Loss of control of hydraulic energy

This initiating event relates to the failure to control hydraulic energy while installing, commissioning/decommissioning, operating, maintaining, accessing and/or testing equipment, plant and infrastructure.

Here, hydraulic energy refers to fluids with a range of viscosities above or below atmospheric pressure - which could be due to mechanical (e.g. hydraulic pump), gravitational (e.g. reservoir release), or suction force (e.g. pump suction, vacuum). Potential energy associated with fluid reservoirs - dams, elevated water tanks, column pressure, accumulators – is considered in this initiating event. Fluids may be water-oil-based, or synthetic; and include water, oils, fuels, solubles, solvents, emulsions, paints, paint thinners, and greases, etc..

The failure to control hydraulic energy means that unplanned pressurised fluid energy is released. There are four key isolation steps: (1) identification, (2) operation, (3) verification, and (4) securing the device. Control of stored energy is implied in each of the four isolation steps.

Outcomes may include injuries or death as a result of: planned or unplanned fluid release, unplanned movement of equipment (e.g. mobile and or field equipment) and components (e.g. hoses, pipes), catastrophic failure of components, pressure intensification (over pressurisation), reservoir release (e.g. gravitationally generated), projectiles, fluid injection etc.. Other outcomes may include asset damage, production loss, environmental harm and reputational damage.

Scope includes the life cycle of the asset (design and selection, installation and commissioning, operation and maintenance, modification, decommissioning and disposal).

The information in this initiating event does not address:

- The chemical properties (i.e. corrosive properties) or toxicity of fluid (e.g. burns etc.), see RISKGATE Chemicals topic
- Flammability risks of fluids, see RISKGATE Fire topic
- Inrush and inundation events (e.g. from old workings, open cuts, etc.), see RISKGATE Inrush topic
- Pneumatic pressure, see RISKGATE Isolation topic Pneumatic Energy
- Steam, see RISKGATE Isolation topic Radiating Energy
- Solids or gases
CAUSE Equipment not designed and built to industry/community standards

PRE CONTROL Risk assessment (RA) prior to bringing anything new onto site

- Conduct an overall RA prior to developing the design and specifications
- Consider broader standards within the community (e.g. common industrial practice, municipal, international, national standards from other countries, if relevant)
- Generate a functional specification describing what the equipment needs to do
- Conduct a second more detailed RA at the final design stage (e.g. RAMBO analysis: Reliability, Accessibility, Maintainability, Buildability, Operability)
- Include a broad cross section of the workforce in the RA (including users of the equipment/isolation)
- Confirm new machinery aligns with site’s competency/authorisation/familiarisation process or alter these accordingly (i.e. introduction to site standard or approval process, etc.)

Was this Cause useful?

CAUSE No visual indicators of energy state (present/not present)

PRE CONTROL Design equipment to enable isolation in conformance with industry/community standards

PRE CONTROL Visual indication of energy state to be included in the equipment design

- Physical separation of energy sources (e.g. ability to disconnect hoses, etc.)
- Include hydraulic pressure gauges before and after the isolation point (e.g. needle deflection gauge)
- Preference given to mechanical representation of energy state as digital indicators are more likely to misrepresent energy state (Note, if digital gauge used confirm compliance with functional safety standards)
- Secondary pressure gauges may be required in some applications to provide redundancy or verification
- Provision for use of testing apparatus (e.g. test point provided to allow use of portable pressure gauge) – confirm compatibility with available tooling
- Easily accessible test points
- Confirm visual indicator can be viewed externally

PRE CONTROL Design visual indicators to account for environmental factors (e.g. weather conditions, light conditions)
Confirm workplace ergonomics/lighting facilitates easy reading of isolation labelling
Safe access to view the visual indicators of energy state (consider proximity to other hazards)
Durability of visual indicators relative to environmental and operational conditions (e.g. location, guarding, etc.)

Was this Cause useful?

CAUSE Energy level (pressure) is not labelled or is incorrectly labelled
PRE CONTROL Equipment labelling is compliant with relevant industry/community standards for occupational health and safety signs
  - Australian standards (e.g. valve, MDG41, AS1319 etc.)
  - Australian standard for piped installations (colour coding for contents/pressures, ratings of hoses/sheathing, arrows, signage)
  - Legislation (e.g. Coal Mining Safety and Health Act and regulations, QLD Mines & Quarries Safety and Health Act)
  - Note. State mining legislation may have other standards/guidelines - codes of practice (NSW)
PRE CONTROL Develop a site/business/group unit specification that is compliant with the standards of equipment labelling, especially isolation and apply systematically to all assets
  - Asset numbering
  - Descriptive/distinctive labelling (that incorporates a variety of coding methods – alphanumeric, colour, different sizes etc)
  - Consistent placement/location (allowing for ready access to labelling)
  - Durability of labelling (e.g. adhesion/fade etc.)
  - Consider human factors (e.g. dyslexia, literacy)
  - As-built drawings/plans need to reflect end-user asset numbering/labels
PRE CONTROL Design labels to account for environmental factors (e.g. weather conditions, light conditions)
  - Confirm workplace ergonomics/lighting facilitates easy reading of energy level labelling
  - Safe access to view the energy level labels (consider proximity to other hazards)
  - Durability of energy level labels relative to environmental and operational conditions
  - Use of durable label fixing devices (i.e. cannot be easily removed without matching tool – not cable ties)
PRE CONTROL Selection of appropriate scale gauge to align with expected system pressures

- Match the gauge to system pressure and work application
- Up to date documentation and schematic drawings
- Identification and availability of critical components (i.e. ability to maintain or replace indicator)
- Awareness, training, competency of personnel

Was this Cause useful?

CAUSE Non-distinctive asset labelling system (e.g. asset codes differ by only one digit)

PRE CONTROL Establish an asset labelling system

- Standardise the asset labelling system (ID numbers/codes) across the company ensuring the same scheme is used across different sites/units etc
- Database for tracking assets and isolation components throughout plant lifecycle, linking asset number to work management systems, operating procedures, isolating procedures, sub-assets, permit to work systems, training systems, etc
- Asset labelling system to be consistent with, or linked to the OEM numbering (serial number)

Was this Cause useful?

CAUSE The layout of isolation points is confusing or ambiguous (e.g. multiple operating isolation points on the same panel and not clearly marked)

PRE CONTROL Design the panel layout for intuitive use

- Isolation process to be logical/clear/intuitive
- Consistent placement of labels next to apparatus
- Develop a conceptual diagram/map that mimics the layout of complex panels
- Ergonomic design allows easy access to isolation mechanisms
- Minimise the level of complexity (of panel layout) for the end-user
- Include drawings/operational procedures in permit to work system and work instructions

PRE CONTROL Develop a process to identify incidents where failure occurs

Capture failures in an incident management system and assign actions to rectify and prevent recurrence (e.g. identify problems that may be common to certain component/brand)
Circulate information within industry – share lessons learned
Update isolation procedures relative to above
Design of an incident management system to capture/identify isolation issues

Was this Cause useful?

OPERATION: Design/Procurement

CAUSE Isolation device not designed to cater for operational or maintenance user requirements

PRE CONTROL Design systems to limit the requirement of isolation for specific tasks (e.g. inspection, condition monitoring etc.)

- Hydraulic test point (e.g. KISS systems)
- Level indication, contained reservoir inspection windows
- Differential pressure gauges (either side of isolation point; across filters)
- User accessible resets – controls external to panels
- Segregation and barriers to allow routine maintenance without exposure to hydraulic energy
- Remote diagnostic terminals
- Remote diagnostics (e.g. control room system based confirmatory checks; load centres or transformers on longwall; roof support/chock control systems)

PRE CONTROL Equipment design considerations for operating the isolation device

- Consider isolation to a mining standard as a fundamental part of the design process
- Where practical equipment to have a local - isolation device (e.g. main line valve, main pressure isolation valve)
- Ergonomics/workplace layout (access and lighting) to facilitate easy access to isolation device
- Clearly label/identify isolation device
- Facilities provided for remote operation of pressure valves and containment while operating isolator (valve pressure design adequate to manage system pressure, operating under pressure and flow)
- Isolation device is lockable
- Confirm isolation device supplied matches original equipment manufacturer’s (OEM’s) specifications (e.g. not a different model or version)
- Device to be usable within mine operating procedures to facilitate local mine practices and standards
Consider practical implications of valve location to minimise outages or to provide ability to isolate specific sections or components of the asset. Isolation process to be considered during design to reduce complexity (i.e. minimise number of steps and manage sequential operation by interlocking etc.).

Ingress protection rating (e.g. contaminants; include materials suitable to corrosive fluids) appropriate for installation location (weathering).

Position of isolation device to be intuitive and to clearly identify status of isolation valve.

Inadvertent exposure to uncontrolled pressure to be prevented by isolation interlock – where practical (e.g. utilise pilot control/circuit for main valve operation; isolation key interlock system).

