1.0 PURPOSE

This specification describes the minimum requirements for a hoist maintenance safeguard (HMS) system for mine hoists.

The HMS system is a means of preventing hoist operation or movement to allow specified maintenance work to be done safely on a mine hoist plant.

2.0 SCOPE

The use of this standard is specific to maintenance work on mine hoist plants and is only valid at mines that have developed and approved procedures for its use. Only duly trained, qualified and authorized personnel may use the HMS system.

The ZES procedure “Control of Hazardous Energy for Hoist Plant Maintenance” (MPROC-60014) classifies the types of maintenance work that are done on a mine hoist plant and categorizes the protection levels required to perform each class of work. The category 2 protection level is used to disable hoist controls where hoist movement is the primary hazard for workers.

This standard defines the minimum requirements for implementing the safety measures required to prevent movement of the hoist by disabling the hoist control system to achieve the category 2 hoist protection level. The safety measures consist of equipment safeguarding using an engineered system, procedures and training.

The HMS system does not isolate electrical power to the hoist plant and does not protect workers performing work on hoist electrical systems. Standard locking and tagging procedures for electrical work in accordance with the Electrical Safety Program apply in these cases. The HMS system should not be used for hoist equipment protection; this should be done using the ZES Program’s standard lockout procedures.

3.0 REFERENCE DOCUMENTATION

The following documents are related to this specification:

- CSA-Z432 Safeguarding of Machinery
- CSA-Z460 Control of hazardous energy - Lockout and other methods
- MPROC-60014 ZES - Control of Hazardous Energy for Hoist Plant Maintenance
4.0 DEFINITIONS

- “Trip out the hoist” - open hoist safety circuit and bring hoist to an immediate safe stop.
- Lockout – a procedure that disconnects, blocks, or bleeds of all sources of energy (electrical, pneumatic, steam, hydraulics, mechanical, stored, or any other source of energy) that may create a motion or action by any part of the machinery and/or its auxiliary equipment and places a lock on the disconnect device or at the point of disconnect.
- Safeguard – guards or protective devices used to protect persons from the hazards that cannot reasonably be removed or sufficiently limited by design.
- Hoist Plant – includes the prime mover, transmission equipment, head-frame, sheaves, ropes, shaft, shaft conveyances, shaft furnishings, hoist controls, counterweight, signaling and communications equipment and any other equipment used in connection with a hoist.

5.0 SYSTEM REQUIREMENTS

5.1 GENERAL DESCRIPTION

The HMS system disables movement of the hoist without isolating the main source of electrical power to the hoist. The system is integrated with the hoist control and safety monitor systems.

The HMS system operates under three states:
- Off
- Ready
- Safeguarded

The hoist operator activates the HMS system at the Hoist Operator console putting the HMS system into the ready state at a selected HMS station.

Once the hoist is properly positioned, maintenance personnel put the hoist into the safeguarded state at the selected HMS station located at the site where the work is being performed. The safeguarded state prevents the hoist from operating or moving. The hoist controls are tested to confirm they are disabled, then the Category 2 work can proceed. If required, the safeguarded state may be turned off to allow repositioning of the hoist.

When the maintenance work is completed the safeguarded state is turned off by the workers at the HMS station. The hoist operator is then able to change the HMS system from the ready state to the off state at the Hoist Operator HMI. The hoist would then be switched to other modes of operation as required.
5.2 FUNCTIONAL DESCRIPTION

The HMS system shall comply with the “control reliable” requirements of CSA Z432 (dual channel with monitoring). The dual channels each disable the hoist and cause the hoist control logic to disable hoist operation and apply the brakes. The dual channels may be: software and firmware based controllers; hardwire based components; or one of each.

