, Objectives and Scope

Purpose

- The purpose of this training is to provide essential requirements that must be followed when conducting Isolation of Hazardous Energy work at Chevron facilities.

Objective

- Understand the key concepts and requirements of the of the Isolation of Hazardous Energy Standard
- Know the key terms associated with the Isolation of Hazardous Energy activities
- Understand the steps involved for work involving Isolation of Hazardous Energy

Scope

- This standard applies to all Chevron employees and contractors working at Chevron facilities, job sites and/or any joint venture operations where joint venture agreements allow its use.

Regulatory Requirements

- Discuss additional local regulatory requirements throughout this training as appropriate



Key Definitions

- **Bonding** – Electrically tying or connecting two conducting metal bodies together so that they have the same electro potential. Bonding prevents static accumulation by providing a low resistance path for the generated static charge. Bonding wires will be sufficiently sized to provide adequate electrical continuity, eg, 4 AWG or larger copper wire or braided metal grounding straps



- **Grounding/Earthing** – Connecting a fuel handling system to the ground or earth to ensure that the fuel handling system is at zero potential.



Key Definitions

- **Electrical Isolation** – The opening and locking of electrical switched or circuit breakers at the main power source, disconnecting leads, or removing fuses to make it physically impossible for electrical power to get to the equipment
- **Extra Low Voltage** – Any voltage normally not exceeding 50 volts A.C. or 120 volts D.C
- **Low Voltage** – Any voltage exceeding 50 volts A.C. or 120 volts D.C., and that is <1000 volts AC (1500 volts DC) between conductors or that is <600 volts AC (900 volts DC) between conductors and the earth.
- **High Voltage** - Voltage that is >1000 volts AC (1500 volts DC) between conductors or that is >600 volts AC (900 volts DC) between conductors and the earth.
- **Lockout** – When a lock is used to lock an isolation device in the “off” or “safe” position.
- **Hazardous Energy** – any of the following energy forms
 - Electricity
 - Fluid pressure
 - Air Pressure
 - Kinetic Energy (Energy of a moving object or materials)
 - Potential Energy (Stored energy that an object has the potential to release)
 - Pressurized liquid or gases
 - Chemical Energy
 - Thermal Energy



Key Definitions

- **Isolation** – The process to segregate the hazardous energy or toxic substance from the recipient. This may be achieved by a number of methods such as blinding, electrical isolation, positive physical isolation, etc.
- **Isolation or Lock Out device** – A mechanical device that is used to physically lock out an isolation point and prevent transmission or release of energy. The method of prevention may be by opening the path (such as circuit breaker) or by blocking the path (such as a blind). Examples include: chain, valve handle, lockable switch, blinds/ spades, blank flanges.
- **Blind/Spade** – A circular metal plate used to block the flow path in a pipeline that is bolted between two pipe flanges. Typically either a ‘Pancake blind’ (sometimes called a ‘skillet blind’) or ‘Spectacle blind’ is utilized.
 - The blind/spade must be designed for the full maximum design pressure of the equipment into which it will be installed.



‘Pancake Blind’



‘Spectacle Blind’

Key Definitions

- **Positive Physical Isolation** – An isolation where there is zero potential of an energy release. That is, equipment is positively separated from the hazardous energy and toxic substance using one of the following methods:
 - Removal of a section (spool) of piping.
 - Physical removal of a circuit breaker and earthing the system.
 - Removal of mechanical couplings.



Key Definitions

– **Tag** – A device used to identify an isolation point and indicate the reason for the isolation. Tags warn personnel not to operate the tagged item and indicate when it was fitted and who it was fitted by.

– **Tag-Out** – The act of attaching a tag at each isolation point warning personnel not to operate.



Isolation of Hazardous Energy

Energy shall be isolated:

- If there is a potential for unexpected energization, start-up or release of residual or stored energy from machinery/equipment and processes during servicing and maintenance.
- If a guard or other safety device is bypassed, altered or removed.
- If a person must put any part of their body into a machine or equipment to perform work at a point of operation or if there is a zone of danger around machinery.

