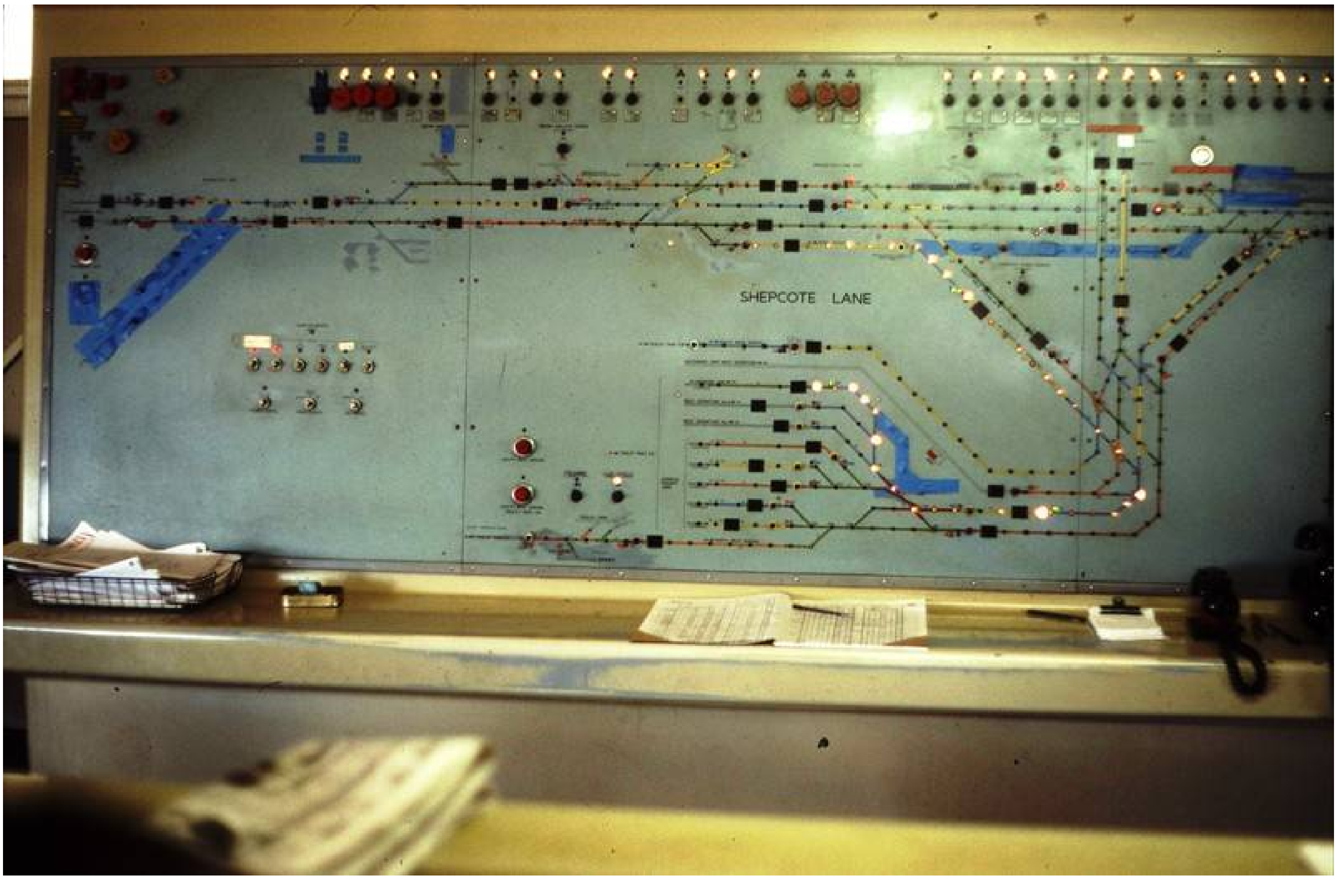
British Power Signalling Register



by Andrew K Overton

Version 25.4, 04/10/2025

Go to www.bpsr.org.uk for regularly updated versions. Before using this information please ensure you have the latest pdf and workbook download. The author welcomes additional information by email: andrewkoverton@gmail.com

Contents

Cover photo - *Shepcote Lane, Westinghouse MCD NX(PP)[+], 30 August 1990 [Photo: © CJ Woolstenholmes]*

Introduction

There have been many lists of signal boxes and associated equipment produced over the years and all have followed a common convention: the equipment details in them have been tied firmly to the building housing them - the 'signal box'. In the case of mechanical signal boxes with a lever interlocking frame controlling a relatively small area this has worked well, and the system has also successfully incorporated small power signalling installations based around a single interlocking. However, this system is fundamentally unsuited to cataloguing the larger modern power signalling installations which have numerous interlockings in several locations, some or all of which may be of different types and ages, having migrated from control by other signal boxes now abolished or been added some time after the commissioning of the box. The interlockings of modern signalling installations have been poorly catalogued and yet it is arguable that each interlocking is very much the equivalent of a signal box of old, merely controlled from a remote location, and deserving of a proper record. A wide range of non-block post signalling equipment (local control panels, ground switch panels etc.), some of which are larger than those in signal boxes, has gone unrecorded owing to listings being centred around the signal box as a defining feature.

No criticism of other researchers is intended by this analysis. When most of these registers were begun no work had been done to list and analyse signalling equipment and buildings, and the race was on to record the fast-disappearing mechanical scene. Access to the larger power signalling installations was far more difficult than to mechanical boxes. Thirty years on from the pioneering work of these authors, however, it is perhaps time to realise that the work in that direction being largely complete, attention should now turn to the Cinderella installations as they themselves are increasingly swept away by the tide of new technology and their own life expiry. New technologies have been yet more difficult to list under the old conventions, a problem which will get worse in the future.

It is against this background that the British Power Signalling Register was created. My intention has been to compile a comprehensive record of all types of installation, based around the equipment rather than its geographical location. I took the decision to not even record the building housing the equipment as in the modern age I do not feel that in many cases it has any relevance. It is a matter of fact that the most modern signalling systems, based around PC technology, in theory could be worked by a signalman (throughout this work I avoid the modern term 'signaller') from the comfort of his own home via a broadband telecommunications link, thus rendering the whole concept of the signal box virtual and something which exists only in the software. The limitations of previous work also informed my decision to divorce the listings of interlockings from those of the controlling equipment - the interface. With a mechanical lever frame the interlocking is an intrinsic component of the frame as a whole but power signalling keeps the controls and interlockings at arms length - sometimes at many thousands of arms' lengths! This technology can only be meaningfully recorded in a way which mirrors the system itself. It was also important to 'future-proof' the register so that as far as could be foreseen it would be able to cope with the signalling systems of tomorrow, without retrospective rejigging.

Another problem recognised even by the compilers of previous registers is that no-one had undertaken to study the designs of power signalling equipment and communicate these to an audience. Even the terms by which the various types of equipment are referred to had not, in many cases, been strictly defined or previously recorded - where they had the references were not easily accessible by other than signalling engineers. There had been an assumption that 'everyone knew' what certain names meant but this had led to conflict and confusion in the provision of information regarding certain locations, depending on the interpretation placed on those names by each individual. Some equipment which has seen limited applications has never had any universally agreed name. Part of this work has therefore been to study the terms already in use and to set out strict definitions, generally through discussion with engineering professionals. Where new terms were thought to be helpful these have been introduced but have been kept to an absolute minimum and complete redefinitions of colloquially used terms have been avoided.

The provision of data in the form of a catalogue or register is only partly useful to the researcher. True the facts are gathered together into one source but making use of them for ongoing research can be aided or hindered by the format. It was felt that a paper-based register would entail many hours of work to extract data for analysis and in this age of home computing would be an anachronism. Thus the decision was made to use spreadsheets, with a system of terms used to describe equipment which would aid the data analysis tools available with that software (Sort and Filter commands etc.). For this reason the use of copious notes providing essential supporting information to the data entries has been avoided as much as possible.

It was the initial intention to produce the power signalling equivalent to *The Guide to Mechanical Locking Frames* (Signalling Study Group, 1989) as part of this work but it was found early on that splitting interfaces into sub-categories under each design manufacturer was not practicable. Unlike mechanical lever frames panels etc. have been produced in generally far fewer numbers and during a period of rapid advances in electrical and electronic engineering technology. This has meant that the detailed appearance of panels has often changed rapidly with only a few capable of being grouped into anything other than the broadest and most meaningless sub-sets. This is a particular feature of the large number of interfaces produced by the British Rail (BR) regional workshops at Crewe and York, which made use of whatever bits were on hand at the time of each order. The only alternative was to create a very great number of sub-sets, sometimes containing but a handful of examples, and it was felt that this would be far too complicated and cumbersome a system to be taken into general usage. The result is that the evolution of designs has been generally described and illustrated with photos, being only split into design manufacturers' official model designations.

Power signalling installations based around miniature lever or slide frames are not included in the same sections as switch or button based interfaces but are recorded separately. This is because frame-based power signalling fits more properly into the mechanical era; the interface and interlocking are intrinsically combined into one unit and the latter component acts directly on the lever or slide, a fundamental difference to switch- and button-based technology. So the use of buttons and switches has been a general prerequisite for inclusion in the main register.

The information used to compile the register has been drawn from a wide variety of primary sources and contemporary publications. The vast majority of dates have been established by reference to the lists of signalling alterations published in the journal of The Signalling Record Society and in their annual alterations sheets. Photographic evidence has been obtained in almost every case to confirm the identification of equipment and information from previously published works has not been incorporated unless independently verified to avoid perpetuating past misunderstandings. For the same reason, information provided by human sources has been thoroughly verified before incorporation. In the few cases where it has not been possible to verify information this is clearly indicated. Any remaining mistakes are therefore the responsibility of the author alone, who would be very grateful to be informed of them with supporting evidence for the correction. It is intended that this should be a living document which is updated in line with future alterations to signalling infrastructure and the author would be most grateful to be informed of changes which need to be reflected in the listings. Information can be sent by email to andrewkoverton@gmail.com

Acknowledgements

It is almost a cliché to say that a work could not have been completed without the help of this, that and the other person, but in the case of this register I make no apology for saying so. It is simply not possible for any one person to hold the amount of information spanning 80 or so years necessary to compile a work of this kind. It would have been completely impractical to make much headway at all without the generous help given by a great number of people who have thrown open their records and answered, in many cases, a bombardment of queries and follow up questions. My main task has been the compilation and analysis of the vast amount of data on hand, as well as ferreting out missing detail. This work should therefore be seen not as solely my own, but rather as a combined pooling of the many years of research and recording undertaken by the very many people interested in the British signalling scene, without whose efforts it simply would not have happened.

I would like to take this opportunity to place on record especial thanks to: Mike Addison for throwing his files open to me and patiently answering innumerable emails; David Allen for a database of BR North-eastern Region Weekly Operating Notices (WONs) and access to photos; Bob Davies, Chris Bellett, Graham Floyd and Simon Foster, engineers and *The Signal Box* website forum contributors, for invaluable help and a great deal of technical information; Michael Back for digging into his archive to produce difficult dates; Mick Charlesworth for help with Sheffield Power Signal Box (PSB) Local Control Panels (LCPs); David Collins for providing much information from the former BR(WR) area and thereby saving me a very great deal of work; Tony Cornell for help with early GE lines installations; John Creed, Martin Elms and Nick Wellington for keeping me on the right track south of the Thames through their comprehensive knowledge and archives; Dennis Crowe for sending me so many PSB plans and resignalling notices many years ago, which were filed without great interest at the time but which have proved to be a goldmine; John Francis for technical assistance and Westinghouse information; Peter Gibbons for help with the Three Bridges area; Mark Glover of Invensys Rail Ltd. for permission to use Westinghouse photos; Steve Gwinnett for help with the Kings Cross PSB stageworks; Tim Hadfield of TEW for generously answering many enquiries and providing lists of equipment; John Hinson for his excellent discussion forum at *The Signal Box* website, through which many queries were answered, and for help with direct enquiries; Alan Mackie for throwing his own records open to me, answering many emails and investigating so many matters north of the border through his network of contacts; John McCrickard for generously filling in the gaps in my collection of SRS signalling alterations sheets and journals from his own library, and for providing me with a network of initial contacts; Peter Kay for inspiration through the long-running Signal Box Directory series and for making his own research freely available to me; Simon Lowe for much Scottish assistance; John Midcalf for the great number of photographs sent to me, without which identification of so many interfaces and constructing the history of developments would have been inestimably more difficult; Ian Mitchell for making me aware of the SSI Applications Manual, the data from which saved me from many hours of work and numerous location visits, and for providing a great deal of information on the history of IECC; Roger Newman for prompting me to include a study of power frames and for providing several difficult dates; Richard Pulleyn for digging through his records of many BR(ER) installations; Danny Scroggins for making his own photographic collection freely available to me as well his records of current signalling installations; the Signalling Record Society for building up a record of alterations and for its archive, without which it would not have been possible for this project to have succeeded; David Stansfield for help with Kings Cross LCPs; Peter Woodbridge for invaluable guidance and critique from the signal engineer's viewpoint; the late Chris Woolstenholmes for the body of photographs he built up of power signalling installations; plus certain individuals who wish to remain anonymous. The photographers who have allowed their work to be used to illustrate this Register are individually credited and I am most grateful to them all. Many of the above also gave much time proof-reading and critiquing the draft copy and my thanks go to the individuals concerned.

I have also received many collective hours of assistance from the following people, to whom I am deeply grateful: Nick Allsop, Ken Appleby, Paul Armstrong, John Bennett, Chris Booth, Trevor Booth, Pete Burke, Peter Churchman, Chris Cock, Keith Cross, Nick Fleetwood, Andrew Gardiner, Tony Higgs, Brian Hornsey, David Ingham, Reg Instone, Andy Knowles, Neil Mackay, Graham Maxtone, Robert Mills, the staff of the National Railway Museum Search Engine, Mick Nicholson, Richard Pike, Ralph Potter, Allan Pym, Alan Roberts, Matt Saunders, Ian Smith, Garth Tilt, Adrian Vaughan, Charles Weightman, John Whitaker - as well as many railway and signalling contractors' staff and enthusiasts who have responded to emails enquiring about installations and anyone I have inadvertently forgotten.

Acknowledgements with Version 25.4

Since the original version of the BPSR was published I have been contacted by many people offering corrections and additional information to fill in blanks, and providing details of changes to the power signalling scene. I have been particularly gratified by the support the publication has enjoyed by professionals, for whom it is proving to be a useful resource: this was always a major aim. To continue to acknowledge individuals separately would result in this section becoming a significant proportion of the total pagecount, so I hope that I will be excused for offering a combined 'thank you' to all. I am extremely grateful to everyone who has taken the trouble to contact me and for the continued help I have enjoyed during my ongoing researches.

References

Hard-copy

A Centennial, History of Alstom Signaling Inc., 1904 - 2004, (Alstom 2004)

A History of North Eastern Railway Signalling (by Neil Mackay, NERA, 2016)

A Hundred Years of Speed with Safety, (by O S Nock, The Hobnob Press, 2006)

Another Way to Modernise, E10k Interlockings (Or RRI on the WR), (by Mike Page, technical paper, 2003)

AEI - GRS Railway Signalling Catalogue, (AEI-GRS, 1960 [with amendments to 1964])

Bristol Resignalling Brochure, (by MV-GRS, circa 1935)

British Rail (and Railtrack (RT), Network Rail (NR)) Resignalling Notices, Signalling Scheme Plans, Periodical Operating Notices (PONs) and WONs - assorted various (1949 - date)

British Rail (North Eastern Region) Official Signalling Photo Collection (NRM)

British Rail (Western Region) Official Signalling Photo Collection (NRM Catalogue No. 1997 / 7485)

British Railways Board S&T Committee Minutes 1961 - 1992, (The National Archives, RAIL 167/1128 - 1133)

ERSE MkI & II Handbook, (British Rail, 1979)

ERSE MkIV Product Specification, (Network Rail, 2006)
Fifty Years of Railway Signalling, (by O S Nock, IRSE, 1962)

Freight and a City, (BTC, The British Transport Films Collection DVD Vol. 4, 1966)

GEC-GS Resignalling Brochures, various (GEC-GS, undated)

GRS and MV-GRS Resignalling Brochures, (GRS / MV-GRS, 1935 - 1950)

Glossary of Signalling Terms, Railway Group Guidance Note GK/GN0802, (Rail Safety & Standards Board, 2004)

Great Central Railway Minute Books and Signalling Works Files, various (The National Archives)

Great Western Railway Magazine, 1905 -1935 editions

Great Western Railway Signalling Notices - assorted various

London & North Eastern Railway Magazine, 1937

London & North Eastern Railway Minute Books and Signalling Works Files, various (The National Archives)

London & North Western Railway Minute Books, various (The National Archives)

London & South Western Railway Minute Books, various (The National Archives)

Merry-Go-Round on the Rails, (by David Monk-Steel, The Historical Model Railway Society, 2011)

Miscellaneous photographs of signal box interiors and power frames (NRM, prints in 3 folders)

Modern Railway Signalling, (by M G Tweedie & T S Lascelles, Blackie & Son Ltd, 1925)

Modern Railways, 1962 - 1995 (complete)

National Archives MT6, MT29 and MT114 files (various)

Newsletters Nos. 2 - 101, (Signalling Record Society, 1970 - 1986)

A Pictorial Record of Great Western Signalling, (by Adrian Vaughan, OPC, 1984 revised)

A Pictorial Record of LNER Constituent Signalling, (by A A MacLean, OPC, 1983)

A Pictorial Record of LNWR Signalling, (by Richard D Foster, OPC, 1982)

Points and Aspects, (BTC, The British Transport Films Collection DVD Vol. 8, 1974)

Power Railway Signalling (Part Two), (by H Raynar Wilson, 1908)

Principles of Relay Interlocking & Control Panels (*British Practice*), (N Marshall, IRSE, 1961)

Proceedings of the Institution of Railway Signal Engineers, 1913 -2001 (complete)

Railway Gazette and Railway Gazette International, 1907 - 1985 (complete)

Railway Signalling, (by O S Nock (Ed.), A & C Black, 1985)

Railway Signalling and Communications, Installation and Maintenance (St. Margaret's Technical Press Ltd., circa 1950 (undated))

Railway Signalling Systems, (by John R Day & B K Cooper, Frederick Muller Ltd, 1958)

Route Control Systems AEI - GRS (*British Practice*), (A C Wesley, IRSE, 1961)

Route Control Systems: The SGE 1958 Route Relay Interlocking System (*British Practice*), (J V Goldsbrough, IRSE, 1961)

Route Control Systems (W B & S Co.) (*British Practice*), (J E Hawkes, IRSE, 1961)

Route Relay Interlocking, Mile End - Stratford, (MV-GRS, 1950)

Saltley and Trent Resignalling, (AEI-General Signal Ltd, undated)

SGE Resignalling Brochures, various (SGE, 1936 - 1964)

Signal Box Alterations, Annual Sheets, (Signalling Record Society, 1977 - 2011)

Signal Box Directory 1987, (by the Signalling Study Group, 1987)

Signal Box Directory 1992, (by Peter Kay, 1992)

Signalling Atlas and Signal box Directory Second Edition (by Peter Kay & Derek Coe, Signalling Record Society, 2004)

Signalling Atlas and Signal box Directory Third Edition (by Peter Kay, Signalling Record Society, 2010)

Signalling Relays and Their Place in the Development of Modern Signalling, (by M P White, IRSE paper, 2007)

Solid State Interlocking (SSI) (*British Practice*), (D H Stratton, IRSE, 1988)

SSI Applications Manual, SSI 8150E Issue 6 (Network Rail, 2002)

SSI Applications Manual, SSI 8150E Issue 9 (Network Rail, 2009)

SSI Configuration Guide, NR/GN/SIG/1790 (Network Rail, 02/06/2012)

SSI Configuration Guide, RT/E/C/17901 Issue 3 (Railtrack, 1999)

South Eastern and Chatham Railway Minute Books, various (The National Archives)

The Style 'L' Power Frame, (by J D Francis, published by the author, 1989)

Talbot, John, collection of photo albums in Signalling Record Society Archive, Droitwich Spa

The Signal Engineers, (BTC, The British Transport Films Collection DVD Vol. 8, 1962)

The Signalling Record Nos. 1 - 140, (Signalling Record Society, 1987 - 2010)

Westinghouse Resignalling Brochures, various (Westinghouse Brake & Signal Co. Ltd., 1905 - 1981)

Westinghouse Signalling Catalogue, (Westinghouse Brake & Signal Co. Ltd., undated ca. 1961)

Websites

URLs were valid at time of writing

Mark Adlington's WB&S miniature lever frames site https://www.wbsframe.mste.co.uk/public/index.htm

Nick Allsop's photographic gallery http://nickallsop.fotopic.net/ (no longer valid at April 2011)

Facebook - Signalboxes and Signalling Group
https://www.facebook.com/groups/168118503304604/?ref=bookmarks

Flickr - The British Railway Signalling Pool https://www.flickr.com/groups/462645@N22/pool/

Andrew Gardiner's photographic gallery https://www.flickr.com/photos/llangollen_signalman/

Stephen Lawton's photographic gallery http://supersignaller.fotopic.net/ (no longer valid at April 2011)

Limit of Shunt https://www.limitofshunt.org.uk/ (no longer valid at June 2025)

Danny Scroggins' photographic gallery https://photos.signalling.org/

Alex Seal's Bristol power signalling website
https://www.alextrack.co.uk/railways/signalling/power_signalling_at_bristol/

The Signal Box https://signalbox.org/

Signal Box Prefix Codes http://www.railwaycodes.org.uk/signal/signal_boxes0.shtm

Signalling Notices http://www.signallingnotices.org.uk/ (no longer valid at January 2020)

John Tilly's photographic gallery https://www.tillyweb.biz/gallery/odyframe.htm

Wikipedia - *Integrated Electronic Control Centre*
https://en.wikipedia.org/wiki/Integrated_Electronic_Control_Centre

And various websites belonging to the current signalling contractors - by the nature of news releases relating to contracted work and products these are ephemeral and the provision of URLs here is of little use.

Glossary

Types of interface and interlocking and their associated technology, along with their abbreviations, are shown in dedicated sections of the text.

Check-Locking	The prevention of a lever or slide from completing its full travel until the equipment it is controlling has responded fully to its command.
Console	The casing or housing into which an interface is fixed.
Detection	A system for confirming the position of points or signals.
Direct Wire	A system for the connection of an interlocking to an interface without the use of remote control systems.
Equipment Plate	A separate surface beneath a fascia plate to which indication lamp, switch, button etc. units are secured. Not always provided.
Escutcheon	The coloured collar surrounding the base of a push-button which denotes its function.
ESOC	Emergency Signals On Control: a type of area-wide ERS
Fascia (Plate)	The surface of a non-mosaic interface visible to the operator and upon which the switch / button descriptions and track layout may be depicted.
FDM	Frequency Division Multiplex: a system for the remote control of interlockings based on the allocation of specific electro-magnetic frequencies to different equipment.
GSP	Ground Switch Panel: a small, normally unmanned, interface released from another interface for the control of little-used connections. A modern version of the ground frame.
Illuminated Diagram	A depiction of the track layout containing track circuit indications.
Interface	The control surface including the buttons or switches used for the operation of signalling equipment.
(An) Interlocking	An interlocking is a collection of apparatus performing an interlocking function.
LCP	Local Control Panel: a normally unmanned interface (IFS, NX or OCS) at an interlocking controlled by remote control equipment from another interface, and brought into operation when disruption to the remote control equipment occurs.
LCWS	Local Control Workstation: as for LCP but the interface type is WS.
Maintainer's Panel	Equipment which provides only indications of the state of signalling equipment, without a method of control, for the use of maintenance staff.
MAS	Multiple Aspect Signalling.