Disabling the hoist includes:
- Opening the safety circuit
- Blocking the drive so that motor current cannot be produced
  - DC – do not open the loop breaker
  - AC – do not open the main AC breaker or lose drive pre-charge
- Setting the speed input reference to zero
- Applying the brakes, including:
  - De-energizing the brake hydraulic pumps for spring-applied hydraulic released brake systems
  - De-energizing control valves to apply full brake effort for air-applied weight-backup brakes.

The HMS system has three states:
- Off
  - Allows the hoist to operate in any of its normal modes of operation (i.e. not safeguarded). Generally these modes may include: Auto, Manual, Inspection, Test.
- Ready
  - Enables all of the HMS features, interlocks and fault monitoring, enables operation of a selected HMS field station, and limits hoist speed to 100 ft/min.
- Safeguarded
  - Disables the hoist controls preventing the operation and movement of the hoist.

The HMS system controls are comprised of:
- The hoist control interface (HMI or hoist console) located at the hoist operator control desk. The hoist operator HMI is used to switch the HMS system between the off and ready states.
- HMS station(s) located in the field. The HMS station(s) are used by maintenance personnel to switch the HMS system to the safeguarded state.

**Hoist Operator HMI**
The hoist operator HMI interface allows the hoist operator to switch between the HMS off and ready states at a selected HMS station. The HMI displays the state the HMS system is in.

In order to activate the HMS system the hoist must not be in automatic mode. Once the system is activated, the hoist speed is limited to 100 fpm. Once in the ready state the hoisting mode may not be changed to automatic mode.
The hoist controls will monitor the HMS system and display any conditions or errors on the hoist HMI. Any messages appear on all hoist operator HMI screens.

Once the HMS system has been put into the Safeguarded state, the hoist operator cannot switch the HMS system into the Off state.

HMS stations cannot be bypassed by the hoist operator control HMI, except under the following special circumstance:

- If a fault in the HMS system occurs while it is in use, and the hoist must be put back into service before the fault can be corrected, the HMS system fault may be bypassed to allow the hoist to be reset by using a maintenance bypass (password or setting allowed key) of the HMS system. The HMS system cannot be used again until the fault is corrected.

**HMS Station(s)**

The HMS station(s) consist of a control interface to allow maintenance personnel to switch the HMS system to the safeguarded state. The station has separate indicators to display that the hoist system is in the ready and/or safeguarded states. There may be one or more HMS stations, but only one of the stations may be used at a time. Maintenance work requiring protection from hoist operation or movement for more than one area shall be done using just one HMS station or by the lockout of the hoist.

The HMS stations are located in areas where frequent maintenance work requiring hoist safeguarding occurs. In areas where there are no maintenance safeguard stations, the HMS system can be used by means of Remote Tagging following ZES Program procedures.

Typical maintenance safeguarding station locations may include:

- Hoist room
- Shaft collar
- Skip dump
- Headsheave area
- Switching the HMS system into the safeguarded state prevents movement of the hoist.
- The safeguarded state cannot be deactivated until the active HMS station has been switched off.
- If a HMS station is switched on when the system has not been put into the ready state at the hoist HMI, the hoist trips out. The HMS system fault and alarm is activated.
- When the HMS station is switched on and the HMS system is fully functional, the indicator beacon on the HMS station is illuminated and a banner on the hoist HMI indicates that the hoist is in the safeguarded state.