Minimise inadvertent contact during normal operation by using barriers or segregation guards (e.g. kevlar sheathing on hoses; heat shrink; hose socks for coupling/staple failure).

Confirm appropriate functional system design ratings (safety factors for hose/pipe/etc.).

Fit for purpose isolation device (Note, consider duty cycle including frequency and use of isolation point and rated capacity of isolation point).

**PRE CONTROL** Equipment designed to industry/community standards.

Ingress protection (e.g. contaminants; include materials suitable to corrosive fluids).

Adequate mechanical leverage and/or actuator to safely operate isolation valve.

Interlocking (including functional access controls; prevent access until the system is safe).

Mine safety legislation (e.g. MDG 41, AS2671/3791/4024 etc.).

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**VERIFICATION:** Design/Procurement

**CAUSE** Verification devices non-existent or not designed to cater for operational or maintenance user’s requirements.

**PRE CONTROL** Equipment design considerations for verifying isolation.

Risk assessment to select type of verification device/method appropriate to user application.

Close proximity of verification device/feature to asset requiring isolation.

Clear visible hose run between isolation and verification devices, with identification on each end.

Fail to safe indication and/or self-test facility with inbuilt redundancy/high reliability (e.g. secondary gauge; electronic monitoring – pressure).
transducers; cross-checking between mechanical gauges and electronic instrumentation)

Safe release of system pressure as a design feature in verification devices

Diagram or picture (i.e. local to the verification device/feature) illustrating the status/method of use of verification device

Design verification test points to be readily and safely accessible

Design suitable storage for portable verification devices

Ergonomics/workplace lighting in panel to facilitate easy reading of the verification point

Verification method should take into account possibility of multiple supplies/stored pressures/alternative supplies and their impact on the system

System to be designed to accommodate electronic aids to verify correct isolation (e.g. barcode readers and personal digital assistants [PDAs])

Verification equipment designed to operate in total power outage (e.g. mechanical gauges)

Standardisation or consistency in verification methods and labelling across sites

Provision for facility to challenge test verification devices/features (i.e. test points for portable gauges)

Physical disconnection of hosing – visible means of isolation to decommission system

PRE CONTROL Industry/community standards

PRE CONTROL A high potential incidents (HPI) reporting system

Capture failures in an incident management system and assign actions to rectify and prevent recurrence (e.g. identify problems with a particular component/brand)

Circulate information within industry – share lessons learned

Design of a site incident management system to capture/identify isolation verification issues (i.e. both HPI and non-reportable incidents)

Web based safety alert systems that can be searched and cross linked to a site incident management system - within the mining sector and across hydraulics specialists

Was this Cause useful?

CAUSE Test point not available for verification

PRE CONTROL Design considerations for inclusion of test points at critical points

Was this Cause useful?
SECURING: Design/Procurement

CAUSE Equipment not able to be effectively secured (in the isolated position)

PRE CONTROL Equipment design considerations

- Risk assessment for selection of lockout devices relative to intended use
- Facility for padlocking, securing of padlock – confirm sufficiently robust
- Fit for purpose lock out facility – to allow lock to be fitted AND the mechanism to be held in the isolated position when lock is applied, accommodate suitable number of locks (e.g. scissor lock to always ensure one lock position available)
- Inability to circumvent the locking mechanism (e.g. isolation handle captive to isolation device)
- Use isolation valve with facility for safe controlled venting of system pressure, and to prevent repressurisation
- Design to prevent inadvertent lock on position (e.g. isolation locking point to line up with off position and be intuitive (e.g. off = out of line; on = in line; splined or keyed interlock of handle to valve)
- Place isolation securing device as close to equipment as possible and confirm that isolation point is close to the work
- Consider location of isolator point with regard to maintaining access to valves for operation or maintenance

Was this Cause useful?

IDENTIFICATION: Installation/Commissioning

CAUSE Incorrect or lack of information (drawings/schematics/documents) during factory acceptance (off-site)

PRE CONTROL Factory acceptance testing

- Review asset prior to taking delivery (users to be involved; test procedures)
- Request asset test results and documentation prior to site delivery
- Update construction/installation/commissioning information to reflect as-built equipment

PRE CONTROL Equipment specification

- Detailed equipment specification is to be issued for design/supply
- As-built drawings to be provided prior to handover
  Where appropriate, drawings to be provided in an editable format (i.e. not .pdf) to allow easy update of on-site drawings (Note, for equipment alterations that do not compromise safety)
PRE CONTROL Document control system (i.e. a formal document management system)

- Site specific block of drawing numbers integrated into site maintenance systems
- Change management process (including a sign-off by authorised personnel) for new and revised drawings
- Provision of hard copy/soft copy drawings on equipment that is easy to access and kept clean; accompanied by on-site storage of drawings
- Confirm out-dated drawings/revisions are replaced

**Was this Cause useful?**

**CAUSE** Original equipment manufacturers’ (OEMs) modifications made and not captured (including hardware, software, code, version control)

PRE CONTROL Change management process for changes made during the commissioning/installation process

- Version control – modifications made to software systems (e.g. codes, comments, work order links)
- Revision control – modifications made to documentation systems with history (link to work order)
- Communicate changes to operators
- Monitor technical alerts/OEM faults and upgrades (e.g. using safety alert management systems)
- Confirm authorisation occurs (e.g. sign-off authorities) prior to actioning of change
- Risk management process to address changes from original design

**Was this Cause useful?**

**CAUSE** Ineffective commissioning procedure

PRE CONTROL Commissioning procedure

- Develop a commissioning plan that establishes the framework for how commissioning will take place (e.g. roles, responsibilities and accountabilities during commissioning)
- Develop a commissioning schedule - take enough time (esp. if pressured to get asset working)
- Undertake hydraulic commissioning in consultation with other disciplines to prevent interaction issues that may present dangers to personnel and equipment – need for cross-disciplinary plans
Develop and use detailed commissioning check sheets (inspection and test plan [ITP]) to confirm that isolation device/procedure, labelling etc is installed correctly and functional

Audit/quality control/assurance of installation: confirm that the equipment meets the design specification

Competent workers and procedures to manage the process (personnel who have an awareness of equipment and procedures and who can identify potential isolation inadequacies early)

Clear process for identifying in-service/under-commission isolation requirements for equipment – including notification of personnel

Reference the change management process

Was this Cause useful?

OPERATION: Installation/Commissioning

CAUSE Incorrect or lack of as-built drawings for installation and commissioning of operating device at site

PRE CONTROL Factory acceptance testing

Review asset prior to taking delivery (Note, users to be involved in review process)

Update construction drawings to reflect as-built

PRE CONTROL Equipment specification

Detailed equipment specification to be issued for design/supply

As-built drawings to be provided prior to handover

Where appropriate, drawings to be provided in an editable format (i.e. not .pdf) to allow easy update of on-site drawings (Note, for changes to equipment that do not compromise safety)

PRE CONTROL Document control system (i.e. formal document management system)

Site specific block of drawing numbers that are integrated into site maintenance systems

Change management process (with sign-off authorities) for new and revised drawings

Provision of hard copy/soft copy drawings on equipment that are easy to access and kept clean; accompanied by on-site storage of drawings

Confirm out-dated drawings/revisions are replaced

PRE CONTROL On-site testing of asset when integrated into site

Include original equipment manufacturer’s (OEM’s) expertise in site-based testing
Test hydraulics during commissioning to confirm compliance with design and performance criteria

Was this Cause useful?

CAUSE Modifications made and not captured at site (including hardware, software, code, version control)

PRE CONTROL Change management process for changes made during the commissioning/installation process
- Risk management process for modifications to original design made at site
- Version control – modifications made to software systems (e.g. codes, comments, work order links)
- Revision control – modifications made to documentation systems with history (e.g. link to work order)
- Document control (Note, refer to drawing updates, etc.)
- Communicate changes to installers
- Monitor technical alerts/OEM faults and upgrades (use safety alert management systems)
- Confirm authorisation occurs (e.g. sign-off authorities), prior to actioning of change

Was this Cause useful?