Normal	A designated position for a set of points. The alternative position to Reverse.
Off	Any proceed signal aspect.
On	The most restrictive aspect which can be displayed by a signal.
OOC	Out Of Correspondence: the situation when a set of points fails to move to the position called for by the controls.
Overlap	The distance ahead of a signal which must be clear before the signal next in rear can clear.
Overlay	A replacement fascia placed over the original. Where the original fascia does not remain beneath, the new item becomes the fascia and should not be called an overlay.
Panel	A generic term which may mean: a) a non-WS interface, b) a non-WS interface and its console, or c) that portion of a large non-WS interface under the control of one operator, where more than one operator is present. This term should be avoided where a precise interpretation of meaning is required.
PCU	Points Control Unit: a normally unmanned interface for the local control of points during the failure of normal operation.
Pull-Plate	A description plate detailing the functions of a control and its interlocking with other controls.
Remote Interlocking	An interlocking which is not situated close to the controlling interface.
Reverse	A designated position for a set of points. The alternative position to Normal.
Route Lights	A row of (generally white) lights on the illuminated diagram showing that a route has been set up by the interface.
SAS	Shunter's Acceptance Switch: equipment provided to give staff in charge of depots, yards etc. control over the admission of trains to their location.
Slot	A method by which joint control of a signal by more than one interface is achieved.
Swinging Overlap	The facility to change the overlap being used by a route by the movement of facing points within it while the route remains set.
TD	Train Describer: equipment provided for the transmission of train identification information between interface operators.
TDM	Time Division Multiplex: a system for the remote control of interlockings based on the allocation of specific time-slots within a period of data transmission to different equipment.
Top Plate	The upper surface of a mosaic tile which is visible to the operator and upon which the switch / button descriptions and track layout may be depicted.

How to Use the Register

Even if you are a signal engineer you are unlikely to be able to fully understand the entries in the spreadsheets without first having read the associated textual explanations and definitions given in the following sections of this document. Some terms will be familiar, some have been created to fulfil a necessity, and many have been strictly defined along with the conventions for recording. To get the most out of the data and to avoid perpetuating old misunderstandings and creating new ones it is recommended that you familiarise yourself with these sections first. This information is contained in the sections headed *Interface Definitions* and *Interlocking Definitions*. Power frames are dealt with separately in their own section.

The other sections provide a historical précis of the various interfaces and interlockings which have been used to date. Here will be found the details of the design manufacturer and equipment abbreviations used in the spreadsheets and there are references in the text to the photographs illustrating the various items discussed which can be found in the appendix. Although, for reasons discussed above, it has not been found possible to break down all interfaces into distinct models, a knowledge of the style of equipment being produced at any particular period should enable the reader to obtain a very good idea how a panel etc. listed in the spreadsheets is likely to look. It may also aid identification of equipment for which details are not currently available.

First a word about Excel workbooks for those who are unfamiliar with them. When you open the Excel file you will notice at the bottom left that there are three 'tabs' named 'Interfaces', 'Interlockings' and 'Power Frames'. These are the spreadsheets that make up the workbook. The one which is currently displayed will be underlined in colour, the other two will be blocked in with colour. To change the sheet currently displayed simply left-click on the tab of the sheet you wish to view. Column widths in the spreadsheets have been selected so that in almost all cases the full text will be on view within the cell. However, in the case of column F in both the Interfaces and Interlockings sheets this has not been possible and the text is wrapped to avoid overspill into the Notes column so you should always click on these cells to obtain the full entries, which will be displayed in the function pane below the toolbar.

Taking the interface sheet first, all the details appertaining to a particular interface will be found in its columns. This sheet is linked to the interlockings sheet via the interlocking column. To find details about the interlockings controlled you need to refer to the interlockings sheet, where each one is listed with its associated details. This procedure can, of course, be conducted in reverse order if your particular interest is in an individual interlocking. This is the method of cross-reference between the two sheets. It must be understood that the interlockings listed in association with any interface (and similarly, the interfaces listed in association with any interlocking) constitute a complete list of those with which it has been associated during its lifetime. These may very well not all have been extant concurrently. You will need to refer to the dates and notes associated with each entry to establish the situation at the period of time in which you are interested. Interlockings come and go and migrate between interfaces in modern signalling in a somewhat fluid fashion.

The spreadsheet format enables the use of sorting and filtering commands for the easy analysis and grouping of data for further study. As there are a small minority of entries for which precise dates are not currently available you will find that these entries are not handled well and will appear grouped together out of sequence during sorting etc.. Owing to this and other idiosyncrasies with data-manipulation commands you should not resave the spreadsheets and thereby overwrite the original after such manipulation has been 'undone', as these entries may not resume their chronological order as in the original document.

Interfaces

Interfaces - Column Descriptions and Definitions

The Interface section lists all power signalling interfaces used on statutory standard gauge lines traversed by 'heavy rail' trains in Great Britain (including the Isle of Wight) utilising switches, buttons or VDU-based controls. This includes significant interfaces in collieries, power stations and other freight terminals, sidings, yards and depots and minor passenger-carrying railways. Insignificant interfaces exempt from inclusion would comprise, for example, an individual control for an isolated signal in a private industrial site and not worked from a recognised signalling location. Emergency local control and ground switch panels, plus remote override controls are included.

Excluded is signalling on metro and tram networks, London Underground (LUL) lines etc., the Channel Tunnel and Eurostar network, HS1, HS2, private test tracks, all lines in Ireland and private industrial railways which are only used by internal traffic. Miniature lever and slide based equipment is not recorded here but can be found in a dedicated section.

Three terms need to be defined for use-

Console - the console is that object which houses the interface, presenting it at a convenient position for operation, and enclosing the electrical connections and wiring to the interface controls. Consoles may be floor standing, or positioned on tables, block-shelves, affixed to walls etc.. The console design is not relevant for the purposes of entries in the database: new panels may be mounted within a pre-existing console and will be listed only by reference to the interface itself.

Fascia - the fascia plate of the interface is its top surface. In the case of those interfaces which have another sheet underneath to which the control and indication units are attached (the **equipment plate**) it is possible for the fascia to be easily replaced. This term should only be applied to surfaces in sheet form, the top surface of a mosaic tile is called a top plate and it is very unusual for these to be replaced rather than the entire tile unit be changed.

Interface - for non-workstation (WS) systems the interface is the control surface(s) comprising of buttons, switches and associated indications. For WS-based systems the interface is the control system software. To qualify for inclusion the controls must operate either:

i. Points
ii. Signals
iii. Slots
iv. Acceptance releases (where these operate directly on signals as a slot, not through the operation of block signalling apparatus of any kind)
v. Releases for: (i) ground frames / switch panels or, (ii) level crossings which are controlled from another location (e.g. by a crossing keeper)
vi. Level crossing Key Lock equipment (KL)

What is not included - Equipment provided for the operation of other infrastructure (RC / CCTV LC controls; automatic level crossing controls, indications and alarms (i.e. AHB, AOCR, MCB-OD etc.); pedestals and controls for Manned Crossing Barriers (MCB / Manned Crossing Gates (MCG) or wicket gates at the same location as the protecting interface; lift / swing / sliding bridge controls; train describers (TDs), telephone equipment etc.); any equipment controlling signals purely for the protection of staff (lock-out facilities, depot protection systems etc.); equipment only provided for temporary / emergency local operation of individual points (Points Control Units etc.) or signal-post-mounted controls to activate automatic interlockings in failure situations; station equipment which initiates route-setting through an interlocking set to operate automatically or in override mode by another interface; signal post replacement switches; ground-mounted emergency stop controls for shunting or loading / unloading signals; or equipment which provides indications only without a method of control (illuminated diagrams, train describer mimic panels, box boys' repeater panels, maintainers' panels, control room screens etc.) - is not regarded as an interface, nor is it taken into account as part of an interface which is valid for inclusion.

It is important to recognise that this is a list of interfaces, not of signal boxes, so where more than one interface exists at a location each will be listed and its history traced. Whether there are one or more interfaces present is decided by reference to their physical separation into individual consoles. So, for example, where a large NX panel housed in one console is worked by several signalmen, each having their own area of control (such areas of control often being called 'panels' by the operators), this would only be recorded as one interface. Where multiple areas of control are worked by interfaces which are housed in separate consoles then they are recorded separately.

Where an interface has its area of control extended over time by the addition of equipment to the physically pre-existing interface surface area, this is not recorded as a separate entry providing the new equipment is of the same type and design / model. However, when equipment of a significantly different type or design / model is added, or when the interface surface area is increased by the addition of new sections, these new sections obtain their own entries and the situation is clarified in the notes. These are the only situations in which divergence is made from the recording convention laid out in the preceding paragraph.

In the case of WS it is replacements / upgrades of the operating system software which are recorded. Where a location has multiple WS, each has its own entry and is dealt with as an independent entity owing to its physical self-containment. Changes to the control area which are effected without changing the operating software version / type are not recorded.

As the interface is defined in terms of the control surface, separate indication panels associated with route-setting installations are not recorded in their own right. However, as these components form an integral part of the interface arrangement, if an indication panel replacement results in the remaining elements being from differing manufacturers the replacement is detailed in the notes to the original interface entry (in the case of a control panel replacement a new entry would be triggered). The diagrams of NX(KS)[-] installations are not recorded in any way as they are primarily maintainer's panels.

Unlike lever frames it is rare for interfaces to be reused, with the exception of KL and IFS[-]. KL require no alterations at all and are frequently reused, the more so as new production ceased many years ago. IFS[-] merely need the description plates associated with their switches to be changed to suit their new home, but in the case of other interfaces extensive alterations to the diagram and positioning of controls will be required. Mosaic panels fare no better, with only the blank tiles being capable of reuse. It is not financially viable to reuse equipment in most cases. There have been instances of panels being recorded elsewhere as second-hand from another location but investigations, and the above considerations, have shown that in reality only the consoles have been reused with brand-new interfaces installed in them. As this work does not define the interface in terms of the console, cases where these are second-hand from another location are considered to be irrelevant and they are merely noted for the historical detail they provide.

It should be understood that there may be differences with other publications which are based on signal box etc. listings in the case of commissioning and decommissioning dates. **The dates herein refer to the official operational status of items of signalling equipment, not of the signalling location** - in the case of replacement of equipment there is almost always a period between decommissioning of the old and commissioning of the new whilst testing is completed; closure may see equipment decommissioned before the signal box is officially abolished as a block post etc..

Where it has not been possible to verify information from a source to the satisfaction of the author such data are shown in *red italic font*.

Column Definitions

Column 1 - Location

The location of the interface is listed under its official name, which in the case of a signal box is the name given in the signalling notice connected with the interface commissioning. Appendages such as PSB, SC, ASC etc are only shown where these form part of the name stated in said notice. No attempt has been made to record minor changes in nomenclature over time but significant name changes are detailed in the notes, and to aid searching a later name may have its own Column 1 entry with redirection to the listing under the original name. Where physically separate interfaces in one location have official differentiating names these have been used in parentheses but in other cases they are differentiated by numerical reference suffixes, e.g. (1), (2) etc.. Where appropriate to aid in identifying a location additional details are appended in parentheses but it is not implied that this forms part of the official name.

Normally unmanned interfaces may be provided at interlockings which are worked remotely by another interface, to be brought into use if, for example, the remote control equipment fails. These are identified by the designation (LCP) - Local Control Panel, or (LCWS) - Local Control Work-Station, in accordance with the interface type, as shown below. The LCP / LCWS designation is not shown in conjunction with those interfaces which are in normal operational use but which can take over extra local control functions during failure conditions.

It is perhaps appropriate here to say a little about the provision and use of LCPs / LCWSs. The practice of provision depended very much on BR regional policy prior to rail-privatisation. BR(ER) and BR(NER) almost always provided them; BR(LMR) never did after the initial Manchester - Crewe modernisation until the Leicester resignalling and later Nuneaton panel; BR(ScR) sometimes provided them; BR(SR) almost always provided them with a preference for NX(KS); BR(WR) hardly ever provided them and when it did they operated as independent block-posts when switched in, taking control of all telephone circuits as well as signalling controls. Regional practices persisted post-privatisation but current NR policy is that they are not to be generally provided. In most cases when they are brought into operation they are operated to the instructions of the signalman in the controlling block post. A minority of LCPs are provided solely for the use of S&T staff for fault finding purposes etc. and are not intended to be used by Operations staff. No account is made of this operational distinction for the purposes of recording in this Register, providing an interface has the capability to locally control signalling equipment then it is eligible for inclusion.

Column 2 - Interface Type

The type of interface in use is recorded in accordance with the definitions, designations and type names set out below. It should be understood that the physical appearance of interfaces varies widely according to the individual manufacturers' designs but all conform to the distinct methods of operation herein described.

Combined and Separate Control & Indication Panels

Interfaces may have the surface containing the control buttons / switches physically combined into one module of equipment with the illuminated track diagram, or these controls may be actually positioned on the diagram (either geographically placed or separately grouped) - a combined arrangement. Alternatively, the control surface may be a physically separate item from the diagram - a separate arrangement. Where a combined arrangement is employed this is indicated by [+] following the interface type designation; where a separate arrangement is employed this is indicated by [-]. Where the arrangement is unknown neither symbol is shown.

Where the illuminated track diagram component is supported separately from the control surface, the fact that these two elements may actually be arranged so close together as to be touching will not be sufficient to define the whole as combined. It is only so designated if the control surface and diagram are physically joined to form a single, free-standing module of equipment.

Route-Setting Equipment

Entrance - Exit (NX)

NX (Entrance-Exit) equipment may consist of the signalling controls (buttons / switches) being mounted geographically on the illuminated track diagram; or a split-level arrangement whereby the signalling controls are generally mounted geographically on a simplified, non-illuminated, desk-style track diagram (except NX(KS)), with the main illuminated diagram separate. They are route-setting panels, which means that when the signalman operates the equipment in normal operation, he does not operate point controls as part of the process: points move automatically to the required position as routes are set up. Individual point controls are provided, however, for making movements for which a signal is not provided (single line working, moving trains during engineering work, etc.) and in cases where a signal must not or cannot be cleared.

To clear signals the signalman must operate two controls for each section of route (signal to signal, or signal to siding / buffer stop etc.), one at the eNtrance and another at the eXit, from whence these panels get their abbreviated name. An intermediate control may need to be operated if there is a choice of route. The controls may consist of buttons, switches, or a combination of both.

Four types of panel are defined, differentiated as shown in the table below by reference **only** to those signals which act as both an exit from a route in rear plus an entrance to a route in advance:

Name	**Abbreviation**	**Features**
NX Push-Push	NX(PP)	Generally one button at the signal: acts as entrance button for route in advance and exit button for route in rear
NX Turn-Push	NX(TP)	Switch and button at the signal: switch acts as entrance for route in advance, button acts as exit for route in rear
NX Key-Switch	NX(KS)	Key switch at the signal in lieu of button: acts as entrance switch for route in advance and exit switch for route in rear. Switches may also be grouped non-geographically or on a separate unit
NX Double-Button	NX(DB)	Always two buttons at the signal: one acts as entrance button for route in advance, other acts as exit button for route in rear

Note - some NX(PP) panels have two buttons at **some** signals, where the additional button is used to select the class of route (a shorter overlap at junctions, position light aspect etc.), or in other cases there may be an automatic working button (may be marked by letter 'A' and with a blue escutcheon), generally offset from the line of track. Care must be taken not to mistake these panels as NX(DB), where separate buttons are provided at **every** signal which is both a route entrance and exit, even where there is no choice of overlap / aspect etc..

NX(KS) panels are less commonly observed and are worthy of further explanation. They are intended for temporary operation as part of stageworks or as LCPs, with the controls consisting of three-position GPO Type 1000 telephone-concentrator-style key switches for points and signals. Those for signals are sprung to return to the middle position, being pressed down to simulate the pressing in of a conventional NX(PP) button, and being pressed up to simulate the pulling up of a button. Points switches are pressed to the Normal or Reverse position to call the points, where they remain until reset, being normally in the centre position for route-setting. The route-setting process is as for NX(PP) but with the switches taking the place of conventional NX buttons. In the case of NX(KS)[-], normally only the illuminated maintainer's panel is permanently positioned and the control panel switch unit is a separate interchangeable item which is portable and plugged in to a socket at the interlocking where it is required. To identify which controls will work which signals etc. where it is positioned, either a unique template is fitted over the switches, or labels are applied. In exceptional cases where a switch unit of unique configuration is provided this will be permanently located.

Certain unusual examples of NX(TP) employ telephone-concentrator-style key entrance switches which toggle up and / or down instead of rotary turn-switches.

In some cases, usually where there is no choice of route or only two possible routes, certain signals may be operated by one control at the entrance of the route only, there being no exit button / switch. Where these are incorporated within a panel including other signals requiring both entrance and exit actions to clear the interface is regarded as being NX.

There are examples in older literature of the term NX Double-Push being used to describe panels which were elsewhere called NX Push-Push. In order to define a single term for this kind of panel the latter term has been chosen.

It should be noted that NX(DB) are rare and only six examples are known: at Seamer, the Cliffe and Howden interlocking areas of Selby panel, the 1995 replacement section of Stratford C Panel, part of the Stratford North London Line panel, and the 1994 & 2010 Britannia Crossing panels of the Dart Valley Railway.

One Control Switch (OCS)

The name of this system has its roots in an early item of Westinghouse promotional literature which stated that "... all that is needed for the setting of a route is the operation of **one control switch**......". With the OCS system each signalled route is provided with a separate control (button or switch), which the signalman operates to set the route (signal to signal, or signal to siding / buffer stop etc.). Where a signal has more than one route a control will be provided for each one, or it will consist of a switch with an On position and two alternative positions to select each of the two routes. In some cases where the class of route is separately selected these options too will have their own individual controls. The controls may be grouped or geographically positioned on the illuminated diagram, positioned on an integral desk, or positioned in a separate console. The defining feature of the OCS system is that each route is selected individually at the entrance stage, whereas with an NX system the route selection is made when the exit control is operated.

As with NX panel operation, the signalman does not set the points in the route individually, these move automatically to the required position as part of the route-setting operation initiated by the route control. Separate point controls are again provided for exceptional circumstances.

Multi-Position Key (MPK)

The MPK system is based on the OCS method of control but aims to reduce the number of control switches / buttons required and make the interface more compact. The desired route from a signal is first chosen by selecting a route button, or by turning a pointer on a multi-position dial control, before the route-setting process is finalised by operating the signal control. The route selection control may be separate from the signal control, or the two elements may be combined into one common component. Signals which have only one route and class selection option are only provided with a signal control. The controls may be geographically positioned on the illuminated diagram (when the saving of space is particularly valuable), or positioned in a separate console. The differentiating feature from OCS is that more than one action is required to complete the route-setting process.

In common with other route-setting systems the signalman does not set the points in the route individually, these move automatically to the required position as part of the route-setting sequence. Separate point controls are again provided for exceptional circumstances.

A small number of interfaces utilise MPK principles in unusual formats. These range from single route switches which are turned left or right from the central On position to select one of two routes; or equipment based on the NX(KS) system but where signals have just one keyswitch, irrespective of the number of routes available, and where alternative routes need to be selected this is done by first turning a single common dial (to positions marked Route A, Route B etc.) before the switch is depressed to clear the signal; or portable, transferable switch units with templates, where standard switches are used for IPS and alternative route selection and depression of a telephone-style keyswitch completes the route-setting process. Owing to the rarity and highly individual nature of these interfaces the precise method of operation is detailed in the Notes column. Where plug-in, transferable switch units are employed for LCPs an 'n/a' entry is entered in the Design & Model column.

Workstation (WS)

Locations which use visual display units (VDUs) and electronic controls (trackerball, keyboard and or mouse) to operate micro-processor-based signalling systems are shown by the designation WS. Each WS is recorded individually. Where WSs have additional desk controls for the operation of relay interlocking overrides or Emergency Signals On Controls (ESOCs), these are separately recorded as individually defined.

Remote Override Control (ROC)

Override controls are often provided in connection with remote interlockings controlled by Time Division Multiplex (TDM) or Frequency Division Multiplex (FDM) links. They allow a small number of priority routes to be set and signals to work automatically if normal control from the interface is lost. These are normally just one of the controls positioned on the interface amongst the others provided for normal signalling and in these cases they are not be recorded. However, in the case of WSs controlling relay interlockings a separate interface is sometimes provided for the control of override systems and in these cases they are recorded using the designation ROC.

No [+] or [-] suffixes are given for ROC as normal signalling indications are irrelevant to their operation.

Local Override Control (LOC)

Override controls as outlined above are sometimes provided remote from the controlling interface at the actual interlocking itself and can be operated from site, on the signalman's instruction, if a failure occurs. In these circumstances they are recorded under the name of the interlocking which they control and using the designation LOC.

No [+] or [-] suffixes are given for LOC for the same reason stated above for ROC.

Non-Route-Setting Equipment

Individual Function Switch (IFS)

The name of this type of equipment, IFS (Individual Function Switch), is the key to distinguishing it from route-setting signalling systems. In the latter case, the NX buttons / switch or OCS button / switch is responsible for operating any number of sets of points and signals within the portion of route. In an IFS system each switch operates just one set of points or one signal.

The method of IFS operation is that the signalman works his equipment in the same way as he would do a mechanical lever frame: each set of points is first set to the correct position by operating the controlling switch(es), then one signal switch is operated to clear each signal. It is not a route-setting system as the signalman does not set up 'routes', he sets individual components within the route separately. This system of operation allows IFS to be distinguished from route-setting signalling systems (NX or OCS panels) because:

a) In the case of NX operation, the signalman must generally operate two controls (button / switch) to clear each signal: one positioned at the signal at the start of each section of route and another at the end of the section of route. He does not set points individually, all points in the route move to the required position automatically.
b) In the case of OCS operation, the signalman operates just one button / switch to set up the required section of route and he does not set points individually, all points in the route move to the required position automatically.

In the case of IFS[+] the switches may be mounted on the illuminated diagram in positions corresponding to the depiction of the respective pieces of equipment, they may be grouped together on the diagram, or they may be mounted in a console with the diagram attached to it. IFS[-] can be identified as consisting of a switch, or set of switches, mounted on a free standing piece of equipment or fixed to the block-shelf and separate from the illuminated track diagram for the area controlled.

IFS can also be used for Ground Switch Panels (GSPs), a form of electrical ground frame. Certain LCPs employ a kind of transferable IFS(KS)[-] which is visually identical to NX(KS)[-] installations (see description above) except in the method of operation: the key-switches are used to individually set points and signals, rather than to route-set.

For the purpose of recording the equipment in use, where it consists of several individual switches etc. not grouped together into a single unit (attached to the block-shelf, say), only one note of IFS[-] is made and the details explained in the notes. However, if different dates of installation or abolition need to be noted, each switch, or batch of switches, is recorded separately.

In some IFS installations the controls for signals consist of buttons, rather than switches, geographically located on a panel, the whole having the appearance of an NX panel. However, these can be distinguished from NX panels by **all** signal buttons requiring only a single push to clear them (i.e. no entrance / exit action) and the requirement always to set points by individual point switches.

Special types of IFS may be provided to control marshalling yards where loose shunting of wagons takes place. There may be no interlocking between hump shunting signals and the yard points and there may be complex additional controls for wagon retardation. Simple systems have individual point switches for the sorting siding points which are manually set for each cut. An improved system additionally provides buttons for each destination siding which will set all the points required from the hump summit - a kind of route-setting but not linked to signal clearance. In these systems there is mechanical interlocking to prevent more than one button being depressed at a time. The button is released and the next route can be selected once the previous cut has cleared the king points and each set of points will move as required as they are cleared by the preceding wagons. Point switches have a central position for when the buttons are in use but they can be used at any time to redirect wagons, even when a route has been set through them with the buttons. Other systems are able to store varying numbers of preset siding selections (typically up to 50 in later systems), with only the button which fills the store being held down until one cut is cleared out by passing the king points, whereupon another cut can be added in. This process, with unlimited storage, can be achieved by punched tape. During normal operation, therefore, the panel works automatically once the cut destinations have been programmed in. It should be noted that in some cases routes which are programmed in at one interface may control points which are actually individually controlled by another interface, which may be situated in another building. In order to distinguish these Yard interfaces and the special circumstances which may appertain to their operation the following definitions are used -

Name	**Abbreviation**	**Features**
Yard Type 1	Y1	Sorting siding points must be set individually
Yard Type 2	Y2	Sorting siding points may be set either individually, or by the use of siding selection buttons one cut at a time
Yard Type 3	Y3	Sorting siding points may be set either individually, or by the use of siding selection buttons by presetting multiple cuts

These definitions are appended to the IFS definition in parentheses, i.e. IFS(Y1)[+].

Shunter's acceptance switches (SAS) are also a special type of IFS. They are provided to give staff in charge of yards, sidings, depots, freight terminals etc. control over the entrance of trains from lines controlled by a signal box etc.. The switch may act as a slot on the incoming signal(s), or a release on points leading into the yard etc.. There may be more than one acceptance switch on the SAS unit. If the interface has exclusive control of at least one signal (of any type) or set of points in addition to acceptance control then it is defined in accordance with the appropriate definition for other types of equipment. However, if it does not also have further functions giving exclusive control of at least one signal (of any type) or set of points, in addition to acceptance control, then it is considered to be a SAS and is not recorded.