### 5.3 FAULTS

All faults with the HMS system shall annunciate at the hoist operator’s station and at all of the HMS stations.
<table>
<thead>
<tr>
<th>Fault Condition:</th>
<th>Action:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any faults detected within the HMS system</td>
<td>1. Hoist trips out, warnings are annunciated on the HMI and the HMS system cannot be put into Ready state. Faults remain on hoist HMI until they are repaired. Entry in Special Instructions that HMS system is not available.</td>
</tr>
<tr>
<td>HMS station power failure</td>
<td>1. A warning is displayed on the hoist HMI that there is a fault with the HMS system 2. Prevents the HMS system from being enabled</td>
</tr>
<tr>
<td>HMS station safeguard switched ON while not in ready state.</td>
<td>1. Trip out the hoist. 2. A warning is displayed on the hoist HMI that there is a fault with the HMS system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fault Condition:</th>
<th>Action:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The state of each of the two the HMS channels do not match each other</td>
<td>1. Trip out the hoist and put the HMS system into fault condition 2. HMS station amber beacon light turns off 3. Fault light and buzzers indicate at HMS station 4. HMI indicates fault condition</td>
</tr>
<tr>
<td>Loss of communications</td>
<td>1. Trip out the hoist and put the HMS system into fault condition 2. HMS indicates fault condition</td>
</tr>
<tr>
<td>Any faults in the hoist system in general or the HMS system in particular;</td>
<td>1. Trip out the hoist and put the HMS system into fault condition 2. HMS station amber beacon light turns off 3. Fault light and buzzers indicate at HMS station 4. HMI indicates fault condition</td>
</tr>
<tr>
<td>Worker switches the wrong HMS station to safeguarded</td>
<td>1. Trip out the hoist and put the HMS system into fault condition 2. HMS indicates fault condition</td>
</tr>
<tr>
<td>General power failure in the hoist system.</td>
<td>1. HMS system remains in Ready state and annunciate fault. 2. The HMS system must be turned off at the hoist console to allow the hoist to be reset.</td>
</tr>
<tr>
<td>HMS station power failure</td>
<td>1. HMS system remains in Ready state. 2. The HMS system can be switched off by the hoist operator.</td>
</tr>
</tbody>
</table>
### While HMS System is Safeguarded:

<table>
<thead>
<tr>
<th>Fault Condition:</th>
<th>Action:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The drive is not at zero output (current or torque).</td>
<td>Trip out the hoist and open the loop breaker and/or main AC breaker. Annunciate fault.</td>
</tr>
<tr>
<td>Speed and/or position indicates that hoist movement is detected</td>
<td></td>
</tr>
</tbody>
</table>
| HMS station power failure | 1. Trip out the hoist and open loop breaker and/or main AC breaker, HMS system remains in Safeguarded state, annunciate the fault.  
2. On restoration of power:  
   - The workers must confirm that the HMS system is properly safeguarded.  
   - The HMS station must be switched off and the HMS system switched off at the HMI to allow the hoist to be reset, following which the HMS system can be reactivated following the normal procedure.  
3. If power cannot be restored and the hoist must be put back in service, a procedure must be followed to ensure that:  
   - the maintenance work being done under the HMS system is cancelled,  
   - the personal protection locks are removed,  
   - the HMS station is switched off,  
   - an entry is made in the hoist operator’s log book releasing the hoist,  
   - a maintenance bypass (password or setting allowed key) is used to allow the hoist to be reset. |
| General power failure in the hoist system. | 1. HMS system remains in Safeguarded state and annunciates the fault. Hoist loop breaker and/or main AC breaker will have tripped out.  
2. The HMS system must be turned off at the HMS station and then at the hoist console to allow the hoist to be reset. |
5.4 EQUIPMENT

5.4.1 Hoist Control Interface

HMS controls are located on a “special operations” or “maintenance” page on the HMI.

Control buttons:

- HMS station selection (OFF/READY)

Annunciation:

- HMS system is off
- HMS system is in ready state for the selected station
- HMS system is in safeguarded state at the selected station
- Annunciate when there is a fault in the HMS system at the selected station

5.4.2 HMS Stations

The HMS stations consist of the following:

- Physical lockable switch with two selections, “Safeguard Off” and “Safeguard On”, to switch on the safeguarded state.
- The user interface may consist of:
  - Pilot lights and beacon; or
  - A panel mounted graphics terminal and beacon.
- The HMS station is a NEMA 4X stainless steel enclosure.

