The SERB
Instruction Manual

Manufacturer: PS Rail / Dynamic Sampling
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Date of Manufacture: 2006
Serial Number: SERB1

Technical Data

Operational Weight Empty: 1.25 Tonnes
Maximum Operational Weight on Trolley 2.00 Tonnes
Maximum Operational Weight off Trolley 2.20 Tonnes

Nominal Engine Power 21 kW.
Operational (Max) Hydraulic Pressure 140 Bar
APPROVED OPERATORS
All operators of this machine shall have been assessed as competent by either Mr. Petar Stanojevic or Mr. Tony Parker.

1- Introduction
The SERB (Specialist Excavation of Railway Ballast) is a machine which has been developed to advance the technology of railway trackbed investigation. It enables good quality, consistent, representative sampling of coarse granular materials. It has many features incorporated for protecting the machine operator and people on and around the worksite, and takes into account all applicable safety regulations.

The machine can only be used in a possession, and would normally be operated on trolleys. It can be used in the cess for excavation in granular soils away from the line, provided that there is sufficient space available for safe operation.

This manual gives a working description of the machine and its hydraulic system, and instructions for safe operation and maintenance.

2- Description and Major Components
The SERB excavates coarse granular soils using 100mm dia vacuum pipes which can operate at a rate of up to 100kg/minute.

It consists of a hopper, approximately 1.2 x 1.4 x 0.9m high, whose upper section houses a hydraulically driven fan which creates a powerful vacuum. The front end of the hopper is provided with two vacuum ports, one at either side, to which vacuum pipes are attached. After excavation is complete the contents are emptied via a door in the front of the hopper: a hydraulic ram is used to raise the rear of the hopper.

A further power take off (PTO) is available to drive additional sampling equipment as required.

Figures 2 – 5 indicate the major components of the SERB.
11 – Chassis
12 – Twin Crawler Tracks
13 – Hydraulic Power Pack
14 – Hopper Unit – 1 cu. m
15 – Fan housing
16 – Vertical axis fan
17 – Hydraulic Motor
18 – Vacuum Ports
19 – Vertical Exhaust Outlet with Protective Grid
20 – Hinged access doors
21 – Hydraulic Pipes
22 – Hydraulic Ram
23 – Flexible Vacuum Hose
24 – Rigid Vacuum Pipe
2.2 The Hydraulic Circuit (See Appendix 1 for Circuit Diagram)

The hydraulic circuit consists of three in-line identical pumps on a single shaft, each delivering 22 l/minute at a typical working pressure of 110 bar. These supply three main valve blocks, (referred to as valves 1 to 3 below) which each incorporate pressure relief valves factory-set to 140 bar.

In order to achieve maximum suction power the flow from each pump is directed to the fan motor, giving a flow rate of 66l/minute.

Tractive power is provided via valves 2 and 3 when set in neutral mode which operate the left and right tracks respectively. Each track is operated independently by solenoids controlled by self centering toggle switches located on the remote control cable.

The flow from valve 3 also provides the power to raise and lower the hopper when in neutral mode.

The flow from valve 2 can also be directed to an auxiliary power take off to enable other tools to be used in conjunction with the SERB.

2.3 Controls

The control panels are illustrated in figures 7 and 8.

![Figure 7 - Hopper Control Panel](image)

![Figure 8 – Remote Track Control](image)

The hopper control panel is located above the engine, and consists of four valve control levers. Operation is generally self explanatory.

The vacuum is operated by pushing each lever labelled VAC forward in turn, starting with the left hand lever, waiting a few seconds until the fan speed stabilises before pushing the next lever.

The crawler tracks are operated by the Remote Track Control. The levers labelled VAC 2nd SPEED and VAC 3rd SPEED must be in the neutral position in order to operate the tracks.

The following instructions are intended for those working with the SERB in order to reduce or eliminate risks during transiting, operation and maintenance.

