



(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  | 14 |
| 2. References               | 1    | 15. Prescribed jigs and methods                | 14 |
| 3. Abbreviations            | 1    | 16. Jigs and gauges                            | 14 |
| 4. Definitions              | 2    | 17. Equipment identification and documentation | 15 |
| 5. Introduction             | 2    | 18. Record retention                           | 15 |
| 6. Usage of item            | 3    | Document history                               | 16 |
| 7. Equipment design outline | 3    | Document index data                            | 16 |
| 8. Applicability            | 4    | <b>Attachments</b>                             |    |
| 9. Critical functions       | 4    | 1. References                                  | 17 |
| 10. Performance parameters  | 6    | 2. Illustrated parts list                      | 18 |
| 11. Equipment configuration | 6    | 3. Critical parameters and settings            | 30 |
| 12. General requirements    | 6    | 4. Specification hierarchy                     | 31 |
| 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 all variants of the Glass Enclosed (GE) Air Valve 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            |
| GE  | Glass Enclosed                  |
| 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 Glass Enclosed Air Valves which are used in the signalling system on the London Underground. These items are more commonly referred to as GE Valves, a term will be used throughout this document.

GE Valves are used as part of the signalling system which means that their performance affects the safe movement of trains. They have been designed to be ultra reliable pieces of equipment whose mechanical and electrical integrity will be relied on throughout its extended working life. It is a mandatory requirement that a GE Valve 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 allows a GE Valve to remain in an energised state when the electrical input dictates that it should be de-energised, is classed as a serious failure. Serious failures are investigated exhaustively to establish the cause of the failure. Investigations into serious failures will examine every aspect of the failure including materials and processes used during the overhaul work. Failure investigations are extremely costly to perform and could result in the need to change many units in service.

Items supplied for overhaul will be complete units which usually will have failed in service although some may be in working order. 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.

A general view of a GE Valve is shown in Figure A.

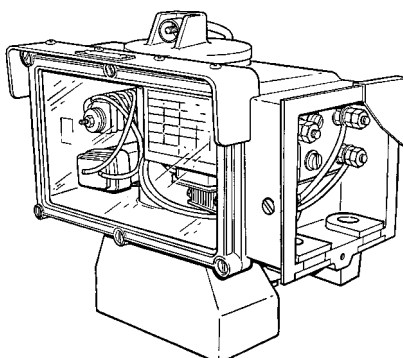


Figure A General View of a GE Valve



## 6. Usage of item

The GE Valve is a three port air valve used to feed compressed air at a nominal 60 p.s.i. from the air main to various items of signal equipment. The main use of the valve is to operate trainstops and point groundlocks. Uses also include operation of motorised tripcock testers and other miscellaneous pieces of pneumatically operated equipment.

Partial builds of the GE Valve are used as sub-assemblies of the Point Valves and the Outdoor Disc Signal. (See section 8 of this Specification for further details.)

Air flow through a GE Valve is limited by it having only a  $\frac{1}{8}$  in. diameter passage through the valve bush. This makes it totally unsuitable for feeding point cylinders and any other high volume, quick acting, pneumatic device. Although the air flow is minimal, the flow rate is critical to the operation of point groundlocks.

GE Valves are usually post mounted, close to the air main from which they are fed by a hose connection coupled to the air main by a 4-way isolating air-cock. Air feed and equipment connections are made using flexible hose terminated with  $\frac{1}{2}$  in. BSP fittings. The equipment fed by the valve exhausts through the valve using an un-silenced exhaust port cast into the body of the valve.

The air main contains considerable quantities of water, glycol and rust deposits which are carried through the system by the air flow. These conditions make it very difficult to achieve good seals at the two valve seats contained in the valve. A filter is fitted to both the inlet and feed hose connection in an attempt to keep particles from entering the valve from the air main or from the equipment being fed.

## 7. Equipment design outline

Design features built into the GE Valve include:

- Construction that is designed to be ultra reliable in operation
- Construction designed to withstand the severe vibration conditions present where the units are mounted usually very near to the track bed.
- An ability to re-furbish the main wearing components without the need to scrap major items.

Two variants of the GE Valve exist which are similar in operation. The Fault Screen version has, in addition to the components in the regular version, a fault screen terminal and certain insulating components to insulate the transformer and fault screen terminal from the case of the unit.

