



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

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1. Scope

This Specification is written to comply with Engineering Standard 1-202 in defining the requirements for the overhaul of all variants of Point Escapements (4' and 6') 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	NDT	Non Destructive Testing
DCN	Design Change Notice	MPI	Magnetic Particle Inspection
LU	London Underground		
OEM	Original Equipment Manufacturer		
WSL	Westinghouse Signal Limited		

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 the 4' and 6' Point Escapements which are used in the signalling system on the London Underground.

The Escapements are classified as items of vital signalling equipment which means that they are used to perform a safety critical 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 item that has been overhauled shall have a functional performance, a safety integrity, a reliability, an expected service life in its installed condition and a shelf life equivalent to that of a new item.

Any failure condition which causes a set of points to be free to move under the influence of a passing train or other forces 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, or a misoperation showing a tendency towards 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 wear caused by a long period in service with frequent operation, 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.

Figure A shows a general view of the different styles of Escapement.

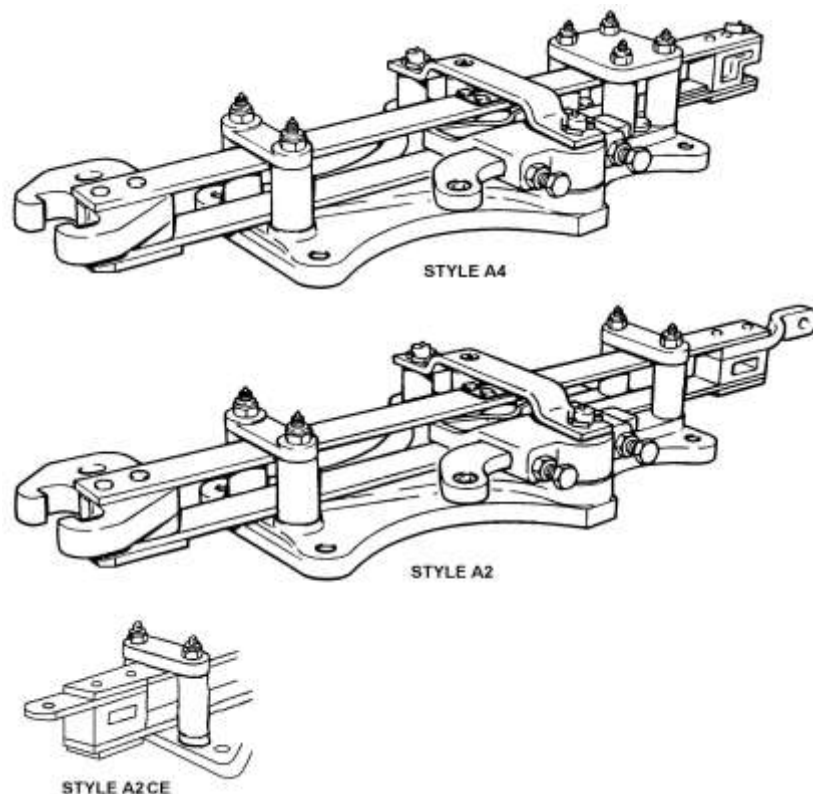


Figure A. General view of Style A2 and A4 Escapements



6. Usage of item

The Escapement is the primary operating mechanism of 4' and 6' point mechanisms. A 4' set of points has the escapement mounted between the running rails in what is termed the 4' way. A 6' set of points has the escapement mounted outside the running rails in what is termed the 6' way.

A double acting air motor is attached to the operating claw of the Escapement. The air motor typically has a piston with a diameter of 4" and a stroke of nominally 8". It is fed with compressed air at a pressure of 60 p.s.i. and is continuously pressurized to keep it at the full extent of its stroke. Large thrusts (approximately 750 lbs) are generated by the air motor which can be magnified by the angled drive imparted by the Escapement Crank. In addition to the large drive forces, large forces are exerted on the mechanism by the movement of trains over the points and by forces generated by the permanent way.

The undriven end of the slide bar connects directly to the lock slide mechanism which is used to detect the position of the switches and also to lock the escapement and slide bar by the use of the secondary Groundlock.

7. Equipment design outline

Design features built into the Escapements include:-

- Construction that is designed to be ultra reliable in operation
- Construction designed to resist the considerable forces to which it will be subjected when moving and holding a set of points
- An ability to configure a left-hand or right-hand configuration from the same component count
- An ability to re-furbish the main wearing components without the need to scrap major items.

The basic method of operation is identical for both 4' and 6' escapements. Linear motion of the slide bar in line with the running rails is converted to movement at right angles to the running rails to drive the tips of the switches from one stock rail to the other. The amount of drive is adjustable by varying the projection of the Escape Arm out of the Escape Crank (also sometimes referred to as the 'butterfly').

