GRADER BRAKE SYSTEM
IN SERVICE TESTING AND INSPECTION
35909

Prepared for: **Owners and end users**

Prepared by: **Cougar IME**

Date: **27-9-19**

Revision: **C**

Contents

1 Document Scope

This document describes recommended in-service brake testing and inspection for the Cougar IME Grader. Graders of this design were manufactured by Boart Longyear, Industrea and GE Mining.
The Brake system is design registered with the department of planning and environment has been designed to Mining Design Guideline 39 and amendment 1.

This document should be read in conjunction with grader maintenance and operation manuals.

The grader brake system is an air over hydraulic pressure applied service brake system, with a spring applied, hydraulically released Emergency/ Park/ Automatic brake. The service brake units are located adjacent to the drive wheels on the tandem beam and are independent to the Emergency/park brake units mounted in the centre of the tandem beam and applied via the chain drive. The schematic has drawing number 7-091004-700.

Both the service and parking brakes are not adjustable on the grader. Regular brake testing is required to verify the operation and performance of the braking systems.

2 Frequency of Testing

In Service Testing of brake systems is recommended to be carried out on the Grader at intervals of 250 hours or monthly, whichever occurs first.
In service testing should be carried out as outlined in MDG39.

Cougar IME recommend that a calibrated heavy vehicle brake test meter be used for all dynamic testing and that a load cell pull-test or actual gradient be used for brake holding tests at no less than 3 monthly intervals.

Test	**Frequency**
Daily test	8 engine hours or daily
Dynamic service brake testing as per MDG 39 & service checks	250hrs or monthly
Dynamic secondary brake testing as per MDG 39 & service checks. Note: testing the secondary brake also tests the emergency/park brake dynamic performance.	250hrs or Monthly
Pull test or gradient test	750 hrs or 3 monthly
Service brake inspection	1000 engine hours or yearly
Emergency/park brake unit inspection	1000 engine hours or yearly
Park brake v/v change out	2000 engine hours or two yearly (safety

	critical component)
Emergency/park brake unit overhaul or replacement	2000 engine hours or two yearly (safety critical component)
Pilot valve replacement	4000 engine hours or 4 yearly (safety critical component)
Quick release valve replacement	4000 engine hours or 4 yearly

It is recommended that a “Full system test” be undertaken immediately after any repairs or maintenance to any part of the braking system and before the vehicle is returned to service.

Note: The Daily test does not comply with any standards or guidelines but, gives a guide as to the possible deterioration of the brake systems between the Intermediate check and Full system tests.

This procedure or an edited version of this procedure should be incorporated into the Maintenance Management System of any underground coal mine using Cougar IME Graders.

The frequency of in-service testing may be based on historical records of performance, repairs and maintenance and reduced or extended.

WARNING

Braking systems and components are subject to wear and failure through misuse and damage in the mining environment. Regular in-service testing reduces the probability of a sudden and unexpected system or component failure. A number of undetected failures may result in an incident causing injury to a person or persons.

3 Definitions

The definitions used throughout this procedure are identical to those used in Handbook for the Approval Assessment of Transport Braking Systems on Free-Steered Vehicles in Underground Coal Mines MDG39 Amend Dec 2006.

4 General Safety

The following tests either requires the vehicle to be driven at speed on a nominated test track or full transmission stall against the brakes. Measures must be taken to ensure the safety of the person undertaking the testing and any other persons or plant and equipment that may be in the vicinity of testing. Clear all-round visibility is essential. Suitable clearances and surface conditions are also essential. All test track/areas must conform to MDG 39 Appendix B requirements.

The test area should be sufficient length to ensure that the vehicle may be brought safely to rest in the event of a brake failure of any kind during testing.

It may be necessary to install barriers or tapes in accordance with the mine's general safety rules in the test area.

When working on or around the machine always wear the appropriate personal protective equipment, always carry out appropriate risk assessments and apply the risk assessment results.