CAUSE Incorrect installation of the isolation device preventing effective energy control

PRE CONTROL Installation process
- Confirm correct installation tools and technique used (e.g. fit for purpose (FFP) equipment, consult with manufacturer for specified tools)
- Current documentation (e.g. as-built drawings, hosing schedules, piping and instrumentation diagrams (P&ID)/schematics, single line diagrams, manuals)
- Correct parts (e.g. staples, hose socks, correct hardware for application)
- Competent staff and procedures to manage the process (e.g. familiarisation of equipment use, awareness and competencies in the isolation procedures, work under project direction of person competent in hydraulics systems)

PRE CONTROL Commissioning process to check integrity of installation
- Develop a commissioning plan that establishes the framework for how commissioning will take place (e.g. roles, responsibilities and accountabilities during commissioning)
Develop a commissioning schedule - take enough time (especially if pressure to get asset working)

Need for cross-disciplinary plans and coordination (e.g. test safety interlocks prior to hydraulics commissioning to prevent interaction issues that may be hazardous to personnel and equipment)

Develop and use detailed commissioning check sheets (inspection and test plan [ITP]) to confirm that that isolation device/procedures, labelling, guarding, barriers, interlocks are installed correctly and functional; applies to new and used equipment

Audit/quality control/assurance of installation: confirm that the equipment meets the design specification

Competent workers and procedures to manage the process (personnel who have an awareness of equipment and procedures and who can identify potential isolation inadequacies early)

Clear process for identifying in-service/under-commission isolation requirements for equipment – including notification of personnel

PRE CONTROL Isolation processes during commissioning phase

Pre-installation/pre-commission risk assessment /job safety analysis (JSA) identifying isolation requirements and equipment commissioning plan

Clearly communicate daily work plan – including isolation and commissioning requirements for the day

Increased level of supervision and inspection of isolation process during commissioning

Demarcation of areas under test (e.g. apply access permits to commissioning areas)

Training in isolation procedures

Appropriate locks and tags to be available for personnel

VERIFICATION: Installation/Commissioning

CAUSE Incorrect or lack of as-built drawings for verification of isolation device

PRE CONTROL Factory acceptance testing

Review asset prior to taking delivery (Note, end users to be involved)

Update construction drawings to reflect as-built

PRE CONTROL Equipment specification

Detailed equipment specification to be issued for design/supply

As-built drawings to be provided prior to handover
Where appropriate, drawings to be provided in an editable format (i.e. not .pdf) to allow on-site drawings to be easily updated (Note, for changes to equipment that do not compromise safety)

PRE CONTROL Document control system (i.e. formal document management system)
- Site specific block of drawing numbers integrated into site maintenance systems
- Change management process (including sign-off authorities) for new and revised drawings
- Provision of hard copy/soft copy drawings on equipment that is easy access and kept clean; accompanied by on site storage of drawings
- Confirm old drawings/revisions are replaced

Was this Cause useful?

CAUSE Modifications made to isolation device and not captured (including hardware, software, code, version control) – both site and original equipment manufacturer’s (OEM’s) modifications

PRE CONTROL Change management process
- Risk management process
- Version control – modifications made to software systems (codes, comments, work order links)
- Revision control – modifications made to documentation systems with history (link to work order)
- Documentation control – [see previous section]
- Communicate changes to installers and OEM for design and warranty considerations
- Monitor technical alerts / OEM faults and upgrades – safety alert management systems
- Confirm authorisation occurs (e.g. sign-off authorities) prior to actioning change

Was this Cause useful?

CAUSE Incorrect installation of the isolation verification device preventing effective energy control

PRE CONTROL Installation process for the verification feature or device
- Use correct installation tools and techniques (e.g. fit for purpose equipment). Consult manufacturer for specified tools.
- Current documentation (e.g. as-built drawings, hose schedules, piping & instrumentation diagrams, single line diagrams, manuals, etc.)
- Correct parts - correct hardware for application (e.g. incorrect gauges)
Competent staff and procedures to manage the process (e.g. familiarisation of equipment use; understanding and competence in isolation procedures)

Authorisation of persons to work on or isolate hydraulic circuits based on competency or experience (e.g. diesel fitters moving from mobile plant to longwall; need permit to isolate and/or work process)

PRE CONTROL Commissioning process for the verification feature or device

- Develop and use a commissioning plan - clear structure that identifies roles, responsibilities and accountabilities during commissioning
- Develop a commissioning schedule - take enough time (Note, especially if pressure to get asset working)
- Develop and use detailed commissioning sheets (inspection and test plan [ITP]) Detailed commissioning check sheets (inspection and test plan [ITP]) to confirm that isolation device/procedures, labelling, guarding, barriers, interlocks are installed correctly
- Audit/quality control/assurance of installation: confirm that the equipment meets the design specification
- Competent workers and procedures to manage the process (personnel who have an awareness of equipment and procedures and who can identify potential isolation inadequacies early)
- Confirm that the equipment meets the design specification – compliance (specification, certification) review to confirm built, supplied, installed as per design
- Clear process for identifying in-service/under-commission isolation requirements for equipment – including notification of personnel

PRE CONTROL Isolation procedures for install and commissioning of verification feature or device

- Pre-installation/pre-commission risk assessment /job safety analysis (JSA) identifying isolation requirements and equipment commissioning plan
- Clearly communicate daily work plan – including isolation and commissioning requirements for the day
- Increased level of supervision and inspection of isolation process during commissioning
- Demarcation of areas under test – apply access permits to commissioning areas
- Training in the isolation procedures
- Appropriate locks and tags to be available for personnel

Was this Cause useful?
CAUSE: Locking device is not fit for purpose for the installed isolation device

PRE CONTROL Equipment design considerations

- Undertake a risk assessment for selection of lockout devices relative to intended use
- Facility for padlocking, securing of padlock – confirm sufficiently robust
- Use fit for purpose lock out facility to allow lock to be fitted AND the mechanism to be held in the isolated position when lock is applied and to accommodate suitable number of locks (e.g. scissor lock to always ensure one lock position available)
- Inability to circumvent the locking mechanism (e.g. isolation handle captive to isolation device)
- Provision of integral earthing valves with lock out facility
- Design to prevent inadvertent lock on position (e.g. isolation locking point to line up with off position)
- Place isolation securing device as close to equipment as possible and confirm that isolation point is close to the work
- Consider location of isolator point with regard to maintaining clearances from live conductors - to allow for the use of conductive lock out equipment

PRE CONTROL Inspection during commissioning of isolation device

- Confirm isolator has locking facility or availability of independent locking device (e.g. lockable pin, lockable cables, props or supports)
- Functional test of lock on isolation device
- Lock does not interfere with any other integral operational components
- Confirm that the isolation device cannot be overridden – mechanical interlocking is secure and effective
- Lock prevents function of the isolation device – when lock applied, device cannot be turned on
- Confirm compatibility between locking facility and site isolation processes (e.g. scissor fits locking device on valve that has been installed, diameter of lock shaft, length of shank)
- Ease of access for operation of isolation valves

PRE CONTROL Procedures to confirm that system is safe for testing

- Barricading and controlled access to test area
- Review of test procedure

Was this Cause useful?

IDENTIFICATION: Operation/Maintenance
CAUSE Labelling and signage not maintained or damaged (e.g. deterioration due to weather, wear & tear)

PRE CONTROL Develop and implement a maintenance plan (tactics and strategies) to maintain isolation identification and labelling/signage

Regular/routine scheduled inspections of the condition of signs/labels to be incorporated into general maintenance activities

Provide detailed instructions in maintenance checks relative to specific labels, location, condition, legibility

All defects should be recorded in a defect management system that is used to issue work orders for replacements, maintenance, etc.

Was this Cause useful?

CAUSE Inability to identify source of hydraulic pressure or isolation points (e.g. tracing a hose/pipe out, orientation of equipment impairs the view of the label)

PRE CONTROL Hose/pipe identification standard/management systems

Confirm labels can be identified from multiple vantage points (e.g. use more than one identification label on equipment)

Label at both ends (using identifier bands, colour codes, etc.)

PRE CONTROL Hydraulic system schematics

Hydraulic system plans (drawings, mimic displays, software based, schematics etc.) to identify layout of hoses/pipes and isolation points

Operational system for updating hydraulic system plans – not necessarily captured in document management system

PRE CONTROL Training, awareness and competency

Hose/pipe identification and management

Procedures used to access hydraulic systems

Trained and authorised isolation officers (e.g. permit to isolate)

Was this Cause useful?

CAUSE Visual indicators not maintained/installed incorrectly

PRE CONTROL Develop and implement a maintenance plan (tactics and strategies) to maintain isolation indicators

Regular/routine scheduled inspection of condition of isolation indicators to be incorporated into maintenance activities

Confirm sufficient stocks of critical indicators

Provide detailed instructions in maintenance checks relative to specific isolation indicators, condition
All defects should be recorded in a defect management system that is used to issue work order for replacement, maintenance etc.

Was this Cause useful?

CAUSE Lack of drawings associated with equipment (e.g. including transfer between sites)
PRE CONTROL Equipment specification
   - As-built drawings to be provided prior to handover
   - Where appropriate, drawings to be provided in an editable format (i.e. not .pdf) to allow easy update of on-site drawings (Note, for equipment alterations that do not compromise safety)
PRE CONTROL Document control system (i.e. formal document management system)
   - Provision of hard copy/soft copy drawings on equipment that is easy to access and kept clean; accompanied by on-site storage of drawings
   - Confirm out-dated drawings/revisions are replaced

Was this Cause useful?