Depot Protection Systems (DPS) are located at traction maintenance depots and control signals and sometimes derailers reading into / out of maintenance sheds for the protection of staff working therein. They are interlocked with the doors of these buildings and staff alarms and lock-outs. The controls may consist of individual switches or plungers positioned with the signals, and / or simple panels with control keys and displays for the input of commands. DPS are not recorded herein.

Note - in the case of IFS installations the term 'switches' includes push-buttons.

Confusion between OCS and IFS Systems

Care must be taken to correctly distinguish between OCS and IFS systems. As well as the differences discussed above, which are easier to see with the equipment in operation, another way to differentiate these systems when only a photo is available is to look at the individual point switches. Point switches on IFS-based equipment have only two positions: normal or reverse, and the switches will always be in one position or the other. Points switches on OCS-based equipment have three positions: normal, centre, and *reverse, and during normal operation the switches will all be seen to be in the central position, allowing route-setting to move the points. This is usually the easiest way to distinguish these systems, working also for IFS Panels which use geographically situated 'one-push' NX-style buttons at signals - at first glance these are easy to mistake for a NX panel. However, this method should be used with caution in the case of LCPs, where some IFS[+] do have a central position for the point switches to be left in when the panel is not in use, and Yard panels where a central position will be provided on IFS(Y2) and IFS(Y3).*

Emergency Replacement Switch (ERS)

Emergency replacement switches are a special type of IFS which perform a specific function. Controlling signals which normally clear automatically from their most restrictive aspect without individual operation by the signalman, they allow the most restrictive aspect to be maintained in cases of emergency, to allow the signalman to stop and caution a train, or to protect certain road movements over automatic or user-worked level crossings, for example. They can be found associated with auto-distant, automatic and semi-automatic signals - not controlled signals. Fog replacement switches, used to give additional control over a signal in rear during fog or falling snow owing to the mixing of semaphores with colour light signals, are also a type of ERS.

ERS controls can normally be easily recognised as they are usually clearly labelled as such. Sometimes, however, the control may simply be labelled with the letters E or R (E for signals which cannot be relied upon to have responded to the control, R in cases where they can). The fact that they are left Off and unworked by the signalman during the normal passage of trains helps in their identification, but care is needed not to confuse them with an automatic working facility on a controlled signal. Red switches or button escutcheons may be provided on ERS controls, whereas blue ones are used to denote an automatic working control on a controlled signal.

Some WSs employ ESOCs, which place to danger every signal in an entire interlocking: these are provided in the form of buttons on a separate unit on the signalman's desk and not as part of the on-screen functions. ESOCs are regarded as a type of ERS for the purposes of recording.

Where an ERS is incorporated within another type of interface which is specifically defined here it is not recorded; however, where the unit of equipment is only used for ERS controls it is then individually recorded. In the case of WSs which have a unit which includes override controls for relay interlockings as well as ESOCs it should be noted that the definition 'ROC' has been given precedence for recording over 'ERS', as an override control will by definition include a 'Signals On' ERS function. Signal post replacement switches and other switches or plungers provided on the ground for the purposes of placing a signal to danger in an emergency are not recorded.

Only one note of ERS is made, whether or not there are multiple ERS provided at a location, unless different dates of installation or abolition need to be recorded.

ERS are never taken into account for the purposes of classifying an installation as Hybrid.

Note - in the case of ERS the term 'switch' includes push-button.

Key-Lock Instrument (KL)

The key-lock method is a way of interlocking manual level crossing gates with the signalling system. A set of keys is provided which release the locks on the gates, being secured in a key-lock instrument until released. The release may be controlled by the signalman or crossing keeper who works the gates, if he has control over the protecting signals, or by another signal box or gate box if they control the signals protecting the level crossing. In operation the system is similar to a ground-frame release. A variation of this system abolishes the release by another interface and the turning of the keys places protecting signals to danger, provided no train is closely approaching.

Where the release is controlled by the signalman or crossing keeper who works the gates the keys may be locked into the interface working the protecting signals. In these circumstances the apparatus has been ignored for the purposes of recording. Where the key-lock apparatus is a separate instrument which consists merely of the key-lock controls, it has then been recorded using the designation KL. Where two instruments are provided to control one set of gates (one instrument per key) these are regarded as one instrument for the purposes of recording. Only electrical key-lock instruments are recorded: where the key-lock keys are held in locks on a lever frame they are not eligible for inclusion.

No [+] or [-] suffixes are given for KL as illuminated track diagrams are not provided.

Hybrid Installations

In some circumstances more than one type of equipment may co-exist on the same interface. Some marshalling yard panels, for example, were manufactured with both individual function switches for yard points and shunting signals, as well as NX operated routes. Some Westinghouse yard panels are known to employ the use of a one-push NX button to initiate route setting with the IFS operation of a hump shunting signal control completing the process. In cases where different methods of control are intermixed within the same track area the separate components are identified along with the designation 'Hybrid', e.g. NX(PP)[+] / IFS(Y3)[+] Hybrid.

Where different methods of control are employed over different track areas of a panel located within the same console the arrangement is not considered to be Hybrid and the components are listed separately and individually. An example of this might be where the area of control an interface has been extended and the new area employs a different method of operation.

Note that NX panels which also incorporate signals requiring only an entrance control to be operated to clear them are not considered to be Hybrid panels.

In some circumstances a lever frame may co-exist and need to be operated co-operatively to set a route. The following convention has been observed to designate the arrangement as Hybrid:

- Where the power signalled equipment is intermixed within or adjacent to the area of control of the lever frame and interlocked with it, the installation is considered to be Hybrid. Examples of this might be where all the points are worked by the lever frame but the signals are worked by switches, or where additional signals have been added within Station Limits worked by switches - both Frame / IFS[-] Hybrid. No attempt is made to categorise the type of frame in use.
- Where the power signalled equipment is located beyond the area of control of the lever frame and not interlocked with it, the installation is not be considered to be Hybrid and is recorded in the usual way. Examples of this might be where the box has taken over the area of control of a once-adjacent box and a panel has been provided to work that layout; or Intermediate Block or distant signals have been provided worked by switches. The fact that part of a panel is used as an illuminated diagram for a frame worked area, even where frame-worked points and / or signals have their indications displayed on the panel, will not be sufficient to give rise to a Hybrid classification unless the criteria in the first bullet-point are met.

The lever frame must operate the type of equipment previously defined above for deciding on the eligibility of an interface for inclusion. In no circumstances do Emergency Replacement Switches give rise to a Hybrid designation.

Non Route-setting NX (NRNX) Hybrid

One rare type of hybrid utilises a lever frame to operate points and FPLs, with a NX panel to clear the signals once the route has been set. Electrical interlocking exists between the lever frame and the panel. The NX panel is not a route-setting installation as operation of the interface buttons / switches does not set the route, this must be done individually beforehand with the lever frame. This type of installation is designated NRNX Hybrid, with the type of NX panel (as defined above for route-setting NX panels) appended to the NRNX designation, i.e. NRNX(PP)[+].

The difference between a conventional Frame / NX Hybrid arrangement should be understood. With a Frame / NX Hybrid the frame and panel have their own signals, with electrical interlocking between the two systems. With a Frame / NRNX hybrid the frame does not operate signals, only points etc., and vice versa in the case of the NRNX panel, and the two systems are entirely interdependent. Care should be taken not to confuse these two hybrid forms.

Column 3 - Design and Model

The design manufacturer is recorded in accordance with the details set out in the section headed *Interface Designs* for each interface. The design manufacturer is regarded as being the organisation with overall control of production to their specifications, irrespective of whether or not they actually manufacture the interface or its components themselves or sub-contract the work. Where production of an interface is known to have been sub-contracted to another manufacturer this will be noted. Where an interface design is produced under license by another manufacturer in overall control of production, they will be regarded as the design manufacturer. Where a design manufacturer applies an official model designation to a particular interface this is also shown. Where the design manufacturer changes owing to takeover / merger etc. and a successor organisation inherits the rights to a design, subsequent interfaces are recorded under the new design manufacturer's name with the original design manufacturer's name appended in brackets, i.e. AEI-GRS (MV-GRS): it is under the original design manufacturer's name that the description of the interface is found in the *Interface Designs* section. This only applies where no significant further development of the interface has been undertaken by the successor organisation, otherwise it is regarded as a new model.

In the case of WSs the manufacturer of the desktop hardware is not recorded as it is of very little relevance: keyboard, mouse and VDU equipment is standard IT product and can be sourced from any office supply establishment. ERS and ROC controls which are integrated into the bespoke IECC console are similarly treated. The relevant interface with this type of signalling is the operating system used to control the signalling and which communicates with the interlocking system (note: these are two separate elements, see *Interlockings - Column Descriptions and Definitions* and *Interlocking Designs* sections for details of the latter) and it is this which is recorded in the case of WSs. The name of the operating system design manufacturer and the operating system name is recorded (i.e. Westinghouse WestCAD). It should be understood that in the case of WS systems the design manufacturer may not always be responsible for the manufacture of the generic electronics, or for the data preparation, but they are in charge of the concept and work is undertaken to their specifications. Where a design manufacturer takes over production of a system previously produced by another, without significant further development, the name of the design manufacturer originally producing the system is appended in brackets as for other interfaces. Note that the term Integrated Electronic Control Centre (IECC) is an operating system trade name and relates to the first such system to be developed for UK use (by BR), being used in the first generation of WS interfaces (and subsequently developed).

Where the design and model designation is followed by [**R**] this denotes that the fascia plate, or fascia overlay, has been entirely replaced or overlaid by one in a different style to the original. This is done when older interface surfaces have become illegible owing to wear and tear, or significant areas of the original layout have been altered. Where only a section of the panel surface undergoes this work this is not noted, as the point is to alert the observer to the reason why the appearance of the panel may not be as expected from the recorded type - this will be obvious when portions of the original surface are still visible. The replacement is not recorded in a separate entry but the date of the modification is noted, where known. Note - if an interface which does not have an equipment plate undergoes fascia plate replacement then it will constitute an interface replacement and be recorded as such, not by the [**R**] annotation.

No design and model entries are made for (KS)[-] LCP installations with transferrable switch units as the only items of equipment specific to these locations are the maintainer's panels, which are not recorded here, the control panel switch units being easily substituted, not to a bespoke design for that location and not tied to any one place. Indeed, on some occasions only the maintainer's panel will be found in situ. Only the control facility is being recorded and the entry 'na' (not applicable) is shown in these cases. Where a permanently located non-transferable switch unit bespoke to that location is provided design and model entries are made.

Some IFS[-] and ERS[-] consist of individual switch units fixed to a block-shelf, structure, signal etc. and are of proprietary make sourced complete from electrical suppliers (domestic light switches are known to have been used). No meaningful work having been undertaken to adapt the switches for their application to railway signalling (they have simply been connected up) it is considered that these manufacturers are of no relevance to a work of this kind and they are identified by the entry 'Generic Switch'. Only the initial commissioning date of the original switch is shown and not any subsequent renewal with another Generic Switch.

Column 4 - Commissioned

This is the date when the interface was officially signed into operational use at that location. Where it has not been possible to establish the precise date of commissioning in the case of work performed over a weekend etc., the start date of the commissioning weekend has been taken as the interface commissioning date. In the case of large interfaces brought into full operation over a period of time the commissioning date recorded is the date that any part of it was first brought into use. Where an actual commissioning date has been used which differs from an officially published date the discrepancy is highlighted in the Notes column to avoid confusion.

Column 5 - Decommissioned

This is the date when the interface was officially signed out of operational use at that location. Where it has not been possible to establish the precise date of decommissioning in the case of work performed over a weekend etc., the start date of the decommissioning weekend has been taken as the interface decommissioning date. No attempt has been made to consistently record the dates when sections of an interface were taken out of use, although in some cases these may be noted. In the case of large interfaces, sections of which were taken out of use over a period of time, the decommissioning date recorded is the date when the last part of it was taken out of use. Where an actual decommissioning date has been used which differs from an officially published date the discrepancy is highlighted in the Notes column to avoid confusion.

Decommissioning of 'non-railway-organisation' interfaces, i.e. those at power stations, collieries etc, is rarely, if ever, formally notified and they tend to simply fall into disuse with the closure of the rail connection. In the case of these installations the closure of the rail connection or location itself, or the date of last use, will be taken to be the decommissioning date.

Column 6 - Interlockings

The interlockings controlled by the interface are listed in this column. All interlockings which have been controlled are listed in this column and it should not be assumed that all interlockings listed were controlled concurrently. This is the cross-reference element with the Interlockings spreadsheet, in which full details about the interlockings and their dates of use can be found. Where no interlocking exists within the recording definitions set out here the entry 'na' - not applicable - is shown.

Column 7 - Notes

Further pertinent details are included here. Where multiple interfaces at one location co-existed the items of signalling or, in the case of larger areas of control, the geographical area controlled is described for each interface to ease identification. This also applies where another interface was a power or mechanical lever frame. It should be understood that this description is intended as an aid to correctly identifying the interface and it should not be assumed that every item of equipment noted, or the entire geographical area described, was controlled at any one time. In the case of any interface which controlled more than one interlocking during its lifetime, but not for the full lifetime of that interface, the dates during which each interlocking was controlled are noted.

Interface Designs

'Normal' Operation

In order to avoid the necessity for repeated explanations of how particular interfaces function, one typical sequence of operation will now be described and categorised as 'normal'. The simple description 'normal operation' will be used in this register thereafter in respect of interfaces which utilise this method.

Note - It should be clearly understood that the method of operation described below is just one of several which may be employed and there are many other methods which vary in detail to a greater or lesser extent from this template. Interfaces which operate in other than the fashion described below in any respect will have the differences clearly described in the section dealing with that design manufacturer's products.

Route-setting Interfaces

Route-setting interfaces have employed a largely standardised method of operation since their initial introduction. Taking NX(PP) panels as the template, these consist of push-buttons which can be internally illuminated, and switches for individually operating points (individual point switches - IPS) and other equipment. Each push-button has either a coloured ring surrounding the hole in the panel or a plastic escutcheon, coloured red for buttons which control a main aspect; yellow for subsidiaries or shunts; black for exit only, route or overlap selection; green for slots; blue for ERS and automatic working; and brown for ground frame releases. Where the button controls more than one of these functions the colouring consists of segments of the applicable colours. The head of the button is engraved with an arrow-head showing the directions of application - an outline symbol denoting an entrance function, solid black denoting an exit function, and a symbol combining one of each where it has a dual function. For other controls the button head may be engraved with letters (E or R for ERS, A for automatic working, and F for a ground frame release) or left clear. The IPS have white normal, reverse and free indication lamps associated with them. The free lamp is illuminated when the points are free of interlocking controls preventing their movement and it flashes when the points are out-of-correspondence.

To set a route the entrance button is pressed first, causing it to flash, then the required exit button is pressed. White route lights then become progressively illuminated along the route on the panel to the exit signal as long as the route is available and clear (and may extend into the overlap depending on the interlocking design - see *Interlocking Designs* for more details). On single or bi-directional lines an arrow or other directional indicator will illuminate alongside the route lights. If the route is not available no route lights illuminate and the button ceases to flash. The route lights at points (pivot lights) become illuminated only when they are correctly detected in the correct position for the movement. When the route is correctly set the light in the entrance button becomes steady. If it is necessary to set another portion of route this may then be done by repeating this procedure, with the previous exit button now perhaps being pressed again and acting as the entrance button for the next section.

Signals will clear in accordance with the approach controls (if any) upon them. Stop signals are shown On by a red lamp in the head of the signal symbol, distants by a yellow lamp; main aspect signals are shown Off by a green lamp, shunts and subsidiaries by a white lamp. In each case On and Off indications display through the same 'window' in the signal symbol. Track circuit occupation is shown by magenta lights throughout the respective track circuit - these replace route lights where a route has been set, i.e. only the lights which were lit white show magenta, but all lamps in a track circuit light on occupation if no route has been called (described as 'flooding').

When a train passes a signal the button is pulled up and the light goes out. As the train clears each track circuit the magenta lights clear momentarily to white before they too are extinguished. If the entrance button is not pulled up the white route lights remain lit behind the train as it proceeds. Signals revert automatically to On in accordance with track circuit occupation and either first-wheel or last-wheel replacement controls in the circuitry.

Attempting to set a route before all points are free to move to the correct position and all conflicting moves are clear is called 'presetting' and is normally prevented by the interlocking. However, it is permitted to call a route if a previous movement is proceeding on the route the next one will take and no points require to move but it is not yet clear of the signal section - this is called 'pumping' or 'restroking'. It is also permitted to call a route from a different entrance signal to the one passed by a preceding train before it is clear of the signal section, provided the first train is already clear of any points which require to be moved for the following train - this is called 'oversetting'.

The operation of an IPS away from its central (automatic route-setting position) position to either Normal or Reverse locks points in that position and attempts to call a route requiring them in the opposite position will fail. Routes can be called through points which are locked in the required position. If a set of points fails to move to the required position the Out of Correspondence (OOC) light will flash to bring the signalman's attention to the situation. The IPS can be used to swing the points back and forth to try to obtain detection.

Where facing points ahead of a signal provide alternative overlaps, an overlap is altered by operation of the IPS, or by operation of another route which 'swings' the overlap to another one available. Where alternative lengths of overlap are provided, these are selected by alternative exit buttons. Where alternative routes are available between signals these are chosen by depression of the corresponding alternative route button before the exit button. Where alternative classes of signal may be chosen separate exit buttons are provided.

Where it may be necessary to make a movement through the overlap of a signal after a train has stopped, or into an occupied signal section in the opposite direction, the route lights extinguish after a predetermined time interval, provided the entrance button has been pulled up and the route is freed. This is called 'timing-out'.

Where it is necessary to cancel a route before a train has passed a signal the entrance button is pulled up and the On indication commences to flash. The entrance button and route lights remain lit and the route remains locked - this is called approach locking. At the end of the approach locking release or 'back-lock' period (generally 30 seconds for shunt and subsidiary aspects, 2 minutes for main aspects) the On indication will become steady, the route lights and entrance button will extinguish and the route will be freed. If, during the 'back-lock', period an approaching train passes the entrance signal at Danger, at the end of the release period the route lights ahead of the train will not extinguish and the route ahead will remain locked; the route in rear of the train, however, will be freed. Depending on the interlocking design provided, if a train is sufficiently far away from the signal which is replaced to danger so as not to see any change of aspect the route may be freed immediately and the panel indications revert to a state corresponding to no route being set - this is called comprehensive approach locking (CAL).

In certain cases where a signal has only one route on plain line an exit button does not need to be pressed to set a route. When the entrance button is pressed it lights with a steady white light straight away and, if the controls allow, the signal clears. Route lights are not provided for routes which are set by the pressing of an entrance button only, or over which the interface has no direct control (automatic sections, signals operated exclusively by a gatebox etc.). Signal On / Off indications are only provided for those signals which are directly controlled.

Buttons provided for selecting alternative routes only light when pressed during the route-setting process and extinguish when the route is set. ERS buttons are normally unlit but light when pulled to place a signal to the On position. Buttons provided for slots and releases light when pushed to activate the control and extinguish when the slot / release is cancelled by pulling the button.

In the case of NX[-] the route and track circuit lights, and signal On / Off indications are shown only on the indication panel. Point indications are shown with the IPS only on the control panel.

NX(DB) panels operate in the same way as NX(PP) with the exception that separate entrance and exit buttons are provided.

NX(TP) panels are similar to NX(PP), except in the obvious matter of the entrance switch. These are normally of the rotary type and point along the line of route in the direction in which they apply. To commence the route-setting procedure the switch is turned up 30-45 degrees to select a main aspect, down 30-45 degrees to select a subsidiary aspect or a shunt signal. Exceptionally the switch may be of a non-rotary type which is normally in the central position and can be pushed up or down to select the class of route as above. Thereafter operation is as for NX(PP). A switch is restored to its original position to reset or cancel a route. There is no internal illumination in the switch. An exit button is not provided for a signal which has only one route. Switches are provided in lieu of buttons for all other controls (slots, ERS etc.).

In the case of MPK and OCS panels the sequence of indications on the illuminated diagram is broadly as for NX operation but in earlier installations route lights and track circuit lights can be separate lamps lit concurrently. Operation of a route switch is all that is required to commence the route-setting procedure. Replacement of the switch either before or after the passage of a train brings into play the same sequence of events and indications. The signal On / Off indications are normally shown along with the route switch. Route switches are normally red for a main aspect and white for a subsidiary or shunt.

It should be noted that use of the facility for the automatic cancellation of routes behind a train (Train Operated Route Release - TORR) is only provided exceptionally in the interlockings commonly installed with NX panels, as are systems for the automated setting of routes. For more details of these facilities see the *Interlocking Designs - Technological Developments* section.

WSs operate on broadly the same theme as NX panels. Trackerball, mouse or keyboard commands are used to manually initiate the route setting from the entrance signal to the exit signal or location on the screen display, and some WS systems additionally allow OCS-style operation via keyboard commands. Facilities for the automated setting of routes are provided more commonly than with NX panels, though by no means universally. Points can also be individually operated by use of these tools. Several VDUs are provided to give both overviews and detailed views of the area of control, as well as general purpose screens displaying keyboard inputs and alarms. The trackerball control is used to move a cursor around the signalling display screens to target equipment to be operated. In addition a keyboard provides the facility to type in commands, consisting of a QWERTY keyboard plus function keys. NX-style operation is achieved with the trackerball and desk buttons emulating panel operation - signal to signal, alternative routes, setting of automatic working, operation of points, operation of block signalling equipment etc. can all be achieved in the same way as they would on a NX panel with Normal operation. The use of keyboard-typed commands allows routes to be set in a pseudo-OCS manner as only one command input is required, similar to the turning of just one control switch. A variety of coloured superimpositions and overlays can be shown on the signalling view screens to act as reminders.

In SSI or CBI areas the actual aspect displayed by each signal capable of control by the interface is depicted on the screen display in the head of the signal symbol, rather than simple On / Off indications, but in RI areas only the latter indications may be given (although sometimes the workstation is programmed to calculate the correct aspect and display it accordingly): non-controllable signal symbol heads are shown all grey. Lines and signal symbol posts are shown as grey when no route is set, with both the entrance signal's post and the line immediately ahead of the signal flashing white when route-setting is initiated; the whole line of route, including the full overlap and signal post becoming steady white when a route is correctly set. By the time WS were invented the use of route lights extending up to the overlap point was standard. Points are shown OOC by the track flashing grey (if no route is set) or white (if a route is set) at the point end. Normal and Reverse, N and R characters respectively, are only shown on the detail view screen, not on the overview screen. Track circuit occupation is indicated by the track showing red. TORR is an integral part of WS-based control and routes clear automatically. Train descriptions are shown geographically in berths on the track display.

Non Route-setting Interfaces

In the case of IFS each switch operates an individual control. Before operating the control to clear a signal any points which require to be moved to an alternative position are first operated by the black IPS. IPS have only two positions, corresponding to Normal and Reverse. Once the points are set the desired signal control is operated to clear the signal. Where more than one route or class of signal is available there is usually only one signal switch provided, selection being achieved by the lie of the points and track circuit occupation. Signal switches are normally red for a main aspect, yellow for a subsidiary or shunt, and a combination of the two colours when both classes of route are available. Signal indications are shown alongside their respective switches. Signal switches may have an additional white 'locked' light, which when illuminated indicates that the signal is not free to be operated owing to other conflicting movements. Signal On / Off indications are only provided for those signals which are directly controlled.

Signals will clear in accordance with the approach controls (if any) upon them. Stop signals are shown On by a red lamp at the switch, distants by a yellow lamp; main aspect signals are shown Off by a green lamp, shunts and subsidiaries by a white lamp. Track circuit occupation is shown by red lights on the respective track circuit on the panel diagram in the case of IFS[+], or on the separate illuminated diagram in the case of IFS [-]. Far fewer lights are provided than on route-setting panels, usually just near the extremities of each track circuit. Track circuits always flood and route lights are only rarely provided.

When a train passes a signal the switch is replaced. Signals revert automatically to On in accordance with track circuit occupation and either first-wheel or last-wheel replacement controls in the circuitry.

The interlocking usually permits the setting of a signal before the route is clear provided the previous movement is proceeding on the route the next one will take and all points have been set in the required position - the terms 'oversetting', 'pumping' and 'restroking' do not apply to non-route-setting interfaces.