Always check gauges and ensure all pressure is released on hydraulic and pneumatic systems prior to working on them (including undoing hose ends).

5 Test Course and Conditions

5.1 For Static Tests

The static test must have adequate clear room around the vehicle to allow the vehicle to be brought back to rest in the case of brake failure.

Note: The test area where the vehicle is located during the test shall meet the requirements of MDG 39. Dips, bumps, slopes and other surface condition

shall affect the results and cannot be compensated for by comparisons or other means.

5.2 For Deceleration Tests

The test course on which braking tests are carried out shall have sufficient length to enable them to be carried out safely with adequate over run distances to allow for brake failure.

Note: Where a test course is not available, meeting the above requirements, then operators should select a test course for in-service testing which will be maintained and consistent for long periods. The results from the same test course may then be used to indicate performance trends that may then be employed within the maintenance management system to predict service/repair requirements. Testing should always be done in the same direction of travel on the test course.

5.3 For Holding Tests

Use a ramp having a 25% grade with suitable wheel chocks just clear of the wheels to allow for brake failure. Alternatively, a calibrated load cell and rated safety chains for a pull test can be used.

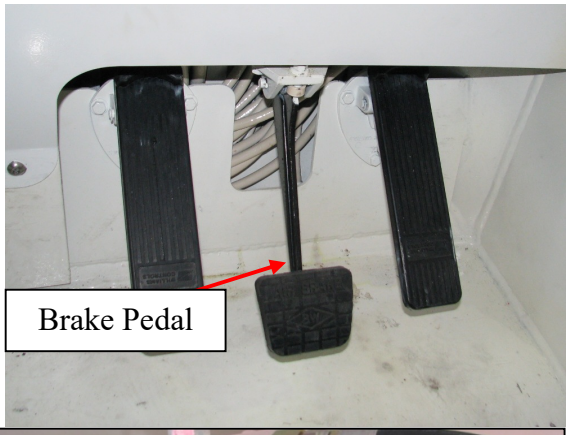
6 Test Instruments

Any brake testing instrument employed for in-service testing should be calibrated and comply with the requirements of MDG39 Appendix G.

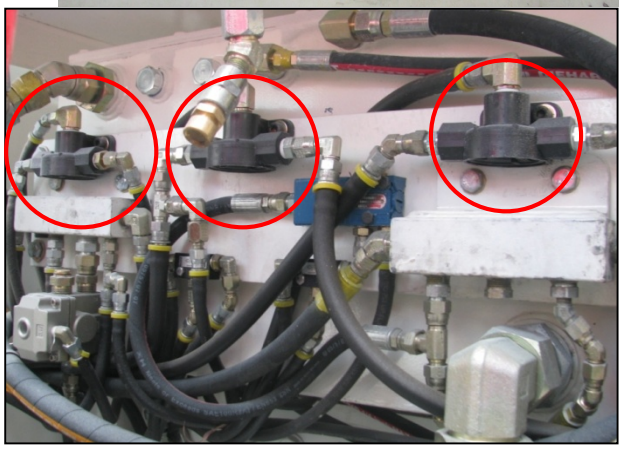
7 Service Brakes

7.1 Service Brakes

The service brakes are applied via pneumatic pressure. The service brake pedal allows air to flow from the air reservoirs, through the quick release valves, and to the brake assemblies. The rear service brakes are supplied from the main air reservoir while the front service brakes are supplied from the auxiliary air reservoir.



The quick release valves allow air to discharge rapidly from the brake units once supply pressure is released. They are located forward of the engine.



From left to right in picture:
LHS – Park / emergency quick exhaust
Mid – Rear brake quick exhaust
RHS – Front brake quick exhaust

Provided to the front and rear service and park/emergency brake circuits. Allows for faster release of the brakes.