Both variants of the GE Valve operate from a 100 volt supply at both  $33\frac{1}{3}$  Hz and 125 Hz. The electrical circuit consists of a step down transformer feeding a full wave rectifier circuit, smoothing capacitor and the magnet coil. The secondary of the transformer supplies approximately 30 volts to the A.C. side of the rectifier.

The original design used a cast iron valve chamber. The current design uses a brass valve chamber casting to mitigate the corrosion effects caused by the hostile nature of the air supply. Both types are still in service and both may be overhauled and re-used.

The GE Valve comprises three main component assemblies. These are:-

**Magnet and case assembly.** This item contains the transformer, rectifier, capacitor, magnet core and valve stem and the terminal connections for the electrical input. The components are all housed in a 'glass' fronted weatherproof case which has two compartments, one sealed containing the main components and a second termination compartment containing the input terminals. A drop-on lid protects the terminations. Cable entry is provided via insulated bushes which are packed with sealant by site staff when the unit is installed.

**Valve chamber assembly.** This contains the valve seats and the pin valve controlling air feed from the supply to the apparatus. The exhaust valve seat is contained in the valve body. The exhaust seal is formed

between the bottom end of the armature stem and the exhaust valve seat. A spring is used to return the pin valve onto its seating and to lift the armature stem. Air flow through the valve is determined by the diameter of the orifice in the valve body and by the lift of the pin valve. The size and positioning of the valve seats within the valve body, the length of the pin valve and the geometry of the lower end of the armature stem are critical to the correct set-up of a GE Valve.

Back-plate assembly. This casting contains the main fixing holes for mounting the unit to the fixed infrastructure and the hose connections for the air feed and for the controlled air supply to the connected signal equipment.

## 8. Applicability

This specification applies to the following items.

| Item                                                            | Stores List No. |
|-----------------------------------------------------------------|-----------------|
| GE Valve 100 volt $33\frac{1}{3}$ /125 Hz (universal)           | 91-S-41         |
| Fault Screen GE Valve 100 v $33\frac{1}{3}$ /125 Hz (universal) | 91-S-46         |

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

Partial assemblies of some of the components of the Illustrated Parts List are used as sub-assemblies for other equipments. Thus:-

For Point Auxiliary Valves. units comprising items 1-01 to 1-59 and 2-84 to 2-122 are used as a sub-assembly of a complete equipment.

For Disc Signals. units comprising items 1-01 to 1-69 and 2-84 to 2-122 are used as a sub-assembly of a complete equipment.

## 9. Critical functions

Critical Functions of the GE Valve 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.

Electrical Safety. Satisfactory earthing and bonding of the Valve 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 following table.



| Criticality Rating (CR) | SAFETY RELATED CRITERIA                                                                                                                                                                                             | RELIABILITY RELATED CRITERIA                                                                                                                                                                                                                                                                                                                                     |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10                      | <b>Life critical – sole dependence</b><br>Occurrence of this deviation alone may lead to an incident causing death or injury.                                                                                       |                                                                                                                                                                                                                                                                                                                                                                  |
| 8                       | <b>Life critical – shared dependence</b><br>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                       | <b>Life critical – contributory</b><br>Occurrence of this deviation increases the probability of an event which may lead to an incident causing death or injury.                                                    | <b>Service critical – sole dependence</b><br>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                       |                                                                                                                                                                                                                     | <b>Service critical – shared dependence</b><br>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                       |                                                                                                                                                                                                                     | <b>Service critical – contributory</b><br>Occurrence of this deviation, increases the probability 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                       | <b>Not life critical</b>                                                                                                                                                                                            | <b>Not service critical</b>                                                                                                                                                                                                                                                                                                                                      |

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 GE Valve are defined and quantified below.

### 10.1 Pick-up voltage

The Pick-up voltage, measured with supply frequencies of  $33\frac{1}{3}$  Hz and 125 Hz and with an air supply of 60 p.s.i. shall be  $\leq 80$  volts.

### 10.2 Drop-away voltage

The Drop-away voltage, measured with supply frequencies of  $33\frac{1}{3}$  Hz and 125 Hz and with an air supply of 60 p.s.i. shall be  $\geq 30$  volts.