OOC lights are not provided and the failure of the required detection indication to light when the switch is operated is considered sufficient to bring the signalman's attention to the situation. Points are always locked in the position set by the IPS. A 'locked' light is provided at each IPS but it should be noted that this indicates when the points are locked by the interlocking, i.e. owing to a signal reading through them having been cleared, not that they are locked by the point mechanism.

Overlap and route selection facilities are not normally provided with IFS. If it is necessary to make a movement through the overlap of a signal after a train has stopped, or into an occupied signal section in the opposite direction, the 'locked' light for the signal which it is desired to clear or points which require to be moved will extinguish when the route is timed-out and freed.

Where it is necessary to replace a signal before a train has passed it the On indication will be steady but the locked lights of other signals and points will indicate when it has timed-out. At the end of the timing-out period (generally 30 seconds for shunt and subsidiary aspects, 2 minutes for main aspects) the locked indications will extinguish and the route will be freed. If, during the backlock period, an approaching train passes the signal at Danger, at the end of the time-out the locked lights on points ahead of the train will not extinguish and those points will remain locked; the points in rear of the train, however, will be freed.

ERS normally have only an On indication which illuminates when the switch is operated.

In the case of IFS which utilise buttons for signal controls in lieu of switches the description given above remains generally valid. Buttons behave in the same way as 'one push' NX buttons.

Interface Designs - Descriptions

Commissioning dates refer to equipment commissioned as new, not second-hand installations.

Note **-** *Several examples are known of manufacturers affixing their own logos at a later date to interfaces made by another design manufacturer, usually as a result of provision of TD equipment. These may be additional to the logo of the original interface manufacturer or they may replace it. Great care should be taken not to mis-identify an interface as a result of this practice (known examples: Bletchley PSB, Cricklewood Depot, Edinburgh SC, Euston PSB, Exchange Sidings Dagenham, Faversham & Perth).*

Adtranz [Interface commissioned 1997]

Formed in 1996 through the merger of ABB and Daimler-Benz. ABB withdrew from the partnership in 1999 and the company became DaimlerChrysler Rail Systems, before being acquired by Bombardier Transportation in 2001.

Designed only one interface, the NX(PP)[+] at Wimbledon for the Barnes area, being a continuation of the ML Engineering design with EAO components.

AEA Technology Rail (AEAT) [Interfaces commissioned 1997 - 2006]

Formed by AEA Technology plc as a business name to run the taken-over former BR Research establishment at Derby in 1996. In August 2006 the firm was bought by DeltaRail Group Ltd..

Designed IECC operating systems as a continuation of BR Research / Sema Group production and further developed it, the first new system being installed at York IECC in 2000. No further development of Radio Electronic Token Block (RETB) was made although the rights were acquired.

Alstom [Interfaces commissioned 2024 – date]

GEC formed a trading partnership with Compagnie Générale d'Electricité in 1989 to form GEC-Alsthom. In 1998 Alsthom acquired GS and with the break up of GEC the partnership ended. The company name was slightly amended to Alstom. Acquired the GETS signalling business in November 2015 and continued to manufacture that company's products.

Originally, Alstom produced no interfaces of its own and work was subcontracted to established suppliers such as Henry Williams and TEW. Some interfaces appeared with an Alstom label on the console where they were the main contractor but this is misleading and should be treated with caution. From 2024 they began commissioning a newly developed version of the GETS MCS WS system called MCS Infinity, which used mouse and keyboard operation with large curved display screens.

Amey [Interfaces commissioned 2000 - 2013]

Previously involved in resignalling schemes then began providing contracted infrastructure services for Network Rail in 2009.

In 2000 a temporary OCS[+] was designed for Bristol PSB for the Bristol Parkway area to facilitate resignalling alterations on the main panel. This was inserted into the former train recorder's console, consisting of a laminated paper fascia, LED lamps, industrial-style switches etc. Signal On / Off lamps were located in the signal symbols.

An IFS[+] was designed for the temporary box at Portsmouth Harbour in 2007, consisting of a plywood console with the panel inserted into the sloping front. There was a row of Square-D switches at the bottom of the laminated paper track diagram, with LED points / signals indications located with the switches. LED TC and route lamps were provided. A wooden-legged case was employed at Truro in 2009 to contain an axle-counter reset panel, complete with track diagram, incorporating, amongst other indications, an ESOC for the Penryn remote interlocking. This was manufactured by the Maindee depot.

The company also designed an IFS[-] GSP for Acton West Ground Frame for the yard resignalling which was built in-house at Exeter by the installation team. Consisting of a reverse screen-printed diagram on a Perspex sheet (reminiscent of a Darvic fascia), industrial style signal buttons and points switches were geographically positioned. Point ends had two indication lamps on the line of route on the track diagram to show detection, in similar vein to the 1960s Westinghouse IFS[+] for yard ground-staff operation.

Ansaldo Signal [Interfaces commissioned 2003 - 2006]
Ansaldo STS [Interfaces commissioned 2010 - date]

Formed in 1996 as Ansaldo Signal (which included in its interests the US firm Union Switch & Signal) and combined with Finmeccanica and CSEE in 2006 to trade as Ansaldo STS.

First entered the market with an installation at Manchester South of ACC (Apparato Centrale a Calcolatore), a combined interlocking and WS operating system. The ACC system combined the functions of signalling, route and fault control into one software package but for UK purposes the signalling control function was cherry-picked out of the system, leading to severe problems. The system utilised very large wall-mounted overview screens (*Figure 1*) with a series of detailed-view screens mounted on the workstation console (*Figure 2*). Control was effected by bespoke keyboard and mouse, with no trackerball or command buttons. Screen background was black and route-setting operation was normal. No automatic route setting facility is provided.

Ansaldo's version of European Rail Traffic Management system (ERTMS) was brought into use on the Cambrian Coast lines in 2010, utilising RCC (Route Control Centre) WS software. The system chosen dispenses with fixed signals and speed restriction signs with all information being displayed in the driving cab with much use of GSM-R radio communications.

Figure 1 - Ansaldo ACC WS, Manchester South. © Stephen Lawton

Figure 2 - Ansaldo ACC WS, Manchester South. © Stephen Lawton

Asea Brown Boveri (ABB) Signal [Interfaces commissioned 1993]

Formed on 5th January 1988 from the merger of Asea and Brown, Boveri & Cie. Bought out EB Signal in 1992. Became Adtranz in 1996 through merger with Daimler-Benz, but reverted to ABB in 1999 after the merger was dissolved.

In 1993 at Drax Power Station the company applied their MOD 300 Distributed Control Scheme (DCS) system, used for the control of the power station plant, to also control the signalling of the rail network there. This was a WS-based system with trackerball and keyboard control. Operation was normal and pseudo-OCS functions were also available through route-setting selection from a drop-down list of possible routes (*Figure 3*).

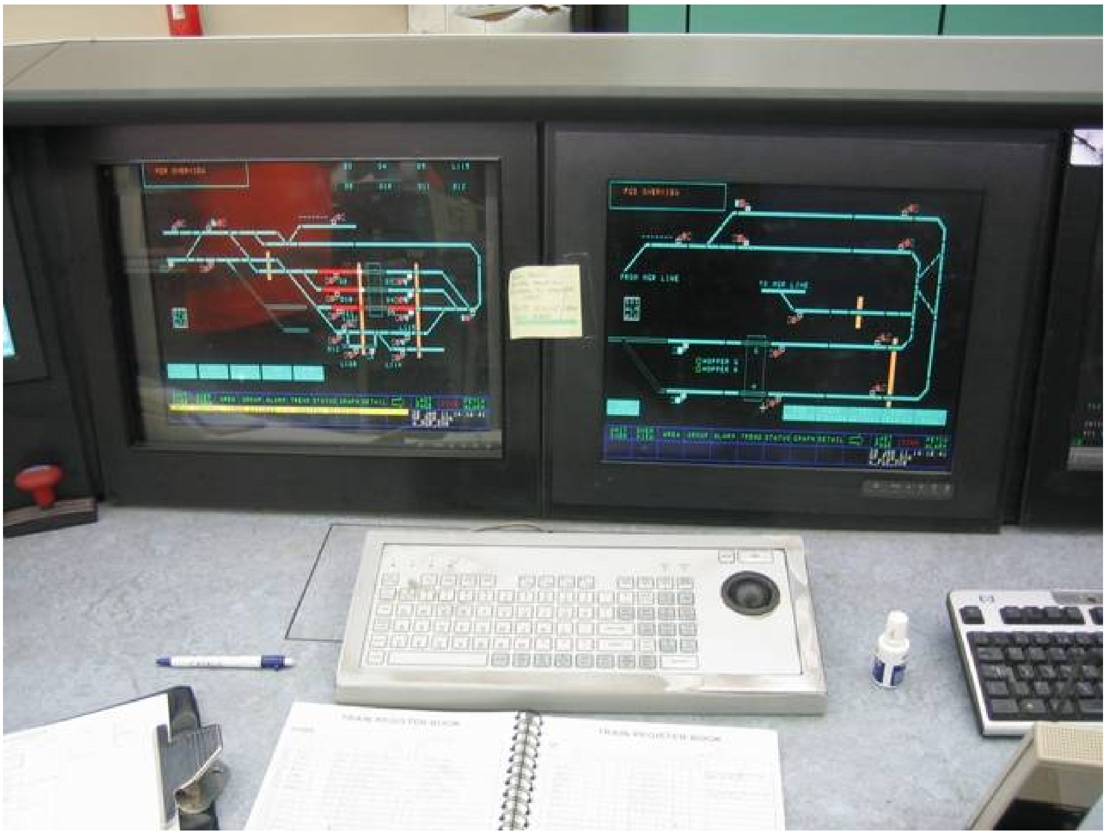


Figure 3 - ABB DCS WS, Drax PS FGD Control Room (Coal, Ash & Dust WS). © Andrew K Overton

Associated Electrical Industries - General Railway Signalling (AEI-GRS) [Interfaces commissioned 1958 - 1967]

Formed from the abandonment of the Metropolitan Vickers name by the AEI group on 1st January 1960, but interfaces appeared with AEI-GRS maker's plates from 1959. In 1967 AEI was taken over by GEC and merged with SGE to form Associated General Signal AGS.

The last of the range of MV-GRS NX(TP) panels were produced by AEI-GRS and are described under the former company's entry.

The style of thumb-switch used in the MV-GRS panel at Thornton Yard was reused in the 1959/60 period during work on the Glasgow Suburban network and several mechanical boxes were hybridised with a new IFS[-] (*Figure 4*). These comprised rows of thumb switches with small indication lamps housed in a moulded fibreglass case. A similar style was used for a small IFS[+] for York Dringhouses in 1961.

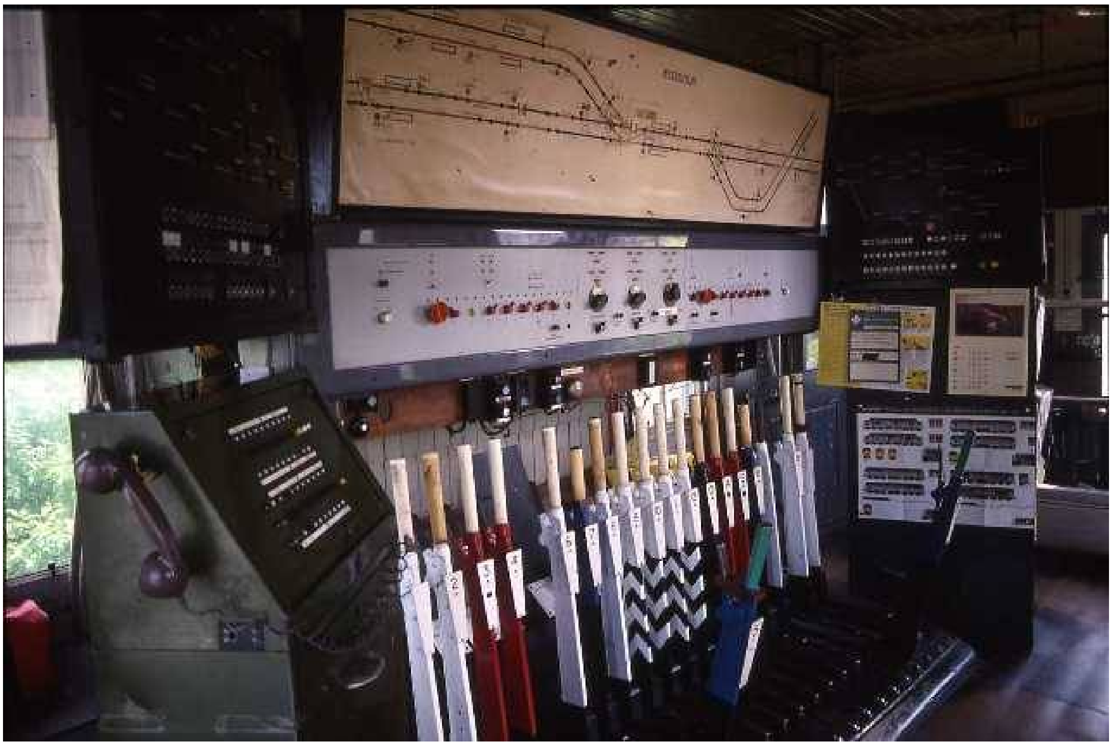


Figure 4 - AEI-GRS Frame / IFS[-] Hybrid, Westerton. © CJ Woolstenholmes

At Atherstone in 1962 an IFS[+] was housed in angular sheet-steel box, with the diagram being in the same style as the NX(PP)[+] panels described below (but in one sheet, not in square sections) with the rows of switches below. For work on the LT&S at this period the MV-GRS NX(TP)[+] was developed and used in an NRNX installation at Upminster (*Figure 5*), with a lever frame retained for point operation, rather than using an IFS Unit. This was similar to the panels at Acton and West Ealing but with mechanical points too now indicated by lamps on the line of route. The exit buttons became white with a black arrow. AEI-GRS also obtained work for Modernisation Plan marshalling yards, although they were never a major provider of the actual panels, supplying only Ripple Lane in 1961 with MV-GRS-style IFS elements as used at Thornton, but with MV-GRS-style NX(TP) components utilising points indication lamps.

In 1963 panel design turned away from the NX(TP) to a NX(PP) (*Figure 6*). A more modern style of panel with route lights, they were composed of sections slightly under 12" x 12" fitted in front of pre-punched grids, except separate control panels which were in steel sheet form. They were not truly mosaic and the tiles could not be removed from the front, although the sectionalised construction more readily facilitated layout alterations. In the case of separate control and indication panels, tiles were not used on the former component, being instead of sheet steel construction. The IPS were of distinctive form. Operation was normal except in the following respects:

(i) IPS which worked trap points had an additional flashing red light to remind the signalman to restore them to normal after making a movement
(ii) During route setting the route lights did not progress beyond a set of points until detection was obtained
(iii) Route lights were provided in sections controlled by automatic signals
(iv) Alternative overlaps were selected by an overlap button engraved with an 'O' and with a black escutcheon, depressed after the exit button. Swinging the overlap of an already set route was effected by re-pressing the entrance button, followed by the alternative overlap button

(v) To cancel the route of a controlled signal (not fitted with an auto-working facility) it was normally necessary to pull and hold the entrance button for 60 seconds (for running signals) or 30 seconds (for shunting signals)

This style of equipment was also used in a set of IFS[+] for gate boxes on the former GE lines in 1969 which employed the NX-style buttons as 'one push' controls in place of switches for signal operation. Design ended in 1971 after seeing some large installations at Trent and Saltley.

The later stages of the Guildford resignalling in 1969 saw the introduction of NX(KS) technology for LCPs at Effingham Jcn in combination with BR(SR) illuminated diagrams for maintainer's panels. This arrangement was then used more extensively on the Dartford resignalling of 1970.

Figure 5 - AEI-GRS Frame / NRNX(TP)[+] Hybrid, Upminster. © David Allen

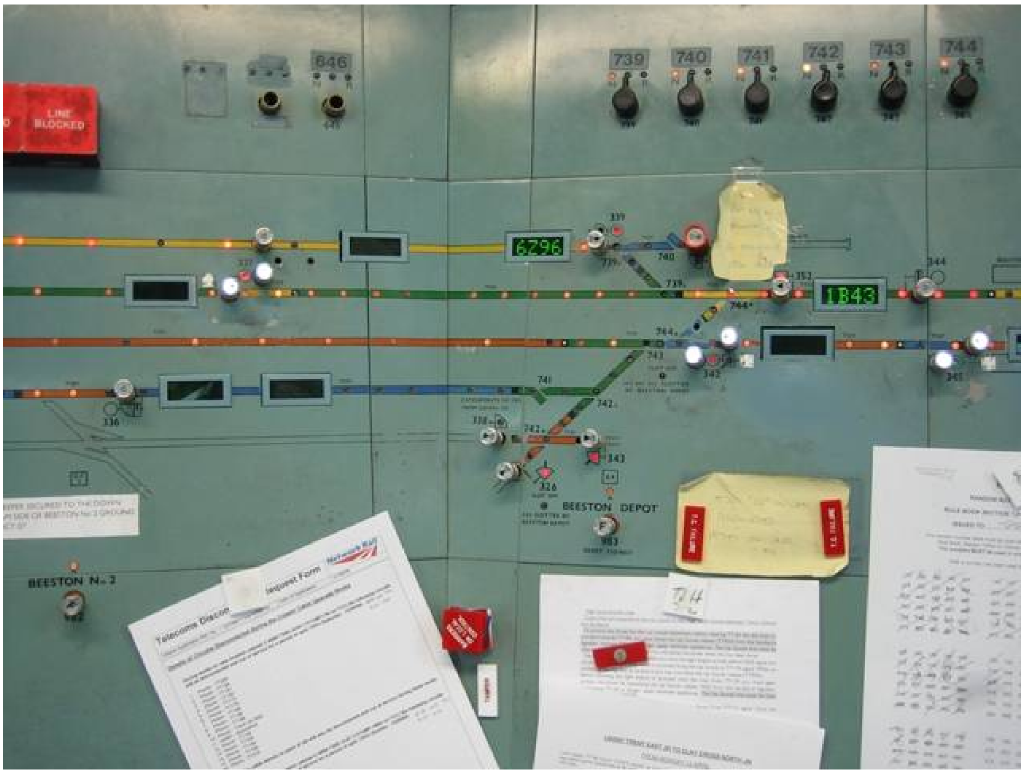


Figure 6 - AEI-GRS NX(PP)[+], Trent. © Andrew K Overton

Associated General Signal (AGS) [Interfaces commissioned 1969 -1971]

Formed from the takeover of AEI by GEC and the merger with SGE. Also known as AEI-General Signal Ltd., which version often appears on maker's plates. Traded under the GEC-GS name from late 1971 after the AEI name was abandoned.

Continued to supply the AEI-GRS models of interfaces. In 1968 AGS reached a deal with the Integra company to use their Domino NX panels and the AGS NX makes were dropped when current orders had been fulfilled, the first Integra installation being at Temple Mills West. These panels were supplied by Henry Williams and are described in that design manufacturer's section. The consoles bore the AGS logo, however, and were of moulded fibreglass construction. It is known that Henry Williams also supplied the Cadder and Greenhill Upper Jcn panels to AGS to the old AEI-GRS design in 1971.

Babcock Rail [Interfaces commissioned 2011 - date]

Babcock International Group took over First Engineering in July 2008.

Designed an IFS[+] for Banavie in 2011 in a style very similar in switch / button / indication LEDs to a mid-1990s NRS interface, continuing the occasional production of interfaces undertaken under the First Engineering name, and an ERS[-] unit at Liverpool Lime Street for closure stageworks in 2017.

Bluebell Railway [Interfaces commissioned 2002 - 2013]

This minor railway followed BR(SR) practice in the use of Square D style IFS[-].

Bombardier Transportation [Interfaces commissioned 2014 - date]

Acquired Adtranz in 2001 but not active in the UK market before 2014.

Commissioned their *EBI*Screen WS system at North Pole Depot as part of an *EBI*Flo100 installation, utilising proprietary keyboard and mouse to control the signalling displayed on standard PC screens, and at a number of subsequent depots as part of the IEP Programme..

British Pneumatic Railway Signalling Company (BPRSCo) [Interfaces commissioned 1907]
British Power Railway Signalling Company (BPRSCo) [Interfaces commissioned 1931 - ca 1935]

The latter company was incorporated in 1912 but trading continued in the former name until between 1917 & 1919 before liquidation. Actual production was totally sub-contracted to Evans O'Donnell / McKenzie & Holland & Westinghouse at Chippenham.

Although a significant force in power frames this company did not design many interfaces valid for inclusion here. The exceptions were interfaces using push-buttons used in the marshalling yards at Wath, Rogerstone, Banbury and Mottram. The Wath IFS(Y1)[-] installations in 1907 consisted of two straight rows of push-buttons on a wooden fascia operating individual points to the normal or reverse position, with a separate non-illuminated diagram. Operation was electro-pneumatic. Point detection and indication was provided on a panel above the push-buttons, by way of normally hidden numbered flaps which came into sight if detection was lost. These flaps were also connected through track circuits so that the number was visible with the points fouled. The 1930s installations at Rogerstone, Banbury and Mottram were similar and saw the interface developed to an IFS(Y2)[+] by the addition of a row of lower route setting buttons, which set all the points from the hump into each siding, as well as individual points buttons. Route setting buttons were locked once one had been pressed until the wagon cleared the king points. The illuminated diagram was combined with the push-button console. The Wath interfaces were replaced at some unknown date – suspected to be during the first quarter of the 20th century - with replacements in a similar style but with the push-buttons staggered alternatively up and down along the two rows on a polished metal fascia, and they omitted the point detection and indication panel, these indications being displayed on an illuminated diagram (*Figure 7*).

Figure 7 - BPRSCo IFS(Y1)[-], Wath B Hump. © John Midcalf

British Rail Eastern Region (BR(ER)) [Interfaces commissioned 1951 - 1993]

Note, for convenience the former BR(AR) and BR(NER) are considered to be part of BR(ER) here.

A wide range of interfaces were designed by the BR(ER) workshops at York over a long period of time. This was a development from the supply and repair of traditional signalling equipment for mechanical signalling. The interface housings / consoles were made in the factory but the components such as switches, buttons, lamps etc. were commercial spares, usually from the signalling contractors, available at the time of interface construction, with a continuing preference for Westinghouse parts. These changed over time and followed the changing patterns used by the source contractors. The same style of interfaces as used in signalboxes were also employed as LCPs. A small number of interfaces were designed and these are specifically noted: at least two IFS[-] with dark plywood casings, into which was set a metal front plate mounting Westinghouse MCD-style thumb-switches and Post Office indication lamps are known to have been designed by Newcastle area S&T (*Figure 8*). Three early IFS[-] were designed for the MS&W electrification resignallings and one for Shenfield, utilising rough plywood fascias with black Traffolite description plates and with SGE switches of a pattern used on MPK[+] interfaces (*Figure 9*); no 'locked' lights were provided at points. It is believed that these four interfaces were made at Leyton Works.

In the 1950s and early 1960s IFS interfaces were also being purchased from the signalling contractors, possibly as the pace of modernisation outstripped the ability of York to fulfil all orders, but after this time the region only outsourced the largest interfaces and small panels were generally provided by their own workshop. Even in the case of the major MAS schemes York often provided the stageworks interfaces for boxes, which were eventually to become local control panels. Many interfaces have a BR (York) maker's sticker on front and although this may always have been affixed when they left the factory they are not always in place in later years.