CAUSE Performing isolation while not fit for work
PRE CONTROL Pre-task fitness for work procedure during high risk isolation activities
   - Random drug and alcohol testing
   - Cognitive/psychomotor testing (e.g. Occupational Safety Performance Assessment [OSPAT], hand-eye coordination)
   - Rapid eye movement tests
   - Sleep, rest, wakefulness assessment
   - Physical assessment and questioning
PRE CONTROL Operational procedures for monitoring and maintaining fitness
   - Supervision to monitor behaviour – increase relative to risk
   - Supervisor to conduct safety checks of the isolation process
   - Develop schedules and rosters that are appropriate to the risk of daily tasks
   - Routine breaks
   - Utilise systems to monitor time on site (e.g. clock on/clock off system; electronic communication to supervisor when time on exceeds threshold)
   - Do not schedule high risk isolation activities for periods when workers are prone to fatigue and/or reduced alertness (e.g. towards end of shift or first shift back on site)
PRE CONTROL Training, awareness and competency – fitness for work

Fitness for work policy (e.g. fatigue management, drug and alcohol, prescription, medication, mental state)

Recognition of signs of fatigue and altered state

Was this Cause useful?

CAUSE Failure to identify the energy correctly due to inadequate skills and knowledge (Note, this may be a worker working within or outside their field of expertise)

PRE CONTROL Appointment of isolation officers and effective procedures for isolation of hydraulic energies

- Develop systems or procedures that enable isolation officers to effectively isolate a system, plant or equipment for other workers
- Systems in place so that all workers know when and how to contact an isolation officer
- Isolation officer available at all times to implement and manage isolation procedures for scheduled tasks being undertaken by other workers
- Develop isolation schematics (e.g. matrix) for plant equipment that visually documents tasks and associated isolation points

PRE CONTROL Design and install systems to prevent unauthorised or inadvertent operation for specialised tasks (i.e. hard controls, barriers)

- Barricades to control access to hydraulic pump stations or actuators; hydraulic systems on mobile or fixed plant
- Lock box for more complicated or complex isolation (e.g. group isolation, prior to maintenance to confirm safety of unauthorised personnel)

PRE CONTROL Design and implement procedures to prevent unauthorised or inadvertent operation for specialised tasks (i.e. soft controls)

- Competency-based authorisation procedures to control access to hydraulic pump stations; hydraulics systems on fixed or mobile plant
- Signage for authorised access (when not locked)
- Authorised hydraulics operators for high pressure work or isolation (e.g. permit to work)
- Develop and implement isolation procedures that are machine specific and detailed (e.g. pictorial, location of labels and standard of labels, isolation schematics)
- Work procedures to list details of isolation points
- Authorisation for hydraulic fitters
- Site induction to include awareness of hydraulic system hazards

PRE CONTROL Design to reduce the complexity of the isolation process

- Single point isolation (e.g. main isolator on manifold)
Consider ring main hydraulic circuits to isolate both sides of work site

Was this Cause useful?

CAUSE Human factors (e.g. colour blindness, dyslexia, literacy)
PRE CONTROL Pre-employment/recruitment testing for human factors that may compromise safe isolation performance (dyslexia, literacy, colour blindness etc)
  Job role dependent (i.e. relative to risk)
  Alternate training(e.g. literacy), certification protocols
PRE CONTROL Design equipment relative to human factors
  Labelling of equipment not to rely on colour coding (e.g. integrate with alphanumeric coding)
  Descriptive/distinctive/intuitive labelling that incorporates a variety of coding methods (e.g. alphanumeric, colour, etc.) - not too complex and consider size of code
  Use of diagrams, drawings, pictograms to assist individuals with a low level of literacy

Was this Cause useful?

CAUSE Adjacent and stored energy sources are not identified (e.g. accumulator; hydraulic isolator has been operated but engine still able to start creating pinch points, etc.)
PRE CONTROL Task hazard identification
  Planning and pre-job site visit
  Careful review of drawings/schematics to identify all relevant isolation points including accumulators, sources of backpressure, and secondary pressure from load compressing cylinders
  Supervision
  Task level risk assessment (e.g. “Take 5”, SLAM [stop look assess manage])
PRE CONTROL Confirm barriers/guarding are in place
  Regular inspection of condition of barriers and guards (include as part of maintenance plan)
  Look for signs of barrier removal or not being re-installed
  Audit – against standards

Was this Cause useful?

CAUSE Mid-stream changes to task/scope of work introduces unidentified energy sources
PRE CONTROL Maintenance procedures, work instructions, isolation procedures etc
   If task changes, implement change management plan
   Monitor visual indicators of isolation (e.g. gauges) throughout the task
PRE CONTROL Document control system (i.e. safety and health management system)
   Process to identify incidents where failure occurs – review incident management system
   Communicate lessons learned across site to trigger corrective actions (e.g. update work methods, processes, hardware etc.)
   Ongoing training – refresher

Was this Cause useful?

CAUSE Failure to identify potential for fluid under pressure to vent
PRE CONTROL Workplace inspection before reversing isolation
PRE CONTROL Training, awareness and competency
   Workforce awareness training on potential outcomes of fluid injection working on or around hydraulic systems (i.e. permanent/significant injury)
   Workforce training on potential signs/indicators of high pressure fluid venting on and around hydraulic systems

Was this Cause useful?

OPERATION: Operation/Maintenance

CAUSE Overly complex isolation process leading to error in isolating procedure
PRE CONTROL Redesign of equipment to simplify isolation
   See equipment design considerations
   Note, in some instance well documented isolation procedures may be an appropriate control
PRE CONTROL Documented isolation procedure
   Identify upfront the complexity and relative risk of task or consequences if isolation isn’t effective
   Work procedure to be detailed, current and specific to equipment/task and identifies all energy sources not just hydraulics
   Develop procedures for complex tasks that can be undertaken with lower risk alternative energy/power sources
Use pictures, diagrams, single line diagrams, etc. to clearly illustrate the steps in the isolation process.

Use simple not technical language in diagrams and text.

Confirm documentation clearly describes the isolation sequence for ease of interpretation with provision for operator confirmation that steps have been undertaken (e.g. checklist).

Include checks for labelling of isolation device (e.g. labels are clearly identifiable, located in correct position etc.).

Build in provision for second person to validate isolation process in accordance with procedure and correct isolation points with provision for confirmation (e.g. sign-off).

For accumulators, flag the requirement to dissipate and verify all stored energy and prior to commencing task.

**PRE CONTROL** Training, awareness and competency for complex tasks

- Training relative to task and equipment
- Original equipment manufacturer (OEM) to deliver training for new equipment
- Virtual learning and assessment for competency
- Practical learning and assessment (i.e. learn by doing under supervision)
- Simulated isolation processes and scenarios (e.g. simulator for fault finding)

***Was this Cause useful?***

**CAUSE** Overriding an isolation device

**PRE CONTROL** Equipment design considerations

- Design isolation devices with material strength that prevents ease of removal (bending/cutting)

**PRE CONTROL** Inspection of isolation devices (evidence of tampering)

**PRE CONTROL** Safe isolation procedures

- Always follow the original equipment manufacturers’ (OEMs) instructions
- Always follow the correct site procedures
- Obtain the right permits and authorities - link isolation into work permits
- Formal, documented, risk-based process for overriding (this should be a rare occurrence but provision should be made)

**PRE CONTROL** Training and awareness of consequences

- Training for hazards associated with hydraulic systems
- Awareness of disciplinary action for actively overriding safety systems
Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)

Entrenched safety culture in team – awareness of impact on other workers and their family – legal duty of care

PRE CONTROL Temporary decommissioning

Consider removal of energy sources where extended periods of isolation are necessary to undertake a task (e.g. longwall move decommissioning of chock pressures)

Was this Cause useful?

CAUSE Incorrect, incomplete or out dated isolation procedures

PRE CONTROL Review isolation procedures

During the first application of the isolation procedures test that the isolation steps are effective, and the document is logical, and uses understandable language accompanied by diagrams etc.

Review procedures every time an isolation task is performed

Change management process for equipment modification to trigger update of isolation procedures – where required

All isolation procedures to be part of the Work Health Safety Management Plan

Response to an event or recommended change – incident, inspection, audit

Accurate methodology for identification of all energy sources (not just hydraulic energy sources)

Procedures written in the language of the user and sufficient supervision is in place if English is second language

PRE CONTROL Process to identify incidents where failure occurs

Captures failures in incident management system and assign actions to rectify and prevent recurrence (e.g. identify problems that may be common to certain component/brand)

Circulate information within the industry – share lessons learned

Update isolation procedures relative to above

Design of an incident management system to capture/identify isolation issues

PRE CONTROL Audit process for documents

Document control system - review on time basis to confirm isolation procedures are up-to-date/understandable/written in language of user

Was this Cause useful?
CAUSE Wear and tear or failure of the isolation device and associated components

PRE CONTROL Schedule and implement a maintenance plan
- Develop maintenance program based on failure modes of isolation device and associated components (e.g. barriers, interlocks)
- Schedule regular inspection to look for signs of failure and action maintenance as required
- If isolation device and associated components are inoperable, tag as out of service and action
- If isolation device and associated components are compromised, place in defect management system and action
- Test operation of interlocking devices and undertake maintenance as required
- Establish procedures for issuing of keys used for securing of isolation (e.g. not copying Castell/Fortress/other keys)
- Schedule regular inspection of barriers and identification (labelling/signage/colour etc.) to confirm they in place, not damaged, legible and serviceable

PRE CONTROL Training, awareness and competency
- Training system to control and verify formal competencies (qualifications, licenses, etc.) and retraining periods relative to specific task and equipment
- Process to induct and test competency of new staff to test and verify knowledge, skills, competencies relative to machinery and isolation devices
- Introduction and application of hydraulics standard or mechanical engineering management plan
- Identification of signs of wear and tear, potential for failure, etc.
- Familiarisation of hydraulic energies associated with equipment and/or systems, isolation device function and location on machine

Was this Cause useful?