On 4' Escapements locking dabs are fitted, one to the upper slide bar and one to the lower. The dabs fit into ports on two locking bars, one of which is connected to each switch rail. The locking bars are treated as a separate item of equipment and are therefore not covered by this specification.

Three distinct actions occur during the 8" stroke of the escapement. These actions are 'unlock', 'drive' and 'lock'.

During the 'unlocking' part of the stroke, the slide bar moves the locking dab out of the ports in the locking bars. The Drive Roller runs along the flat face of the Escapement Crank so there is no change in Escapement Crank position and therefore the switches are not moved.

During the 'drive' part of the stroke, the Drive Roller engages with the Escapement Crank and moves it to align the approaching face parallel to the line of motion. The angular movement of the Crank is used to provide drive to the Crank Arm. The amount of drive may be varied by adjusting the position of the Crank Arm in the Escapement Crank.

During the 'locking' part of the stroke, the slide bar moves the locking dab into the other set of ports in the locking bars. The Drive Roller runs along the flat face of the Escapement Crank so there is no change in Escapement Crank position and therefore the switches are not moved.

8. Applicability

This specification applies to the following items.

Item	Stores List No.
Escapement – 4 ft – (Left Hand) - Style A4	26-S-34
Escapement – 4 ft – (Right Hand) - Style A4	26-S-49



Escapement – 6 ft – Claw Drive (Left Hand) - Style A2	26-S-777
Escapement – 6 ft – Claw Drive (Right Hand) - Style A2	26-S-733
Escapement – 6 ft – Clevis Drive (Left Hand) - Style A2	26-S-734
Escapement – 6 ft – Clevis Drive (Right Hand) - Style A2	26-S-735

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

Other variants of these basic Escapements do exist. They will be dealt with as special orders against this generic specification. No reference to any special types is used in this specification neither does the illustrated parts list give any indication of their configuration.

9. Critical functions

Critical Functions of the Escapement 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 Escapement Crank and Crank Arm: Considerable force (approximately 750 lbs.) will be exerted on the Escapement during the drive part of the stroke when it is handling the full force of the point motor. It is imperative that the structural integrity is maintained under all circumstances to ensure that 'drive' is applied to the switch tips at all times. Any failure which allows free movement of the Drive Rod (part of the fixed trackside equipment which connects to the pivot bush of the Crank Arm) will be considered a wrong-side failure.

High Structural Integrity of Lock Dabs: The Lock Dabs are required to prevent the Locking Bars (part of the fixed trackside equipment) from moving except when caused to do so as a result of movement of the Crank Arm. The Lock Dabs are therefore required to be securely attached to the Slide Bars and the Slide Bars are to be securely supported by the Guide Rollers and associated components fixed to the Base Casting. Any failure which allows the Locking Bars (part of the fixed trackside equipment) to move when they should be held in a locked position will be considered a wrong-side failure.

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.	



Criticality Rating (CR)	SAFETY RELATED CRITERIA	RELIABILITY RELATED CRITERIA
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 Escapements are defined and quantified below.

10.1 Operating stroke

The operating stroke of all Escapements shall be $8'' + \frac{1}{8}''$ – nil.

For the first and last $2\frac{1}{4}''$ of the stroke the movement of the Escape Crank shall be less than $\frac{1}{32}''$ measured at right angles to the longitudinal centre-line of the Escapement.



11. Equipment configuration

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

Common parts exist which are used on both styles of Escapement. Additionally, some items have alternative components which may be utilized.

Style A2 Escapements are more generally referred to as 6' units.

Style A4 Escapements are more generally referred to as 4' units.

Figure 1 in the Illustrated Parts List is drawn showing a Right Hand version. A Left Hand version may be configured from an identical parts inventory by assembling the Escape Crank and associated components on the opposite side of the Slide Bar assembly. This may not be done in the field as one component (item 1-10) is press fitted into its seating and other components are locked with lock tabs after fitting and cannot be moved without fitting new lock tabs. Therefore an Escapement must be configured in the workshop to a specific hand as ordered.

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 1-24b is the Base for a style A4 (4') Escapement.

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 conditions associated with the overhaul work detailed in this Specification.

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. Any staff involved in the NDT process shall be qualified and certified in accordance with BS EN ISO 9712. All certification to be attained by an independent accountable body.

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

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, or which will have been removed from service as a result of a failure.



No item returned after failing in service shall be overhauled until the failure report has been reviewed and accepted by the Client in accordance with a defined arrangement agreed with the Client.

Unless stated to the contrary, all processes detailed in this specification shall be performed for each overhaul.

13.1.1 Dismantle

The Escapement shall be dismantled in a manner that shall not damage or shorten the life of any component that is required to be re-used. The life of all recyclable components is indefinite.

The items listed below shall be discarded and replaced with new items at every overhaul.

Locking Plates (all)	Asset Plate	Aeronuts (all)
Oil Nipples	Split Pins	

The items listed below shall be discarded or modified as appropriate to bring the component to the specification given in the detailed parts listing.