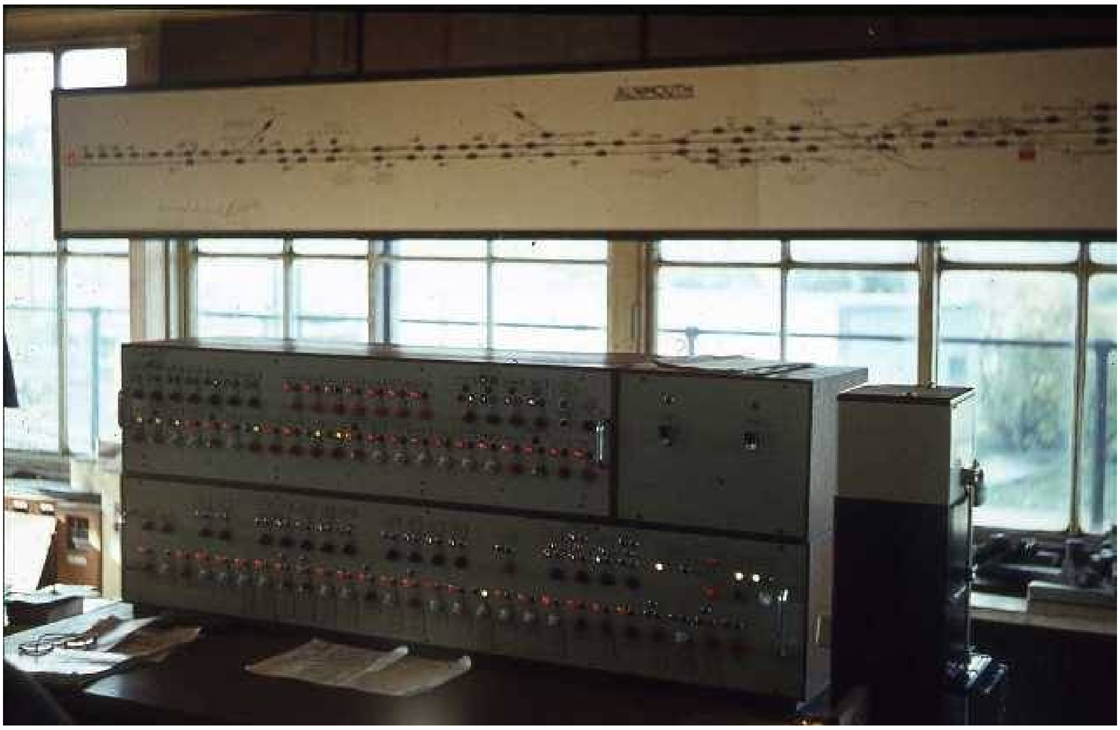


Figure 8 - BR(ER) IFS[-] locally made, Alnmouth. © CJ Woolstenholmes

Figure 9 - BR(ER) IFS[-] Wombwell Main. © John Midcalf

Figure 10 - BR(ER) IFS[-], Cliff House. © CJ Woolstenholmes

The LNER pattern of single thumb-switch IFS[-] was initially retained for use, both as IFS[-] and ERS[-]. In late 1959 / early 1960 a prototype electrical Key-Lock instrument in wooden-cased form was trialled at Yapham Crossing. At Low Gates in 1960 the first production version of a new design of interfaces appeared in IFS[-] form. Construction was of rounded aluminium Imoff extrusions painted cream, with blue painted sheet metal panel infills and the front was of a modular construction, with various switch etc. elements being combined to form the required interface. This gave the appearance of slot-in components, but in fact the elements were hard-wired together after assembly and could not be removed. Westinghouse OCS-style thumb switches and Post Office indication lamps were employed. Several subsequent installations in this style were made (*Figure 10*) and they were also used for multiple ERS[-]. Key Lock instruments were also produced in this style (*Figure 11*) and this method of control was eventually employed at a large number of crossings, some of which had previously had no signal protection and which needed to be integrated into MAS schemes (there has been much reuse of second-hand Key-Lock instruments in new installations post-rail privatisation).

Figure 11 - BR(ER) IFS[+] & KL, Arram. © Richard D Pulleyn

The design was modified during 1964 and a new style of console was introduced with polished aluminium Imoff extrusions with cream-painted steel sheet infills replacing the pseudo-modular concept, although a few interfaces continued to be commissioned to the old design into 1965. Hull Bridge was the first to use this design and retained OCS-style thumb switches, and although thereafter Westinghouse miniature thumb switches were used in a small number of interfaces the design settled on large black 'cooker' switches with a coloured plastic disc around the shaft to denote function. Westinghouse miniature light-funnel switch indications for points and signals were introduced and IFS point switches obtained 'locked' lights. Track circuit lamps changed from Post Office type to the new Westinghouse miniature style, after a short crossover period. Traffolite description plates engraved with functions also began to appear below switches on IFS, replacing painted-on details. Panel diagrams were enamel painted onto the fascia in a very similar style to that employed on genuine Westinghouse interfaces. It can be difficult to distinguish these from genuine Westinghouse products but the use of Imoff extrusions for the console design is not a Westinghouse trait: the latter firm at this time were using fibreglass moulded consoles. The workshop's first NX(PP)[+] appeared at Thirsk, utilising normal route-setting operation (*Figure 12*).

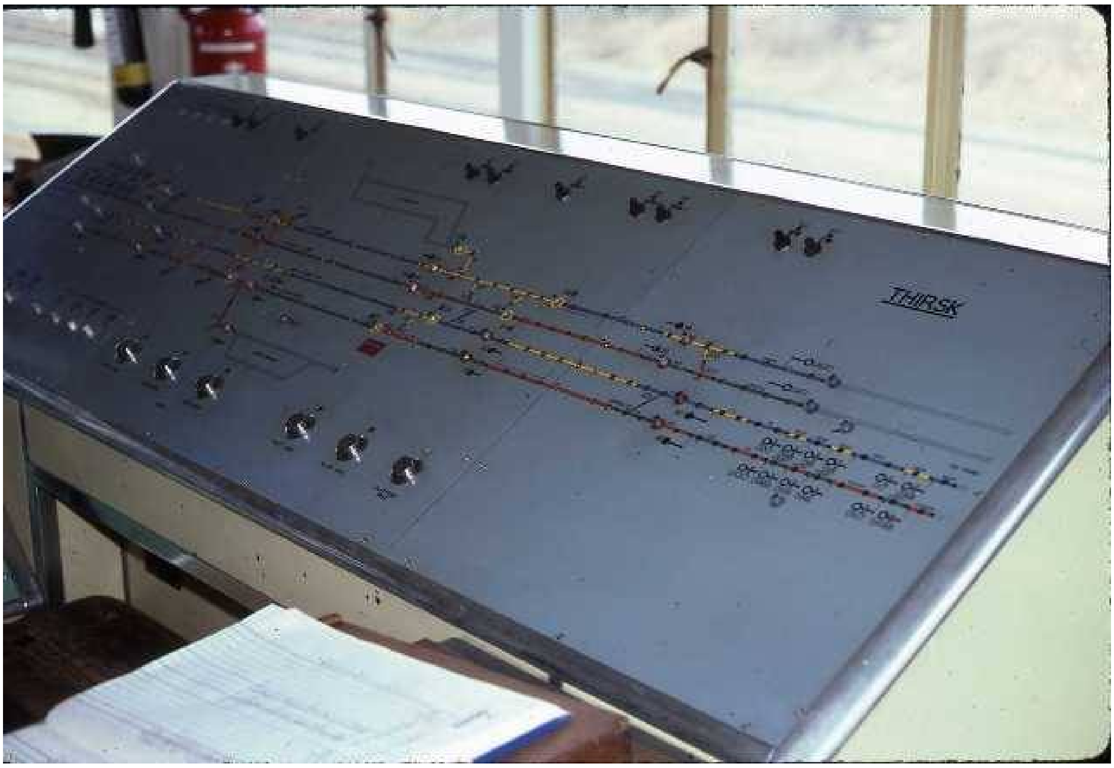


Figure 12 - BR(ER) NX(PP)[+], Thirsk. © CJ Woolstenholmes

Figure 13 - BR(ER) IFS[+], Dilston. © Network Rail

A small number of interesting IFS[+] were designed from the second half of the 1960s through the 1970s utilising NX style push buttons geographically located on the panel to operate signals and other functions - at first glance these can be confused for NX(PP)[+] (*Figure 13*). The Pelaw example, provided to work the line to Harton, saw the use of a fibreglass console by the York workshops - an experiment which did not, as far as is known, lead to any further use of the material for console design. Whether it was moulded in-house, or bought in, is not known. The Whitwell console had Hammerite finish infill sheets. This style of installation in the Leeds area was of further interest in utilising buttons for points operation - one per set of points - with each push moving the points to the opposite position (the one at Neville Hill Depot West being renewed in modern style with Swisstac buttons and LEDs in 1990).

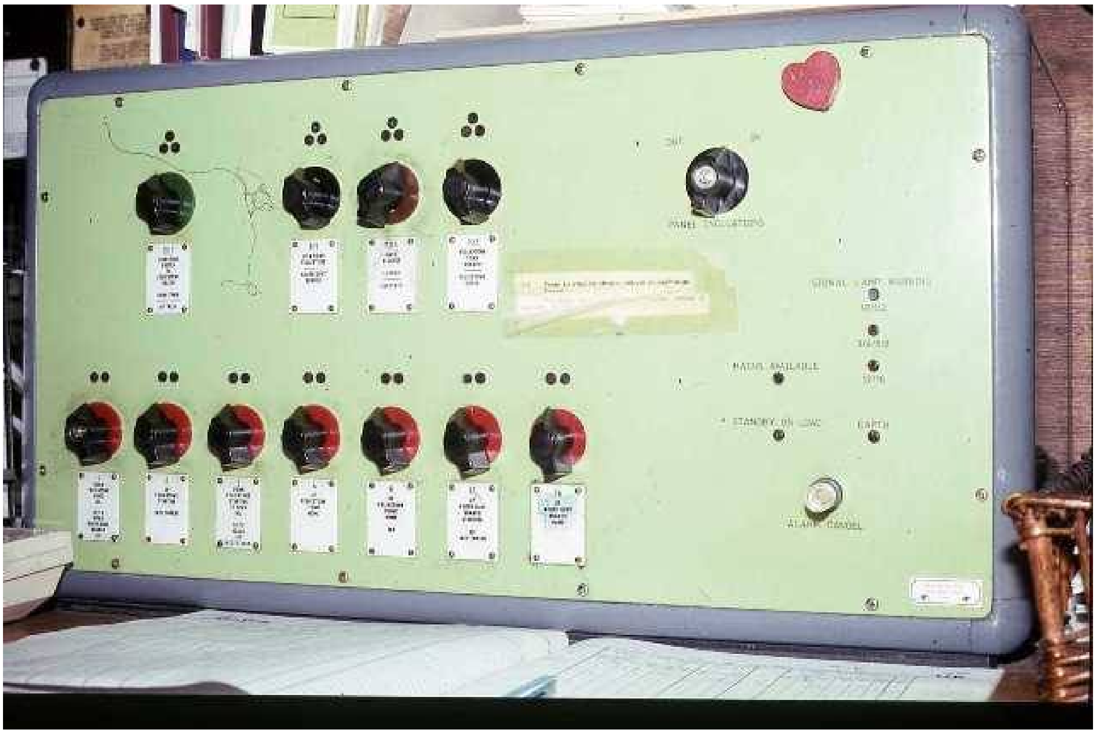


Figure 14 - BR(ER) IFS[-], Trimley. © CJ Woolstenholmes

Figure 15 - BR(ER) KL, Noblethorpe. © Andrew K Overton

During the 1970s the console casing infills became the same colour as the front (generally blue or green) (*Figure 14*). Some small IFSs were also made with no casings and a Hammerite finish, with Post Office type lamps, and a large number of Key Lock instruments were also made to this design (*Figure 15*).

One-switch ERS also evolved through the use of the 'cooker' switch in a rounded metal box, either painted blue or in Hammerite finish. IFS[-], rather than IFS[+], gained favour and a great number were produced, working in conjunction with a standard illuminated box diagram - easier to alter in case of layout changes.

Many larger interfaces were originally mounted on stilt legs, then later in cradles with V-shaped notches cut out of the tops (*Figure 16)*. This allowed the face of the equipment to be presented at a sloping angle to the signalman, making it convenient to work whilst seated, but without production of an expensive console shell. In the 1970s an alternative arrangement was additionally introduced, with the provision of a sloping section to the console front, allowing desk mounting, with the interface surface conveniently positioned for operation without the need for the V-cradle (*Figure 17*).

Figure 16 - BR(ER) NX(PP)[+], Clipstone Jcn. © John Midcalf

Figure 17 **-** *BR(ER) IFS[+], Ferme Park Reception Sidings Control Cabin. © David Stansfield*

The pattern of lamps and switches used throughout the 1970s changed as Westinghouse moved over to the M3 pattern and the Imoff console surrounds were generally painted grey. However cooker switches generally continued in favour, with larger generic lamps of a type one might source at any electrical wholesalers used in IFS (*Figure 18*). A small number of IFS[-] were designed with a square console of hammered finish, rather than one with Imoff extrusions, but these were not common (*Figure 19*). A depot IFS[+] was later designed, with point switches geographically positioned either on the illuminated diagram or a mimic below (*Figure 20*). IFS[+] were also designed for NCB / BSC bunker terminals in generally the same style as those made for BR signalboxes.

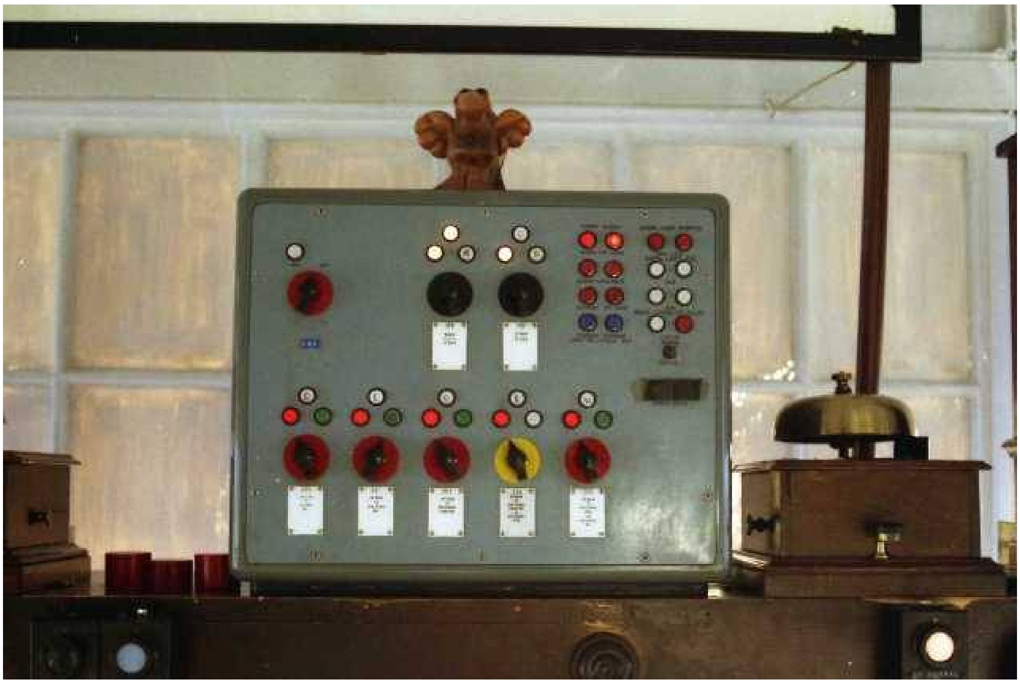


Figure 18 **-** *BR(ER) IFS[-], Melton Lane. © Andrew K Overton*

Figure 19 - BR(ER) IFS[-], Thorpe Gates. © Andrew K Overton

Figure 20 - BR(ER) IFS[+], Crown Point Control Cabin. © Graham Floyd

In the late 1970s a GSP design was introduced, consisting of a simple track diagram screen-printed onto a small painted steel sheet, with 'cooker' switches and generic lamps, contained in a lineside location cabinet (*Figure 21*). The pattern of switches and lamps employed evolved in line with those used on signalbox interfaces. In 1977 a GSP at Birtley No.2 used push-buttons instead of switches, somewhat in the style of the BR(LMR) GSP design and described below but this was not the usual arrangement for BR(ER).

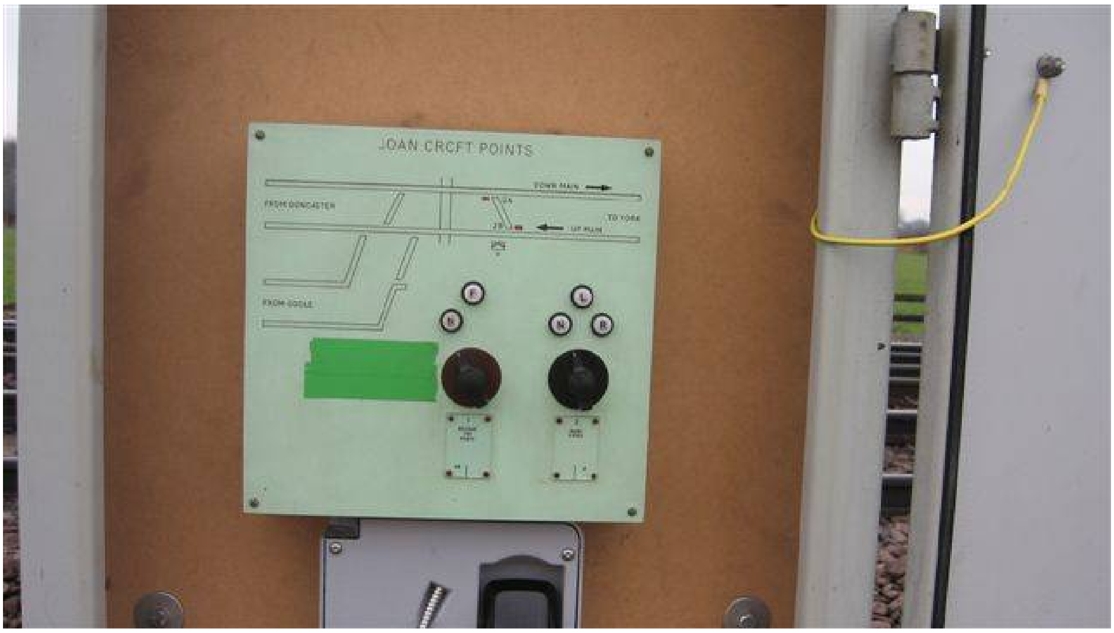


Figure 21 - BR(ER) GSP IFS[-], Joan Croft GSP. © Keith Cross

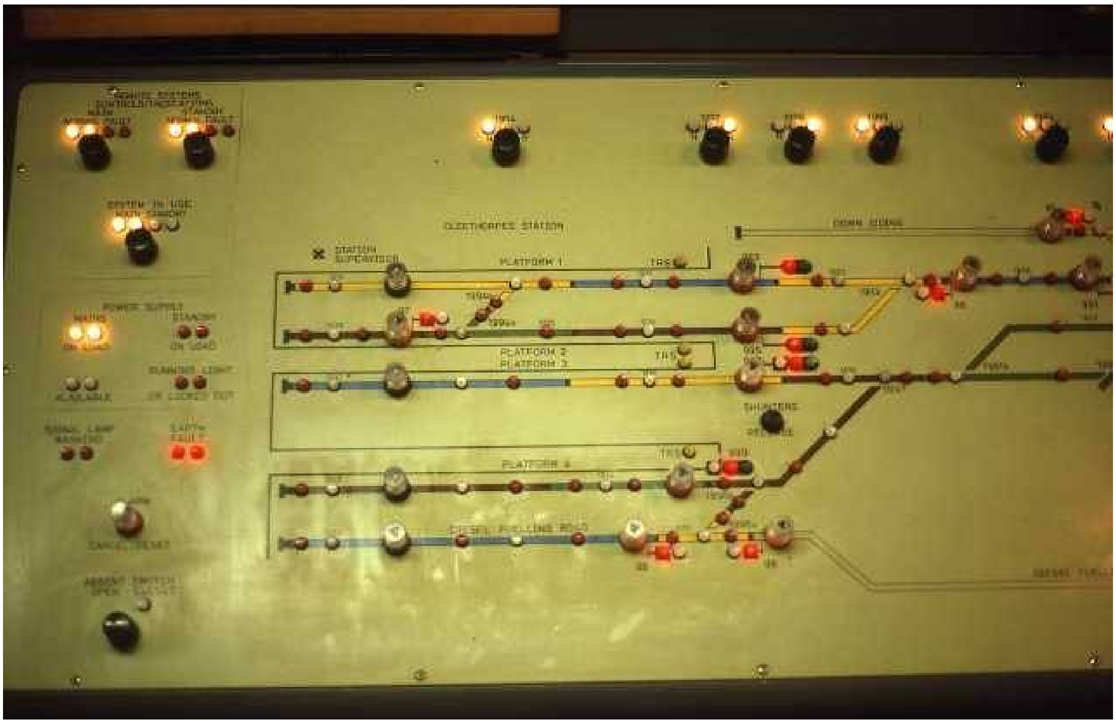


Figure 22 - BR(ER) NX(PP)[+], Pasture Street. © CJ Woolstenholmes

In 1983 NX(PP) with separate route and track circuit lamps appeared, the lamps distinctive and proud of the fascia (*Figure 22*). Signals had separate lamps for On / Off shown in the head of the diagram symbol and large Swisstac push-buttons were introduced later. GPLs were distinctive in having the On indication in the head of the symbol with the Off lamp above the symbol. By 1988 the enamelled sheet-steel interface surface and Imoff casing design had been replaced by one with a plastic laminated card fascia held in the console shell by beading. Small LED lamps started to replace the proud style but the use of separate lamps and the positioning in signal symbols was retained (*Figure 23*).

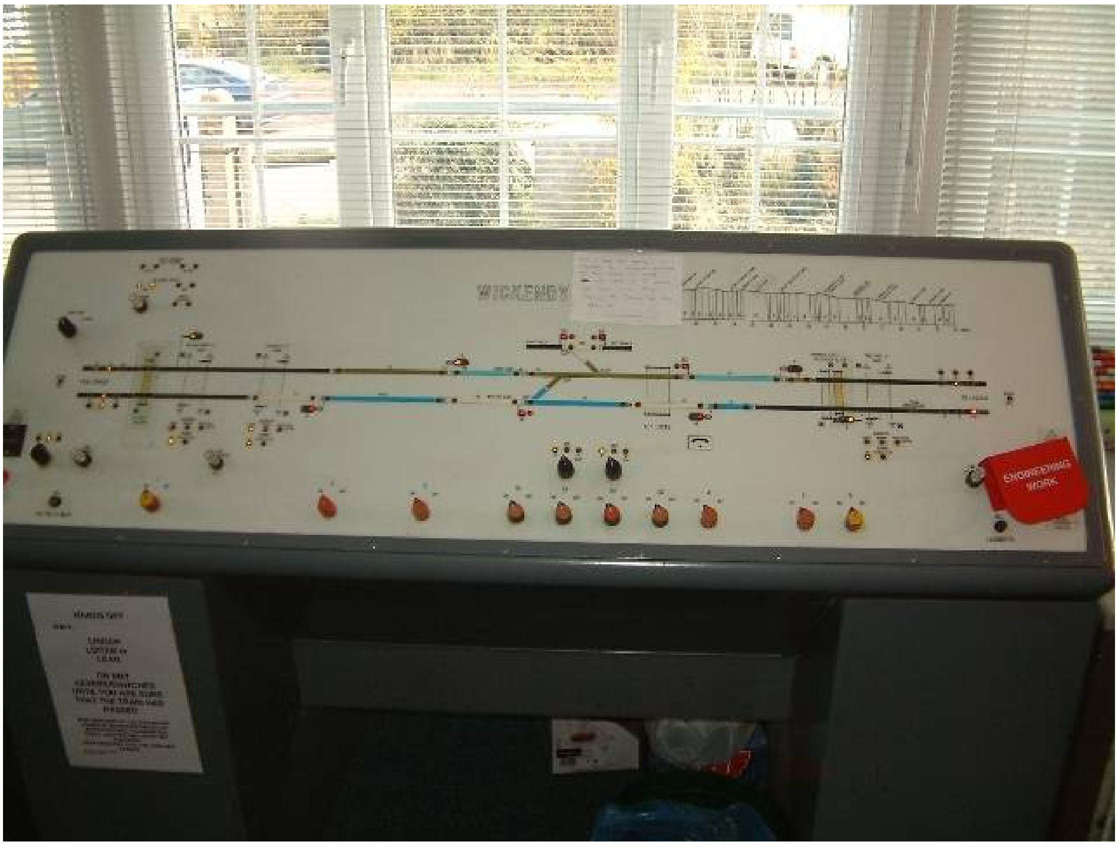


Figure 23 **-** *BR(ER) IFS[+], Wickenby. © John Midcalf*

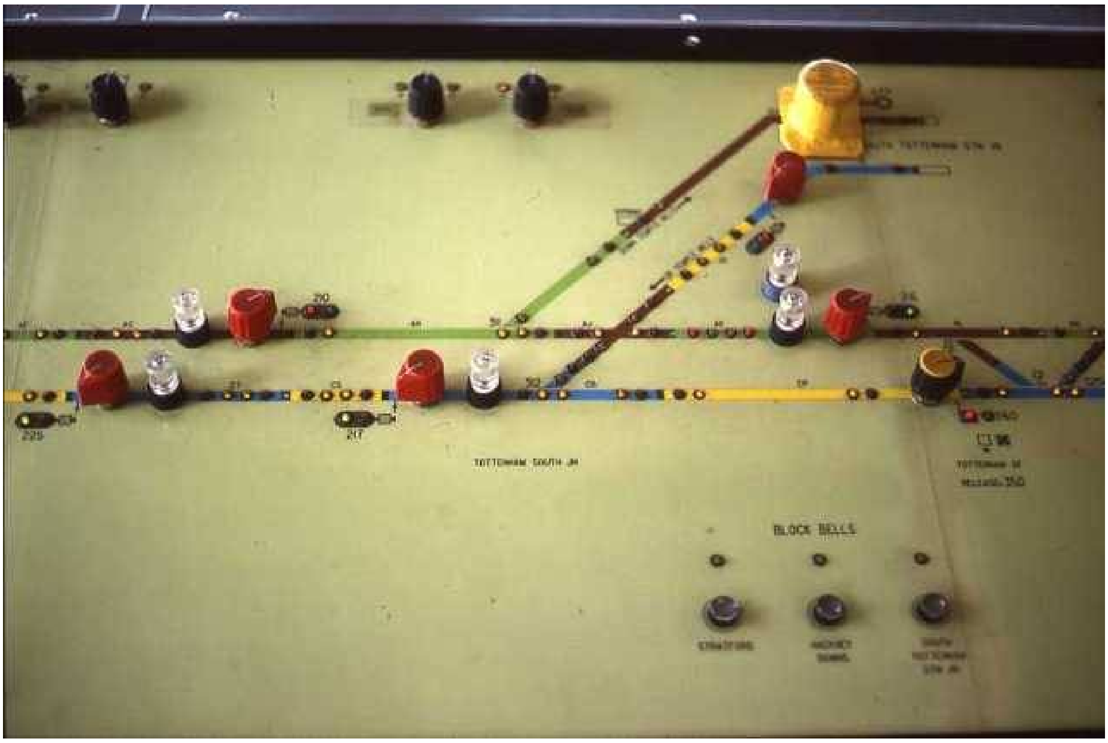


Figure 24 **-** *BR(ER) NX(TP)[+], Brimsdown. © CJ Woolstenholmes*

The NX(PP) panel design was supplemented by NX(TP) (*Figure 24*), and some IFS[+] saw the continued use of one-push buttons geographically positioned in lieu of switches (*Figure 25*). The NX(TP) had IPS-style entrance switches, operation of which lit all available exit buttons until one was selected, whereupon the rest went out. Push-buttons were also used for some ERS[-] in conjunction with AHB stopping / non-stopping crossing sequence controls. IFS[-] continued to employ a sheet-steel front, probably as the convenience of the paper fascia when changes to the layout were made was not so important with this type (*Figure 26*).