CAUSE Human error leading to incorrect isolation of equipment

PRE CONTROL Pre-task fitness for work procedure
- Random drug and alcohol testing
- Cognitive/psychomotor testing (e.g. Occupational Safety Performance Assessment [OSPAT], hand-eye coordination)
- Rapid eye movement test
- Sleep, rest, wakefulness assessment
- Physical assessment and questioning
PRE CONTROL Operational procedures for monitoring and maintaining fitness

Supervision to monitor behaviour – increase relative to risk
Supervisor to conduct safety checks of the isolation process
Develop schedules and rosters that are appropriate to the risk of daily tasks
Routine breaks
Utilise systems to monitor time on site (e.g. clock on/clock off system; electronic communication to supervisor when time on exceeds threshold)
Do not schedule high risk isolation activities for periods when workers are prone to fatigue and/or reduced alertness (e.g. towards end of shift or first shift back on site)

PRE CONTROL Training, awareness and competency – fitness for work

Fitness for work policy (e.g. fatigue management, drug and alcohol, prescription drugs, medication, mental state)
Recognition of signs of fatigue and altered state
Know the difference between confidence and competence when performing high risk tasks

PRE CONTROL Implement and maintain barriers and processes to prevent unauthorised access and operation of isolation device or valve

Use lock-on/lock-off valves, key issue protocols, padlocks, etc. to prevent inadvertent operation or unauthorised use of isolation device
Establish restricted areas with swipe or key access – including key issue protocols and padlocks to confirm that only competent personnel have access to isolation device
Barriers and interlocks (e.g. guarding around winder drive on drift winder system)

PRE CONTROL Implement and maintain procedures to prevent unauthorised operation of the isolation device

Authorisation procedures to control access to hydraulic pump stations; hydraulics systems on fixed or mobile plant
Signage for authorised access (when not locked)
Develop and implement isolation procedures that are machine specific and detailed (e.g. pictorial, location of labels and standard of labels, Isolation schematics)
Hydraulic energy isolation procedures to be incorporated into individual and group competencies
Training and awareness of hazards associated with hydraulic energy at induction and through operational equipment training
PRE CONTROL Pre-employment/recruitment testing for human factors that may compromise safe isolation performance (dyslexia, literacy, colour blindness etc)

- Job role dependent (i.e. relative to risk)
- Alternate training (e.g. literacy), certification protocols

PRE CONTROL Design equipment relative to human factors

- Labelling of equipment not to rely on colour coding (e.g. integrate with alphanumeric coding)
- Descriptive/distinctive/intuitive labelling that incorporates a variety of coding methods (e.g. alphanumeric, colour, etc.) - not too complex and consider size of code
- Use of diagrams, drawings, pictograms to assist individuals with a low level of literacy

Was this Cause useful?

CAUSE Use of incorrect isolation point (i.e. isolation by control/pilot)

PRE CONTROL Equipment design considerations for operating the isolation device

- Consider isolation to a mining standard as a fundamental part of the design process
- Where practical equipment to have a main hydraulic system isolation valve (e.g. chocks)
- Ergonomics/workplace layout (access and lighting) to facilitate easy access to isolation device
- Clearly label/identify isolation device
- Consider inadvertent exposure to uncontrolled pressure to be prevented by isolation interlock – where practical (e.g. utilise pilot control/circuit for main valve operation; isolation key interlock system)
- Isolation device is lockable
- Confirm isolation device supplied matches original equipment manufacturers’ (OEMs) specifications (e.g. not a different model or version)
- Device to be usable within mine operating procedures to facilitate local mine practices and standards
- Consider the practical implications of valve location to minimise downtime or to provide ability to isolate sectionalised components of the asset
- Isolation process to be considered during design to reduce complexity (i.e. minimise the number of steps and manage sequential operation by interlocking etc.)
Ingress protection (e.g. contaminants; include materials suitable to corrosive fluids) appropriate for installation location (weathering)

Position of isolation device to be intuitive and able to clearly identify the status of the isolation valve

Fit for purpose isolation device (Note, consider duty cycle to understand the required duty including frequency and use of isolation point; rated capacity of equipment; e.g. need to make sure that valve is durable to frequency of use)

PRE CONTROL Safe isolation procedures

Always follow the original equipment manufacturer’s (OEM’s) instructions

Always follow the correct site procedures

Cross-check isolation against current drawings and manuals (e.g. hydraulic system schematics)

Obtain the right permits and authorities - link isolation into work permits

Formal, documented, risk-based process for overriding (this should be a rare occurrence but provision should be made)

PRE CONTROL Training, awareness and competency

Training system to control and verify formal competencies (e.g. qualifications, licenses, etc.) and re-training periods relative to specific task and equipment

Process to induct and test competency of personnel working on hydraulic circuits on site (i.e. to test and verify knowledge, skills, competencies relative to machinery and isolation devices)

Introduction and application of hydraulics standard, and mechanical engineering management plan

Identification and location of main pressure valve isolation point

Awareness of Australian standards for isolation of hydraulic systems

Familiarisation of hydraulic energies associated with equipment and/or systems, isolation device function and location on machine

VERIFICATION: Operation/Maintenance

CAUSE Verification instruments used outside design parameters, or in an inappropriate situation

PRE CONTROL Fit for purpose equipment

Equipment to be clearly labelled with pressure rating (e.g. maximum working pressure; identification marks on fittings, if any)

Equipment tested and calibrated for intended use/rating

Critical gauges to be calibrated and maintained regularly
Maintain equipment in working order (e.g. leaking gauges, connections or hoses)

Confirm sufficient stocks for critical gauge replacement

**PRE CONTROL** Training, awareness and competency

- Selection of verification devices appropriate to hydraulic pressure and equipment use on site
- Limitations of verification device – refer to original equipment manufacturer’s (OEM’s) specifications and recommended use
- Correct testing procedure – prove verification device before and after isolation (e.g. check indicator, isolate and dissipate stored energy, check indicator, re-energise, check indicator, repeat)

**Was this Cause useful?**

**CAUSE** Failure to verify isolation because required instruments not available (or out of service, missing/lost, sent away)

**PRE CONTROL** Confirm verification equipment is available and maintained

- Identify equipment requirements for site tasks and equipment
- Confirm sufficient back-up equipment available (e.g. on-site stock, agreement with supplier or nearby site)

**PRE CONTROL** Safe work procedure

- Stop work if appropriate equipment is not available to safely verify isolation
- Notify supervisor of requirement for specific equipment or service

**Was this Cause useful?**

**CAUSE** Failure to verify isolation because test point not available

**PRE CONTROL** If isolation cannot be verified, halt task and seek advice from site engineer

**Was this Cause useful?**

**CAUSE** Test equipment not adequately maintained

**PRE CONTROL** Schedule and implement a maintenance plan

- Equipment shall be scheduled for regular testing and calibration as per OEM and industry best practice
- Schedule regular inspection to look for signs of wear and tear and action maintenance as required
- If test equipment and associated components are inoperable, tag as out of service and remove from workplace
If test equipment and associated components are compromised, tag as out of service and register in defect management system for repair

**PRE CONTROL Pre-use inspection**
- Check last testing and calibration expiry date
- General inspection of equipment condition and serviceability
- Suitably rated verification equipment selected for the task

**PRE CONTROL Training, awareness and competency**
- Familiarity with equipment including signs of wear and tear
- Hydraulic testing equipment cleaned after every use and stored in approved packaging and located in accordance with equipment register
- Training in the appropriate use of verification equipment

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**CAUSE Failure to set test instrument to correct mode of operation**

**PRE CONTROL Training, awareness and competency**
- Limitations of verification device – refer to original equipment manufacturer's (OEM's) specifications and recommended use
- Correct testing procedure – prove instrument before and after isolation - always test on a known pressure source before testing for isolation and then re-test on known pressure source

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**CAUSE Failure to act on verification process indicating that isolation has not been effective**

**PRE CONTROL Safe guarding**
- Use safe guarding mechanisms that take control of, or dissipate, hydraulic energies which are de-activated when personnel enter a hazardous situation

**PRE CONTROL Safe work procedures**
- Stop work and reassess isolation and verification effectiveness
- Cross-check verification process undertaken against authorised isolation procedures
- Second party to confirm compliance with isolation procedure
- Cross-check verification process with current drawings and manuals used for determining isolation equipment (e.g. hydraulic system schematics)
- Cross-check verification with risk assessed alternate verification device or procedure

**PRE CONTROL Training, awareness and competency**
Awareness of safe work procedure to recognise change to expected verification outcome and recognise requirement to stop work and reassess

Was this Cause useful?

