



(Minor changes to the previous edition are indicated by ◆ placed before the relevant paragraphs)

Contents	Page		
1. Scope	1	14. Packaging and shipping of completed units	12
2. References	1	15. Prescribed methods	12
3. Abbreviations	1	16. Jigs and gauges	13
4. Definitions	2	17. Equipment identification and documentation	13
5. Introduction	2	18. Record retention	13
6. Usage of item	3	Document history	14
7. Equipment design outline	3	Document index data	14
8. Applicability	4	Attachments	
9. Critical functions	4	1. References	15
10. Performance parameters	6	2. Illustrated parts list	16
11. Equipment configuration	7	3. Critical parameters and settings	21
12. General requirements	7	4. Specification hierarchy	22
13. Overhaul definition	7		

1. Scope

This Specification is written to comply with Engineering Standard 1-202 in defining the requirements for the overhaul of Twin Cylinder E.P. Point Groundlocks which are used extensively in the signalling system on the London Underground.

The specification hierarchy which supports these requirements is detailed in Attachment 4 to the Specification.

2. References

The text of this document cites other documents that provide information or guidance. These are listed in Attachment 1.

References to British Standards or standards in other standards systems shall be taken to include the words 'or equivalent'.

3. Abbreviations

The following abbreviations are used in this document (if from a published source this is indicated):

CPS	Critical Parameter or Setting
DCN	Design Change Notice
EPWL	Electro Pneumatic Point Ground Lock
LU	London Underground
OEM	Original Equipment Manufacturer
p.s.i.	Pounds per Square Inch
WL	Point Ground Lock



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4. Definitions

The Client – The Client is the Infracore representative responsible for administering the contract under which the overhaul work is being performed.

The Contractor – The Contractor refers to the organisation responsible for the delivery of overhauled equipment.

5. Introduction

This specification has been written to detail the overhaul requirements of Twin Cylinder Electro Pneumatic Ground Locks which are used in the signalling system on the London Underground. These items are known as EPWL's within the business and that term will be used throughout this document.

The EPWL is classified as an item of vital signalling equipment which means that it is used to perform a critical safety function directly affecting the safe movement of trains. It has been designed to be an ultra reliable piece of equipment whose mechanical integrity will be relied on throughout its extended working life. It is a mandatory requirement that every unit will perform to its original 'as manufactured' specification after it has been overhauled.

Any failure condition which causes the unit to behave as though it is detected in its locked position when it is not is classed as a 'wrong-side' failure. Additionally, any breakage or weakening of the locking plunger is classed as a wrong-side failure. Wrong-side failures are investigated exhaustively to establish the cause of the failure. Investigations into wrong-side failures will examine materials, processes and the history of overhaul operations to establish the exact cause of the event and to ensure that no other items are likely to suffer a similar failure. An occurrence of a wrong-side failure, even if no accident or damage is caused, can be extremely costly to investigate and could result in the need to change many units in service.

Items supplied for overhaul will be complete units which may be in working order or may have failed in service. The failure mode of equipments will vary, ranging from simple causes such as open circuit contacts, to items which have suffered severe damage. In the latter case there will be an element of salvage involved in the overhaul process. The equipment will be supplied in an 'as found' condition after being removed from its working position on the railway.

The service life of this equipment is 15 years. The shelf life is 3 years.

A general view of an EPWL is shown in Figure A.

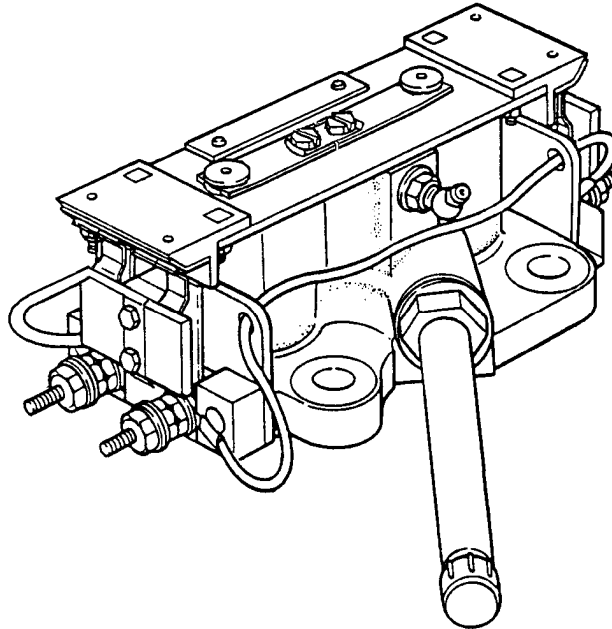


Figure A - General view of an EPWL

6. Usage of item

The EPWL is part of the secondary locking mechanism utilized on 4' and 6' point mechanisms which handle 'facing' passenger train movements. A facing train movement is one in which the train approaches the points in a divergent direction. Facing and trailing point mechanisms are generally locked in position whenever the track circuit in which they are located is detected as occupied. It is a LU standard that for facing points used for passenger movements, a secondary, independently controlled lock is provided.

