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About This Standard

This specification defines the requirements for point drive mechanisms for use on Australian Rail Track Corporation Infrastructure.

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1. Introduction

1.1. Scope

This specification applies to conventional electric switch machines and to electrically, hydraulically and pneumatically powered claw lock and similar mechanisms for the operation of turnouts on the rail system in New South Wales.

Unless otherwise stated in the particular Order or Contract the mechanisms shall be required to operate turnouts manufactured from Australian Standard 60 kg rail to standard designs with fixed heel switches and/or tangential geometry turnouts with switches manufactured from UIC 60B asymmetric switch rail. One machine or power unit shall be capable of driving tangential turnouts in the range 250 metre to 1200 metre radius.

1.2. Referenced Documents

The following documents are referenced in this specification:

Australian Standard	AS9001	Quality Assurance
Specification	SPS 02	Operating Environment
Specification	SPS 44	Single Core Cable
Association of American Railroads Manual	Part 12.2	Electric Motor Switch Operating Mechanism

1.3. Definitions

"Conventional" Electric Switch Machine:

A machine operated by an electric motor through a gearbox and containing, in a single casing, a drive mechanism, a facing point lock mechanism and a switch detection mechanism

"Claw Lock Mechanism"

A mechanism in which the drive and facing point lock are combined and which directly locks the switch to the stockrail. The "Claw" may operate in the horizontal or vertical plane.

ARTC

Australian Rail Track Corporation ARTC's representative

A company, person or authority appointed by Australian Rail Track Corporation to make determinations and/or carry out inspections on their behalf.

2. Tenders

2.1. Tendering Requirements

2.1.1 Quality Assurance

Tenderers are required to hold or be in the process of obtaining Quality Assurance Accreditation to AS 9001 (ISO 9001). Notwithstanding, ARTC or their representative reserves the right to carry out quality assurance inspection at any stage during the manufacture and delivery of any machine, mechanism or component supplied to this specification.

2.1.2 Warranty

Machines, mechanisms and components shall be warranted free of defect for a period of two (2) years from date of supply or one (1) year from date of installation whichever occurs first. The warranty shall include freedom from deterioration of any kind while stored in the containers and in the condition received from the manufacturer. Storage shall, unless otherwise stated in the particular order or contract, be taken to mean protected from direct rainfall but otherwise in an uncontrolled environment.

2.1.3 Complete Tenders

Tenderers shall be for complete machines or mechanisms. Offers for part machines such as drive assembly, lock assembly or detection assembly will not be considered.

2.1.4 Information to be Provided with Tenders

So that Tenders may be fully and fairly evaluated, the following information is to be provided with the Tender:

- Details of service history of the machine/mechanism.
- If previously supplied to Australian Rail Track Corporation or its predecessor State Rail Authority, details of any variations in design and/or materials when compared to previous supplies
- If not already forwarded with previous orders/contracts, detailed description of the machine/mechanism, its operation, and materials used in manufacture and internal machine layout.
- If not already supplied with previous orders/contracts, drawings showing the overall size, mounting hole size and centres, drive, lock and detection connection positions for any machine; drawings showing the assembly of any claw lock or similar mechanism.
- Circuit diagrams for the machine (pneumatic motors excepted)
- Electric motor start/run/stall current curves.
- Complete spare parts listing for all machines/mechanisms/components.
- Either an estimate or a period based on service history, of the time or number of operations to overhaul necessitating removal from track. (This would be expected to exceed 350,000 operations). In addition an estimate or

period based on service history of the time or number of operations which will lead to wear in the facing point lock or detector slides and/or linkages exceeding a total of 1 mm.

- Recommended service schedules and consumables.
- A listing and the source of any special tools required for maintenance or overhaul.

2.2. Tender Assessment

Tenders will be assessed both on the basis of cost and on technical merit in meeting the requirements.

Cost, for the purposes of tender assessment, shall mean “whole of life” cost assuming the mechanism has a life span of 20 years.

The assessment shall include an estimate of the cost of any consumable items and parts which may require replacement as well as an estimate of the labour costs of necessary periodic maintenance during the first ten (10) years of the mechanisms service life. Reliability data, failure mode effect and maintenance task analysis data, and life expectancy data supplied by the Tenderer shall also be considered.

Weighting shall be given to superior technical merit and superior life expectancy which may result in lower tenders being passed over.

3. Conventional Electric Switch Machine

3.1. General

The conventional electric switch machine shall be of the non-trailable type.

Reversal of the machine for left or right hand operation shall involve no more than reversal of the lock and detector slides and, where necessary, re-termination of motor control wiring.

3.2. Maintenance

Machines shall be designed such that regular periodic maintenance requirements are not necessary at less than 12 weekly intervals. Components which do require regular maintenance or lubrication shall be readily accessible and it shall be possible to carry out this regular maintenance without having to disconnect the machine from the turnout.

3.3. Operating Environment

The machine shall be subject to the environmental conditions listed for Category F equipment in Specification SPS 02 and, in addition, the possibility of water entry during periods of local flooding.

Materials used in and lubricants used in or recommended shall be such that variations in ambient conditions within the specified range have no effect on operation or reliability. Additionally, shortterm water entry (e.g. dried and cleaned within 72 hours) shall not cause long-term loss of reliability.

3.4. Performance Requirements

3.4.1 Thrust

The machine shall provide a throw bar thrust equal to or greater than that shown in the test load diagram in Appendix A when the nominal rated voltage is available at the motor terminals. In addition the machine, when in the full stroke position, either normal or reverse, shall be capable of withstanding a force of 1700 Kg applied externally to the throw bar, without suffering damage of any form.