This Isolation of Hazardous Energy standard applies to equipment which include, but not limited to the following equipment:

- Machinery.
- Process and other industrial equipment.
- Vessels.
- Piping.
- Other systems (e.g., pressure relief system).

Note: Regardless of location of isolation points (whether on Chevron property or off our property) the isolation requirements of this standard shall be met. It may be necessary to review your facility to understand where electrical, pipeline, etc. isolation points may be, and to develop an agreement/MOU for allowing Chevron employees and/or contractors to access the site and to properly isolate the equipment.



Hazard Analysis

A Hazard Analysis needs to be conducted prior to any Isolation of Hazardous Energy

- The Hazard Analysis must identify any potential for the presence of stored energy, flammable or toxic gases and other potential hazardous conditions or substances, including all potential forms of hazardous energy specific to the job.



- Isolation of process streams (toxic, flammable, etc.), high voltage electrical systems, and some mechanical systems requires special consideration and must only be performed by contractors or competent personnel who specialize in isolation of those systems.

Isolation of Hazardous Energy

Procedural Steps for Isolation

Shut Down the Equipment

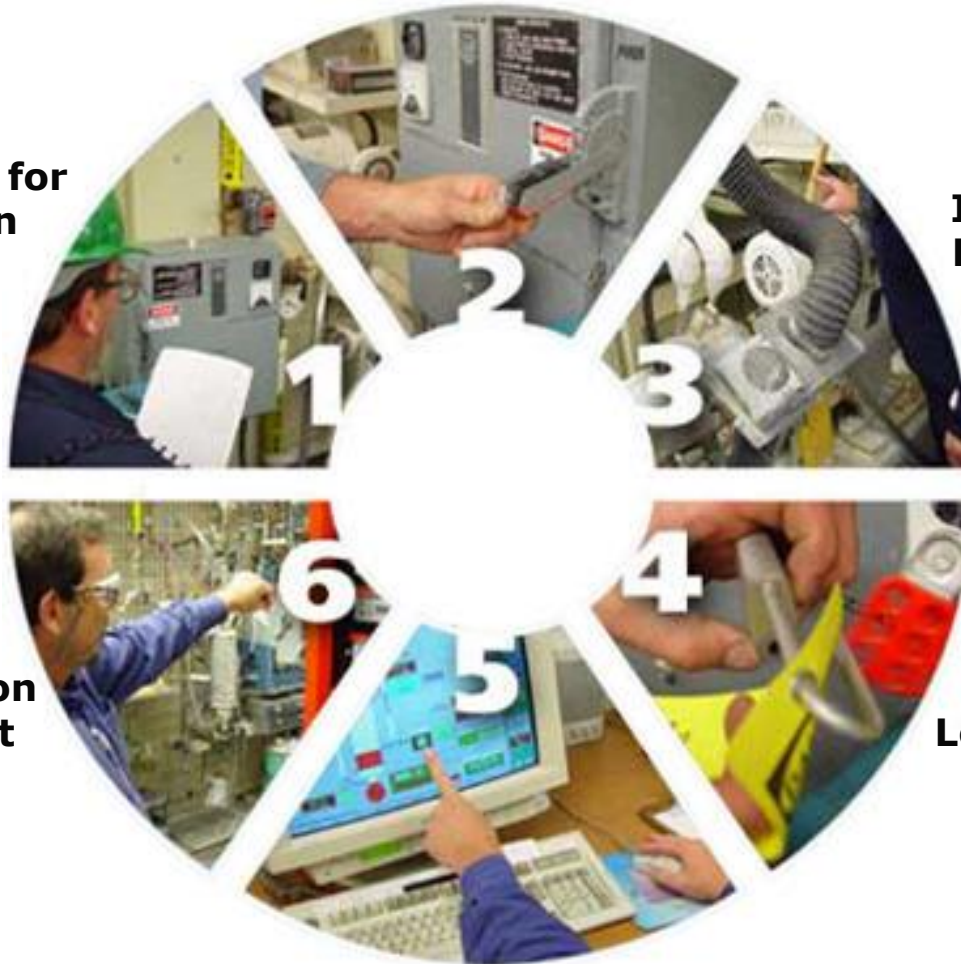
Prepare for Isolation

Isolate the Equipment

Apply Lockout/Tagout Devices

Verify Isolation of Equipment and Return to Service

Control Stored Energy



Isolation of Hazardous Energy

Preparing for Isolation

Authorization

- Isolation work shall only be performed after the equipment owner (typically Operations) has authorized the isolation.

General Work Permit

- A Permit to Work shall be required for the Isolation of Hazardous Energy except for the following conditions:
 - a. Servicing or maintenance of cord and plug connected electrical equipment when the energization or start up of equipment is controlled by unplugging and the power is under the exclusive control at all times of personnel performing the work.
 - b. Isolation of Process and Production Equipment that is described in a Qualified Standard Operating Procedure or simple isolations described by a Maintenance Procedure.
 - c. Normal production operations (e.g., minor adjustments or servicing) under the following conditions:
 - A guard or other safety device is not bypassed, altered or removed.
 - Personnel are not required to put any part of their body into a machine or equipment to perform work at a point of operation or in a designated zone of danger around machinery.