Figure 25 - BR(ER) IFS[+], Thorpe le Soken. © CJ Woolstenholmes

Figure 26 - BR(ER) IFS[-], Ulceby Jcn. © John Midcalf

In 1993 there were significantly alterations in the panel surface and indication lamps with the NX(PP)[+] at Huddersfield. The fascia was now on non reflective vinyl-coated card and a flat style of LED lamp was used. Separate track circuit and route lights were used, with yellow used for the Off aspect in subs and shunts. Normal operation was employed.

As well as complete new interfaces, from the 1970s onward BR(ER) also designed replacements and extensions for existing NX and OCS control and indication panels, often made to closely match the original equipment.

BR London Midland Region (BR((LMR)) [Interfaces commissioned 1955 - 1995]

The BR(LMR) workshop at Gresty Road, Crewe was at least as prolific as the York workshop of BR(ER). This region went one step further in that from the mid-1970s, right up to privatisation, very few interfaces were procured from the signalling contractors, design of even the largest panels being managed in-house. It would seem that after the rush of modernisation was over the LMR decided that they were quite capable of supplying all of their own equipment once the basic components had been bought in and only outsourced when the limits of workshop space and personnel, coupled with a rush of orders, made this absolutely unavoidable. A preference for the style of switches and buttons used by ML Engineering can be seen in the NX panels made by Crewe but from around 1985 this gave way to Westinghouse and GEC-GS, probably as a result of ML sourcing their panel components from Swissinco. As with BR(ER) products, it can at times be quite difficult to differentiate the large Crewe built panels from the genuine products of a contractor but the LMR policy of producing in-house is always a strong indicator, coupled with the more home-made appearance of the consoles, often to a recognisable Gresty Road style.

As with York, Gresty Road had been active in producing equipment for mechanical boxes. A system was developed at Crewe for incorporating repeaters and block instruments into the block shelves and this was expanded into design of IFS[-] and ERS[-] with some recognisable parallels in design and materials crossing over. Function descriptions were engraved into Traffolite with indication lamps showing through holes, with rotary control switches inset individually into a blockshelf. A variety of switch designs were used over the years, with black cooker-style and ML Engineering patterns at first and large metal items in later years. A large IFS[-] installation could be made up by a row of such switches (*Figure 27*), or they could be combined within a box to form a self-contained unit, free standing or block shelf mounted. A standard BR(LMR) illuminated diagram was used for the indication panel.

Design of larger power signalling interfaces started in 1961 with three IFS[+] for the Crewe marshalling yards. Very reminiscent of Westinghouse OCS, which components they used extensively, a desk to the front contained coloured control switches on a distinctive black Traffolite surface, into which were engraved the function descriptions, with inset repeater lamps. The integral illuminated diagram to the rear formed a complete console unit (*Figure 28)*.

Figure 27 - BR(LMR) IFS[-], Bardon Hill. © John Midcalf

Figure 28 - BR(LMR) IFS[+], Crewe Sorting Sidings North. © Andrew Gardiner

Between 1978 and 1987 several OCS were designed which followed a new general pattern. A number of these appeared in the Greater Manchester area but they were also found in the London area

(*Figures 29 & 30*). In broad terms they comprised a horizontal, shallow desk containing route switches, with an upright illuminated diagram to the rear upon which were mounted individual point switches and other controls. Diagrams were generally enamelled onto steel, although Darvic was occasionally used.

Figure 29 - BR(LMR) OCS[+], Hazel Grove (with replacement fascia). © Stephen Lawton

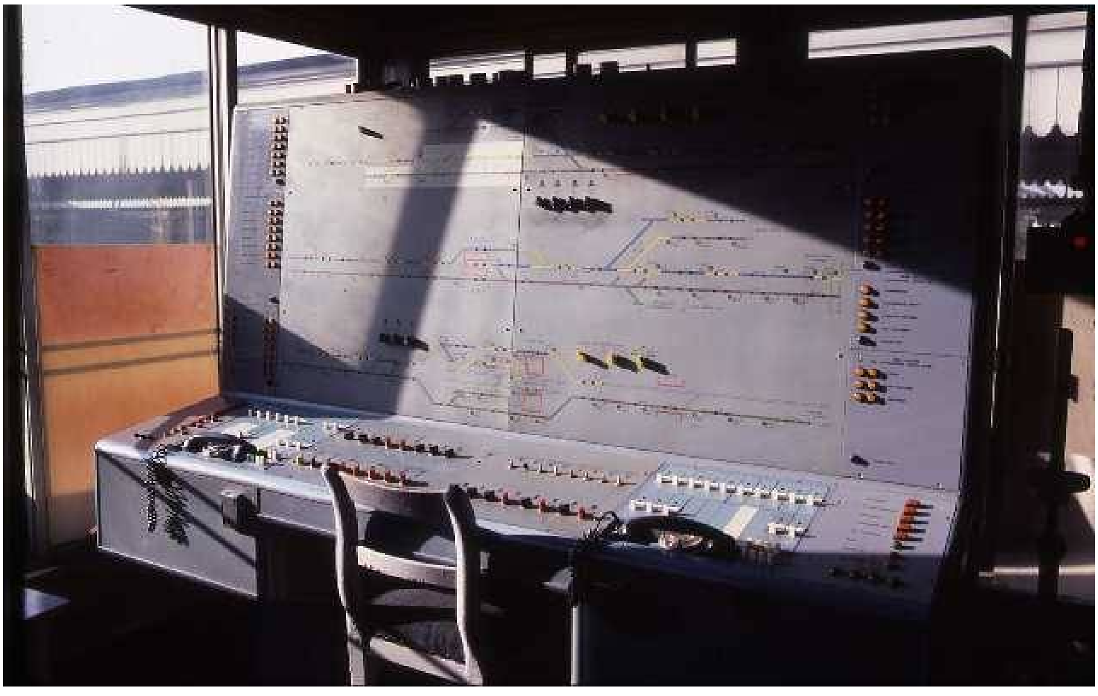


Figure 30 - BR(LMR) OCS[+], Willesden New Station. © CJ Woolstenholmes

An IFS[+] similar to the OCS console was designed, with a non-illuminated diagram and large switches - of the same pattern as the IFS[-] - on the desk, with the actual illuminated diagram to the rear

(*Figure 31*).The late 1970s also saw the introduction of a GSP, utilising elevator-style push-buttons on a simple diagram, all enclosed in a lockable box (*Figure 32*) - the BR(LMR) GSP. This design was later adopted by BR as the national standard for GSPs.

Figure 31 - BR(LMR) IFS[+], Blakedown. © CJ Woolstenholmes

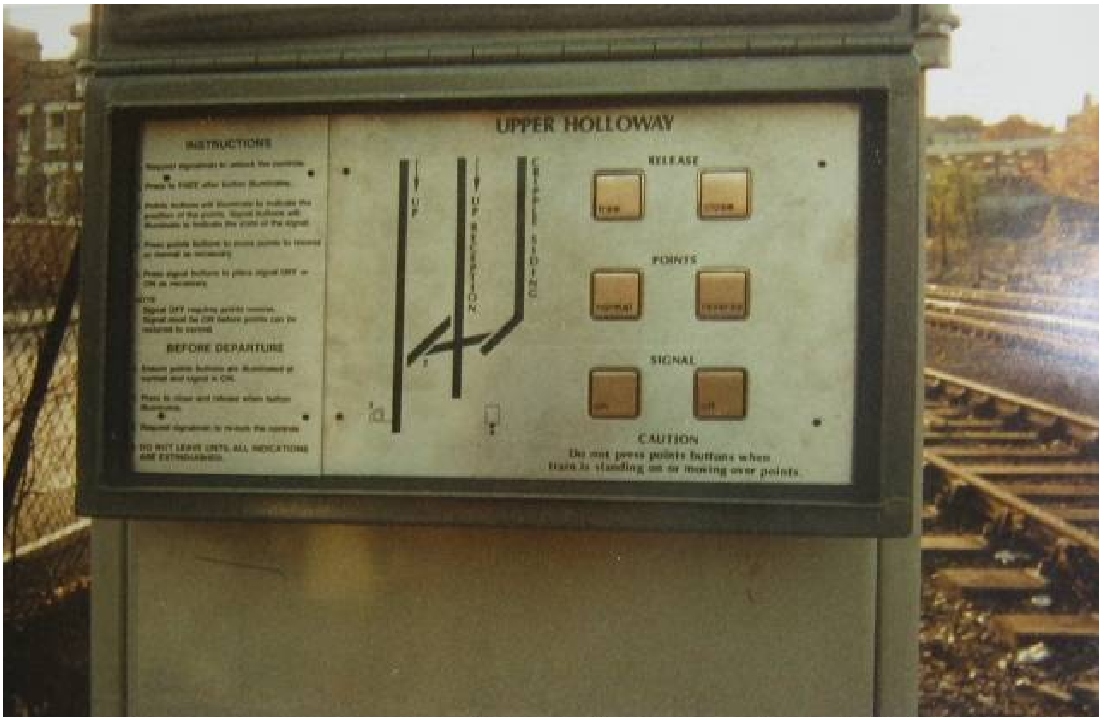


Figure 32 - BR(LMR) GSP IFS[-], Upper Holloway GSP. © SRS John Talbot Collection

NX(PP)[+] design began in 1970 with a small block-shelf-mounted panel at Rugeley No.1 to control the Armitage area. This was untypical, with prominent, raised, separate track circuit and route lamps with the panel contained in a console with polished Imoff extrusions. The next installation, at Colwich in 1974, retained the console construction but the fascia plate material was Darvic with ML Engineering switches, and combined route and track circuit lamps shone through apertures in the surface (*Figure 33*).

Figure 33 - BR(LMR) Frame / NX(PP)[+] Hybrid, Colwich. © Graham Floyd

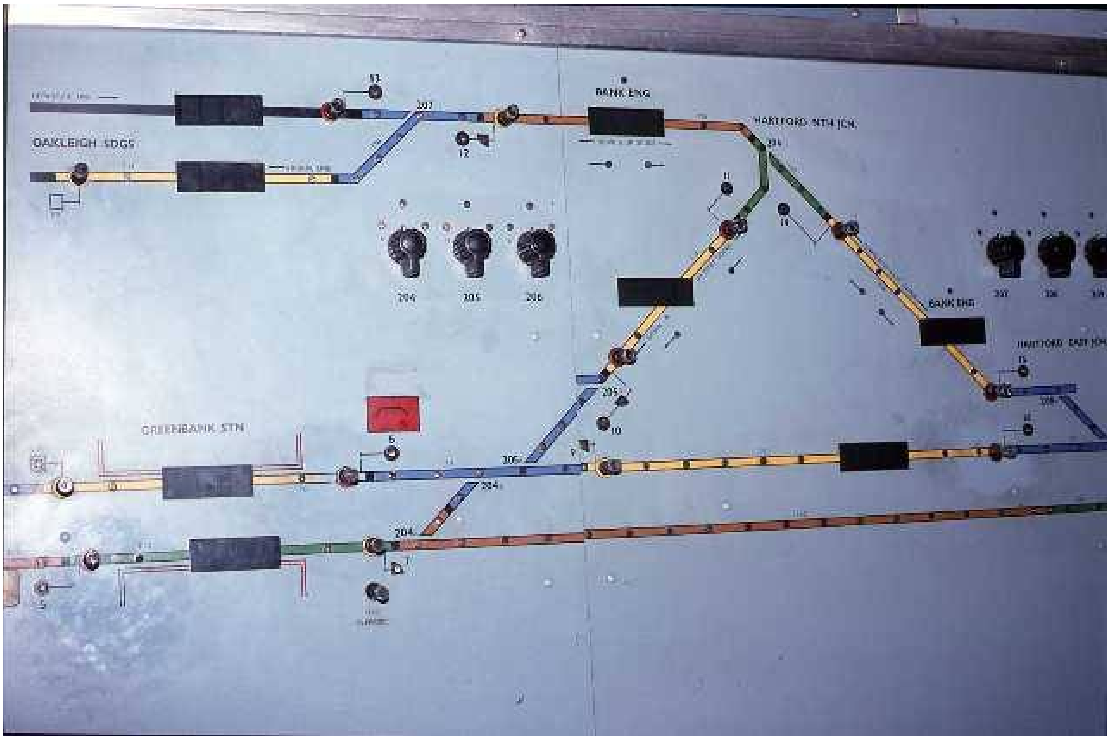


Figure 34 - BR(LMR) NX(PP)[+], Greenbank. © CJ Woolstenholmes

This style was used again over the coming years with a variety of switches - although not universally as painted sheet steel fascia plates were also used - and it also saw service for IFS[+]. From 1980 some medium to large NX(PP) were produced with steel sheets for the fascia plates (*Figure 34*) and with ML Engineering components featuring prominently at first. From the mid-1980s Westinghouse components replaced those from ML Engineering.

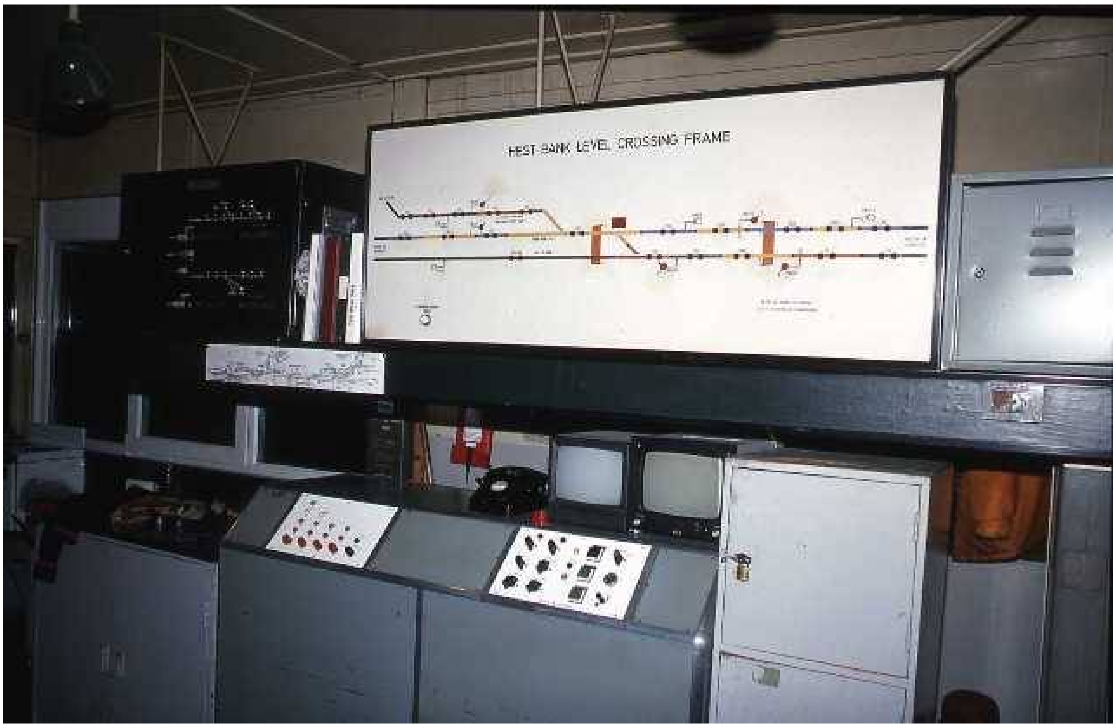


Figure 35 - BR(LMR) IFS[-], Hest Bank. © CJ Woolstenholmes

Figure 36 - BR(LMR) IFS[-], Hest Bank. © CJ Woolstenholmes

The early 1980s saw a range of basic IFS designed (*Figure 35*), floor mounted and with an angled control surface at about waist height containing switches (with three distinctive protuberances) and indications, mounted on a white Traffolite plate (*Figure 36*). Standard LMR-style illuminated diagrams were used, either as a separate item or combined. An OCS[-] at Chinley North Jcn was also made in this style (later reused at Woodley Jcn). Other small panels were designed with a plastic-laminated paper fascia secured by beading to the front. In cases where only the odd switch needed to be provided the IFS[-] could take the form of a simple small metal box with the switches and lamps on the front

By the mid-1980s a rectangular box-shaped IFS[+] and small NX(PP) panels with large Swisstac buttons were being designed (*Figure 37*). These were free-standing on a table or desk, with the track circuit lamps being of distinctive rectangles with black raised edges as used by Westinghouse around this time - only two per TC even on NX panels. More permanent arrangements were not discontinued, however, and some larger consoles of similar style to the 1980s OCS were designed, employing one-push NX style buttons to create an IFS[+] with large turn switches for points (*Figure 38*). It is in the 1980s when the wide variety of designs makes any attempt at describing a house-style rather futile.

1993 saw the design of a NX(PP)[-] for Snow Hill LCP, Birmingham (commissioned in 1995), with the non-geographic NX buttons and IPS in rows on a unit detached from the illuminated diagram.

At rail privatisation Gresty Road became part of NRS and design of new equipment ceased with reorganisation.

Note - a small number of BR(LMR) interfaces are known to have been dispatched from Gresty Road in kit form, to be wired up and completed by the Area S&T workshops. In some cases these may bear the Area S&T workshops' label. Construction was also sub-contracted out to BR(ER) York workshops on occasions and these may bear that manufacturer's distinctive label.

Figure 37 - BR(LMR) NX(PP)[+], Manton Jcn. © John Midcalf

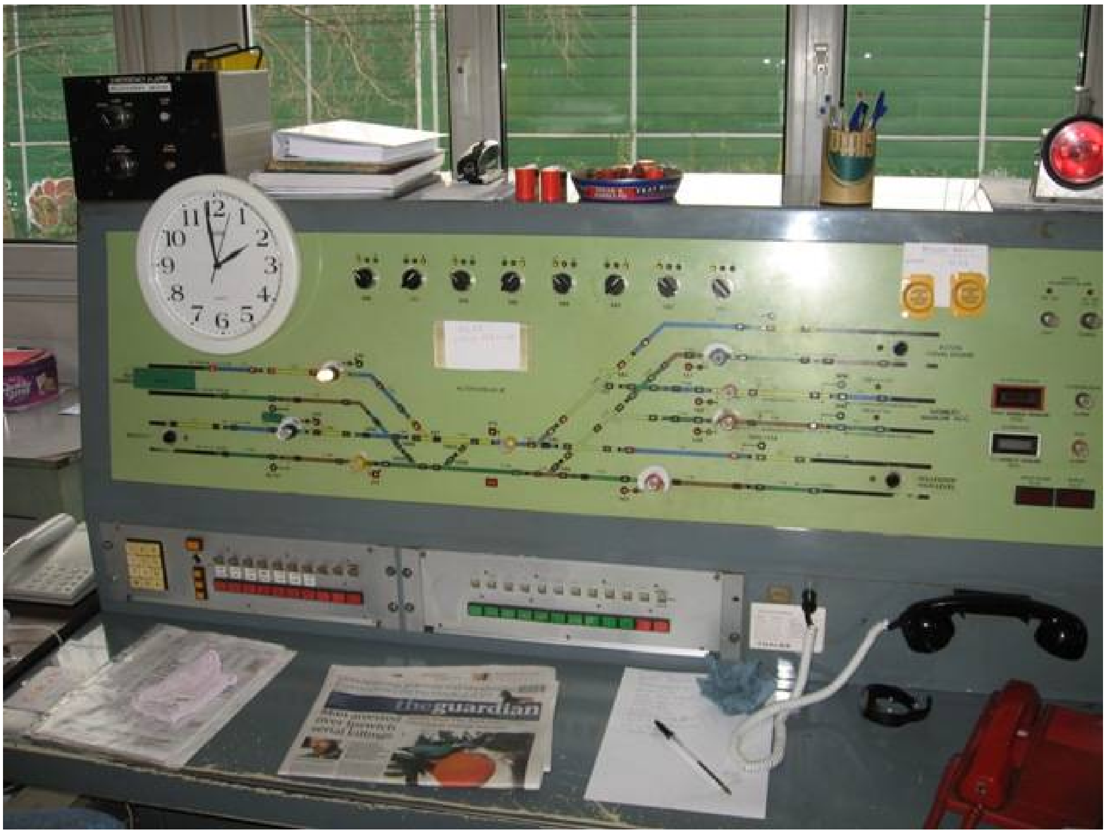


Figure 38 - BR(LMR) IFS[+], Acton Wells Jcn. © Network Rail

British Rail Research (BRR) [Interfaces commissioned 1984 - 1996]
Bought by AEAT in 1996.

British Rail produced a lot of equipment in regional workshops as described below but nationally rolled-out products were few and late in the day. These were electronic technologies developed by the research division at Derby. The first was RETB in 1984, a WS operating system for single lines working in conjunction with SSI, first commissioned at Dingwall. Then came IECC, a WS operating system developed with Sema Group for use in the new breed of large WS-based signal boxes, capable of interfacing with relay interlockings, SSI and later CBI. This was first installed at Liverpool Street IECC in 1989. Both RETB and IECC used bespoke workstations to interface with the specialised operating systems. BR manufactured the Dingwall RETB but thereafter further systems were contracted out to GEC-GS or Westinghouse. No IECC systems were actually manufactured by BR once it had been developed, all operational installations being contracted out: however, this software was uploaded as an off-the-shelf item and as the system was their product they are credited with initial - albeit trial - production.