Annunciation:

- Green indicator light on the panel indicates that the HMS system is in the ready state.
- Flashing amber beacon light on the panel indicates that the HMS station is in the safeguarded state.
- Red fault indication light on the panel and a loud audible alarm (with silence button).

For hardwired control operators:

- Pushbuttons - Allen-Bradley Bulletin 800H
- Switches - Allen-Bradley Bulletin 800H
- Green/Red LED indicator light - Allen-Bradley Bulletin 800H
- Flashing amber beacon - Allen-Bradley Bulletin 855 or equivalent

5.5 SEQUENCE OF OPERATION

Each mine will have a site-specific procedure for use of the HMS system, incorporating the following sequence of operation.
1. Following local mine procedures, an entry is made in the hoist operator’s log book indicating what work is to be done on the hoist.

2. If more than one worker will be working on the hoist using the HMS system, one of the workers is designated to be the contact person with the hoist operator.

3. Worker contacts hoist operator to inform of work being done and that they will be using the HMS system.

4. Worker instructs hoist operator to bring conveyance or hoist near to the desired work position. Hoist will normally be on a 5-bell release for this step.

5. Hoist operator and workers exchange 3 bells.

6. Hoist operator puts the hoist into manual or inspection mode.

7. Hoist operator puts the hoist in the HMS ready state for the selected HMS station.

8. Using slow bells, workers position conveyance or hoist in exact position required to perform the work.

9. At the HMS station, the worker switches the HMS system into the “Safeguard On” state. Once the amber beacon illuminates, confirming that the HMS system is safeguarded, the workers apply personal protection locks and tags to the operator switch. Every worker that is working under the protection of the HMS system shall apply their personal protection locks and tags following ZES Program procedures.

10. Workers test the HMS system to ensure the hoist cannot move by ringing slow bells to move the hoist.

11. Hoist operator tries to move hoist:
   a. If HMS system is working properly the hoist will not move, then the hoist operator and workers exchange 3 bells.
   b. If hoist moves, or if hoist operator detects a problem (e.g. motor current builds, brakes start to release), hoist operator does not answer with 3 bells and contacts workers.

12. Workers may now access the conveyance or hoist.

13. When work is complete, or conveyance must be moved to allow further work, workers remove locks and switch the HMS station to “Safeguard Off”, as follows:

14. If work is complete, workers communicate with hoist operator to turn off the HMS system at the hoist HMI, and release hoist to the operator with 5 bells. Hoist operator answers with 5 bells and switches the HMS system off.

15. If the conveyance is to be moved a long distance and then work will continue, workers instruct hoist operator on what movement is to be made and then give operator 5-bell release. Hoist operator turns HMS system off, and moves hoist accordingly. When hoist is in desired position, the HMS system is switched on and safeguarded as per the above steps.

16. If the conveyance is only required to move a short distance, the move may be made with the HMS system in the ready state (without requiring a reset of the hoist controls). Workers inform hoist operator that a move should be made, and move conveyance to a new position.
using slow bells. Once conveyance is in position, exchange bells and switch to safeguarded state as per steps 9 - 11.

Once the work is completed, following local mine procedures, an entry is made in the hoist operator’s log book.

5.6 SYSTEM FAULTS PROTOCOL

If a fault occurs while the HMS system is in use, the workers using the system:

- Stop the work and stay clear of the hoist or conveyances
- Once the fault is corrected, the HMS system must be deactivated and reactivated again following the above safeguarding procedures

If the fault cannot be corrected, the work may be cancelled to allow the hoist to be operated:

- the HMS station is switched off,
- an entry is made in the hoist operator’s log book releasing the hoist,
- If the HMS system can’t be reset to allow the hoist to be released, a maintenance bypass (password or setting allowed key) of the HMS system is used to allow the hoist to be reset.

If the HMS system is not usable, any work that must be performed on the hoist that requires the hoist to be safeguarded must use a higher level of safeguarding (i.e. lock and tag hoist following the ZES program).