The front and rear service brake pressure gauges indicate the pressure in the lines to the relevant brake packs. Pressures will rise when the brake pedal is pressed. Design pressure for braking is 100psi.
Reservoir pressure gauges (aux and main) indicate air storage pressure. If main reservoir air pressure drops below 52 psi, and park brakes will start to apply.

7.2 Dynamic Service Brake testing

Service brakes shall be tested while the vehicle is on a flat surface at maximum speed, subject to safety considerations.
Tests should be repeated a minimum of three times.
Results obtained during field trials show that the Grader's mean deceleration is between 0.35 and 0.4g.

The minimum average deceleration for the service brake is 0.3g
The maximum response time is 0.7 seconds
Each driver prior to operation can verify the function of the service brake system by driving in second gear against the foot brake. The machine should not drive

through the brakes in this situation. If the Grader fails this test, place an out of service test tag on a visible part of the machine controls and follow the mines defect management plan.

7.3 Service Brake Disc Inspection

Measure the five static disc thicknesses. **A new static disc has a thickness of 1.91 +- 0 .05mm**.

Measure the four. **A new friction disc has a thickness of 3.45 +- 0.13mm.**

Check the thickness of the friction discs groove depth. **The minimum groove limit is specified at 0.127mm.**

8 Emergency/Park Brakes

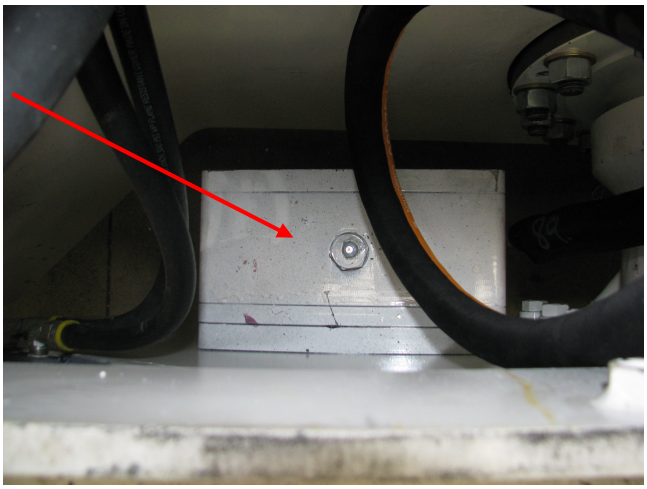
Both emergency park brake assemblies are identical and are manufactured to Cougar IME part number 7-090942-700.

Cougar IME recommends that a park brake pull test be conducted every 3 months to ensure correct operation. Cougar IME recommend that the brakes be tested monthly or every 250 hours service and examined after one year of operation or 1000 hours. It is recommended emergency brake units should be overhauled or replaced every 2000hrs.
Note: Dynamic testing of the emergency park brake also tests the secondary brake performance. Refer secondary brakes for dynamic testing requirements.

The park brake pull test value should be greater than 4057kg or 39,800N calculated for holding on a 1:4

The emergency brake system is a “SAHR” (Spring Applied Hydraulic Release) design and as such is a fail to safety system. The emergency brake actuator is the valve with the red button and is situated in the driver’s compartment on the left-hand side of the driver.

8.1 Emergency/Park Brake Units



Hydraulic pressure is pumped through a check valve, through the brake pilot valves, and then through to the brake manifold and onto the failsafe brake units. The brake units require 52 bar pressure to be fully released. The brake pressure gauge is plumbed into the Brake Manifold.

The failsafe brake is located on the inside of the swing beam assembly, adjacent to

the swing beam mount to the chassis.

8.2 Emergency / Park Brake Discs Inspection

1. Inspect brake units and tandem beams for leaks or damage.

2. Check dimensional measurements of the discs installed in the emergency park brake 7-090942-700. Refer Appendix A for general arrangement detailing the location of these disc parts.

   The brake disk pack height can be inspected by removal of the inspection plug in the emergency brake unit.