The EPWL is mounted on the Point Lock Slide Casting. The Lock Slide has two cut-outs in the top slide bar which line up underneath the EPWL lock plunger when the point mechanism is in the fully Normal or fully Reverse position. In either of these two positions the lock plunger will drop into the locking port on the slide bar and the proving contacts on the EPWL will then be able to close.

The speed of energisation is important to the reliable operation of the points as the withdrawal of the EPWL is not monitored in the circuit which controls the movement of the point motor. If the EPWL is slow to withdraw from the locked position then the slide mechanism will catch against the locking plunger and jam the points. The lock plunger is designed to be strong enough to resist the full force of the point motor when it is fully engaged. Damage may be caused to the EPWL or the slide bar if the bar moves and catches only the tip or edge of the lock.

The design of the unit has taken into account the high integrity that is expected from the item. Accordingly it is a large piece of equipment which seemingly is doing a very simple task. However, every aspect of the design has a direct influence on the safety of the item and therefore on the safety of the London Underground train service.

The design of the signalling system is based on fail-safe principles and hence the regular and expected failures (wires breaking, fuses blowing, loss of power supply, high resistance or open circuit contacts, etc.) should not cause dangerous situations to arise.

7. Equipment design outline

Design features built into the EPWL include:-

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- Construction that is designed to be, as far as is practicable, ultra reliable in operation
- Construction designed to resist the considerable forces to which it will be subjected when acting to prevent movement of a set of points
- Two proving contact pairs wired in parallel to provide a reliable method of detecting that the lock is in its locking position

The EPWL uses a pair of pneumatically driven pistons, symmetrically placed on either side of the lock plunger, to lift it from the locked position to the clear position. The nominal operating pressure applied is 60 p.s.i. supplied via a GE Trainstop Valve using a length of 1/4" bore hose to connect the valve to the EPWL.

A single coil spring acting directly on the lock plunger returns the mechanism to its locked state when the air pressure is removed from the dual pistons.

The proving contacts are designed to break when the lock plunger is more than $\frac{1}{8}$ " - $\frac{3}{16}$ " away from the fully home position.

8. Applicability

This specification applies to the following item.

Item	Stores List No.
Twin cylinder E.P. Groundlock	23-S-10

The Illustrated Parts List and accompanying figure which form Attachment 2 to this document, are part of this specification.

9. Critical functions

Critical Functions of the EPWL are defined to be:-

Ultra-reliable Operation: The equipment has been designed to be a highly reliable item which will work in a hostile environment where it is mounted on the track-bed and therefore subject to high levels of vibration.

High Structural Integrity of Body Casting and Lock Plunger: Considerable force (approximately 750 lbs.) will be exerted on the lock plunger and the body of the EPWL when it is resisting the full force of the point motor. These restraining forces will be transmitted from the lock plunger to the body casting and into the lock slide casting. It is imperative that if the lock is detected as being in the locking position then such applied forces shall be resisted. Cracks or fractures on these components could lead to the possibility of an undetected wrong-side failure occurring.

Fail-safe Proving of Lock Plunger: The lock plunger is required to be proved to be in its locking position before a train may be signalled to pass over the points protected by the EPWL. A defined movement of the plunger away from its locked position shall cause the proving circuit to open.

Standardized Dimensions of Lock Plunger and Locating Surfaces: To ensure interchangeability of units in the field and to ensure correct engagement of the lock plunger with all lock slides the dimensions of the lock plunger and the body casting need to be closely controlled and gauged.

Electrical Safety. Satisfactory earthing and bonding of the EPWL is crucial to ensure that leakage paths to the case or other extraneous metalwork in the event of faults do not give rise to electric shock hazards or to a loss of vital system integrity.

The ability of the item to meet the critical functions listed above throughout its life depends on many factors, not all of which are immediately obvious to people not familiar with all aspects of the design, overhaul and use of the equipment. To ensure that the significance of certain of the detailed requirements is understood and complied with, a number of Critical Parameters or Settings have been designated throughout the text.

Attachment 3 to this Specification lists all the Critical Parameters or Settings [CPS], a reference to the section from which the requirement originates and provides a Criticality Rating of the importance of each CPS item.

The Criticality Rating is based on the severity of the consequence if there is a deviation of the subject parameter from the value specified. Numerical values have been assigned to various levels of the Criticality Rating (CR) according to the table below.