SECURING: Operation/Maintenance

CAUSE Deliberate unauthorised removal or circumvention of locks (i.e. overriding an isolation device)

PRE CONTROL Equipment design considerations
- Appropriate locking device that maintains isolation integrity
- Design isolation devices with sufficient strength and made of suitable materials to prevent ease of removal (bending/cutting)
- Hasp size (diameter and length) is matched to hole size of isolation device
- Isolation handle is captive to the isolation valve

PRE CONTROL Supervision
- Supervision of working practice to confirm task is done in accordance with procedures, check/audit task and act on any variations to the task
- Inspection of telltale signs of overriding (e.g. screw driver scratches around override facilities)

PRE CONTROL Safe isolation procedures
- Equipment designed to enable functional testing as required (e.g. to remove motivation for overriding device)
- Always follow the original equipment manufacturer’s (OEM’s) instructions
- Always follow the correct site procedures
- Obtain the right permits and authorities - link isolation into work permits
- Formal, documented, risk-based process for overriding (this should be a rare occurrence but provision should be made)

PRE CONTROL Training and awareness of consequences
- Implement training about hazards associated with hydraulic systems (e.g. pump induced pressure, load induced pressure, stored/accumulated pressure)
- Awareness of disciplinary action for actively overriding safety systems
- Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)
- Entrenched safety culture in team – awareness of impact on other workers and their family – legal duty of care
PRE CONTROL Management of locks, keys and locking devices

- One active key per lock
- Management of spare keys
- Establish and implement a control of energy procedure/policy (isolation procedure/policy)

PRE CONTROL Periodic inspection of locking devices

- Pre-use inspection
- Inspection program incorporated into maintenance regime (e.g. look for signs of damage or tampering)

Was this Cause useful?

CAUSE Inadequate procedures for authorised removal and circumvention of locks etc.

PRE CONTROL Isolation procedure

- Formal, documented, risk-based process for over-riding, isolation lock tag removal (Note, this should be a rare occurrence but provision should be made, e.g. in cases of emergency, inadvertently leaving a lock on and left site)

Was this Cause useful?

CAUSE Failure to isolate correctly (e.g. does not isolate due to isolating the wrong device, and not able to be verified)

PRE CONTROL Local isolation devices

- Design hydraulic system so that pressure can be verified at all locations

PRE CONTROL Safe guarding

- Use safe guarding mechanisms that take control of, or dissipate, hydraulic energies which are de-activitated when personnel enter a hazardous situation

PRE CONTROL Supervision

- Supervision of working practice to confirm task is done in accordance with procedures, check/audit task and act on any variations to the task
- Supervisors to implement safety observations and review stepwise isolation work procedures to identify risk of failure to isolate (e.g. isolation checker post isolation work)

Was this Cause useful?

CAUSE Using incorrect tag or lock for task

PRE CONTROL Supervision
Supervision of working practice to confirm task is done in accordance with procedures, check/audit task and act on any variations to the task.

PRE CONTROL Safe isolation procedures
- Always follow the original equipment manufacturer's (OEM's) instructions
- Always follow the correct site procedures
- Obtain the right permits and authorities - link isolation into work permits

PRE CONTROL Training and awareness of consequences
- Implement training about hazards associated with hydraulic systems (e.g. pump induced pressure, load induced pressure, stored/accumulated pressure)
- Awareness of disciplinary action for not following isolation procedure
- Entrenched safety culture in team – awareness of impact on other workers and their family – legal duty of care

Was this Cause useful?

CAUSE Inability of workers to do effective isolation required for completion of specific tasks (e.g. miners or electricians needing to work on hydraulic pressure systems)

PRE CONTROL Appointment of isolation officers and effective procedures
- Develop systems or procedures that enable isolation officers to effectively isolate for workers
- Awareness and systems in place so that all workers know the identity and ways to contact isolation officer
- Isolation officer to be available for scheduled work and/or when needed by site personnel not authorised to isolate
- Develop isolation schematics (e.g. matrix) for plant equipment that visually documents tasks and associated isolation points

Was this Cause useful?

IDENTIFICATION: Modification

CAUSE Modifications undertaken outside of industry/community standards impairing the identification of energy source or isolation points

PRE CONTROL Change management plan
- Risk assessment of this type of modification
- Change or modify signage to make verification indicators clearly visible with new modification to be put in place
Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
Communication/documentation of change
Update existing documentation

PRE CONTROL Scheduled audit and inspection
- Schedule audits and inspections of equipment for compliance with industry/community standards
- If non-compliance, report in defect management system with corrective action

PRE CONTROL Training, awareness and competency
- Recognition that a modification has occurred or is required (e.g. inductions – ‘what is a change?’, simulations/scenarios, etc.)
- Communication between shifts, crew etc. that a modification has occurred
- Understanding of change management plan and when they should be applied and how it restricts this type of modification
- Awareness of consequences of modifications (e.g. design, plan, supervision)

PRE CONTROL Applying bridges and forces in line with approved risk based policy (e.g. on electrical circuits and programmable logic controller (PLC) systems controlling hydraulic devices)
- Installation of a hard wired (bridge) bypass or software (force) bypass of circuit component parts
- Documentation process to capture the installation/removal of a bypass
- Training process for temporary modification (safety critical – don’t do, non-safety item – short period of time for modification)

Was this Cause useful?

CAUSE Inadvertent modification (e.g. parts not available, wrong signage replacement, gauge replaced with different scale gauge, work outside procedures due to pressure to maintain production)

PRE CONTROL Inspections and maintenance regime
- Schedule regular inspections and maintenance to identify equipment modifications that do not conform to industry/community standards
- Non-conformance to be recorded in defect management system with corrective action
- Supervisors to be aware of work and undertake PDCA (i.e. Plan, Do, Check, Act) process: supervision to plan task, confirm task is done in accordance with procedures, check/audit task and enact on variations to the task
Capture work into mine planning systems (e.g. change management plan, defect management)

PRE CONTROL Part supply chain process (inventory, ordering) to guarantee availability of specialised components

Identify critical spares and implement a process to manage unilateral procurement change to order

Changes or substitution of parts (alternate supplier) need to be engineering assessed for compatibility and purchase; use to be authorised

Rationalisation of spares (inventory control and stock audit) – may include vendor in analysis

Parts linked to standard jobs (e.g. Associated Parts List [APL]), and maintenance management system (work orders) to be linked, automatically requisitioned and made available

Intuitive interactive tools to identify needed components: fault identification and location, repair procedure, corrective parts (e.g. Link One software; OEM handbooks)

PRE CONTROL Training, awareness and competency

Recognition that a modification has occurred or is required (e.g. inductions – 'what is a change?', simulations/scenarios, etc.)

Understanding of change management plan and when to apply in regards to equipment modification

Communication strategy for changes (e.g. pre-shift/toolbox talk training/re-assessment)

A process for ensuring people work within procedures (countering any non-direct/non-verbal messages or actions to maintain production at all cost)

Awareness of consequences of modification (design, plan, supervision)

CAUSE Unidentified energy source is introduced as result of modification (e.g. when an accumulator supplies energy after main isolator is turned off)

PRE CONTROL Change management plan

Risk assessment for all modifications

Process for capturing original equipment manufacturer's (OEM's) or site modifications and a system to keep data on site (e.g. plant safety file) – need to document all changes

Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change

Communication/documentation of change
Update existing documentation (e.g. asset management records, maintenance records, etc.)

PRE CONTROL Training, awareness and competency
- Recognition that a modification has occurred that may include the identification of secondary energy sources (e.g. accumulators, etc.)
- Cannot control a change unless it is documented
- Communication between shifts, crew etc. that modification has occurred and that a secondary source has been introduced
- Understanding of the change management plan and when it should be applied
- Awareness of consequences of modifications (e.g. design, plan, supervision)

Was this Cause useful?

OPERATION: Modification

CAUSE Documentation is out of date/redundant isolation procedures

PRE CONTROL Change management plan
- Risk assessment for all modifications
- Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
- Communication/documentation of change
- Update existing documentation

PRE CONTROL Document control system (i.e. a formal document management system)
- Site specific block of drawing numbers integrated into site maintenance systems
- Change management process (including a sign-off by authorised personnel) for new and revised drawings
- Provision of hard copy/soft copy drawings on equipment that is easy to access and kept clean; accompanied by on-site storage of drawings
- Confirm out-dated drawings/revisions are replaced

Was this Cause useful?