### 10.3 Air flow

The air flow shall be measured with the valve energised with 100 volts and with air fed at 60 p.s.i. through a  $\frac{1}{2}$  in. hose connected to the 'feed' union connection. The 'delivery' union connection shall be connected to a flow meter using  $\frac{1}{2}$  in. hose. The flow meter shall exhaust to atmosphere.

The air flow through an energised valve shall be at least 220 litres/minute.

### 10.4 Insulation resistance

The Insulation Resistance measured between both input terminals  $T_0$  and  $T_1$  shorted together and all other metallic parts of the unit shall be  $\geq 50$  M $\Omega$  when measured at 1000 V DC.

The Insulation Resistance measured between the fault screen terminal FS (if fitted) and any other metallic part of the unit shall be  $\geq 50$  M $\Omega$  when measured at 1000 V DC.

The Insulation Resistance measured between the fault screen terminal FS (if fitted) and input terminals  $T_0$  and  $T_1$  shorted together shall be  $\geq 50$  M $\Omega$  when measured at 1000 V DC.

## 11. Equipment configuration

An Illustrated Parts List is provided as Attachment 2, comprising an itemised list and two exploded component drawings to describe 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 1-70 is the Oil Spray Cover.

Where items have only 'a' and 'b' components identified for a particular part, the 'a' and 'b' variants are alternative components. Where an un-suffixed part number is used as well as a similarly numbered suffixed one, then both parts are required.

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.

A regulated (0 to 60 p.s.i. ) supply of compressed air is required. Air consumption is minimal.

An adjustable ( 0 to 110 volts) supply of A.C. voltage is called for at frequencies of  $33\frac{1}{3}$  Hz  $\pm$  1 Hz and 125 Hz  $\pm$  1 Hz. The maximum current drain will be 1 Amp.

## 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

GE Valves are generally left in service until they fail. A full overhaul, including repair or replacement of failed component(s) will be performed on each item returned to the workshop.

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 GE Valve 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.

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

|                           |                             |                           |
|---------------------------|-----------------------------|---------------------------|
| Asset Label (1-37)        | Split Pins (all)            | Locking Plates (all)      |
| Armature Stem (1-53a/b)   | Lead Seals and Locking wire | Terminal Screws (1-24a/b) |
| Sealing Washer (1-83)     | Nuts (all)                  | Washers (all)             |
| Valve Seat Bush (1-65a/b) | Oil Spray Cover (1-70)      | Air Filters (1-78)        |



|                      |                  |                   |
|----------------------|------------------|-------------------|
| Copper Washer (1-61) | Spring (1-62)    | Pin Valve (1-63)  |
| Thread Covers (1-81) | Valve Cap (1-32) | Rectifier (2-111) |
| ◆ Capacitor (2-102)  |                  |                   |

Capacitor Assemblies (2-101) not to the current design standard shall be discarded.

Windows (item 1-41) of glass shall be replaced with items to the current design.

The Armature Stop Spring Assembly may remain attached to the case if undamaged and securely attached.

The Wire Inlet Bush (1-13) shall be left in place in the case.

The Weather Hood (1-10) and fixing screws (1-11) may remain in position if undamaged.

Residual Pins (1-58) shall not be removed from the Armature Plate (1-57) until they have been gauged.

Hollow Dowels (1-69) shall not be removed from the Valve Chamber (1-64a/b) until they have been examined.

Ventilation Gauzes (1-4) shall not be removed from the Case until they have been examined.

Termination wires leaving the Magnet Valve Assembly shall be detached from the rectifier by undoing the screwed connections. These wires shall NOT be cut.

The Magnet Valve Assembly shall be removed from the case as a unit and not stripped further until after the examination stage.

The Transformer shall be removed from the Case as a complete assembly and not dismantled into its component parts.

### 13.1.2 Cleaning

The following shall be implemented after the relay 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. Signs of electrical tracking or arcing shall be treated as excessive wear.

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 Case (Item 1-3)**

The Body Casting shall not exhibit any signs of corrosion and general damage.

The Ventilation Gauzes shall be checked for secure fixing in the case, integrity of the gauze and for free passage of air through them. If either item is loose, damaged or blocked then both items shall be renewed.

All tapped holes shall be in good condition. Stripped 1 BA and 2 BA holes may be refurbished as described in section 13.1.4.2 below.