   Item 5 - Disc-Static Brake 7-090950-700
   Item 6 - Dynamic Brake 7-090932-700

   Both the dynamic friction discs and the steel static discs have 4.00mm nominal thickness when newly installed. Given there are five dynamic friction discs and six steel static discs, the total brake pack height of eleven discs is 44mm nominal. 40mm minimum pack height.

Previous testing has shown that the dynamic friction discs will wear to 3.80mm thickness quickly as they bed in during commissioning. Reductions in thickness of the friction discs under this 3.80mm can be deemed in service wear. The brakes are designed to operate with the total pack height down to 40mm. At this total 4.00mm of wear of the brake pack height, which combines wear of all the individual brake discs, the spring-loaded piston reaches the end of its stroke and bottoms out in the emergency brake housing. At this point the emergency brakes will lose effectiveness. Given there is generally no significant wear to the steel static discs, the total wear limit of 4.00mm can be applied against the dynamic friction discs. Therefore, once each dynamic friction disc wears from 4.00mm to 3.2mm, total 0.8mm, across five discs, giving a total wear measurement of the brake pack of 4.00mm, the total brake pack height reaches 40mm.

9 Secondary Automatic Brakes

9.1 Dynamic Brake Testing

Secondary brakes shall be tested while the vehicle is on a flat surface within 10% of maximum speed, subject to safety considerations.
Use a calibrated heavy vehicle brake test meter.
Apply the park brake red button and record results

Minimum average deceleration for the secondary brake for operation on grades up to 1 in 4.5 is 0.24g
The maximum response time is 1 second

Automatic activation of the brake control valve (Red Button in cabin) indicates operation of the driver's door interlock, engine 'Off' switch and safety circuit activation of the **automatic brake**.

The secondary / Automatic brakes will operate in the following situations:

- Activation of the red Emergency/Park brake button
- Loss of service brake pressure (52 psi activation)
- When the operator leaves the driver's cabin (activation of door interlock valve - see below)
- When the engine is stopped by the operator
- When the machine is shut down by the safety shutdown system

10 Daily Test

Refer to sections 6 & 7 above for test course conditions and safety prior to carrying out any testing. During each 8 engine hour or daily period that a vehicle is operated at the mine, the brake system shall be tested to confirm the safe operation of the brakes.

10.1 Service Brake Test (Static Test)

1. Place foot on service brake pedal.
2. Check both service brake gauges register an increase in pressure equivalent to their respective reservoirs greater than 55psi (380 kpa).
3. Select second gear.
4. Select forward direction.
5. Release park brake (button out).
6. Slowly accelerate engine to maximum RPM for approximately 1 second
7. The vehicle should remain stationary.

If the brakes do not hold the vehicle stationary or the pressure gauge does not show that service brake system has the correct pressure of greater than 400 kPa, apply the park brake, turn off the engine, place an out of service tag and follow the mine's Defect Safety Management Plan.

10.2 Park Brake Test (Static)

1. Hydraulic and Service Brake Pressure: Check Hydraulic System pressure. 60 bar (870psi) standby, 140 bar (2030 psi) max.
2. Park Brake Operation: Check “park brake release pressure gauge” indicates 52 bar or more. If it does not exceed 52 bar, the park brakes will drag and the machine should be tagged out of operation and repaired.

10.3 Automatic Brake Test (Static Test)

1. Place foot on service brake pedal.
2. Release park brake (button out).
3. Open operator door
4. The park brake should apply within 1 second.
5. Close operator door.
6. With the service brake still applied, release park brake (button out).
7. Turn the engine off.
8. The park brake should apply within 1 second of the engine stopping.

If the park brake does not apply within 1 second or pressure is incorrect, apply the park brake, turn off the engine, chock the wheels, place an out of service tag and follow the mines Defect Safety Management Plan.