CAUSE Modifications undertaken outside of industry/community standards impairing the operation of energy source or isolation points

PRE CONTROL Change management plan
- Risk assessment for all modifications
Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
Update existing documentation
Training process for temporary modification (safety critical – don’t do, non-safety item – short period of time for modification)

PRE CONTROL Training, awareness and competency

Recognition that a modification has occurred or is required (e.g. inductions – 'what is a change?', simulations/scenarios, etc.)
Communication between shifts, crew etc. that a modification has occurred
Understanding of change management plan and when they should be applied
Awareness of consequences of modifications (e.g. design, plan, supervision)

Was this Cause useful?

CAUSE Incorrect or unauthorised modification (e.g. use of incorrect parts, supply chain purchases generic parts, work outside procedures due to pressure to maintain production)

PRE CONTROL Access control prevents unauthorised modification

Software systems controlling a hydraulic system need to have access control (e.g. password, password management) to prevent unauthorised modification of the program
Hardware control (e.g. keys, key management) to limit or prevent access around critical hydraulic equipment

PRE CONTROL Inspection and maintenance regime

Schedule regular inspections and maintenance to identify equipment modifications that do not conform to industry/community standards
Non-conformance to be recorded in defect management system with corrective action
Supervisors to be aware of work and undertake PDCA (i.e. Plan, Do, Check, Act) process: supervision to plan task, confirm task is done in accordance with procedures, check/audit task and enact on variations to the task
Capture work into mine planning systems (e.g. change management plan, defect management)

PRE CONTROL Part supply chain process (inventory, ordering) to guarantee availability of specialised components
Identify critical spares and implement a process to manage unilateral procurement change to order
Changes or substitution of parts (alternate supplier) need to be engineering assessed for compatibility and purchase; use to be authorised

Rationalisation of spares (inventory control and stock audit) – may include vendor in analysis

Parts linked to standard jobs (e.g. Associated Parts List [APL]), and maintenance management system (work orders) to be linked, automatically requisitioned and made available

Intuitive interactive tools to identify needed components: fault identification and location, repair procedure, corrective parts (e.g. Link One software; OEM handbooks)

PRE CONTROL Training, awareness and competency

Recognition that a modification has occurred or is required (e.g. inductions – ‘what is a change?’, simulations/scenarios, etc.)

Understanding of change management plan and when to apply in regards to equipment modification

Communication strategy for changes (e.g. pre-shift/toolbox talk training/re-assessment)

A process for ensuring people work within procedures (countering any non-direct/non-verbal messages or actions to maintain production at all cost)

Awareness of consequences of modification (design, plan, supervision)

Awareness of disciplinary action for failing to follow procedures associated with the modification of isolation devices

Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)

Entrenched safety culture in team – awareness of impact on other workers and their family – legal duty of care

VERIFICATION: Modification

CAUSE Verification point does not perform the required function due to a modification (change of instruments/scales; location relative to isolation points)

PRE CONTROL Change management plan (specifically consider verification equipment and methodology)

Consider changes necessary to verification devices and equipment ratings - risk assessment

Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
Communication/documentation of change
Update existing documentation

PRE CONTROL Fit for purpose equipment
Selection of verification devices appropriate to pressures and equipment use on site
Equipment to be clearly labelled with pressure rating
Equipment tested and calibrated for intended use/rating
Maintain equipment in working order (e.g. to prevent use of equipment with compromised contact ratio)

PRE CONTROL Inspection and maintenance regime
Schedule regular inspections and maintenance to identify equipment modifications that do not conform to industry/community standards
Non-conformance to be recorded in defect management system with corrective action
Supervisors to be aware of work and undertake PDCA (i.e. Plan, Do, Check, Act) process: supervision to plan task, confirm task is done in accordance with procedures, check/audit task and enact on variations to the task
Capture work into mine planning systems (e.g. change management plan, defect management)

PRE CONTROL Training, awareness and competency
Limitation of verification device – refer to original equipment manufacturer's (OEM's) specifications and recommended use
Correct verification procedure – prove positive and effective isolation

Was this Cause useful?

SECURING: Modification

CAUSE Securing equipment does not perform the required function due to a modification (e.g. self-produced handles, locks/hasps do not fit)

PRE CONTROL Change management plan
Consider changes necessary to confirm securing equipment remains fit for purpose
Risk assessment
Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
Communication/documentation of change
Update existing documentation
PRE CONTROL Fit for purpose equipment

Selection of securing devices appropriate to equipment
Maintain equipment in working order (e.g. to prevent use of equipment with compromised contact ratio)

PRE CONTROL Inspection and maintenance regime

Schedule regular inspections and maintenance to identify equipment modifications that do not conform to industry/community standards
Non-conformance to be recorded in defect management system with corrective action
Supervisors to be aware of work and undertake PDCA (i.e. Plan, Do, Check, Act) process: supervision to plan task, confirm task is done in accordance with procedures, check/audit task and enact on variations to the task
Capture work into mine planning systems (e.g. change management plan, defect management)

PRE CONTROL Training, awareness and competency

Limitation of securing equipment – refer to original equipment manufacturer's (OEM's) specifications and recommended use
Correct securing procedure – confirm that securing equipment is effective

Was this Cause useful?

IDENTIFICATION: Decommissioning

CAUSE Failure to identify all energy sources in the decommissioning process (small or large assets)

PRE CONTROL Risk assessment prior to commencing task

Understand the strategy for how the asset is to be decommissioned relative to the future use of the asset (store, rebuild, end of life)
Consider hazards/potential energies and how energies change as you start to decommission (e.g. stored energy, temporary supplies)
Consider the method used to identify energy sources (e.g. temporary gauges, test points available where required, etc.)
Seek expert or local knowledge prior to decommissioning (e.g. regular maintenance personnel)
Familiarisation and general communication to workers involved – consider the level of job specific knowledge and skills of personnel receiving instructions (Note, these people are often dependent on precautionary advice provided)
Consider permits required for decommission (e.g. excavation, penetration)
Specifically identify all possible sources of stored energy (Note, challenge assumptions on identification of stored energy, physically inspect machinery, use a cross section of the workforce to assess, status of stored energy must be irrefutable)

Consider the age of the asset and the quality of documentation

Audits to confirm adherence to process

PRE CONTROL Change management process

Version control – document modifications captured in software systems (e.g. codes, comments, work order links)

Document control including revisions – track modifications made to drawings and documentation systems with history (e.g. link to work order)

Communicate changes to operators and maintainers

Confirm authorisation occurs (e.g. sign-off authorities) prior to actioning of change

Risk management process that is linked and relative to level of change

PRE CONTROL Complete de-energisation of asset

De-energise stored pressures/accumulators, remove loads that may compress cylinders, and pressurised cylinders

Remove energy sources such as batteries and/or generators that could possibly power hydraulic pumps etc.

Dissipate stored energy in hoses and pipes

Was this Cause useful?

OPERATION: Decommissioning

CAUSE Documentation (drawings/procedures) out of date due to partial decommissioning

PRE-CONTROL Change management plan

Risk assessment

Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change

Communication/documentation of change

Update existing documentation

Was this Cause useful?

CAUSE Decommissioning undertaken outside industry/community standards impairing the operation of energy source or isolation points
PRE CONTROL Training, awareness and competency

Communication between shifts, crew etc. that a modification has occurred

Understanding of change management plan and when they should be applied

Awareness of consequences of modifications (e.g. design, plan, supervision)

PRE CONTROL Change management plan

Risk assessment

Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change

Communication/documentation of change

Update existing documentation

Was this Cause useful?

CAUSE Ineffective decommissioning – fails to remove all hydraulic energy sources (e.g. work outside procedures due to pressure to maintain production)

PRE CONTROL Inspection of decommissioning process

Supervisors to be aware of work and undertake PDCA (i.e. Plan, Do, Check, Act) process: supervision to plan task, confirm task is done in accordance with procedures, check/audit task and enact on variations to the task

Capture work into mine planning systems (e.g. change management plan, defect management)

PRE CONTROL Safe isolation procedures

Always follow the original equipment manufacturer’s (OEM’s) instructions

Always follow the correct site procedures

Obtain the right permits and authorities - link isolation into work permits

PRE CONTROL Training, awareness and competency

Recognition that a decommissioning is a form of modification (e.g. inductions - ‘what is a change?’, simulations/scenarios, etc.)

Understanding of change management plan and when to apply in regards to equipment decommissioning

Communication strategy for changes (e.g. pre-shift/toolbox talk training/re-assessment)
A process for confirming people work within procedures (countering any non-direct/non-verbal messages or actions to maintain production at all cost)

Awareness of consequences of modification (design, plan, supervision)

Personnel to be aware of the hazards associated with modifications to isolation devices

Awareness of disciplinary action for failing to follow procedures associated with the modification of isolation devices

Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)

Was this Cause useful?