3.4.2 Facing Point Lock

The facing point lock shall be a positive mechanical device which cannot be dis-engaged by a force applied external to the machine. The notch(es) in the lockslide shall not be more than 4 mm or less than 3.2 mm wider than the locking dog which enters them.

3.4.3 Operating Time

With the nominal rated voltage applied at the motor terminals and for the loading requirements of Appendix A, operating times shall not exceed:

- Low voltage (20v DC) machines 15.5 seconds
- Medium voltage (50v DC) machines 11 seconds
- High voltage (110v AC or DC) machines 5.5 seconds

3.4.4 Throw Bar Travel

Throw bar travel shall be 145 - 155 mm

3.4.5 Lock and Detector Adjustment Range

The Facing Point Lock and Detector shall provide for a range of switch openings between 107 and 125 mm unless specifically ordered otherwise. Adjustment shall be infinitely variable between these limits.

Notches in the detector slide and rollers activated therefrom shall be sized and shaped so that the slide movement between the detection contacts being open, with no possibility of momentary make due to vibration, and the detection contacts being just closed, without wipe, is not more than 1.6 mm.

3.4.6 Lock and Detector Marking

To enable simple visual checking of lock and detector adjustment, locks and detectors shall be marked external to the case such that:

With the mark aligned with the side of the mechanism case or a securely fixed pointer, the locking dog is in the centre of the notch in the lockslide and the detection contacts are fully made including any wipe.

For the lock: With the mark on the respective lockslide misaligned by 2.4 mm in either direction, the locking dog shall fail to enter the notch. With the mark on the respective lockslide misaligned by 1.6 mm in either direction, the locking dog shall enter the notch.

For detection: With the mark misaligned by 4.8 mm in the direction of the opening

switch, detection contacts shall be open sufficiently to prevent the possibility of momentary make due to vibration. With the mark misaligned by 3.2 mm detection contacts will have made but not completed any wipe or compression.

3.5. Drive Mechanism

3.5.1 Motor

The low voltage DC motor shall be a series wound type.

The medium voltage DC motor shall be a series wound or permag type. The high voltage DC motor shall be a permag type.

The high voltage AC motor shall be a capacitor start induction type.

Operating Voltages shall be:

Low voltage DC	20v	4 volts
Medium Voltage DC	50v	8 volts
High voltage DC	110v	15 volts
High Voltage AC	110v	15v 50 hz

All motors shall be rated for a minimum of 15 minutes full load running per hour. Maximum running currents shall preferably not exceed:

15 amps for low voltage motors

12 amps for medium voltage motors

8 amps for high voltage motors

Starting capacitors for induction motors shall be rated to 220v minimum and terminals shall be provided on the capacitor case.

3.5.2 Clutch

An overload clutch shall be provided to protect the motor and gear train. Preferably the clutch shall be a multi-disk mechanical type.

Clutch slip settings shall be quoted as motor current for DC motors and slip torque or throw bar thrust for Induction motors.

3.5.3 Throw Mechanism

The drive for the throw mechanism shall be non-reversible at each end of the stroke, i.e. a force applied externally to the throw bar shall not be able to move the throw bar.

3.5.4 Emergency Manual Operation

Emergency manual operation for the conventional switch machine shall take the

form of a removable crank handle.

The crank handle shall be indexed such that a handle will only fit into a similarly indexed machine. A minimum of five (5) index codes are required. Crank handles shall fit into the top of the mechanism and be wound in the horizontal plane.

3.6. Electrical

3.6.1 Wiring

All internal wiring shall be double insulated and shall be mechanically protected by bush or conduit where it passes through or close to metal parts

The cable used shall be at least equivalent in both core and insulation to 7/0.5 single conductor described in Specification SPS 44. Conductor sizes in the motor operating circuits shall however be sufficient to ensure that voltage drop within the machine does not exceed 0.5 volts.

Installed wiring within the machine shall exhibit an insulation resistance to other wires and to frame of at least 100 MΩ when tested with a 500 volt megger.

3.6.2 Termination

All wiring, except where plug couplers are used, shall be terminated using heavy duty pre-insulated "supergrip" or similar lugs or pins. Where terminated in plug couplers, insulation grip shall be provided and wiring shall be firmly clamped to the plug coupler housing.

All internal wiring is to be brought to a single terminal block for connection to external wiring or cable. Terminals shall be screw post (2BA minimum) or rail mounted clamp type (Klippon SAK6 or equivalent minimum). Locking pins shall be used with rail mounted terminals. The terminals to accept motor mains shall accept conductor sizes from 7/0.85 to 7/1.7.

Plug couplers shall have gold flashed contacts if used in control and/or indication circuits and shall be rated to at least 200% of motor running current if used in the motor operating circuit. Plugs and sockets shall be positively locked closed by clip or collar.

3.7. Control and Indication

3.7.1 Detection and Facing Point Lock Indication

The contacts, which indicate the status of the facing point lock and the detection, shall preferably be operated independently of one another with no mechanical interlocking.

It shall be possible to test the adjustment of the detection without the necessity to disturb or disconnect the facing point lock and to test the adjustment of the facing point lock without disturbing or disconnecting the detection.

The contacts shall be of an enclosed or semi-enclosed type which do not require cleaning.

The driving arrangements of the contacts shall be such that, for normal field maintenance adjustments, there is no necessity to carry out any adjustment between the roller or cam follower in contact with the detector slide and the applicable contact. Any means of adjustment provided in this area for assembly

shall be factory sealed.

One changeover contact made Normal and R-NI and one changeover contact made Reverse and N-RI shall be provided for lock indication.

Two changeover contacts made normal and R-NI and two changeover contacts Made reverse and NRI shall be provided for switch detection.