 - A JSA or equivalent shall be conducted at the work site in accordance with the Hazard Analysis Standard prior to work involving the Isolation of Hazardous Energy unless exempted by scenarios above.



Isolation of Hazardous Energy

Shutting Down the Equipment

Equipment Preparation

- The facility operating personnel must prepare equipment before any isolation tasks are performed. Preparation work may include, but is not limited to:
 - Emptying, flushing or purging any equipment, pipelines or vessels of any noxious, toxic, or flammable liquid or vapors in a controlled manner.
 - Depressurizing and draining process equipment.
 - Ensuring that affected personnel are made aware of the changed status of the equipment
 - Where possible, arranging other work tasks to minimize the amount of other work being performed in the vicinity of the isolation work
 - Conducting gas tests as required by the Work Authorization Standard and in accordance with the Portable Gas Detection Standard.



Isolation of Hazardous Energy

Isolating the Equipment

Isolation Diagrams are piping, electrical, etc. drawings depicting the system that will need to be isolated including the isolation points (valves, switches, etc.). They are helpful in determining where to isolate the system, especially when the system is complex or when there are many isolation points.

An Isolation Diagram is required with the exception of the following conditions:

- The equipment consists of ten or fewer isolation points within the direct line of sight where the work is being performed (with the exception of a single electrical isolation point) and
- the equipment has fewer than three electrical isolation points.

Note: Isolation Diagrams are required for all Confined Space and Hot Work activities on process piping & equipment involving isolation of hazardous energy.

Electrical Isolation - All electrical work shall be carried out in accordance with the Chevron Electrical Safe Work Standard and local regulatory requirements. Electrical isolation shall only be carried out by a competent and qualified Electrician, except for the following which may be carried out by appropriately trained personnel:

- Tripping of circuit breakers on low (<600 volts) voltage circuits as long as there are no exposed electrical contacts greater than 50 volts.
- Isolation of circuits not exceeding 50 volts dc or ac (rms) as long as there are no exposed electrical contacts greater than 50 volts.

Exceptions are valid only if the protection (shield/barrier within the panel, etc.) offered by the equipment will adequately protect the worker from both electric shock and arc flash. Some guarding that intends to separate the worker from electrical contacts (i.e. some plexiglass barriers) will protect the worker from shock hazard but may not protect against arc flash hazards.