**CAUSE** Use of an isolation point that has become redundant during decommissioning process (e.g. install packs/pumps on longwall moves)

**PRE CONTROL** Change management plan

- Risk assessment
- Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
- Communication/documentation of change
- Update existing documentation

**PRE CONTROL** Isolation procedures include verification steps to identify redundant isolation points

- Clearly identify the redundant isolation point

**PRE CONTROL** Training, awareness and competency

- Recognition that a decommissioning is a form of modification (e.g. inductions - ‘what is a change?’, simulations/scenarios, etc.)
- Understanding of change management plan and when to apply in regards to equipment decommissioning
- Communication strategy for changes (e.g. pre-shift/toolbox talk training/re-assessment)
- A process for confirming people work within procedures (countering any non-direct/non-verbal messages or actions to maintain production at all cost)
- Awareness of consequences of modification (design, plan, supervision)
- Personnel to be aware of the hazards associated with modifications to isolation devices
- Awareness of disciplinary action for failing to follow procedures associated with the modification of isolation devices
Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)

Was this Cause useful?

CAUSE Not following site safety health management system (SHMS) (i.e. contractors and/or other non-trained personnel in decommissioning process; e.g. contractor’s system may be incompatible with SHMS [HSMS in NSW]) [Work Health Safety Management System]

PRE CONTROL Contractual controls
   Contract will clearly stipulate which SHMS that governs work on site
   Principal company actively manages the contractor: audits/inspections of contractors work and on-site activities

PRE CONTROL Training/awareness/monitoring of non-trained personnel
   Induction
   Tool box talks
   Supervision
   Mentoring

Was this Cause useful?

VERIFICATION: Decommissioning

CAUSE Inability to verify due to removal of verification functionality or removing an isolation step (e.g. removal of a verification device within a system - valve) in decommissioning process

PRE CONTROL Decommissioning procedure
   Develop decommissioning task that de-energises complete system with verification prior to removal of gauges and other instrumentation
   Use of temporary gauges, and effective temporary isolation processes when permanent verification devices have been removed

PRE CONTROL Change management plan
   Risk assessment
   Confirm authorisation occurs (e.g. sign-off authorities, password, password control) prior to actioning of change
   Communication/documentation of change
   Update existing documentation

PRE CONTROL Training, awareness and competency
Recognition that a decommissioning is a form of modification (e.g. inductions - ‘what is a change?’, simulations/scenarios, etc.)

Understanding of change management plan and when to apply in regards to equipment decommissioning

Communication strategy for changes (e.g. pre-shift/toolbox talk training/re-assessment)

A process for confirming people work within procedures (countering any non-direct/non-verbal messages or actions to maintain production at all cost)

Awareness of consequences of modification (design, plan, supervision)

Personnel to be aware of the hazards associated with modifications to isolation devices

Awareness of disciplinary action for failing to follow procedures associated with the modification of isolation devices

Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)

Was this Cause useful?

SECURING: Decommissioning

CAUSE Inability to secure an isolation due to decommissioning activities (e.g. lack of adequate locks to secure isolation and signage)

PRE CONTROL Alternate isolation points
  Upstream isolation
  Total disconnection from energy source

PRE CONTROL Alternative means of securing the isolation
  Temporary means of securing (e.g. purpose built isolation covers)
  Total disconnection from energy source

PRE CONTROL Training, awareness and competency
  Recognition that a decommissioning is a form of modification (e.g. inductions - ‘what is a change?’, simulations/scenarios, etc.)
  Understanding of change management plan and when to apply in regards to equipment decommissioning
  Communication strategy for changes (e.g. pre-shift/toolbox talk training/re-assessment)
  A process for confirming people work within procedures (countering any non-direct/non-verbal messages or actions to maintain production at all cost)
Awareness of consequences of modification (design, plan, supervision)

Personnel to be aware of the hazards associated with modifications to isolation devices

Awareness of disciplinary action for failing to follow procedures associated with the modification of isolation devices

Oral and multimedia demonstration of real life consequences or events (e.g. video or presentations by people who have been injured/affected by not following isolation practices)

Was this Cause useful?

IDENTIFICATION: Disposal

CAUSE Disposal/transfer of incompletely decommissioned asset (e.g. containing stored energy)

PRE CONTROL Risk assessment prior to commencing task of disposal/transfer

Review the decommissioning process to identify possible energy sources left on asset

Confirm adequate labelling/documentation to readily identify all energy sources on asset in transfer

Relevant documentation/maintenance and isolation procedures to be supplied with asset to allow for effective introduction to another site

Specifically identify all possible sources of stored energy (challenge assumptions on identification of stored energy, physically inspect machinery, use a cross section of the workforce to assess, status of stored energy must be irrefutable)

Check and signoff sheet to document that verifies that all components of decommissioning have been completed – and all energy sources dissipated

Asset management/transfer of equipment to include a process for verification that energy sources have been decommissioned - with provision to be signed off by appropriate personnel

Was this Cause useful?

CONSEQUENCE Harm to personnel (injury/fatality) due to release of energy during isolation process or after ineffective isolation

MITIGATING CONTROL Establish hydraulic energy levels as a baseline to determine pressure relief valve settings, and personal protective equipment (PPE) where appropriate

Engineering study during mine design to establish pressure settings, volumes, risk to personnel, and develop controls
Periodic review of engineering studies
Implement identified controls from the engineering study

MITIGATING CONTROL Equipment, plant and infrastructure design
Mitigate personnel exposure by shielding with kevlar sheathing of pressure hosing, anchoring hoses, protection/guarding of pressure connection points (e.g. annulus relief valves)
Run hydraulic lines in locations where personnel are not present (e.g. chocks/roof supports)
Replace hoses with pipes where practical (e.g. stainless steel piping)
Compliance with industry/community standards (e.g. AS 4024– hydraulic systems)
Consider addition of dye to hydraulic fluids to be able to identify extent of hydraulic injection
Continuous improvement feedback and revision/updating of site specifications
Remote operation of hydraulic instruments, valves and equipment gear to separate personnel from hazard

MITIGATING CONTROL Personal protective equipment (PPE)
Appropriate use of PPE (incl. safety glasses, overalls, gloves, boots, etc.) when working around hydraulic systems
Undertake risk assessment to assess effectiveness of PPE relevant to the task
Note: PPE may not prevent injury in all circumstances

MITIGATING CONTROL Pressure relief valve settings
Verification that pressure relief settings match the engineering study
Test functionality of pressure relief valves

MITIGATING CONTROL Selection and maintenance of hydraulic test equipment
Hydraulic test equipment to match the engineering study
Pressure rating
Regular testing and calibration of hydraulic test equipment

MITIGATING CONTROL Training, awareness and competency
Safe work procedures and practices to include:
Personnel trained in responding to an hydraulic incident
First Aid associated with hydraulic injection incidents and other injury

MITIGATING CONTROL Confirm emergency response plan has procedures to deal with injuries from hydraulic energy release
Refer to RISKGATE FIRE TOPIC
Awareness and training in fluid injection procedures (ambulance contact, dye detection equipment, establish specialised medical procedures and arrangements for treatment of fluid injection)

Consider use of medical bracelets on suspected fluid injection cases

Were the Controls for ‘CONSEQUENCE Harm to personnel (injury/fatality) due to release of energy during isolation process or after ineffective isolation’ useful?

CONSEQUENCE Damage to or loss of equipment/plant/infrastructure due to release of energy during isolation process, or ineffective isolation

MITIGATING CONTROL Establish hydraulic energy levels as a baseline to determine protection settings and personal protective equipment (PPE)

- Engineering study during mine design to establish pressure settings, volumes, risk to personnel, and develop controls
- Periodic review of engineering studies and update of standards and mechanical engineering management plans associated with hydraulic systems
- Implement identified controls from the engineering study

MITIGATING CONTROL Equipment, plant and infrastructure design

- Replace hoses with pipes where practical (e.g. stainless steel piping)
- Compliance with industry/community standards (e.g. AS 4024– hydraulic systems)
- Continuous improvement feedback and revision/updating of site specifications

MITIGATING CONTROL Pressure relief valve settings

- Verification that protective settings match the engineering study
- Test functionality of pressure relief valves

MITIGATING CONTROL Selection and maintenance of hydraulic test equipment

- Hydraulic test equipment to match the site design engineering study, and revisions/updates
- Pressure rating
- Regular testing and calibration of hydraulic test equipment

MITIGATING CONTROL Training, awareness and competency

- Safe work procedures and practices to include:
  - Safe methods of isolation
  - Personnel trained in responding to an hydraulic incident

MITIGATING CONTROL Emergency response plan

Refer to RISKGATE FIRE TOPIC
Redundancy plan for critical equipment
Appropriate equipment on site to respond to events

Were the Controls for 'CONSEQUENCE Damage to or loss of equipment/plant/infrastructure due to release of energy during isolation process, or ineffective isolation' useful?