The contacts shall be suitable for switching 5 to 50 V DC and 120V AC low current circuits (gold flashed contacts are required) with a minimum current rating of 2 amps at 120VAC and 0.5A at 50VDC**. The contacts (switches) used shall be capable of operating in an environment of low to medium frequency vibration without variation in contact resistance. Electrical isolation between contacts shall be rated at not less than 1000 volts.

3.7.2 Motor Control and Cut-out Contacts

Motor control contacts shall be in addition to detection and indication contacts but may be part of the same contact assemblies as the lock indication contacts provided that the electrical separation between contacts is rated to at least 1000 volts.

A contact shall be provided to open the motor circuit when the emergency crank handle is inserted into the machine.

3.7.3 Motor Contactor and Overload Timer

A motor contactor and motor overload timer are not required to be fitted to the machine.

3.8. Mechanism Casing and Couplings

3.8.1 Case

Machine cases may be manufactured from grey, spheroidal graphite or malleable cast iron, cast aluminium alloy or galvanised mild steel. The case material shall be guaranteed against failure due to corrosion or ageing for a period of 25 years.

The case shall be capable of tolerating a sleeper to sleeper misalignment (twisting) of up to 1 with no effect on the operation of the machine.

Case covers shall not exceed 20kg in weight but shall be capable of supporting a 100 kg load in the centre of the cover with a deflection of less than 1.5mm. The inside surface of the cover shall be treated to minimise condensation.

Seal(s) between case and cover shall be proof against entry of dust and water.

A 50 BSP cable entry shall be provided at that end of the mechanism closest to the terminal block.

3.8.2 Coupling to Points

Drive, lock and detector slides shall be pin or bolt coupled to their respective rods with the pin or bolt in the vertical plane.

Resilient or self-aligning bushes may be used provided that the bush is impervious

** Note that under some operating conditions a low current (mA) back emf of up to 400v may be experienced when the contacts open under load.

to oils, greases and ultra-violet light and is suitably rated for the dynamic loads encountered. Otherwise, slides or lugs shall be fitted with hardened steel bushes.

Preferred bolt or pin sizes are 20 or 24 mm for lock and drive and 16 mm for detection.

4. Claw Lock Mechanisms and Drive Systems

4.1. The Claw Lock Mechanism

4.1.1 General

The claw lock mechanism shall be able to be driven by electric, pneumatic or hydraulic power units with a drive stroke between 180 and 200 mm. Sequence of operation shall be as shown in the diagrams in Appendix B, Figure B 1.

The mechanism shall be fixed to the switch and stockrail, and detector rods (where required) shall be fixed to the switch where shown in Appendix B, Figures B2 and B3.

Claw Locks shall provide for a switch opening of 125.3 mm at the tip of the switch and, where used as 2nd and 3rd drives, for openings between 90 and 60 mm.

Bolts used in the assembly and fitting of the claw lock mechanism shall be zinc plated (or equivalent) and be fitted with self locking nuts. Galvanised bolts, if supplied, shall have the thread cleaned with a die nut to suit the self locking nuts.

4.1.2 Construction

Claws, brackets, drive bars and claw locks (locking bracket or box) shall be made of materials which are inherently suitable for, or are surface treated to be suitable for the bearing, friction and vibration loads which may be encountered with turnouts which require up to 500kg operating forces and are carrying up to 30 tonne axle loads.

All bearing surfaces, including pins and bushes shall be capable of a minimum of 350,000 operations before the total combined wear between the claw pivot pin and the locking face attached to the stockrail exceeds 1.5 mm.

The claw bracket shall provide for at least 25mm of switch creep (longitudinal movement) without causing any binding in the claw lock mechanism.

4.1.3 Adjustment

Adjustment of the mechanism shall be by shim between the claw bracket and the switch, preferably augmented by an eccentric bush around the claw pin. Shims shall be provided in 0.8, 1.6 and 2.4 mm thicknesses.

4.1.4 Lubrication

Provision shall be made for lubrication of the claw pin and rubbing surfaces on the claw, claw bracket and claw lock.

4.1.5 Drive Bar Insulation

The drive bar shall be insulated between the claw lock mechanisms on each side of the turnout. The assembled drive bar when tested with a 500 volt megger shall show a minimum insulation resistance of 100 Megohm.

Insulation shall also be provided where the drive bar connects to the operating mechanism and to any back drive.

4.1.6 Connection to Operating Mechanism

The end of the drive bar shall be provided with two holes drilled in the vertical axis of 20.5 mm diameter at 76 0.5 mm centres for connection of a link to the power unit. The innermost of these holes shall be between 145 and 155 mm from end of the notch in the drive bar and the outermost hole shall be within 40 mm of the end of the drive bar. Refer to Appendix B figure B4

5. Electric Drive Systems for Claw Locks

5.1. General

The electric machine for the operation of claw locks shall be trailable and shall be of the dual control type; i.e. emergency manual operation shall be by hand throw lever in place of crank handle.

The mechanism shall contain a drive assembly (motor, clutch and gearbox) to operate the claw lock and a circuit controller to detect the position of the turnout switches.

Reversal of the machine for left or right hand operation shall involve no more than reversal of the detector slides and, where necessary, re-termination of the motor control wiring.

5.2. Maintenance

The provisions of Clause 3.2 shall apply

5.3. Operating Environment

The provisions of clause 3.3 shall apply

5.4. Performance Requirements

5.4.1 Thrust

The machine shall have an electric motor of sufficient capacity and be geared such that a maximum thrust of 9kn can be delivered at the nominal motor voltage and running current at any point in the stroke. (This figure assumes that the overload clutch is set to maximum capacity and that any breakaway trail clutch is by-passed.)