3.1 Conditions of use

- The SERB is designed to operate in all weather. However in sub-zero temperatures it may not be possible to sample from the frozen trackbed layers.

- Before use the operator should undertake a visual inspection of all components for signs of damage, excessive wear or leakage of hydraulic oil, as described in the maintenance section.

- A spill kit should be available at the worksite at all times to enable minor spillages of hydraulic oil or diesel fuel to be cleaned up in a satisfactory manner.

- The SERB should be stored under cover. Before using after an extended period of storage it will be necessary to carry out all of the routine maintenance checks plus inspection/cleaning of the fan.

- The safety rules assume that the SERB will be used for soil sampling, and it is therefore designed for intermittent use. It is not designed to operate at full power for long periods. Oil temperature should be checked regularly; it should not exceed 60°C.

- The SERB must only be used to excavate inert materials to eliminate danger of explosion. As an addition precaution an earth lead is provided.

- The noise level measured at operators ear level while operating at full power was measured at 88.6 dBA and the maximum vibration level measured on the vacuum pipe was 2.61 m/s². The sound level exceeds the action level but can be mitigated by wearing suitable ear protection. The vibration level exceeds the 8 hour continuous exposure value, but as the machine will not be operated continuously on full power it is considered that the SERB can be operated safely for 8-hours. For longer periods a change of operators is required.

- The SERB should ideally be operated on a level surface but may have to be driven across sloping ground in order to access a site. In general the SERB should not be driven up slopes steeper than 20°. In exceptional circumstances this can be increased to 30° provided the engine faces uphill. Slope indicators are located on the control panel to assist in determining whether the SERB is stable. For information only the following chart gives limiting static stable angles.
Before excavation commences the earthing lead must be attached to the metal frame of the trolley in order to prevent electrostatic discharge from causing ignition of potentially combustible mixtures in the hopper.

### 3.2 General Safety Precautions

- The machine should be operated only by personnel who are fully trained in its operation and are aware of the dangers involved. This applies equally when undertaking maintenance of the machine.

- For engine starting instructions and safety precautions refer to engine manufacturers manual. The operator should be satisfied that the engine has been maintained according to the manufacturer’s instruction.

- Before starting engine make sure that all tools or equipment associated with maintenance or operation of the SERB have been removed.

- All operators and associated personnel will be required to wear standard PPE, including high visibility clothing, hard hats and approved footwear. In addition to this all personnel working within 2m of the SERB are required to wear ear defenders at all times.

- Dust masks must be worn in dry weather, i.e. if there is a possibility of dust emission from the vacuum exhaust outlet.

- Transporting the SERB will normally involve the use of ramps. Care should be taken to ensure that both ends of the ramps are placed on firm reasonably level surfaces and are securely fastened.

- While moving on crawler tracks the operator should ensure that the wire to the remote control is free. If the control panel or wire becomes trapped there is a risk that the control circuits will be broken.
3.3 Inbuilt Safety Features

In order to make the SERB safe to operate and maintain there are various inbuilt safety measures as indicated below. (Refer to Figures 10 and 11).

- The SERB is fitted with emergency stop buttons, one located by the control panel and the other located between the vacuum ports on the front of the hopper.

- The crawler track system was originally designed to transport a 2 tonne hydraulic excavator. The total unloaded weight of the SERB is 1.25 tonnes.

- All sharp edges are rounded off the hopper unit.

- The fan housing is protected on both its underside and exhaust by steel mesh to prevent body parts coming into contact with the fan. An access door is provided in the fan housing to facilitate easy cleaning but this should not be removed without first removing the ignition keys and disconnecting the battery to prevent accidental start up.

- The crawler tracks ensure that it is highly stable when transported by road. There is no need for shoring.

- There are two separate wiring circuits, one for the power pack and the other crawler track control circuit. Both circuits are fused. The power pack circuit has an in-line fuse located on the positive lead close to the battery. The fuse for the crawler track control circuit is located in the small electrical box to which the remote control cable is attached. All electrics are low voltage and therefore present no electrocution hazards.

