



DE BEERS
A DIAMOND IS FOREVER

Cullinan Diamond Mine

Critical Safety Systems on Underground Trackless Mobile Machinery

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28 July 2004



OBJECTIVES

- A) Identify major/critical safety devices and analyze the operation of these systems.
- B) Identifying limitations and problem areas in these systems
- C) Assess the maintenance and management of these systems





A) SAFETY DEVICES

1) Service brake:

- The COP on TMM requires the service brakes to be fail-safe.
- The brake system is thus of the spring applied hydraulic release type.
- In order for the wheels to turn, enough hydraulic pressure has to be maintained.
- When the foot pedal is depressed, the flow of hydraulic oil to the wheel ends is gradually cut off diverting it to the hydraulic tank.
- As this happens the springs steadily applies a force on the disc pack, restricting the wheels from turning.
- Should ,for any reason, the system pressure drop to below that required to hold the spring back, the spring will immediately apply full braking energy.





Safety Devices continued

2) Emergency/Park brake:

There are two types in use on mine:

a) *Electronically controlled*

- Whenever the park brake button from the operator compartment is depressed, the PLC de-energizes the park brake solenoid, which actuates the spool that cuts off the flow of pilot pressure and allows the oil from the wheel hubs to flow back to the hydraulic tank, thus allowing the springs to apply the braking force.
- Provision has been made to prevent the engine from restarting while the park brake button is not depressed.





Safety Devices continued

b) Manually controlled

- The park brake button inside the operators' cabin is directly linked to a single spool, 2-position valve, which directs or relieves the flow of pilot pressure to the park brake selector valve.





Safety Devices continued

3) Protection of operators:

- As a requirement of the mandatory COP (Code of practice) for TMM's, all U/G trackless mobile machinery are to have roll-over protection structures.
- Another function is to protect the operator from falling objects.





Safety Devices continued

4) Door limit switch:

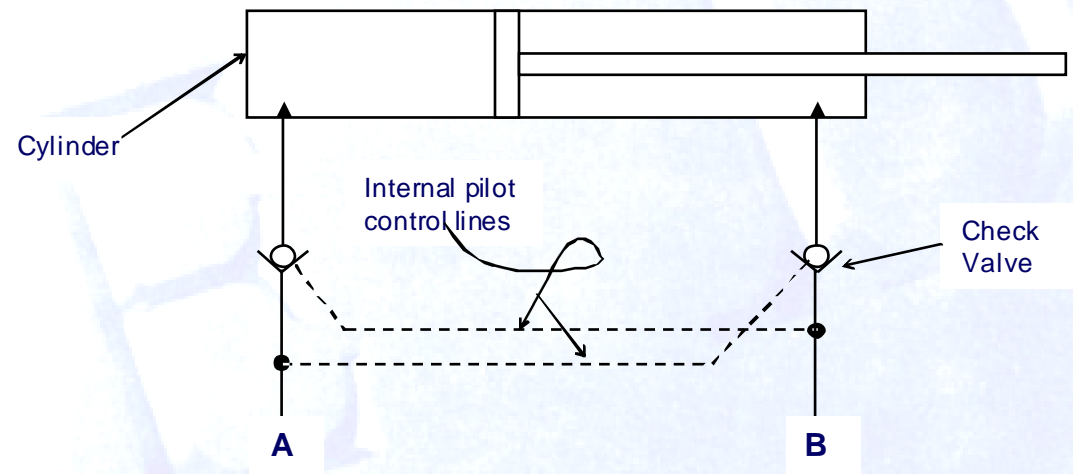
- The purpose of the switch is to ensure that all controls that could set any part of the TMM in motion are cut off from their actuators.
- The electronic door limit switches were previously used to cut off the articulation control levers from the articulation actuators (cylinders).
- However, there has been an incident resulting in one fatality due to this switch being bypassed.
- The door limit switch has since been changed from an electronic to a hydraulic one.





Safety Devices continued

5) Fail-safe valves on double acting hydraulic cylinders:



In order to extend the cylinder, pressure is applied in the flow pressure line A (on the left hand side), and while this pressure is maintained, the check valve on line B, (the right hand side) is opened to allow flow of oil out of the cylinder back to the reservoir.



B) LIMITATIONS AND PROBLEM AREAS

1) Neutral Brakes

- According to the Mines Technical and Non-Functional requirement specifications document, all trackless equipment must have neutral brakes.
- However there's no written procedure for testing and checking the correct state of operation for such a system or mechanism.
- Maintenance procedures only outline the steps to be taken when testing the service brakes and the emergency brakes, but nothing is being said about the neutral brakes.





LIMITATIONS AND PROBLEM AREAS cont.

2) Door limit switch

- Some of the door limit switches only cuts off the hydraulic power to the articulation system; thereby not applying safety brakes when the cabin door is opened.
- Therefore although the operator is protected from being crushed due the articulation of the machine no protection is provided from machine movement in instances where there are no neutral brakes or the neutral.





LIMITATIONS AND PROBLEM AREAS cont.

3) Misuse of safety devices

- There has been instances in the past where the emergency braking system (Ausco Brakes) on utility vehicles broke down to misuse.
- The machine operators would use the emergency or park brakes as though they were service brakes; that is using the emergency brakes for retarding and stopping the vehicles under normal operation.





LIMITATIONS AND PROBLEM AREAS cont.

4) Safety valves on hydraulic cylinders

- In some LHD's these are only found on the main boom cylinder and not on the bucket cylinders.
- There has been an incident involving an LHD whereby one of the hydraulic pipes supplying pressure to the bucket cylinders burst while the bucket was in the raised position, resulting in the bucket immediately tilting down.
- Failure of these pipes cannot be predicted and furthermore there is no safe way of testing or checking if these are still operating properly.





LIMITATIONS AND PROBLEM AREAS cont.

5) Protection of operators

- All TMM's on mine have safety belts in the operator compartment, however not all the TMM's have a structure that will protect the operator from falling objects; neither do they have sound proof cabins.





LIMITATIONS AND PROBLEM AREAS cont.

6) Emission control

- Although the TMM's are required to have silencers, diluters and emulsifiers, there is no technical specification outlining acceptable composition of exhaust fumes produced by these TMM's.
- Furthermore the maintenance of these emissions control components only includes their visual inspection during routine inspections; there is no accurate measurement or determination of their efficiency.





C) MAINTENANCE AND MANAGEMENT OF SYSTEMS

1) Operator checks (daily):

- Door switches
- Brakes (service and emergency)
- Steering
- Starting in gear
- Stop blocks
- Correct functioning of main isolator switch
- Fire extinguisher condition
- Seat belts
- Articulation safety lock links
- Lights and hooter

All above are covered in the prestart check lists which is filled in by operators at the start of each shift





MAINTENANCE AND MANAGEMENT OF SYSTEMS cont.

2) Artisan checks (weekly and monthly):

Same checks as by operators, as well as:

- Transmission (stall test)
- Locking of gears (to required spec)
- Turn points of steering rods
- Oil levels and leaks
- Starting in gear





MAINTENANCE AND MANAGEMENT OF SYSTEMS cont.

3) Documentation:

- GMS (Group Maintenance System) is the document system that is used to control the issuing and capturing of job cards (completed) as well as the control of backlog.
- The system is loaded with the required maintenance schedules from the OEM (Original Equipment Manufacturer) maintenance schedules are worked out on hours worked basis i.e. 250hr service ect.





MODIFIED DUMP TRUCK