Machines shall be delivered ex factory with the break-away trail clutch set to 3.9 - 4.2 kn unless otherwise stipulated in the particular order or contract.

It shall not be possible for any force less than the trail clutch setting to cause the machine to commence to move from the normal or reverse position.

5.4.2 Operating Times

The provisions of clause 3.4.3 shall apply

5.4.3 Throw Bar travel

Throw bar travel shall be within the range 180 to 200 mm

5.4.4 Detector (Circuit Controller) Adjustment

Detection shall, at the least, provide for switch openings in the range 110 to 135 mm

5.4.5 Motor

The provisions of clause 3.5.1 shall apply.

5.4.6 Clutch

The provisions of clause 3.5.2 shall apply

5.4.7 Emergency Manual Operation

Emergency manual operation shall be by hand throw lever. The machine shall also be provided with a power - manual selector lever which operates in the following sequence when changing from power to manual operation:

- Opens control circuits.
- Engages the hand throw lever then disengages the motor mechanism.
- Unlocks the hand throw lever.

From manual to power the selector lever shall:

- Prove that the hand throw lever is fully thrown (either direction) then lock the hand throw lever
- Engage the motor mechanism then disengage the hand throw lever
- Close control circuits.

The hand throw lever and selector lever shall be locked in the power position with a device locked by a "Fortress" key or similar. The device shall be such that the key is retained in the lock when the hand throw and/or selector levers are free to be moved.

5.5. Electrical

5.5.1 Wiring

The provisions of clause 3.6.1 shall apply

5.5.2 Termination

The provisions of clause 3.6.2 shall apply. In addition where a plug coupler and sockets are used to reconfigure the machine for right or left hand switch closed layouts, the unused socket shall be covered with a plate or have a dummy plug fitted with the words "Do Not Remove" engraved into it.

5.5.3 Control and Indication

One changeover contact made Normal and R-NI and one changeover contact made Reverse and N-RI shall be provided for lock indication.

Two changeover contacts made normal and R-NI and two changeover contacts Made reverse and N-RI shall be provided for switch detection.

The contacts shall be of an enclosed or semi-enclosed type which do not require cleaning.

The contacts shall be suitable for switching 5 to 50 V DC and 120V AC low current circuits (gold flashed contacts are required) with a minimum current rating of 2 amps at 120VAC and 0.5A at 50VDC**. The contacts (switches) used shall be capable of operating in an environment of low to medium frequency vibration without variation in contact resistance. Electrical isolation between contacts shall be rated at not less than 1000 volts.

5.5.4 Motor Control and Cut-out Contacts

Motor Control contacts shall be provided in addition to the detection and indication contacts but may be part of the same contact block as the indication contacts provided that the electrical separation between contacts is rated to at least 500 volts.

A cut out contact operated by the selector lever to open circuit the motor when the lever is moved from the power position shall be provided.

5.5.5 Motor Contactor and Overload Timer

A motor contactor and a motor overload timer are not required to be fitted to the machine

5.6. Case

The provisions of clause 3.8.1 shall apply.

6. Pneumatic Motor for Claw Locks

6.1. General

The motor (cylinder) shall be single ended, double acting and self latching at each end of its stroke. A stainless steel piston rod and hard chrome (or stainless steel) bore shall be provided and the motor shall be foot mounted.

Exterior surfaces (where not stainless steel) shall be zinc plated or powder coat finished light grey. Clamping bolts shall be stainless steel.

Latches shall engage at least 6mm from the end of the motor stroke to provide sufficient piston travel after latching to operate detection switches. The shape of the latching mechanism shall be such that the risk of “dog locking”, due to the motor drifting back and bearing against the latch, or the piston moving before the latch is clear, is reduced to the greatest possible degree.

Each latch shall be provided with a manual release. Provision shall be made to restrict access to the manual releases, so that manual release of latching cannot be affected, without unlocking a padlock. The cover(s) or releases themselves shall be secured by a padlock with a 10 mm bow diameter.

The actuators for the detection switches shall be provided with a cap which will operate the required two switches at the same time and which is secured by a locknut. Both cap and locknut shall be adjustable by means of an open ended

** Note that under some operating conditions a low current (mA) back emf of up to 400v may be experienced when the contacts open under load.

spanner. The actuator assembly shall be provided with a spring return mechanism such that return of the actuator to the innermost position (ie piston unlatched position) can be guaranteed, without lubrication other than that from the pneumatic system, for 500,000 operations.

6.2. Electrical

The motor shall be provided with two (2) indication switches at each end which will detect that the motor has completed its stroke (to within 4 mm) and has latched.

The switches used shall be two microswitches, OMRON D4C-1201 or D4C-1601 or MICRO SWITCH 914CE1-3, at each end of the motor.

The microswitches shall be enclosed in an IP65 rated cast aluminium terminal box mounted on the side of the motor opposite the air ports. Terminals provided within the termination box for the connection of incoming cable shall be equivalent to "Klippon SAK4" or 2BA screw stud. The opening in the box for the switch actuator shall be sealed between motor and box with a suitable O-ring or Gasket.

Wiring between microswitches and terminals shall utilise the 4 core cable supplied with the microswitches. Only sufficient sheath shall be removed to permit termination with bootlace ferrules in the terminals. The unused core from each cable is to be capped with insulated end caps or additional terminals must be fitted to which the core can be terminated.