RETB was very different from any other type of WS operating system and it was combined with the interlocking. It comprised a bespoke non-alphabetic keyboard or touch-screen consisting of various command keys, with VDUs to display the area controlled and the tokens which have been issued to trains (*Figure 39)*. There were no route or track circuit indications, nor point and signal indications, as the outside signalling such as there is comprised fixed signals, instruction boards and train operated points and ground frames. The signalman communicated with trains via radio and specific keyboard keys were used to initiate the electronic transmission of authorities (electronic tokens) to on-board receiving units, permitting movements onto the single line sections, and to cancel the tokens when movements were clear. The RETB operating system was controlled through this relatively simple apparatus.

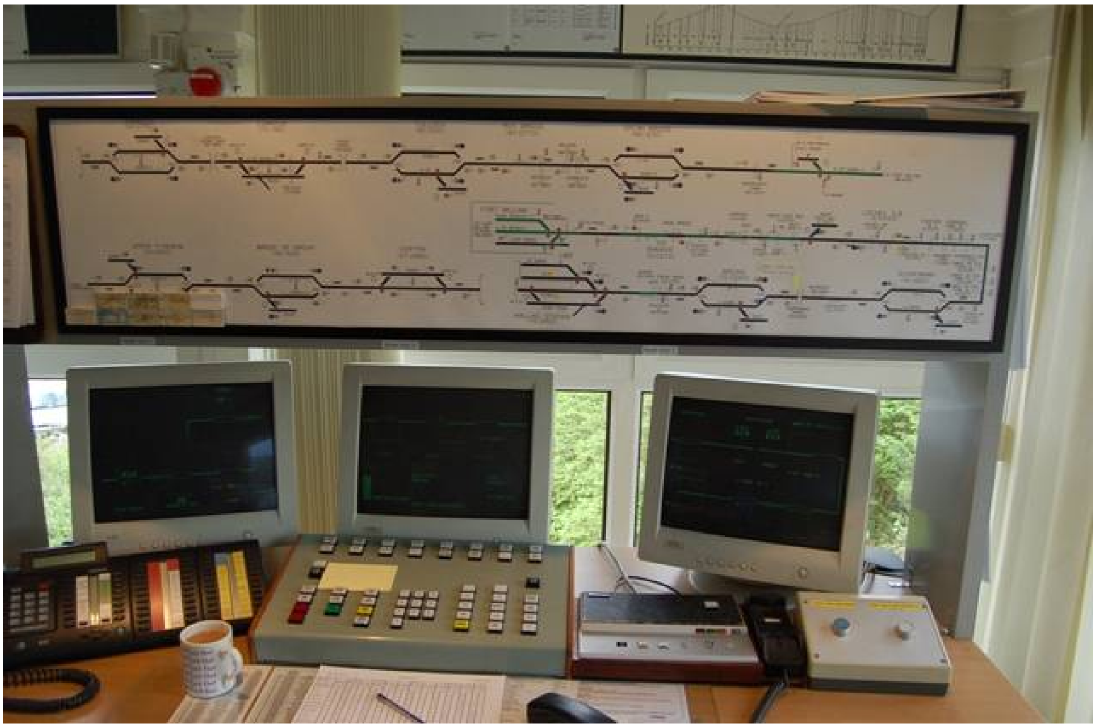


Figure 39 - BRR RETB WS, Banavie North WS. © Graham Maxtone

IECC (*Figure 40*) largely utilised normal WS operation with trackerball and command buttons, with the bespoke console including ROC and ERS controls. Automatic route setting by use of the Automatic Routesetting Subsystem (ARS) was an integral component of this system. As well as the overview and detailed view screens there was a general purpose display screen showing in text form the signalman's actions, alarms etc., all displayed on a black screen background (*Figure 41*). The trackerball desk button commands were as follows - Set, Cancel, Normal, Centre, Reverse. The Set and Cancel buttons were used to initiate or cancel commands, with IPS operation being achieved via the Normal, Centre and Reverse buttons. The special keyboard keys were: red signalling function keys at the top, yellow ARS function keys at the left, green train describer and white alarm function keys on the right. The use of keyboard-typed commands to simulate OCS operation was integral. The system featured the ability to set a through route by selection of only the entrance and final exit signals, missing out the intermediate ones which are set automatically. Train descriptions were colour codes as follows - cyan if signalling was by ARS, pink if signalling was non-ARS, and stone if trains were running to a contingency plan or special timings. During normal working a timing schedule should be input to the system for each train running through the area, non-ARS signalling being reserved for emergency situations, engineering work etc..

With the introduction in 2012 by DeltaRail of IECC Scalable this original version of IECC was renamed IECC Classic to avoid confusion.

Figure 40 - BRR IECC WS, Slough New (Workstation 2). © Andrew K Overton

Figure 41 - BRR IECC WS, Slough New (Workstation 1). © Andrew K Overton

British Rail Scottish Region (BR(ScR)) [Interfaces commissioned 1960 - 1993]

Unlike the two regions immediately to the south BR(ScR) was not a large designer of in-house interfaces and few products have been identified. This may be as a result of lack of demand, with few small installations of interfaces taking place and many large MAS schemes seeing the wholesale replacement of boxes with very large PSBs. More modest panels were sourced from the contractors. Design was centred on Irvine Workshops but the area S&T workshops could also produce one-off items.

Two IFS were designed in 1960 for Gorgie Jcn and Dalry Jcn but no details have yet come to light. 1970 saw further production in a style which was to be recognisable in future. The consoles consisted of an angular steel box in Hammerite finish with Westinghouse miniature thumb switches and lamp units. The fascia of IFS[+] was of BR(ScR) diagram pattern (*Figure 42*). By 1978 IFS[-] were designed which were developed from the ScR Tokenless Block instruments, comprising of the same Imoff extrusions with Hammerite painted metal sheet infills. These retained miniature Westinghouse switches and lamps (*Figure 43*).

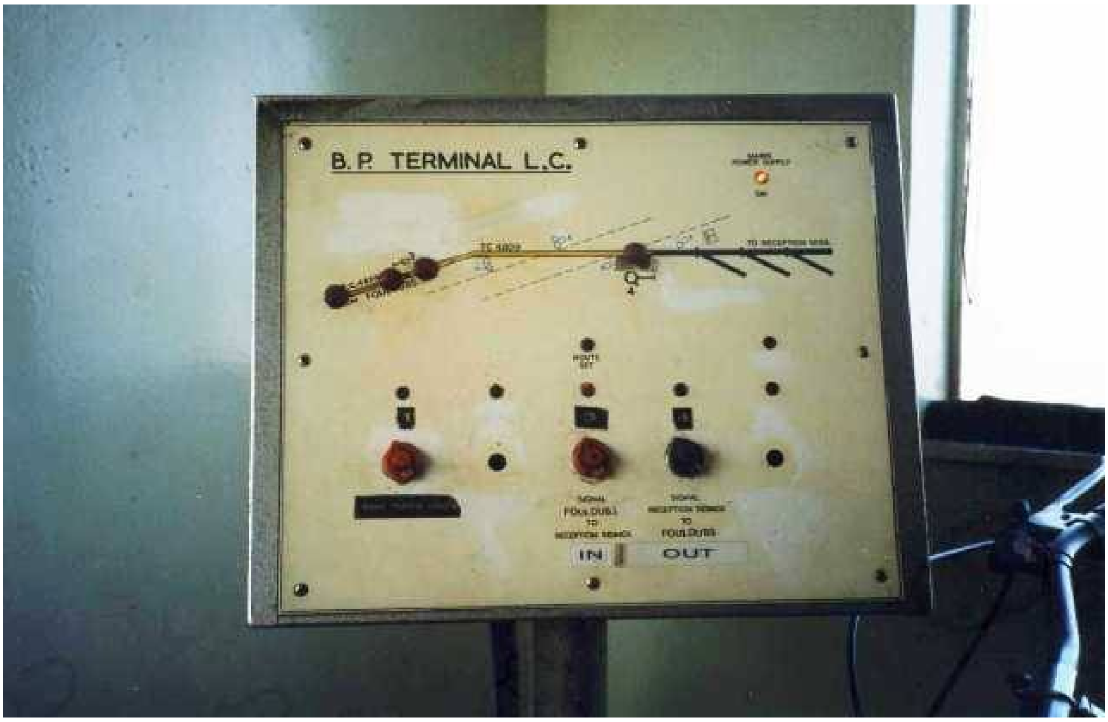


Figure 42 - BR(ScR) IFS[+], BP Terminal LC, Grangemouth. © Simon Lowe

Figure 43 - BR(ScR) IFS[-], Dalwhinnie. © Simon Lowe

Figure 44 - BR(ScR) IFS[+], High Street Jcn. © Andrew Gardiner

1982 saw the design of an IFS[+] for High Street Jcn. Designed at Buchanan House and constructed by Partickhill S&T it utilised NX buttons in one-push mode, with a laminated paper fascia, desk mounted and altogether quite tidy (*Figure 44*). A small run of IFS[+] were designed from the mid-

1980s up to the end of production, consisting of a laminated paper fascia in a small box with large turn switches and LED lamps (*Figure 45*) and this style was adapted in larger form for the panel at Banavie Gate Box in 1987, also constructed at Partickhill. A small number of IFS[-] were designed during the same period with Square-D switches and square indication lamps, giving a rather industrial appearance.

Figure 45 - BR(ScR) IFS[+], Carmondean Jcn. © Andrew Gardiner

Irvine works was closed in 1989 and later equipment was procured from other regional workshops - York supplied much of the equipment for the RETB resignallings - with design of a few interfaces continuing to be undertaken locally.

British Rail Southern Region (BR(SR)) [Interfaces commissioned 1967 - 1988]

BR(SR) was very much the territory of the signalling contractors with equipment bought in. The region had embraced power signalling early and large power schemes consolidated control within a smaller and smaller number of large boxes as time went on, with little need for in-house production of interfaces for infill schemes. Where small interfaces were required to operate a number of points or signals in an existing mechanical box, perhaps through the takeover of a minor adjacent box, this was effected by the use of small Square-D switch units of a style used repeatedly throughout the region and made up to suit the application, designed in the regional workshops at Wimbledon (*Figure 46*). A continuing preference was to be seen for a conventional box diagram to be employed, rather than the use of a combined control and indication panel, and the point and signal indications were sometimes displayed on the diagram rather than on the IFS[-]. In at least one location the switches were placed on the diagram to form an IFS[+].

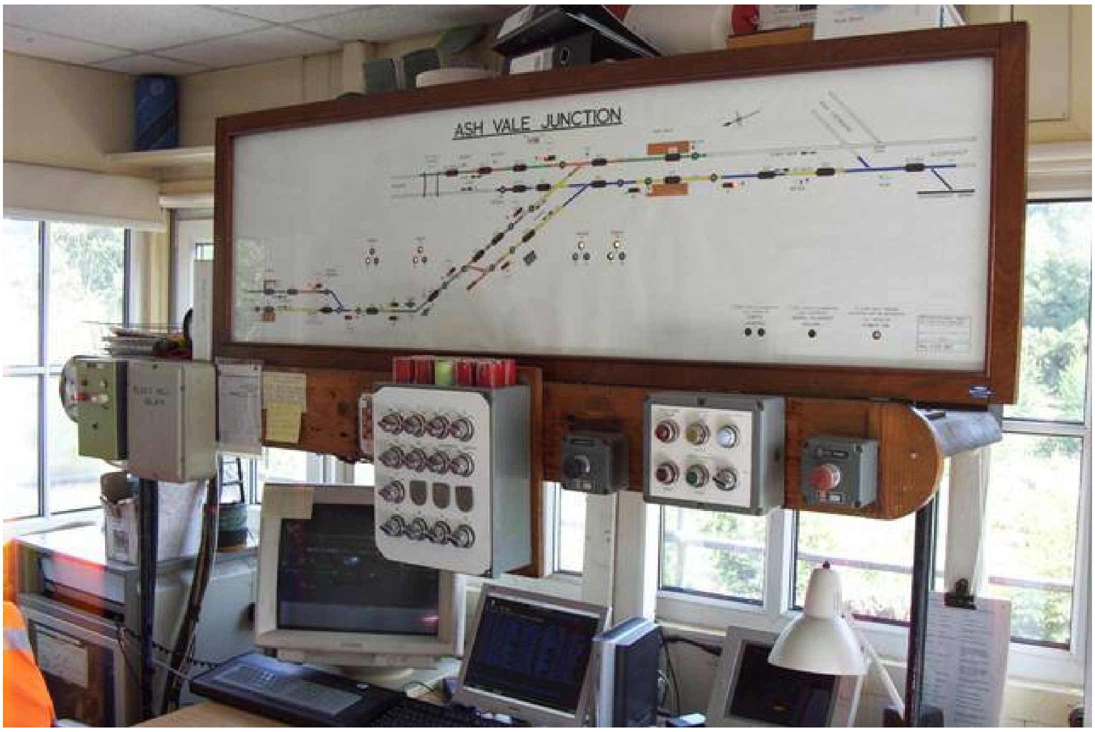


Figure 46 - BR(SR) IFS[-], Ash Vale Jcn. © Nick Wellington

Several depot panels were designed of combined type also using Square-D components. All were IFS[+] and consisted of a desk containing the controlling switches with the indication diagram to the rear. Separate On and Off indications were provided in the head of the signal symbol, with two lamps per track circuit, and, unusually, with white route lights provided. The diagram was in the form of a white laminated card (*Figure 47*). Whyteleafe South obtained something similar, minus route lights and with all the signal indications with the switches on the desk.

Throughout the period a modest number of other interfaces were designed to no particular definite pattern but recognisable as BR(SR) products by the use of proprietary-made controls. In later years laminated card fascias and LED indications were used (*Figure 48*). The number made is too few to make generalisations about design evolution. Wimbledon workshops closed on 3rd April 1987 and the small number of interfaces made thereafter for the region were ordered from BR(ER) York workshops to BR(SR) designs.

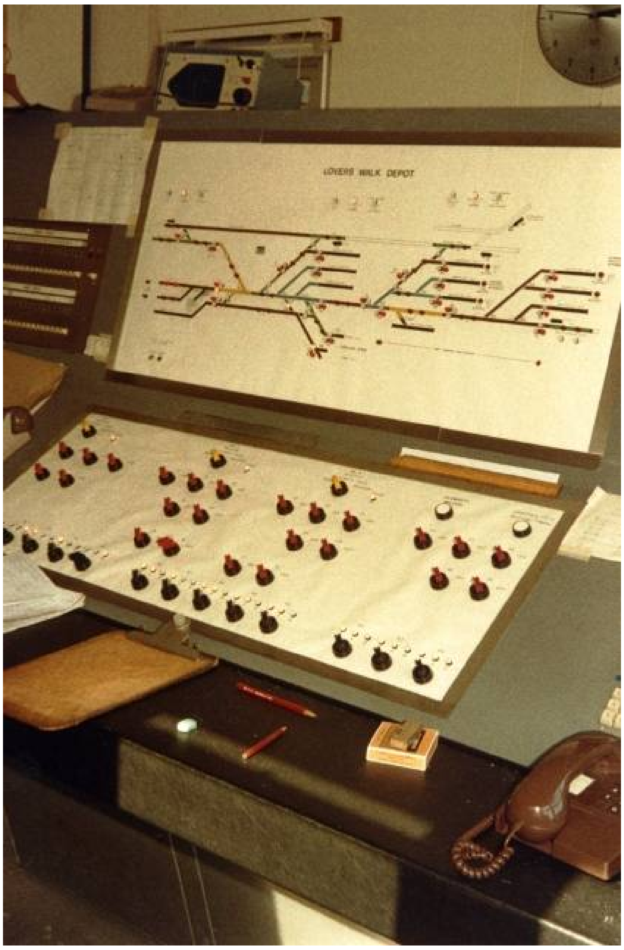


Figure 47 - BR(SR) IFS[+], Lovers Walk Depot. © Peter Gibbons

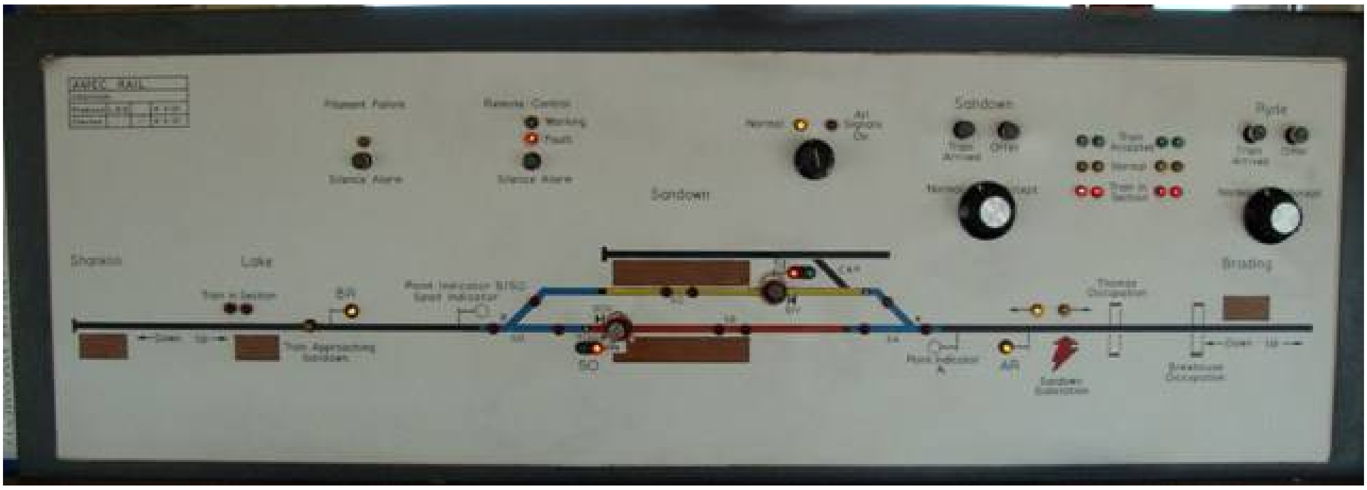


Figure 48 - BR(SR) IFS[+], Ryde St Johns Road. © Richard Pike

British Rail Standard (BRS) [Interfaces commissioned 1985 - date]

The push-button GSP designed by BR(LMR) from the 1970s was adopted as the British Rail standard GSP and was mandated in BRS SW67 Sheet C7. This design continued after rail privatisation, having been manufactured by a range of contractors to date. Owing to the highly standardised nature and the entire use of proprietary components the actual manufacturers of GSPs to this design are not shown and they are recorded as 'BRS SW67 GSP'. For convenience all GSPs to this design commissioned from 1985 are recorded thus, regardless of minor detail differences owing to actual components used.

British Rail Western Region (BR((WR)) [Interfaces commissioned 1949 - 1993]

This region also seems to have designed relatively few in-house interfaces. The exception to this rule was the continued use of the GWR designed KCI for ground frame release, with a considerable number of commissionings mainly in mechanical boxes. These instruments were also adapted to operate IBS - this type having a two-position switch, as opposed to the three-position switch of the ground frame release pattern. KCIs continued to be commissioned until 1977. In a small number of mechanical boxes which controlled ground frames protected by semi-automatic signals in MAS areas block shelf mounted plungers, of the same type as used to release lever locks, were used for release. Depression of the plunger released the Annetts Key in the KRI at the ground frame, allowing the operator there to turn it, which latter action replaced the signals to danger. This replicated the method of release of such ground frames from NX(TP)[+] on this region.

MAS schemes on BR(WR) did not see stageworks of temporary panels to any significant extent and the region hardly ever employed LCPs. Small-scale power signalling schemes were few, the region choosing to bring whole swathes of mechanically signalled areas under the control of large PSBs from the early 1960s, so hardly any small interfaces were required: the few such jobs that did take place were generally provisioned by interfaces bought in. From the 1960s onwards, whenever a very small local scheme did result in a need for an IFS to be made in-house mechanical technology was very much retained and adapted, and there were several examples of individual IFS[-], utilising proprietary turn-switches and mechanical signal arm repeaters, being placed on block-shelves. Larger installations were sometimes grouped roughly together on a home-made mounting board or steel sheet (*Figure 49*). A standard BR(WR) illuminated diagram was provided for the indication panel.

Figure 49 - BR(WR) IFS[-], Axminster. © Network Rail

To facilitate major alterations to the region's standard Henry Williams Integra Domino NX(TP)[+], as well as other temporary panel requirements, NX(TP)[+] were employed consisting of a paper fascia; with non-geographical groups of toggle entrance switches off the line of route, large square white exit buttons which lit when the route was set, and with On and Off indications shown in separate large lamps in the signal symbol. No route lights were provided and track circuits were shown by protruding red lamps on the panel surface, two per track circuit, or WR box-diagram-style lozenges. The consoles were used again and again with the fascia and equipment plate being replaced for each job and the controls and indications rearranged to suit. One panel is know to have travelled extensively between Gloucester PSB, Plymouth PSB, Chard Jcn and Exeter Central.

This temporary design was modified and tidied up and used for a small number of permanent installations, with manufacture being undertaken at the signal workshops at Reading. These distinctive turn-push panels had large steel fascia plates, with two position telephone concentrator-style entrance switches being pressed down to initiate a main route and up for subs and shunts. The large white exit buttons, On and Off indications, lack of route lights and style of protruding red track circuit lamps were similar. The whole effect was a very 'chunky', rough-and-ready looking apparatus (*Figure 50*). Something fairly similar was produced by Llanelli S&T for use at Kidwelly in 1983.

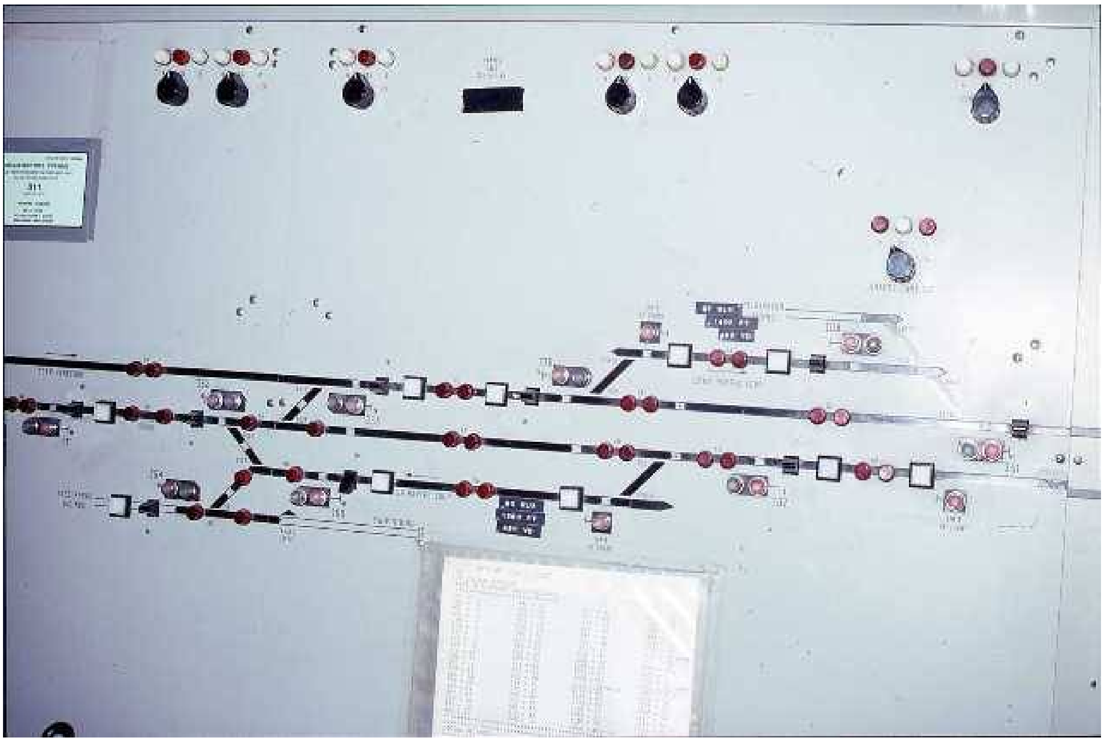


Figure 50 - BR(WR) NX(TP)[+], Little Mill. © CJ Woolstenholmes

This theme was perpetuated in some panels for use as LCPs. An IFS[+] at Newbury interlocking had a similar diagram and the indication of route set was provided by a white lamp on the line of route before the exit signal. Signal routes were selected by rows of small toggle switches on a desk console below, IPS by large turn-switches (*Figure 51*). Bromsgrove OCS[+] had Newbury-style toggle switches grouped on the paper diagram next to their respective signals, with the same toggle switches being used for IPS in a row at the top, having a central position, with N and R indications being provided by pivot lights on the diagram. Weston-super-Mare (*Figure 52*) OCS[+] had one small illuminating button per route geographically located at each signal, which when pressed in locked and set the route. To cancel a route the button was pressed again, which action unlocked it and returned it to the normal position. Swansea OCS[+] had similar buttons to these but in rows on a Newbury-style desk, the whole, again, having a very home-made appearance (*Figure 53*). With all these panels the IPS had a central red locked light rather than an OOC light, in common with the WR Henry Williams NX(TP) panels they were subsidiary to. An IFS[+] was designed to this general style for Alstone in 1982.