Isolation of Hazardous Energy

Applying Lockout/Tagout Devices

- It is not enough to simply isolate the hazardous energy and to de-energize the equipment or system. In addition, the hazardous energy must be prevented from unexpectedly becoming re-energized. This is achieved through locking and tagging out of the isolated parts of the equipment/system.
- Prior to start of any operational, construction or maintenance work that may expose personnel, equipment or the environment to hazardous energy or toxic substances, all equipment controls (such as electrical switches, valves, motor controllers, etc.) that could introduce energy, product, toxic materials, or other hazard into the work area shall be locked and tagged out of service. This may require controlling one or several hazardous energy sources. Lockout devices shall ensure that the isolations are in a safe or off position that prevents energizing of machine or equipment.



Isolation of Hazardous Energy

Applying Lockout/Tagout Devices – LOTO Locks and Tags

- The person in charge (Supervisor) shall ensure that all relevant personnel involved in work requiring isolation have an appropriate number of personal locks.
 - Electrical and Maintenance personnel must have personal, individually keyed locks.
 - Operations personnel can have individually keyed locks, or alternatively can have locks that are keyed alike and shared by the Operators in a department. This alternative requires a work instruction detailing the management of locks and keys for Operations, the turnover process (shift to shift, and Operator to Operator). The turnover must be documented. All department personnel must be trained on the work instruction and turnover process.
- Locks used for hazardous energy isolation should be standardized at each facility and should be used only for hazardous energy isolation.
- Locks must withstand their environment for the maximum period of time that exposure is expected.
- Locks must be strong enough to prevent removal without using excessive force or unusual techniques
- Tags shall be of a suitably durable material for the environment in which they are used. Tags must contain at least the minimum information specified in. Tags must be legibly signed and dated by the installer of the tag. The tags must be securely fastened to all isolation points using the shackle of the lock or a self-locking nylon cable tie. Color coding for craft to align with tag colors unless coding conflicts with Local/Regional Regulatory guidelines:
 - Operations – Yellow
 - Electrician – Red
 - Maintenance/Mechanic – Blue



Isolation of Hazardous Energy

Controlling of the Stored Energy

Anyone (employee and contractor) working on equipment requiring isolation shall install his or her own lock at each isolation point.

Locks should be fitted in the following order:

- The facility operating personnel will ensure that their locks and tags are installed first and the last to be removed.
- The electrical personnel will ensure that their locks and tags are installed next (if needed), after ensuring that the operations personnel have installed their locks and tags.
- The maintenance personnel involved in non-electrical work will ensure that their locks and tags are installed last, after ensuring that the operations and electrical personnel (as appropriate) have fitted their locks and tags.

If contractors are involved in work that requires isolation of hazardous energy:

- Contractors must be informed of facility isolation procedures, including permit procedures, and must conform to all such requirements.
- Contractors will supply their own locks and tags that conform to Chevron requirements.



Isolation of Hazardous Energy

Verification of Isolation and Returning to Service

After locking and tagging out is complete:

- Test equipment to ensure that it will not start while work is being performed (Zero Energy State).
- Test must be done by the person that will do the work.
- Facility operating personnel must witness the test.
- If the electrical, maintenance, or contractor personnel will perform the work, they must:
 - Ensure all necessary Work Permits are in place.
 - Check all operating controls are locked and tagged.
 - Ensure the equipment is tested.

The facility operating personnel will ensure that their locks and tags are installed first and the last to be removed.