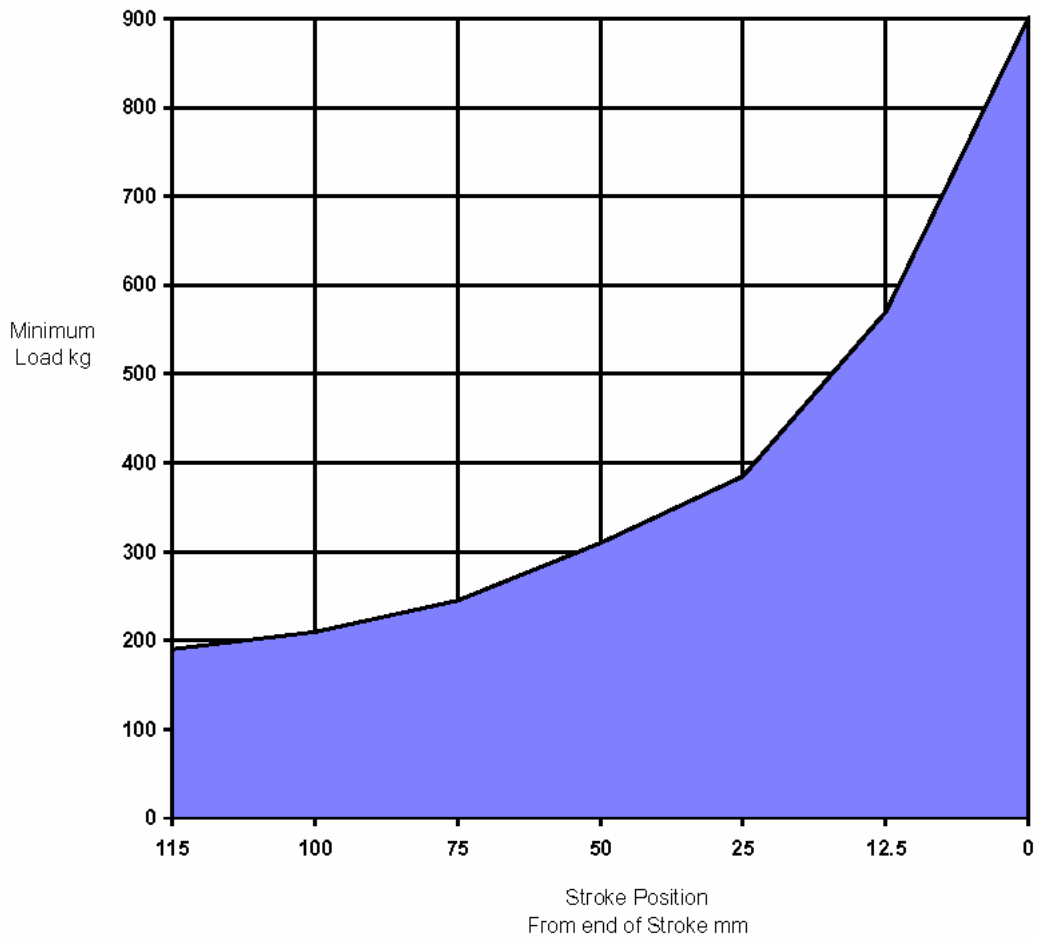
Wiring between microswitches and terminals shall be to the circuit shown in Appendix C Figure C1. Entry for external cables shall provide for a 25 BSP conduit fitting.

6.3. Motor (Cylinder) Dimensions

Motor dimensions shall be:-

Motor Bore	125 mm
Motor Stroke	190mm – 200mm
Piston Rod	
• Diameter	38mm
• Retracted	12 – 16mm
Clearance	
• Thread Length	150mm
• Thread	M33x3.5
Mounting Hole Centres	
• Longitudinal	450mm
• Transverse	90mm
Centre Line Piston Rod to Mounting Plate	90mm
Mounting Hole Diameter	16mm
Air ports	15 BPS
Air Port Location	Side – opposite terminal box

7. Appendix A - Figure A1 Switch Machine Test Load Requirements

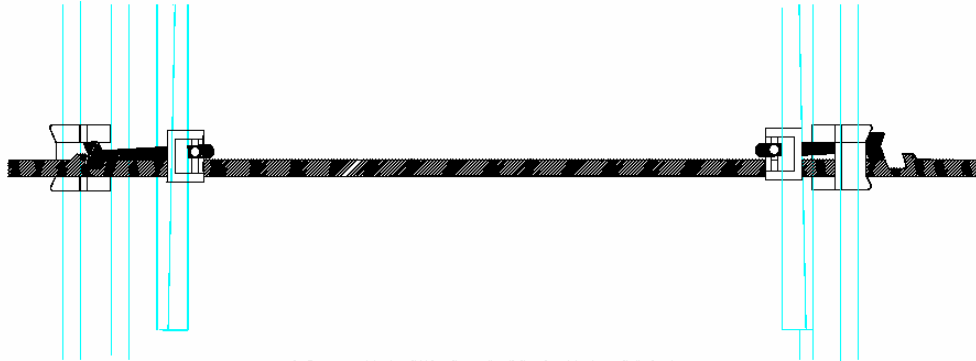


Machine performance shall always be equal to or above the curve

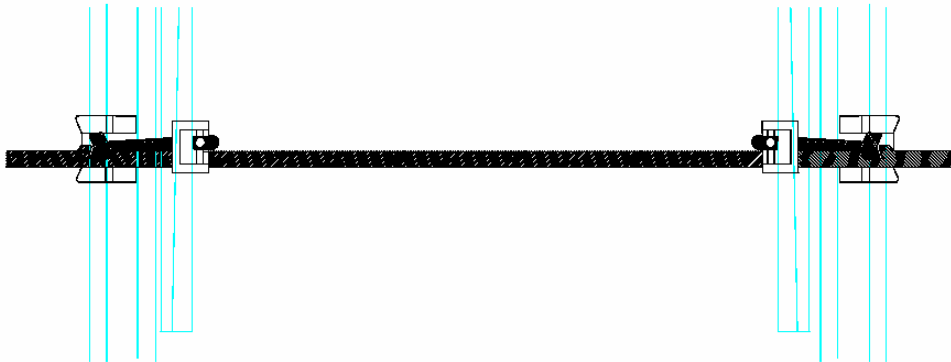
Assumes clutch is set to maximum capacity