10.4 Service Items

1. Check for leaks in both hydraulic and pneumatic systems.
2. Check hydraulic tank cap is in place and filter/breathing.
3. Check hydraulic hand pump and tow valve function.
4. Check hydraulic return filter pressure.
5. Check the pneumatic purge filter for correct filtration and function.
6. Check pneumatic pressure gauges.
7. Check master cylinders for leaks.

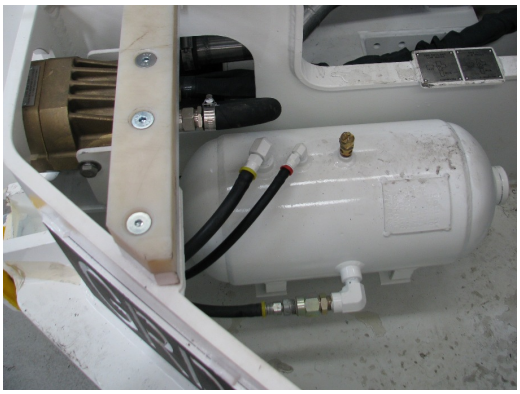
11 Monthly Service items

1. Inspect the foot brake pedal is free from debris, that linkage and pedal bolts are in place and secure and free from corrosion or damage that may affect its operation.
2. Check axle hubs for damage or oil leaks.
3. Check secondary brake housing for damage or leaks.
4. Check the park brake control for build-up of debris or damage that may affect its operation.
1. Check Park/Emergency indicator gauge shows zero pressure when the park brake is applied.
5. Check drive shafts condition.
6. Inspect air reservoirs for leaks/debris or damage.
7. Inspect Brake housing bolts are in place and torqued.

If a defect is found, apply the park brake, turn off the engine, place an out of service tag and follow the mines Defect Safety Management Plan.

11.1 Auxiliary Air Reservoir

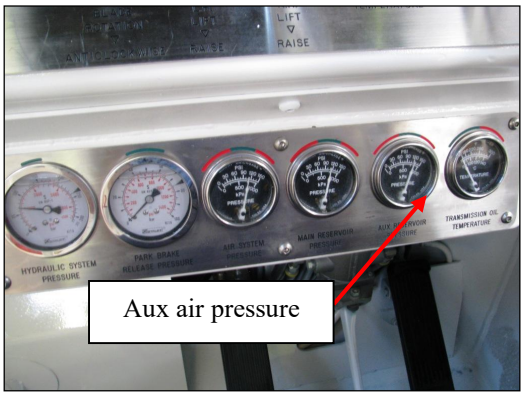
The auxiliary air reservoir is located beneath the exhaust conditioner water supply tank on the right-hand side of the machine.



This is a dedicated air supply for the front service brakes. The rear service brakes are supplied from the main air reservoir. The auxiliary system pressure flows to the auxiliary reservoir pressure gauge.

The safety relief valve is mounted on top of the reservoir.

The drain point for the auxiliary reservoir is located adjacent to the main reservoir drain point, above the drive wheels on the left-hand side of the machine.