Isolation of Hazardous Energy

Equipment Isolation Checklist

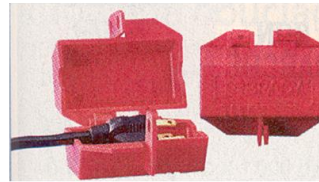
- An Equipment Isolation Checklist (EIC) shall be used in conjunction with a Permit to Work in accordance with the Work Authorization Standard.
- The EIC is used to track and document the status of individual isolation points.
 - The Operator in charge of initial lock out of the equipment will identify each of the isolation points necessary to protect the workers and record them on the EIC.
 - The Operator will sign and date next to each isolation point on the EIC when they apply their lock and tag.
 - Each person working on the equipment or may otherwise be in harm's way will also sign and date when they apply their locks and tags. This applies to both employees and contractors.
- The equipment isolation checklist must be maintained with the Permit to Work at the work site.
- When the locks and tags are removed, the workers and Operator will sign and date that they have removed their locks and tags next to each isolation point on the EIC.
- The EIC will be retained with the Permit package

Equipment Isolation Checklist (EIC)																		GENERAL WORK PERMIT #							
Equipment Number: _____																		Description of Work: _____							
Job Site Location: _____																									
LOCKOUT/TAGOUT		Operations				Electricians				Electricians				Maintenance				Maintenance				Maintenance			
		Installed	Removed	Installed	Removed	Installed	Removed	Installed	Removed	Installed	Removed	Installed	Removed	Installed	Removed	Installed	Removed	Installed	Removed						
Item #	Equipment Isolation Point	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date	Initial	Date
1																									
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BLEEDER VALVES		Bleeder Opened				Bleeder Closed				Verified Closed				Comments											
	Bleeder Valve Location Point	Tagged	Initials	Date				Initials	Date			Initials	Date												
1																									
2																									
3																									
4																									
5																									
Blinds MUST BE INSTALLED FIRST FLANGE OFF of Equipment - Exposed Area MUST BE WIPED FREE OF HYDROCARBON Prior To Any Hot Work																									
BLINDING		Blind Installed				Blind Removed				Blind Removal Verified				Comments											
	Blind Location Point	Tag #	Initials	Date				Initials	Date			Initials	Date												
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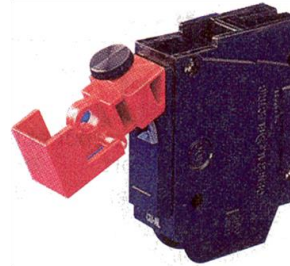
Lock Out Tools

There are a variety of tools to aid in the lock out of equipment in Chevron facilities. Safety catalogues are a good resource.



To lock an outlet

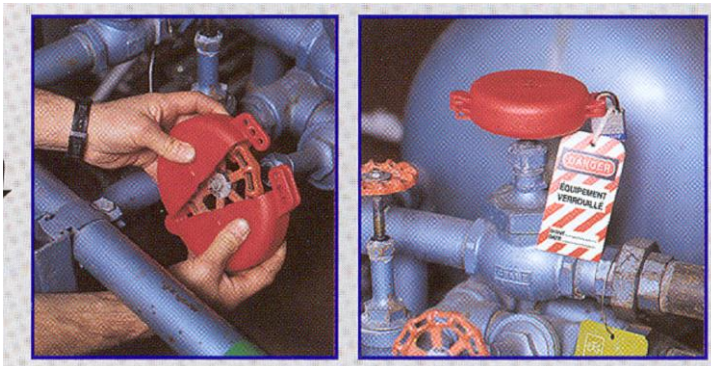
To lock a bigger outlet



To lock a power switch



To lock a circuit breaker



Lock Hasps

A lock hasp (sometimes called a multi-lock device) may be used when multiple locks are necessary. Where a lock hasp is used, it is important that the last hole is not used to add a lock. This provides room for an additional lock hasp to be inserted so more locks can be added later, if required (for example, a 6-hole hasp is only good for five locks plus an additional hasp, not six locks).



Lock Box

Lock Box: Where one primary lock is applied to each isolation point requiring a lock, and the key to the locks is placed inside a lock box. Each worker applies their own lock to the lock box, sealing the primary key inside.