8. Appendix B

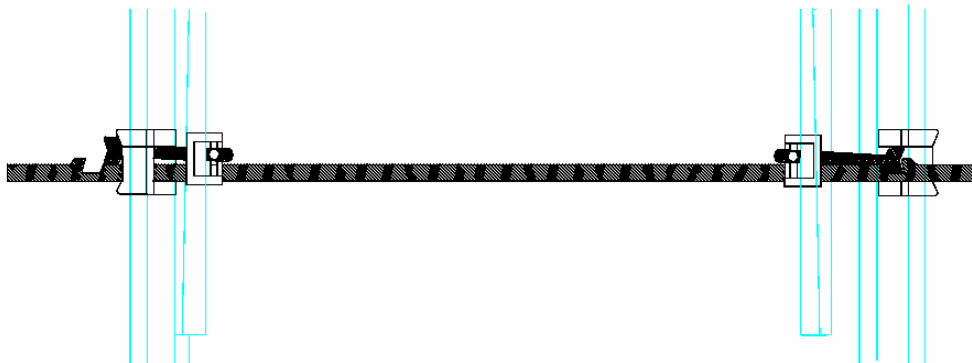
8.1. Appendix B -Figure B1 Claw Lock Operation



RIGHT HAND SWITCH CLOSED AND LOCKED

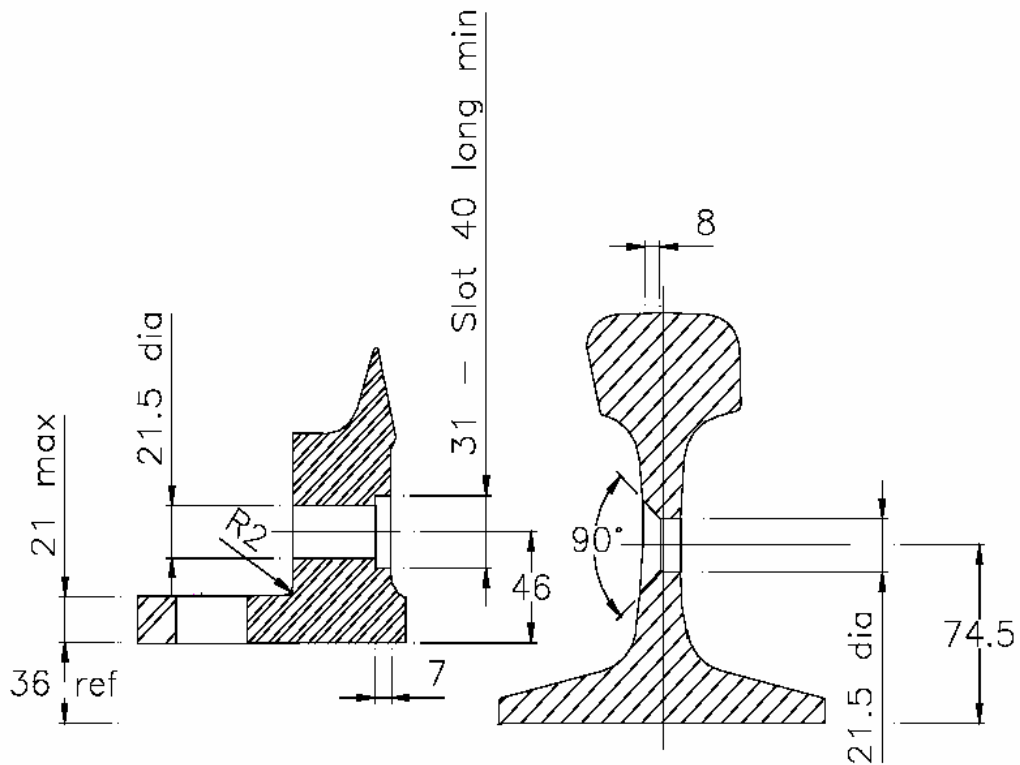


POINTS IN TRANSIT



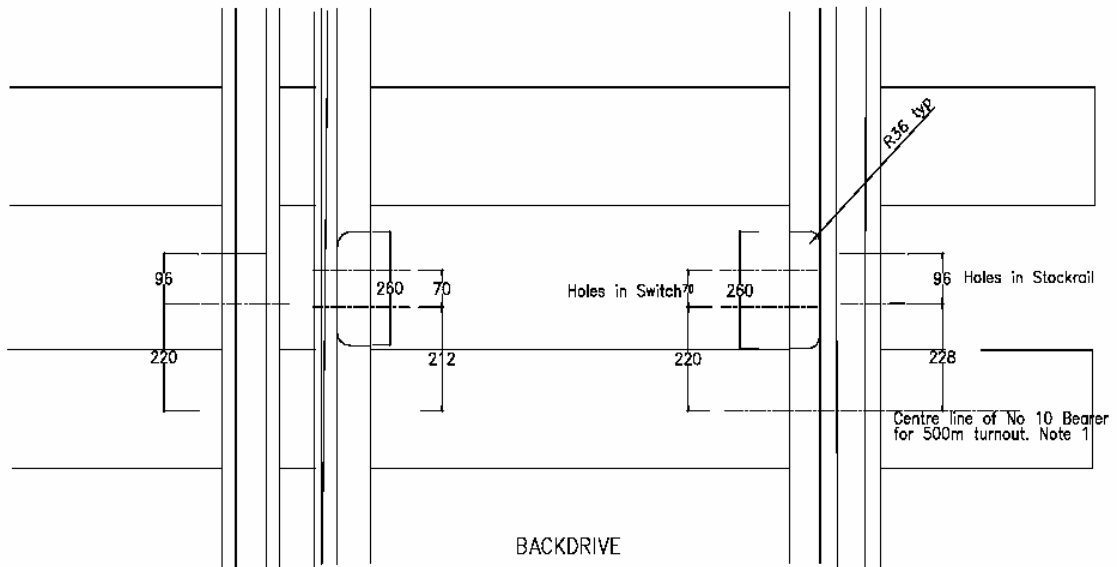
LEFT HAND SWITCH CLOSED AND LOCKED