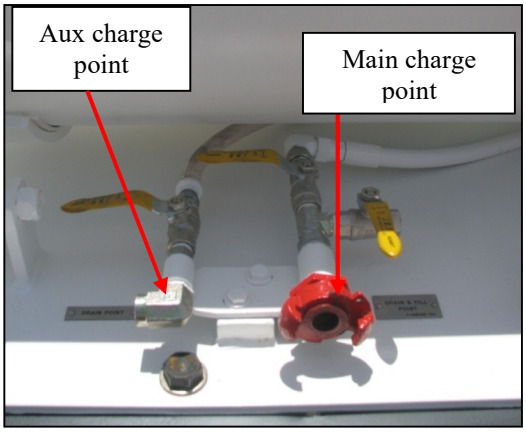


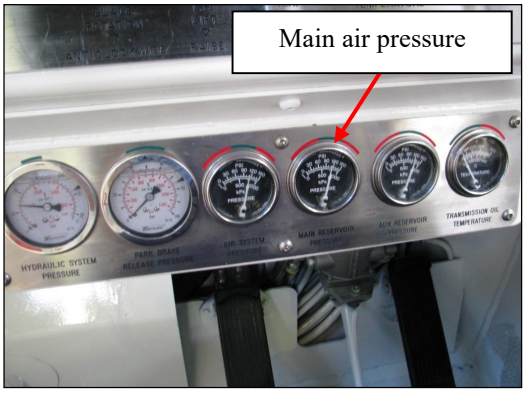
11.2 Main Air Reservoir

The main air reservoir is located on the left-hand side of the machine above the drive wheels.

Description: The main air reservoir is filled via the charge point (below the main air reservoir), and mains system pressure flows to the main reservoir pressure gauge, and supplies the full pneumatic circuit, starting, and rear service brakes. The main air reservoir is isolated from the circuit by a main isolation valve, located in the driver's cabin at the entry.

An auxiliary drain point is located to the left of the main charge point.





Charging the reservoir: Before connecting the mine air supply to the grader, blow out any water that may be present in the hose.

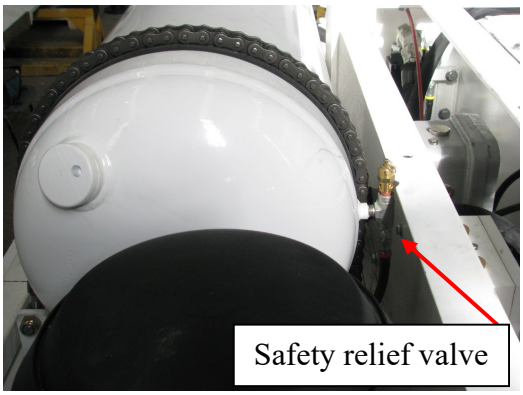
Connect and pin the Minsup coupling.

Open the tap to charge the reservoir.

To disconnect the mine supply hose, close the tap on the Grader and the tap on the mine supply. Open the bleed tap on the Grader to discharge compressed air trapped in the length of the supply hose.

Once the joint is loose, the coupling can be disconnected.

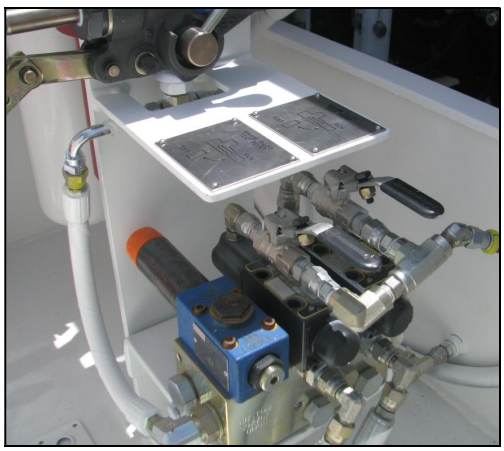
The safety relief valve is mounted behind the main air reservoir tank on the side closest to the engine.



12 Pilot valve test

The secondary, park and Emergency brakes rely on the operation of a pilot valve to dump oil to apply the brakes. Two pilot valves have been supplied in this system, each working on the same air pilot signal but independently applying the brakes. That is failure of one valve to move to the spring justified position will not cause the brake system to fail. A test valve has been fitted to the pilot air on both valves so that each valve can be seen to be operating correctly.