- The Supervisor or Lead Operator will place the single-key lock(s) (primary locks) on each isolation point and place the key to the primary isolation locks in the lockbox.
- The responsible Operator will then place his/her Operator lock on the outside of the lock box.
- An Authorized Person (AP) must be identified each shift for each craft involved in the work (this role cannot be filled by a Permit Issuer).
- The AP must place a Group Lock/Craft Lock or comparable mechanism on the isolated system for the duration of the craft's activities.
- A documented process must be established to transition the role of the AP from shift to shift (e.g., signing as the Permit Holder onto the shift permit).
- Each individual working on the isolated system must utilize a personal lock that is placed on the outside of the lock box prior to starting work.
- When the work on the equipment is complete from the specific craft's perspective, the AP may remove the Group Lock / Craft Lock from the lock box (e.g., machinist's work is complete or the electrician has returned electrical supply to the equipment).



Lock Removal

- Once installed, the locks and tags must only be removed by the persons who installed them or the new documented key holder (in the case of some Operations personnel depending on the facility's written process).
- In exceptional circumstances, someone else may be required to remove a lock, but this may only be authorized by the person in charge and must follow the specific guidelines below.

Step	Action
1.	Make a reasonable and thorough attempt to locate the worker, such as making contact via his or her work telephone and mobile phone. If the worker is a contractor, request that the contracting company contact the worker.
2.	Inform all relevant personnel that the removal of the lock is being undertaken and specify what the lock was isolating and who had fitted the lock.
3.	Evaluate if it is safe to reenergize the equipment by performing all of the following: <ul style="list-style-type: none">• Check the area thoroughly to ensure all equipment has been reassembled correctly.• Ensure all connections to the equipment have been remade.• Remove any tools or equipment from the area. Note: This may require the assistance of a competent person.
4.	Clear the area of all personnel and tools.
5.	Remove the lockout and/or tagout devices.
6.	Re-start the equipment if necessary.
7.	If and when the worker returns and before any further work is performed, notify him or her that the lock and/or tag have been removed.



Isolation of Hazardous Energy

Lock Removal and Where Lock Out is Not Possible

- Lock and tag removal must be carried out in the reverse order to the fitting of the locks and tags, as follows:
 - The maintenance personnel (employee or contractor) remove their locks and tags.
 - The electrical personnel (employee or contractor) remove their locks and tags.
 - The facility operating personnel remove their locks and tags.
- Lock and Tag Removal Documentation
 - As the locks and tags are removed by each person who placed them, each person will initial and date the Equipment Isolation Checklist on each line corresponding to the isolation point.
- For isolation points where it is not physically possible to fit a lock, consideration shall be given to moving further back in the system to identify a point where the system can be locked out. For example, if a pipeline leading to a filter cannot be locked out at the filter, competent personnel shall consider if it is possible to apply a lock to a valve further down the pipeline, or, if a switch cannot be locked out, if the switch can be opened and the entire electrical panel door locked out.
- Where it is determined that it is not possible to apply a lock, it may be acceptable to fit only a tag, provided that additional measures are taken to ensure that the tagged item is not inadvertently operated. The amount of additional measures that are required shall be determined by a hazard assessment and an assessment of the degree of harm that may occur if the equipment is operated. At a minimum, all personnel working in the area of the tagged equipment must be briefed on the reason why the item is tagged out and the implications of operating the equipment.



Isolation of Hazardous Energy

Positive Physical Isolation

Positive Physical Isolation (also known as Positive Isolation) is an isolation where there is zero potential of an energy release. The equipment is positively separated from the hazardous energy and toxic substance using one of the following methods:

- removal of a section (spool) of piping;
- physical removal of a circuit breaker and grounding the system, disconnection of electrical wires, etc.;
- removal of mechanical couplings;
- or blinding.

A double block and bleed arrangement is Not considered Positive Physical Isolation

Positive Physical Isolation is required for:

- All confined space entry
- Hot work on process piping or equipment (with the exception of steam/air/water systems less than 150 psi)
- Work on systems:
 - Containing flammable materials
 - Containing materials above their auto-ignition temperature
 - Containing toxic materials
 - With greater than 150 psi
 - With greater than 150 degrees F (65.6°C)
 - Isolated for more than 6 months.