8.2. Appendix B - Figure B2 Switch & Stockrail Drilling for Claw Lock

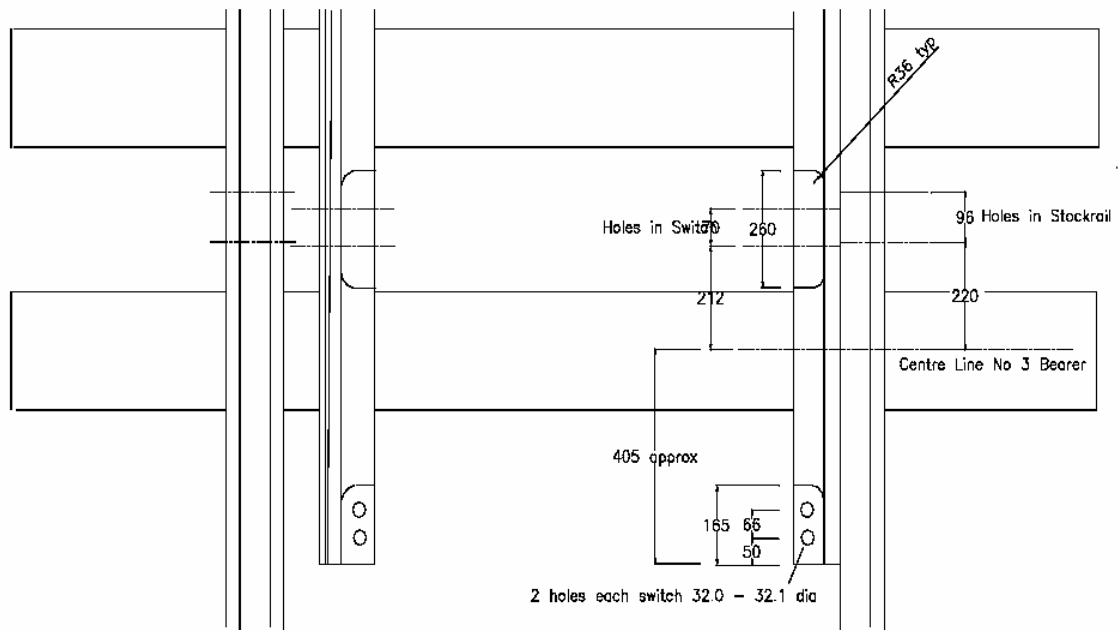


Tolerance: ± 0.5 mm

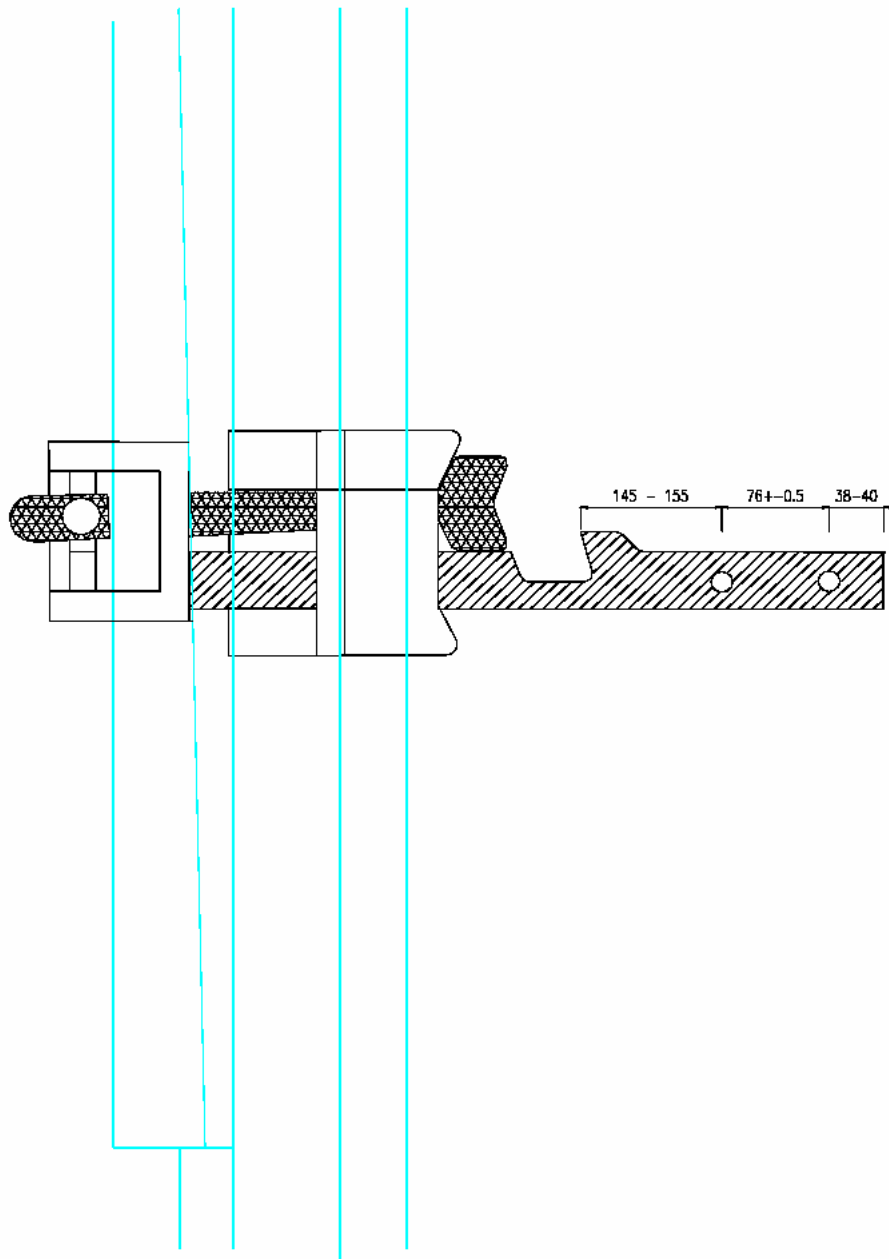
8.3. Appendix B - Figure B3 Switch and Stockrail Drilling for Claw Lock