Criticality Rating (CR)	SAFETY RELATED CRITERIA	RELIABILITY RELATED CRITERIA
10	Life critical – sole dependence Occurrence of this deviation alone may lead to an incident causing death or injury.	
8	Life critical – shared dependence Occurrence of this deviation, together with a second deviation which is potentially latent (i.e. not self announcing), may lead to an incident causing death or injury.	
7	Life critical – contributory Occurrence of this deviation increases the probability of an event which may lead to an incident causing death or injury.	Service critical – sole dependence Occurrence of this deviation alone may lead directly to an incident causing major service delays, and indirectly to the danger of a life threatening incident through enforced use of manual rules for operating the railway.
6		Service critical – shared dependence Occurrence of this deviation, together with a second deviation which is potentially latent (i.e. not self-announcing), may lead directly to an incident causing major service delays, and indirectly to the danger of a life threatening incident through enforced use of manual rules for operating the railway.
5		Service critical – contributory Occurrence of this deviation, increases the probability of an event which may lead to major service delays, and indirectly to the danger of a life threatening incident through enforced use of manual rules for operating the railway.
1	Not life critical	Not service critical



The criticality rating provides a scale of the importance of achieving the specified parameter and therefore of the care needed in designing the process or processes that will lead to the parameter being achieved. The design of the process or processes that will lead to the parameter being met are the responsibility of the Contractor and they shall be designed and documented in accordance with the requirements of Engineering Standard 1-202, Signalling equipment overhaul.

10. Performance parameters

Performance parameters applicable to the EPWL are defined and quantified below.

10.1 Operating pressure

The EPWL shall energise to the fully withdrawn position with an applied air pressure of 20 p.s.i.

The normal operating air pressure is 60 p.s.i. at which pressure the EPWL shall energise and de-energise smoothly with no signs of sticking during any part of the cycle.

10.2 Pick-up time

The Pick-up time shall be measured using a configuration described in this section.

The EPWL shall be fed at 60 p.s.i. via a standard GE Valve with a 1/8" diameter orifice which shall supply the Groundlock through a 10' length of 1/4" bore air hose. An air-tight cock shall be provided, connected at the valve end of the hose.

The Pick-up Time is defined as being the time between applying the energising voltage to the GE Valve and the Lock Plunger reaching its fully withdrawn position. The time shall be measured using an electronic timer triggered by the input voltage to the GE Valve and a positive detection of the Lock Plunger reaching the withdrawn position.

The Pick-up Time shall be ≤ 150 mS.

10.3 Drop-away time

The Drop-away Time shall be measured using the configuration specified in section 10.2.

The Drop-away Time is defined as the time between removing the energising voltage to the GE Valve and the Lock Plunger being detected in its lock position by the proving contacts. The time shall be measured using an electronic timer triggered by the removal of the input voltage to the GE Valve and the making of the EPWL proving contacts.

The Drop-away Time shall be ≤ 450 ms.

10.4 Contact resistance

The contact resistance of each pair of proving contacts, set to the conditions given in section 13.1.5.2 below and with 0.1 Amps flowing through the contacts from a 100 volt A.C. source, shall be less than 0.05Ω .

10.5 Electrical insulation

The insulation resistance between all electrical terminals joined together (with the plunger in its de-energised position and therefore with the contacts closed) and the casting, shall be $\geq 50M\Omega$ when measured at 1000 V D.C.

The insulation resistance between electrical terminals with the plunger in its energised position (contacts open) shall be $\geq 50M\Omega$ when measured at 1000 V D.C.



11. Equipment configuration

An Illustrated Parts List, Attachment 2 to this document, comprising an itemized list and an exploded component drawing, describes the equipment as identified in Section 8 of this specification. The Illustrated Parts List contains all relevant drawing numbers.

A convention of using the figure number followed by the item number has been adopted in this document to uniquely refer to specific components where necessary. Thus, item 1-44 is the Top Cover of the unit.

Unless specifically noted, drawings and figures used in this Specification are for reference only.

12. General requirements

12.1 Compliance with specification

No departures from the requirements of this Specification shall be permitted (either permanently or temporarily) without compliance with the relevant change control procedures.

Neither equivalence of process nor substitution of materials shall be recognised by the Client in receiving work performed against this specification. The Client shall have the immutable expectation that equipment overhauled to this version of the specification shall be 100 % compliant with the specification herein.

12.2 Workshop environment

There are no special requirements for the workshop environment required when working on equipment covered by this Specification.

A supply of compressed air regulated over the range 20 – 60 p.s.i. is required. Air consumption is minimal.

Calibrated test equipment shall be used to carry out all measurements specified.

12.3 Calibre of staff

Any staff involved in the overhaul process shall be competent in the tasks they carry out and the overhauling contractor shall demonstrate this in accordance with the requirements of Engineering Standard 1-203, Competence of personnel working on signal and control systems.

12.4 Operator accountability

Process control documentation is required to be completed by identified certified (stamp-holding) operators and inspectors throughout the overhaul process. Each certified operator and inspector shall possess a uniquely numbered stamp which is traceable to the owner. Only competent operators shall be provided with a stamp. Records of the issue and withdrawal (if appropriate) of every stamp shall be kept and shall be made available to the Client on request. The retention period of these records is required to be indefinite.

13. Overhaul definition

Under certain failure modes of the compressed air supply system it may be possible for the air main to be charged at pressures of up to 10 bar. Pneumatically operated signalling equipment must withstand this pressure. It is not required in this Specification for the equipment to be tested at this pressure. However, the Contractor shall not perform any activity on the equipment which will impair its ability to withstand this pressure.

13.1 Full overhaul

A full overhaul will be performed on items which generally will have been in service for their full routine service life, currently nominally ten years, or which will have been removed from service as a result of a failure.