6.0 TRAINING REQUIREMENTS

All personnel working on the hoist under the protection of the HMS system shall be trained and authorized to use the system, and shall use their personal protection locks and tags at the HMS station.

HMS training consists of the ZES procedure - Control of Hazardous Energy for Hoist Plant Maintenance (MPROC-60014).

The HMS training is common for all mines. Workers who have qualified to use the HMS system may do so at any mine provided they review the site-specific HMS procedure.

The training shall include:

- Review ZES procedure - Control of Hazardous Energy for Hoist Plant Maintenance (MPROC-60014). This standard defines the types of work that may be performed using the HMS system.
- Review the hazards of working around the hoist plant, and the limitations of the HMS system.
- Review the general layout of the HMS system:
  - System activation at hoist HMI
Safeguarding the hoist at the HMS stations

- Review the general procedure for use of the system as defined in this document.

### 7.0 COMMISSIONING SEQUENCE

- Verify procedure for use of the system
- Inspect wiring and connections
- Activate HMS system at hoist console and test:
  - If not in Manual or Inspection mode, HMS system will not activate and messages a warning
  - Once HMS system is activated, switching out of Rope inspection mode trips out hoist and messages a warning
  - Message appears on HMI that HMS is activated
  - Green ready lights illuminate on the selected HMS station
  - Hoist may still be operated on manual control, speed is limited to Rope Inspection speed setting

- When Safeguarded, confirm that:
  - DC –the loop breaker does not trip
  - AC –the main AC breaker does not trip and drive precharge is not lost
  - Speed input reference is set to zero
  - Brake hydraulic pumps are de-energized (for spring-applied hydraulic released brake systems)
  - Brake control valves are de-energized to apply full brake effort (for air-applied weight-backup brakes)
  - Simulate the following to verify that the hoist trips out
    - Drive not at zero output (current or torque)
    - Speed and/or position indicates that hoist movement is detected
  - Message on hoist HMI that hoist is safeguarded
  - Amber light is illuminated on the HMS station that has been switched to Safeguard
  - Simulate faults in the HMS system and verify that the hoist trips out, the red fault lights illuminate and buzzers sound at the HMS stations, and a fault message appear on the hoist HMI:
    - Circuit shorted or opened
    - Switch or relay failure
    - Remote IO failure
    - HMS power failure c/w bypass operation
    - General hoist power failure. Verify that the HMS remains activated when hoist power is restored.
§ HMS is deactivated at the hoist HMI
§ Hoist is switched out of Manual or Inspection mode

- With the hoist in normal operation, switch the HMS station to safeguarded state, verify that:
  - the hoist trips out
  - The HMI indicates a fault due to the HMS system.
  - The indicator lights on the HMS station do not activate.
  - The hoist cannot be reset until the HMS station is switched off.

8.0 REVISION AND TRANSITION NOTES

Revision notes describe: what was changed, and if applicable, why it was changed, and the plan to implement the change, including whether changes are retroactive.

Note: The revision notes are a summary of the changes and may not necessarily be a complete list.

A risk code is entered for each revision and if applicable, the revision notes will describe how risk was addressed for the revision.

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</tr>
<tr>
<td>B</td>
<td>Risk has been addressed for this revision by the reviewer and approver. Low risk or no new hazards identified.</td>
</tr>
<tr>
<td>C</td>
<td>For this revision, a PHR or other risk management tool has been used to address risk and minimize hazards. This risk assessment has been documented and is available through Central Engineering.</td>
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<th>Risk Code</th>
<th>Approved by</th>
<th>Reviewed by</th>
<th>Issue Date YYYY/MM/DD</th>
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</thead>
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<td>1</td>
<td>Issued</td>
<td>C</td>
<td>Al Guse</td>
<td>John Ross</td>
<td>2018/02/14</td>
</tr>
</tbody>
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9.0 APPENDICES

Appendix A: Revision and Transition Notes