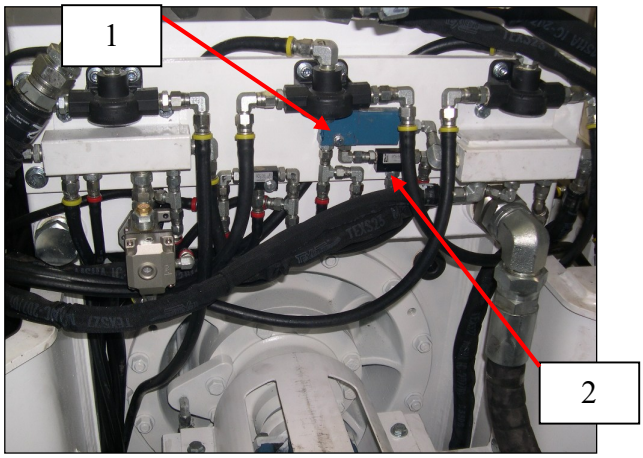
To test the pilot valve, release the brakes and observe hold off pressure on gauge, approximately 52 bar. Then move the test handle to the 'Test' position, the pressure should drop to less than 5 bar to indicate that the pilot valve is working. Return the test valve to the 'Run' position. Repeat this process for the other valve.



Cougar IME recommend that the pilot valves be scheduled for change-out at intervals of two years or 4000 hours operation.

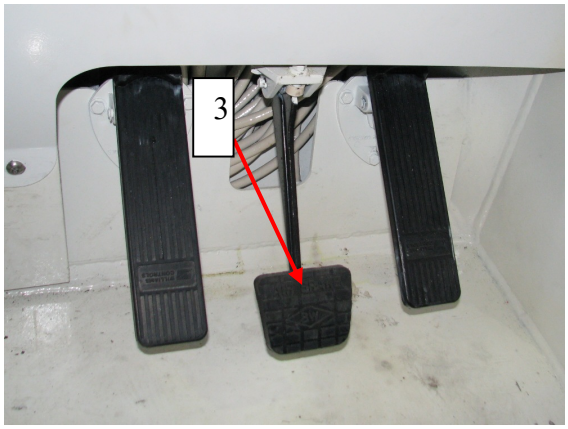
13 De-clutch Valve

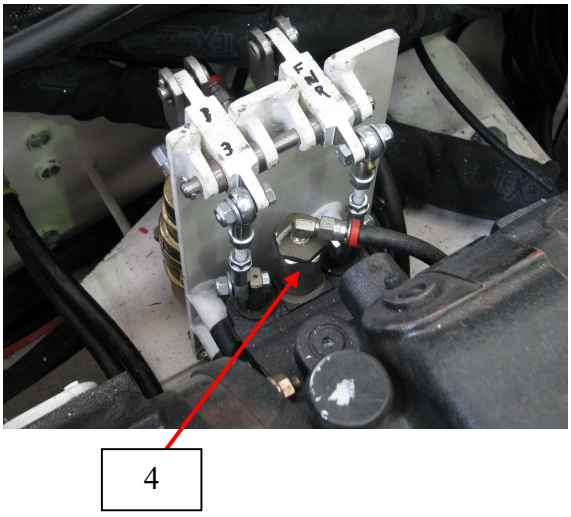
Operation of the park/emergency brake causes the spring brakes to apply and activates the de-clutch valve to disengage the transmission. This feature prevents the machine being driven through the spring brakes.



1 - Brake / Declutch pilot valve
2 - Shuttle Valve
3 - Brake Pedal
4 - Declutch Cylinder

The declutch cylinder is piloted off (clutch engaged) when the park brake hold off pressure is above 240kPa.
Park brake hold off pressure will not come up unless the engine is running and the other interlocks are all satisfied.
The operation of the de-clutch valve can also be controlled by the foot pedal located at the driver's left foot. This control can be used to inch the machine.