Figure 10 - Additional Safety Features on Control Panel
• The high pressure hydraulics are all contained within steel braided hydraulic hoses as standard, and factory-set pressure relief valves are fitted at critical points in the circuit to prevent dangerous pressure build up.

• The engine does become hot so gloves should be worn when operating the SERB. The rear of the engine is fitted with a weldmesh grill to protect the operator from the hottest part of the engine.

• Retaining bolts are used to secure the door in the front of the SERB, either to seal it shut while under vacuum or to hold it open while emptying.

• There are lifting eyes fitted to the top of the hopper, which will enable the SERB to be lifted by crane in an emergency. Locking pins are positioned at the base of the free end of the hopper to secure the hopper in position during lifting.

• A hopper support prop is provided to enable maintenance operations to be carried out safely with the hopper in the raised position.

• A cradle is provided for stowing the remote control when the SERB is stationary. It is designed to protect the toggle switches from accidental operation.

Figure 11 –
Hopper support prop
4.0 Operating in the Railway Environment

In order to transfer the SERB onto the railway a reasonably level access is required, with no part of the route steeper than 1 in 5. Ballast shoulders must either be flattened before attempting ascent, or alternatively ramps should be used.

Once on-track the SERB is moved to its worksite on two Harsco Type A trolleys having non-insulated wheels, linked together. Under normal circumstances the SERB can remain on the trolleys until the end of the shift. However, if the SERB was filled to capacity it would hold up to 900kg of ballast, in which case the combined weight would exceed the maximum permissible load of 1 Tonne per trolley. There are three possible control measures that can be utilised to prevent overloading:-

a) The SERB is used only to excavate small quantities of ballast using well controlled sampling techniques. As a guide no more than, four 350mm dia. 500mm deep ballast auger holes should be excavated before emptying the hopper. This would yield about 300kg of ballast, which is about a third of the total hopper capacity.

b) A volume reducer (having a volume of 0.125m$^3$) is inserted in the hopper to reduce the maximum capacity. The SERB can then be used in uncontrolled excavation mode.

c) The SERB can be removed from the trolleys provided that it does not run along the 4 ft. This activity must be pre-planned, except in an emergency situation.

A site specific method statement must be produced for each site, detailing access arrangements, limits of working, scope of work etc.

4.1 Placing on-track

Before placing the SERB on the line the operator must ensure that a safe system of work has been instigated. The COSS will advise accordingly. In addition to this the operator must check that there are no S & T or other cables in the vicinity which may be damaged by crawler tracks.

In order to place the SERB on the track initially, train movement on adjacent lines must be stopped (except where there is a wideway and the adjacent track is sufficiently far away as to present no danger). Once on the track the SERB is designed to be operated from one side only which will enable it to be used with at least one adjacent line open to traffic, subject to possession planning restrictions.

The SERB can manoeuvre across rails and ballast but ramps are required to move it on and off the trolleys. Care should be taken to ensure that the ramps are correctly positioned on the trolley at their upper ends and that their lower ends rest on firm reasonable level ground.
4.2 Transiting

For transit purposes the SERB should be positioned centrally in order to spread the load evenly between the two trolleys, with the control panel facing the cess.

The method statement (site specific risk assessment) must consider the manpower required to push the SERB uphill while on gradients. A minimum of three men are required to push the SERB on trolley at gradients up to 1 in 100. A fourth man is required for gradients up to 1 in 50. (information taken from “M&E Engineers Networking Group, Code of Practice, COP 0018, March 2006, assuming total weight of SERB and trolleys to be 1350kg, using interpolation). Note – if the adjacent line is open to traffic the gradient must be limited to 1 in 100, as pushing the trolley with more than 3 men will be impracticable.