Contractors

If contractors are involved in work that requires isolation of hazardous energy:

- Contractors must be informed of facility isolation procedures, including permit procedures, and must conform to all such requirements.
- Contractors will supply their own locks and tags that conform to Chevron requirements.



Troubleshooting and Changeovers

If equipment must be placed back in an operating condition in order to identify problems (troubleshooting) or to test or position such equipment (i.e. packaging changeovers), such work may proceed provided that equipment-specific written procedures for troubleshooting are developed by competent personnel to control the sequence of the actions to be taken. The specific procedures must be attached to the Work Permit.

- The procedures for temporary removal of locks or tags and reenergizing machinery or equipment must provide maximum safety coverage for employees when the equipment or machinery must be energized during the course of servicing.
 - All affected parties are notified of the change in isolation state.
 - Changed isolation points are tracked to ensure they are returned to the isolated state after completion of the required work/tests.
 - The Hazard Analysis must consider potential exposures to hazardous energy associated with this activity.
 - Tools and equipment are removed from any areas that may involve moving parts.
 - All affected parties are notified when the equipment has been re-isolated.



Troubleshooting and Changeovers

The following sequence must be followed when testing or repositioning a machine or piece of equipment:

1. Clear the machines or equipment of tools and materials.
2. Remove employees from the machine or equipment area.
3. Remove the lockout or tagout devices as specified.
4. Energize and proceed with testing or positioning.
5. De-energize all systems, isolate the machine or equipment from the energy source and reapply the lockout or tagout devices as specified prior to effecting further repairs, adjustments or maintenance. The removal of lockout or tagout devices and the reenergizing of equipment shall be permitted only during the time necessary for the testing or positioning of the machine, equipment, or component, and only when reenergizing is essential to accomplishing the servicing task.