#### **13.1.3.2 Valve magnet assembly (Item 1-44)**

The terminating wires shall be examined for signs of cracking or other degradation of the insulation. Valve Magnet Assemblies with terminating wire not to the latest specification may be re-used if the terminating wires are in good condition. The Ross Courtney terminations shall be examined for soundness. If satisfactory, re-use as is. Poor terminations may be re-made with new Ross Courtney terminations if lead length allows. Otherwise, the coil shall be re-wound.

The winding shall be examined for signs of overheating. Coils showing evidence of overheating shall be re-wound.

The resistance of the coil shall be checked and shall be in accordance with drawing CS64193.

If the leads and the general coil condition are good then the coil may be re-used.

The paint finish of Magnet Covers (item 1-45) shall be checked. Items with damaged, faded or flaking paint shall be set aside for re-painting. Items may be re-used in their existing state if their condition is satisfactory.

#### **13.1.3.3 Valve chambers (Items 1-64a/b)**

Valve Chambers shall not exhibit any damage and excessive corrosion.

Hollow dowels shall be refurbished in accordance with section 13.1.4.3 if damaged.

All cast iron chambers shall be re-plated.

#### **13.1.3.4 Transformer (Item 2-84)**

The Transformer shall be examined for signs of overheating. Items with coils that show signs of overheating shall have both coils replaced.

Coil terminations shall be securely attached to their coils and each coil shall be firmly fitted to the laminations. Loose coils may be re-secured onto the laminations using Nomex packing. Coils with loose terminations shall be replaced.

The resistance of each coil shall be checked to be in accordance with drawing BS31741.

The insulation resistance measured between each coil and the transformer laminations shall be a minimum of 50 Megohms when measured at 1000 V D.C.

Any coil not meeting all the above criteria shall cause both coils to be replaced.



### 13.1.3.5 Armature plate (Item 1-57)

The condition of the plating of the Armature Plate shall be examined. Items with damaged or peeling plating shall be set aside for refurbishing as detailed in section 13.1.4.5 below.

The height of the Residual Pins (items 1-58) shall be checked to be within the limits of 0.020 in. - 0.022 in. All residual Pins shall be firmly attached to the Armature Plate. Any Residual Pin not meeting both the above criteria shall cause all three pins to be replaced as detailed in section 13.1.4.5 below.

### 13.1.3.6 Capacitor (Item 2-102 )

The Capacitor shall be tested. The capacity shall be within the range 1.9 – 2.1  $\mu$ F.

## 13.1.4 Refurbishment

### 13.1.4.1 Paint finishes

The following items shall be painted to the specification detailed in this section:-

- Weather Hood (Item 1-10)
- Terminal Cover Plate (Item 1-17)
- Window Frame (Item 1-42)
- Valve Chamber (Item 1-64a/b)
- Mounting Bracket (Item 1-76)

Items shall be stripped of all old paint using a process that does not damage the component or leave a residue that affects paint adherence to the cleaned surfaces.

The items shall be painted on all surfaces leaving sealing faces and threads free of paint, as detailed below.

Painting shall be done after the item has completed any refurbishing or replacement of parts required.

A base coat of Red Oxide Primer (manufacturer- Hadfields, reference 1313.006) – LU Part No. 17412/429 shall first be applied followed by a top coat of General Purpose Aluminium Paint to LT Specification 174-27 (LU Part No. 17450/225).

### 13.1.4.2 Case (Item 1-3)

1 BA and 2 BA tapped holes may be refurbished by fitting appropriate rivnuts in accordance with drawing CS64192.

Painting shall be done after the item has completed any refurbishing or replacement of parts required.

Cases shall be stripped of all old paint using a process that does not damage the casting or the thread form of any tapped hole.

Cases shall be painted all over with the exceptions listed below.

All seating faces, threaded holes, ventilation gauzes, the Armature Spring Stop Assembly and all operating faces shall be protected from paint application.

A base coat of Red Oxide Primer (manufacturer- Hadfields, reference 1313.006) – LU Part No. 17412/429 shall be applied to all surfaces.

The inside of the case (including the inside of the terminal compartment) shall be finished with a top coat of gloss white paint.

The outside of the case shall be finished with a top coat of General Purpose Aluminium Paint to LT Specification 174-27 ( LU Part No. 17450/225).