4.3 Adjacent line(s) open to traffic

The SERB may be operated where an adjacent line is open to traffic (follow rules for a separated green zone), provided the following apply:

- train movements on adjacent lines shall be stopped while the SERB is placed on track
- the SERB shall be placed on the track with its control side away from the line open to traffic
- the offside vacuum port shall be capped with a “not to be used” notice attached
- the SERB can be operated with a single Site Warden provided that all personnel remain either on the control side or in front of the hopper, as shown in Figure 12. If there is any need for anyone to go behind the machine into the prohibited area shown on the diagram below i.e. out of site of the Site Warden, all work should cease.

![Diagram of Site Warden and Working Permitted area](image-url)

Figure 12 – Working one Site Warden with Adjacent Line Open to Traffic

Working with adjacent lines to both sides open to traffic may be considered on a site by site basis. The minimum distance from the side of the SERB to the running edge of at
least one of the lines should be 3m or greater to give adequate working space. This should be addressed in the site specific method statement.

4.4 Operation on AC Overhead Electrified Lines

The SERB can be operated safely under Overhead Line Electrification systems without the need for isolation. However, under no circumstances shall staff be permitted to climb on any part of the machine.

4.5 Operation on DC Electrified Lines

The SERB can only be used safely on DC Electrified lines when the conductor rails are isolated.

5 Maintenance

In order to maximise life of the SERB and ensure that it can be operated in a safe manner the operator must ensure that routine maintenance is carried out as listed below. The most important item is to the suction fan, which must be cleaned regularly. Allowing the fan to become dirty or corroded could result in catastrophic failure.

5.1 Cleaning the Suction Fan

The fan should be inspected and cleaned thoroughly at the following times:

- after every 25 hours of operation
- at intermediate intervals (daily) if the SERB is being used in particularly arduous conditions, e.g. where there is standing water or slurried ballast
- if excessive noise or vibration is detected

If, after cleaning there is still excessive noise or vibration from the fan, or there is noticeable corrosion of the fan, operation should cease. The fan, motor and mounting plate assembly should then be returned to the fan manufacturer for overhaul/replacement.

If an excess of dirt or corrosion is permitted to accumulate on the suction fan, in particular the inner curve of the impeller blades, it will impair suction performance and in extreme cases, will cause vibration. If this situation is not rectified, damage to the fan, fan motor, motor bearings and eventually the fan housing structure will result.

Cleaning Procedure

- Before working on the machine position it on firm level ground, ensure the hopper is in its lowered position, stop the engine, remove the key and disconnect the battery. The person cleaning the machine must be in possession of the key at all times.
- After ensuring that the fan is at a complete standstill, remove the inspection cover from the side of the fan housing to expose the fan.
• Using a high pressure water jet and scraper, as necessary, thoroughly clean the fan, paying particular attention to the inside curve of each impellor blade and to the area around the fan hub.
• Refit the Inspection cover.

Maintenance
For maintenance of the diesel engine refer to the Lombardini Service Manual supplied. For all other components, see below.

Daily (Before Operation)
• Undertake a visual inspection of all components for signs of damage, excessive wear or leakage of hydraulic oil. Particular attention should be paid to the flexible hoses feeding the hopper, as these are most susceptible to damage and wear.
• Check level of hydraulic oil. The top and bottom of the sight glass, located above the battery housing, represent the max and min levels respectively. (Top up only with oil complying with ISO VG 32)

After use in slurried ballast or after 25 hours of operation
• Clean and inspect fan (see 5.1)

Every 50 Hours of Operation
• Check the track tension.
• Lubricate with grease all hopper pivot points and door furniture.

Every 500 Hours - Major Maintenance/Repair
• Change hydraulic oil and filters.
• Grease Tracks
• Until there is sufficient experience to extend the maintenance period, the machine should be returned to the manufacturer in order to carry out a detailed inspection.

All maintenance/repairs other than those operations described above should be referred to the manufacturer.
To Common Battery
See Engine Manufacturers Circuit Diagram
Engine Model Number 9MD626/2