Centre Roller Pins not to current design – item 8a/b	Top Slide Bar not to current design – item 3a/b	Bottom Slide Bar not to current design – item 23a/b
Guide Roller Bearing Studs not to current design - item 1-19		

The riveted Slide Bar assembly shall only be dismantled after it has been gauged and examined and specific refurbishment work has been identified.

Studs and Shouldered Studs shall not be removed from the Base until they have been gauged to determine whether they need to be replaced.

13.1.2 CLEANING

The following shall be implemented after the escapement has been dismantled in accordance with Section 13.1.1 above.

All components shall be cleaned and degreased using a technique suitable for that component. A 'suitable technique' shall not cause short term or long term degradation to the component nor shall any solvent used leave undesirable residues on the component which will affect the performance of the component when it forms part of an overhauled unit.

13.1.3 Examination and gauging

All components shall be examined for the effects of excessive or unusual wear, general damage, damage caused by misuse or age, electrical arcing or tracking or overheating. All thread forms shall be checked for signs of over-tightening. Items exhibiting damage that will not be corrected by the specified re-furbishing processes shall be discarded.

All occurrences of excessive or unusual wear or damage shall be catalogued and reported to the Client.

The subject items of such reports and as much of the unit from which they were removed as possible, shall be saved in their as near as original condition after being discovered and shall be clearly tagged and identified and shall be made available for Client inspection if so desired.

It is critical that **only** those components specified for refurbishment should be reclaimed after failing the wear tolerances specified.

Items not meeting the examination criteria shall be discarded if there is no refurbishment process detailed for it in this Specification.



Major components and items with specific examination criteria are listed below.

All component parts set aside for use at assembly shall be to a current approved design. Modification schemes may have been commenced which may not yet have been fully implemented. Units submitted for overhaul may not be to the current build standard. Some components may therefore require to be modified or discarded.

13.1.3.1 General

All oil-ways shall be checked to ensure they are not blocked and that they are clear of material that will damage the bearings, e.g. swarf, grit.

13.1.3.2 Base (Item 1-24a/b)

The Base shall be checked for general condition. Item should be checked for cracking both visually and through NDT in accordance with LU drawing no. EES-WI-123039. The appropriate action should then be taken:

(a) All bases found exhibiting cracks shall be affixed with a "Do Not Use" label and quarantined for further action.

(b) Where no defects are found, bases should be attached with a green 'Fit For Use' label.

The overall length of the Base casting across the stop-faces shall be measured and shall be 25" +nil – $\frac{1}{32}$ ". Bases may be refurbished to correct for wear, see section 13.4.1.

The Thrust Roller bearing hole, or Bush (item 1-10) on previously refurbished units, shall be checked for wear. The maximum acceptable diameter of the bearing hole shall be 1.010". Set aside for refurbishment if bearing hole is oversize.

Wear on the Shouldered Studs (items 1-44a) shall be checked. The minimum acceptable thickness of the Shouldered Stud is 0.380". Items shall not have score marks in the wear surface.

All Studs shall be securely riveted in position. Bases exhibiting loose studs shall be set aside for refurbishment.

13.1.3.3 Slide bar assembly

The assembly shall be checked for soundness of all riveted joints. Re-rivet components where necessary.

All Slide Bar assemblies are to be fitted with a tapered Centre Roller Pin in accordance with drawings BS29060 for 4' Escapements, BS36649 for 6' Escapements and AS34405.

The width of the Top and Bottom Slide Bars (items 1-3a/b and 1-23a/b) shall be checked for wear. The minimum width at any point along the bar shall be 2.240" for 4' escapements and 2.490" for 6' escapements. There shall be no burrs on any part of the blade.

Examine slide bars (1-3a), (1-3b), (1-23a) and (1-23b), if the distance between the centres of the inner rivet holes of the stop plates is not within $34\frac{1}{2}'' \pm \frac{1}{32}''$ the slide bars must be rejected and replaced with those specified in the parts list.

Examine the Lock Plates (items 1-30) for damage to the corners and edges. No damage to corners or edges is acceptable.

The diameter of the tapered hole in the Slide Bar which accepts the Centre Roller Pin shall be gauged. A new Tapered Roller Pin in accordance with drawing AS34406 item 1 or 2, as appropriate, when fitted into the Slide Bar shall protrude above the surface of the Top Slide Bar as detailed in drawing AS34405. Slide Bars not meeting this criteria shall be set aside to be refurbished (see section 13.1.4.4).

The profile of the Slide Bar Lugs shall be checked using J241 for 4' Escapements or J1080 for 6' Escapements.

The Coupling Pin (item 1-26) bearing shall be gauged for wear. The maximum acceptable diameter is 0.755". Wear in this bearing hole will occur in the Slide Bars, the Distance Block (items 21a or 21b) and the Eye. See relevant section below for refurbishment details.