Work Completion

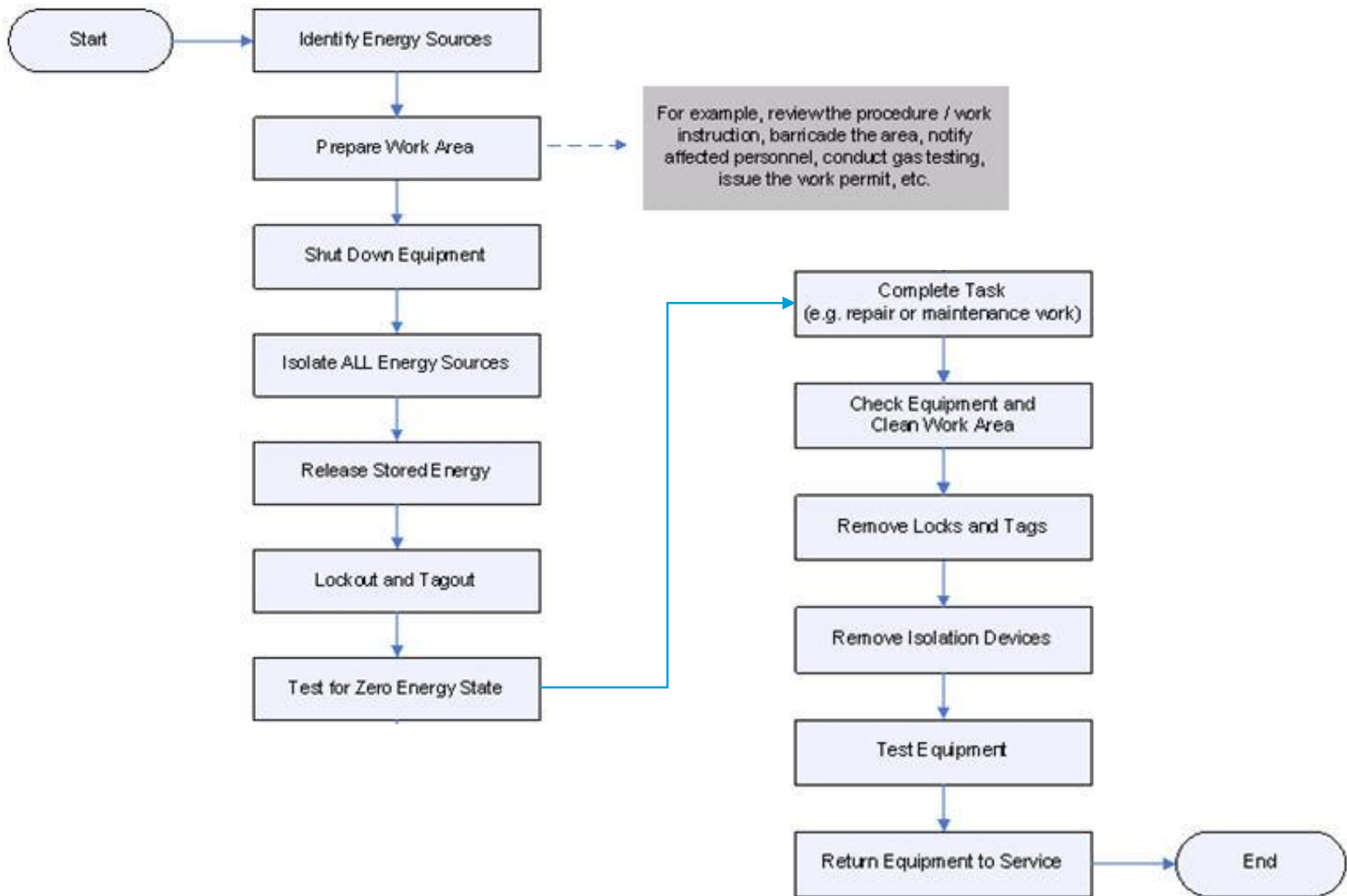
Prior to returning equipment to service, an inspection shall be carried out that includes, but is not limited to the following isolation specific checks:

- Equipment guards and covers have been re-installed.
- Fastenings (such as flange bolts) have been reinstated and proper torque has been applied.
- Seals, connections, or flanges of equipment do not leak.
- Work tools have been removed from the work area.
- Isolation blanks or blinds have been removed
- Operational valves have been correctly set (either open or closed, as appropriate).

- When the work has been completed per the job scope, the Permit Holder returns the permit and related documents to the responsible Permit Issuer. The Permit Issuer will review the job site to ensure the following conditions have been met:
 - The job site has been left in a safe, clean and orderly condition.
 - The work performed meets the scope and specifications.
 - If the above conditions have been met, the Permit Issuer or designee must sign and date the General Work Permit to signify completion.
- Communication must be made to inform affected personnel and other impacted work crews that equipment is ready to put back in service.
- Reenergizing equipment must be done with caution. It may be necessary to have Maintenance personnel on hand to witness the start up of equipment to ensure that there are no problems.



Isolation Flowchart



Summary

All documents will be retained in accordance with the Chevron's Retention Schedule and as required by local regulations. At a minimum, records will be kept for the periods specified below:

- Where a Work Permit is not used in association with an Isolation task, the Equipment Isolation Checklist shall be retained for 1 year after the return to service of the equipment or until an audit has been conducted.
- Equipment Isolation Checklist shall be retained with the Work Permit documents that the Isolation task was associated with for such retention periods as defined in the General Work Permit Standard.

You should now be able to:

- Understand the principles of energy isolation – Lockout/Tagout (LOTO)
- Understand the steps required to isolate energy, to ensure the safety of workers and equipment
- Understand the precautions required to re-energize equipment

Effective Lockout/Tagout takes awareness and participation on everyone's part. Remember, this basic process of Lockout/Tagout also applies at home. Working smart is just as important at home as it is in the workplace.