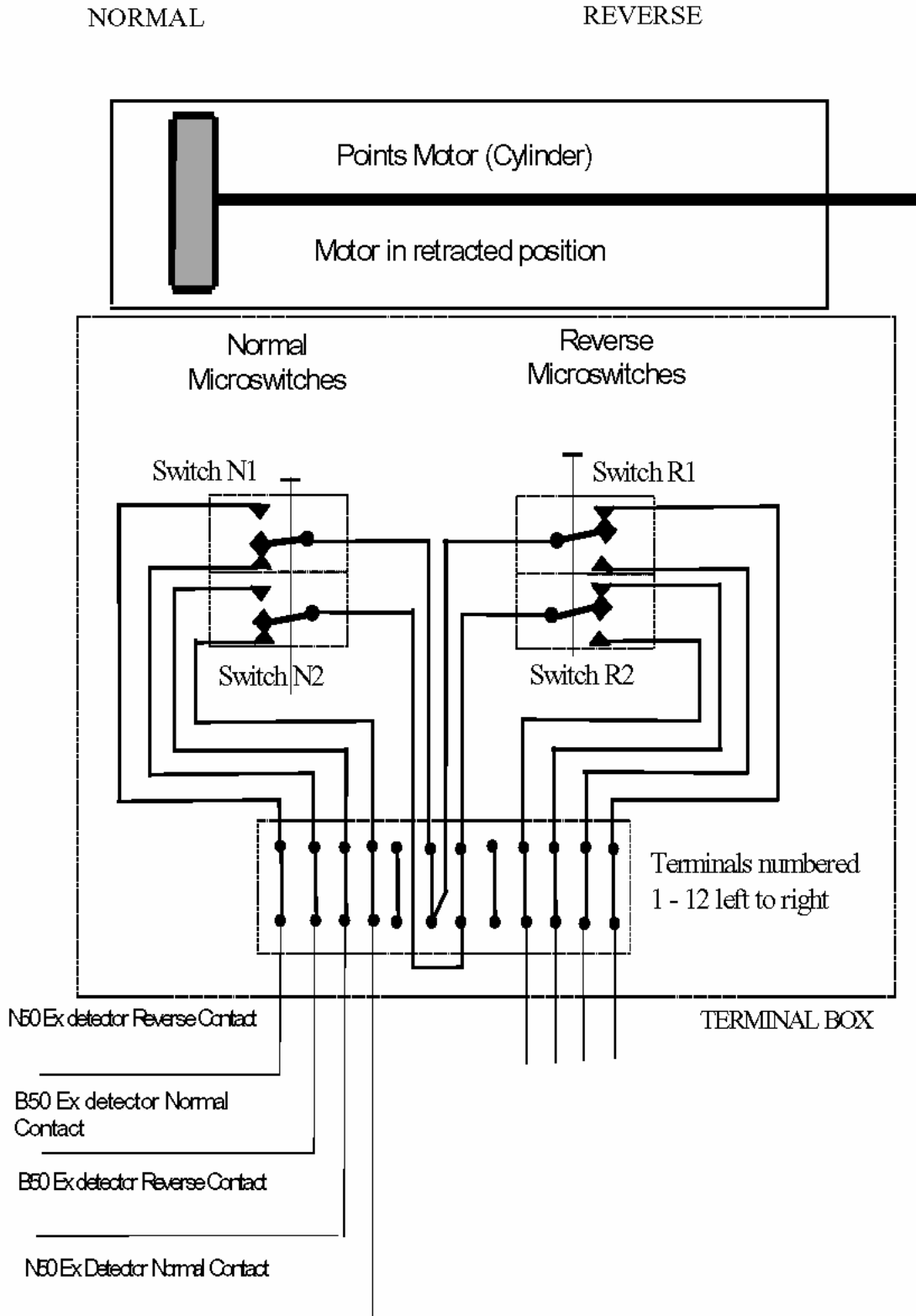
Note 1:
 Turnout manufacturer to determine location of backdrive for 300m, 500m, 800m and 1200m turnouts



8.4. Appendix B - Figure B4 Drive Connection for Claw Lock



9. Appendix C - Figure C1 Pneumatic Motor Detection Circuit



Retracted position is "normal" as drawn. If the extended position is "normal" wiring and terminal numbering will be as drawn but contact position will be mirror image.