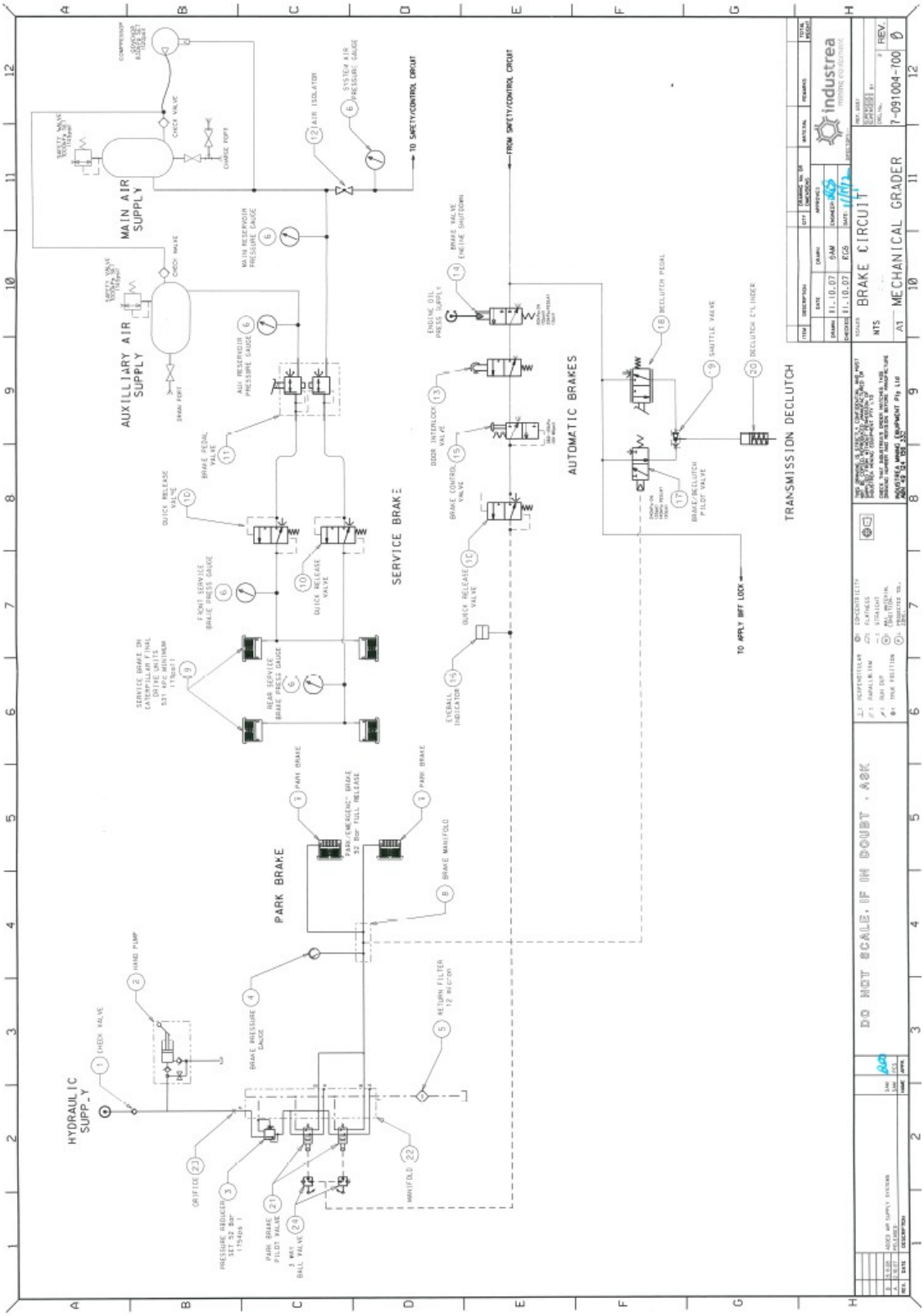
13.1 De-Clutch Interlock Test

Failsafe brake interlock test

1. Apply park brake (button down).
2. Check Park/Emergency indicator gauge shows zero pressure.
3. Select first gear.
4. Select forward direction.
5. Slowly accelerate engine to maximum RPM for approximately 1 second.

The transmission should remain in neutral and the vehicle should remain stationary.

14 Appendix A – Brake Circuit Schematic



15 Appendix B Emergency Park Brake Drawing