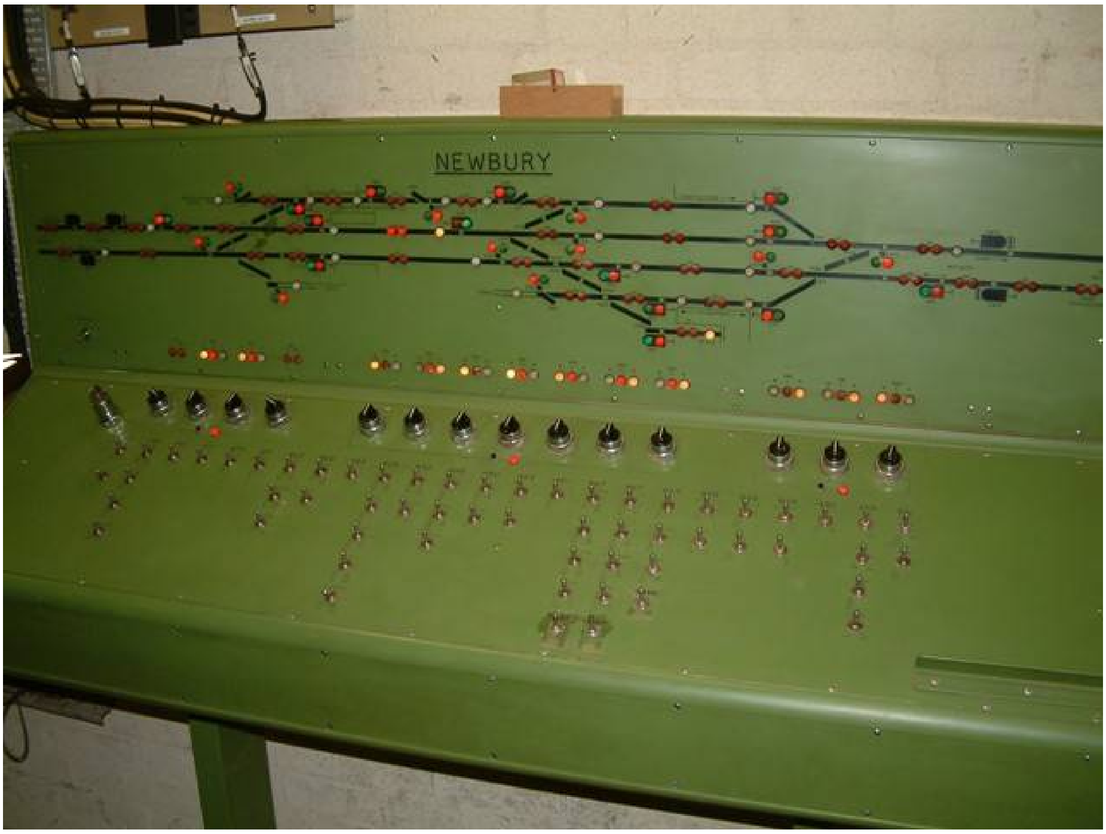


Figure 51 - BR(WR) IFS[+], Newbury LCP. © Network Rail

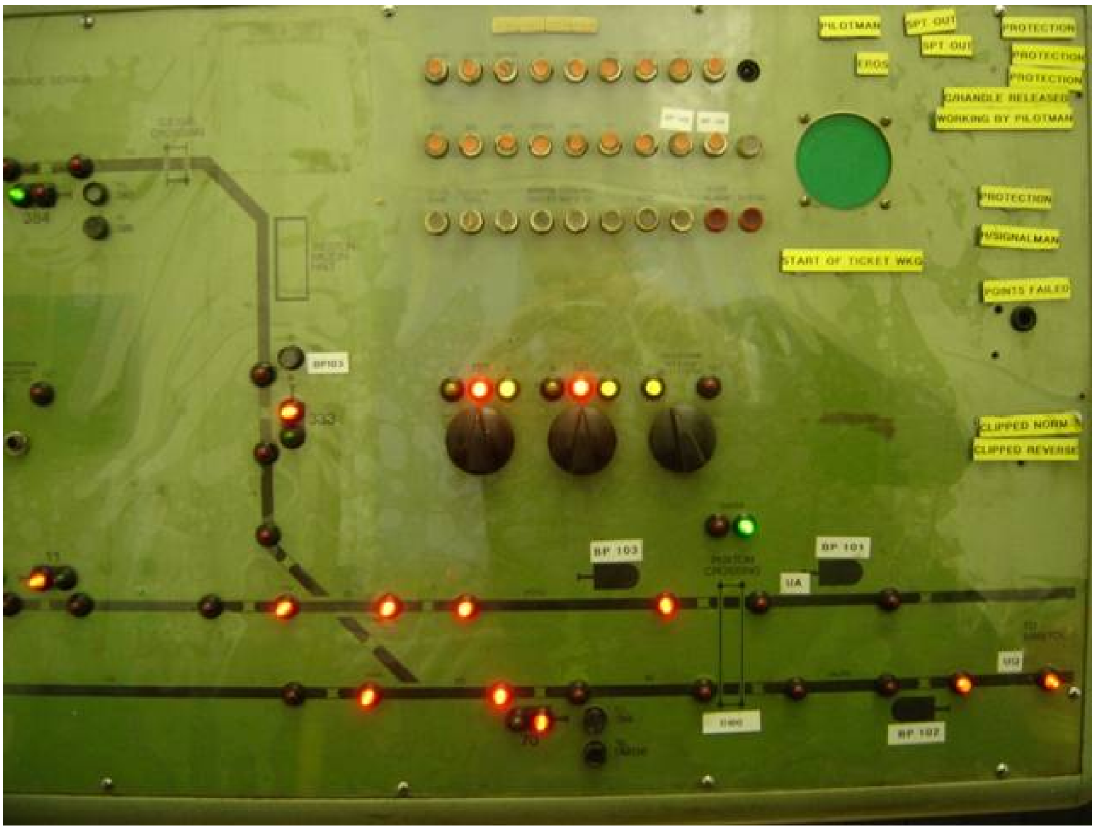


Figure 52 - BR(WR) OCS[+], Weston-Super-Mare LCP. © Network Rail

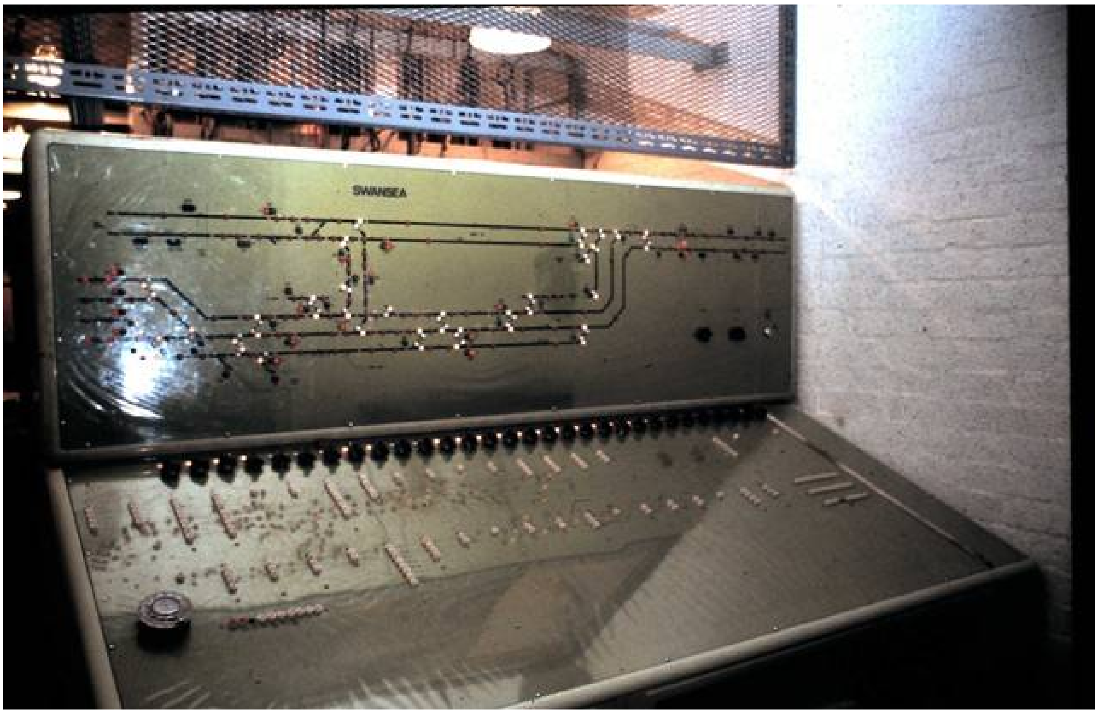


Figure 53 - BR(WR) OCS[+], Swansea LCP. © Network Rail

For Silk Mill Crossing and Taunton East Jcn in 1986 OCS[+] were designed of a similar style to the KBA units used on the region, using many KBA components, and made up locally. They consisted of a wooden console shell with laminated paper fascia. The console of the former installation was reused at Exmouth Jcn in 1988 with a new fascia (*Figure 54*). A similar IFS[+] was used in the temporary box at Henbury West in 1993 but with different switches and lamps. For the Frame / IFS[-] arrangement at Totnes in 1984 and the OCS[+] at Paignton South in 1988 a steel box console shell was used.

For the control of crossing-keeper worked level crossings electrical key lock instruments similar to Annetts Locks were designed from the late 1960s (*Figure 55*). Along with locks on the gates the result was a system similar to that used on BR(ER) where the in-house designed key-lock instrument was used, however here each key was in its own instrument. In most cases the keys were not released by a controlling interface but rather the turning of a key placed the protecting signals to danger and provided approach track circuits were clear the keys could be removed (a 'train approaching indicator' working with the track circuits was provided to assist the crossing keeper). The keys could be turned - but not necessarily released - at any time to perform an ERS function.

Figure 54 - BR(WR) OCS[+], Exmouth Jcn. © Network Rail

Figure 55 - BR(WR) KL, Pantyffynnon Crossing. © Danny Scroggins

Brown, Boverie & Cie (BBC) [Interface commissioned 1984]

Better known for locomotive manufacture but also manufactured industrial control systems. Merged with Asea on 5th January 1988 to form ABB.

Supplied a mosaic IFS[+] of unknown tile size to Port of Tyne Coal Terminal Control Room. It is possible that the associated panel in the Coal Discharge Hopper was also supplied by them but this is unconfirmed.

Capula Control Systems Ltd. [Interface commissioned 2012]

Formed in the 1970s as Instem manufacturing programmable logic controllers for industrial use the company moved into the water automation sector in the 1980s manufacturing control panels, and into power station control systems in the 1990s. Became Capula in 2006 after a management buy out.

Designed a control system for Drax Power Station in 2012 which also incorporated a WS interface for controlling the rail signalling through the existing SSIs. This replicated in appearance the display and functions of the superseded ABB DCS WS system.

CONTEC Transportation Systems

Designers of a WS-based operating system called HMI TCS Visio, which used a standard keyboard and mouse and standard TCP / IP protocol. The first UK application was at Wembley C Sidings in 2015 after the company had become part of the Voestalpine group.

Contelec Engravings Ltd. [Interfaces commissioned 2007 - 2012]

Designed a polycarbonate (MAKROLON) -tiled mosaic panel of 48mm square section (although tiles with a size of any multiple of 24mm could be made), being a virtual copy of the TEW Subklew design of non-reflective grey tile. The panel components were sourced from a Canadian company, SACO Controls Inc., manufacturer of mosaic control panels, with the tiles engraved, made up into the desired interface and wired up by Contelec in their West Midlands factory (*Figure 56*).

WestCAD ERS[-] were supplied for West Midlands SC and Unipart Rail also placed contracts for panel supply, with an IFS[+] at Ashford Depot in 2007. Although very similar indeed to the TEW SM series the indication lamps of the Contelec panels supplied to Unipart Rail were different, as were the switches, being of the typical patterns employed on Unipart Rail manufactured interfaces. At South Tottenham in 2009 a NX(PP)[+] version was employed.

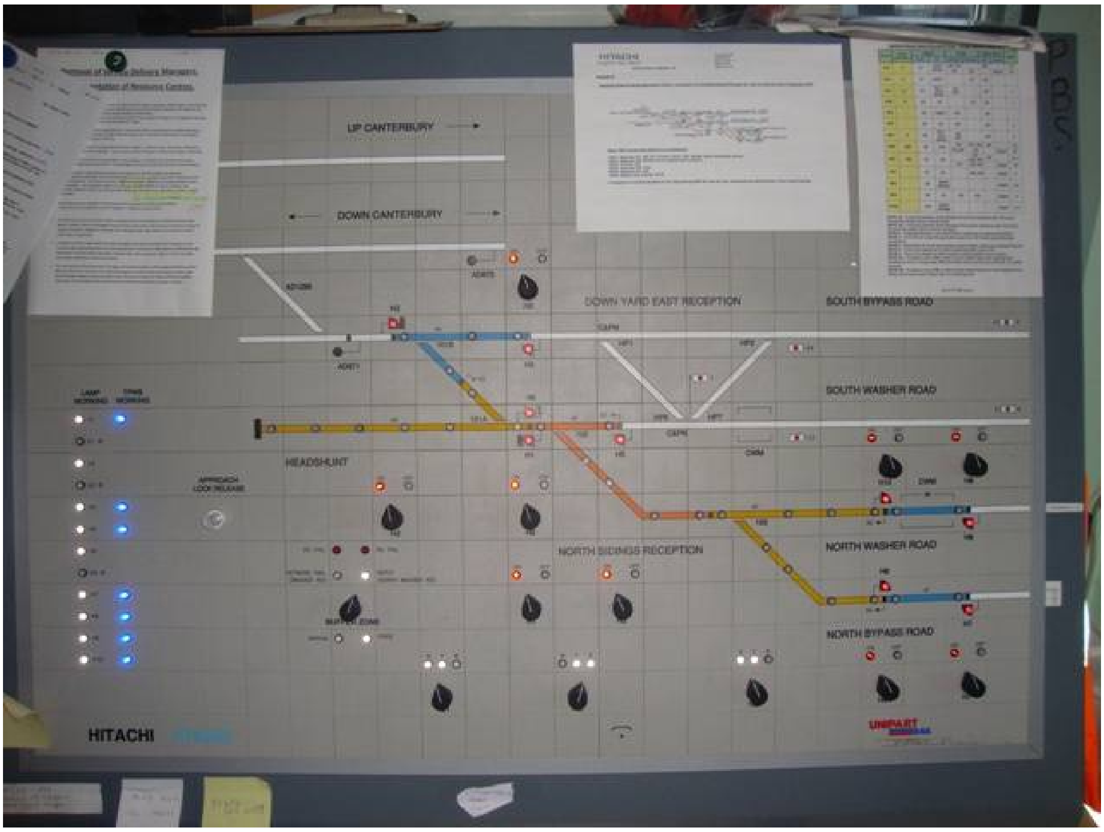


Figure 56 - Contelec Engineering SACO IFS[+], Ashford Depot. © Anon

Dart Valley Railway (DVR) [Interfaces commissioned 1987 - date]

Figure 57 - DVR OCS[+], Britannia Crossing. © Geof Sheppard

This railway designed all of their interfaces in-house in their own workshops for their signal box at Britannia Crossing. In 1987 a pedestal-mounted IFS[+] was designed, controlling just one signal either side of the level crossing, followed a year later by an OCS[+] (*Figure 57*) when the Kingswear interlocking was commissioned. This consisted of a desk-mounted black metal box with the interface on the sloping top in two sections. It had a sheet steel fascia plate with no equipment plate, and the prominent LEDs on the track representation showed white or red for route or TC occupation with route setting by non-geographically positioned Swisstac push-buttons on the bottom half of the fascia. IPS were ML Engineering pattern. An IFS[+] with route lights in similar style was added in 1992 for the Churston and Paignton interlockings, the points at the former being hydro-pneumatic.

In 1994 a NX(DB)[+] was designed with a fascia plate of a similar style to an ML Engineering Darvic item, and lamps as per the OCS[+] (*Figure 58*). Entrance buttons for main running signals were square industrial pattern of a similar style to those on the BR(WR) NX(TP)[+] at Kidwelly, with entrance buttons for GPLs and exit buttons being similar but yellow. Route lights were provided but did not extend into the overlap and entrance buttons remained lit to indicate the route was set. IPS were of an industrial pattern. Initially free-standing the panel was later inset into the box wall. A 2010 replacement was very similar but the fascia colour changed to green.

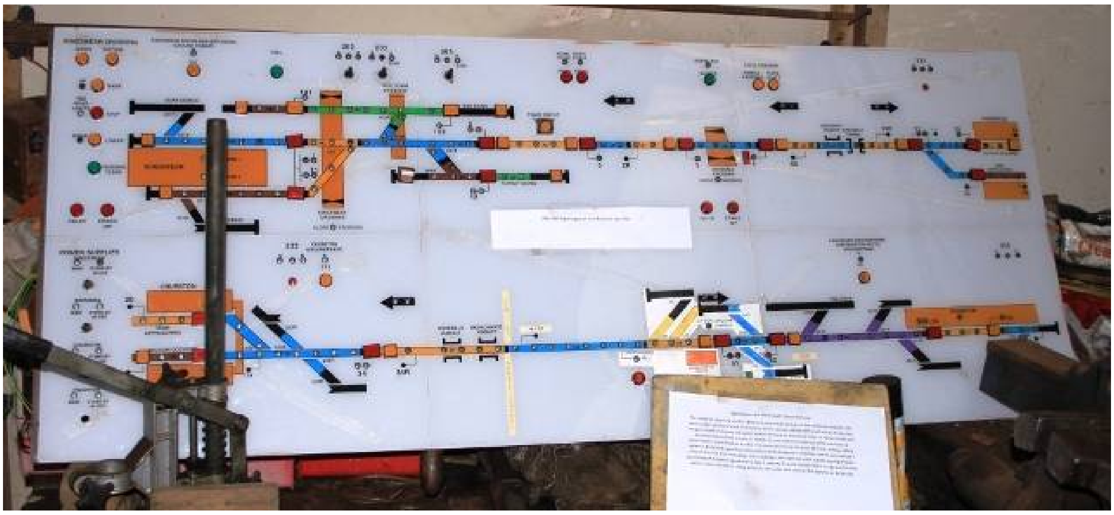


Figure 58- DVR NX(DB)[+], Britannia Crossing. © Geof Sheppard

In 2010 the railway also designed an IFS[+] GSP for Goodrington South with push button operation and a white fascia, the whole being in very similar style to the 1994 NX(DB)[+] but with a painted and engraved steel fascia.

DeltaRail Group Ltd (DeltaRail) [Interfaces commissioned 2009 - 2016]

Bought out AEA Technology Rail in August 2006. Renamed Resonate from 15th September 2016.

Having bought AEA Technology Rail, supply continued with the original IECC operating system. In 2009 the RETB system was upgraded by replacement of the bespoke keyboard with standard touch-screens and with modified operating system software (work had been ongoing before the buy out). As part of the upgrade the associated SSI was replaced with the MkIII version. This work was carried out in conjunction with Park Signalling and the first installation was at Inverness SC.

In 2012 a new version of IECC, entirely developed by DeltaRail, called IECC Scalable Version 1 was designed replacing the original version, which was renamed IECC Classic. The hardware associated with IECC Scalable was significantly altered with each IECC subsystem being contained on a single card, so reducing the number of IECC cabinets required. Duplication of components and connections was designed to increase reliability. A message based information architecture was introduced along with an IBM Websphere message broker - this allowed any of the IECC subsystems to be deployed remotely and for the interlocking interfaces and signallers to be remote from the rest of the system, so facilitating control centre migrations. The first trial installation took place at Swindon B. IECC Scalable was designed to be cost effective for smaller applications than those hitherto used with IECC.

2015 saw the introduction of IECC Scalable Version 2, which did away with the traditional trackerball controls and replaced them with commercial off-the-shelf workstation hardware such as a computer keyboard and mouse. Fixed screen display areas were replaced with display areas which could be altered via pan, zoom and search facilities. The system also provided the facility for reconfigurable control areas and traffic management to be introduced as required. The display screens were in two tiers, with the upper Route Service View tier giving a fixed, non-controllable overview display, and the lower Local Service View tier being manipulated by the signalman and controllable via the mouse and keyboard. Local Service View screens could be panned, zoomed and searched, as well as providing displays of alarms etc.. Left clicking with the mouse was the equivalent to the Set command on a trackerball desk control with a right click bringing up a menu of other commands. Keyboard operation of the majority of commands was also possible. A backup keyboard and mouse was available in case of failure.

EB Signal Ltd [Interfaces commissioned 1990 - 1991]

Bought out ML Engineering in 1989 and were themselves bought out by ABB Signal in 1992.

Continued to supply mosaic panels sourced from EAO components. From around 1991 the company also began to source TEW panels complete for contracts (these are not considered to be EB Signal panels).

Elmside Engineering [Interface commissioned 1985]

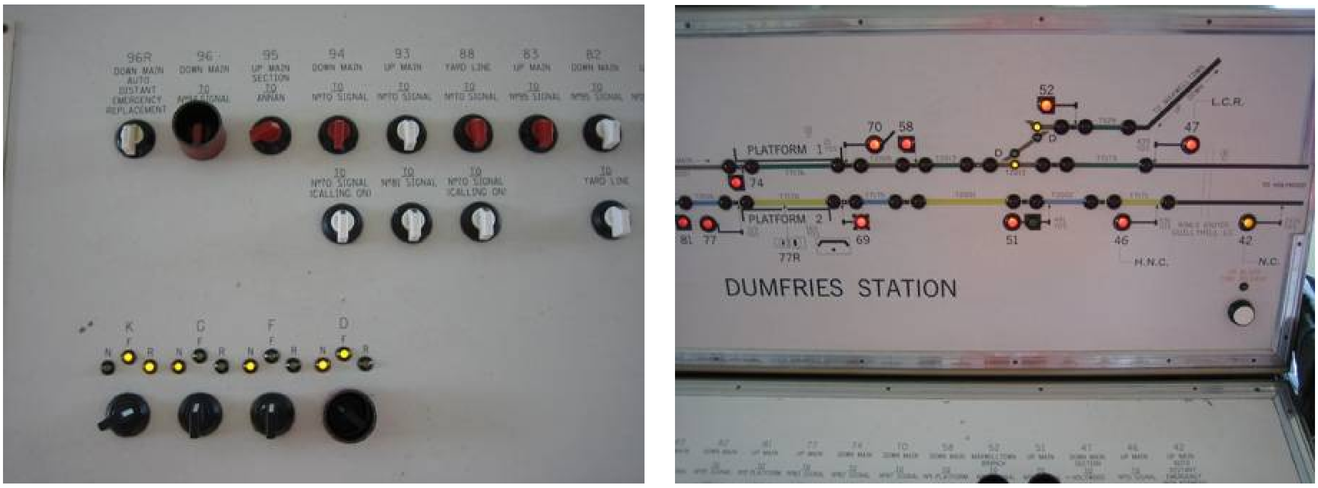
Manufacturer of control panels for the offshore oil industry based in Hitchin. Subcontracted to produce the panel for Llandudno Jcn to their own design with internal wiring designed by BR(LMR).

The sole NX(PP)[+] designed had a steel console housing a fascia of thick steel tiles of similar appearance to Westinghouse M5 tiles. LED indication lamps were used, those for track circuits / route lights being rectangular as used on later Westinghouse M4/5 panels. Swisstac buttons were used with IPS being industrial metal switches with a downward projection.

First Engineering [Interfaces commissioned 1997 - 2005]

Obtained contract for infrastructure maintenance in Scotland on rail privatisation until taken in-house by Network Rail in 2004. Taken over by Babcock International Group in July 2008 and renamed Babcock Rail.

Known to have designed an OCS[+] at Dumfries in 1997 with no route lights (*Figures 59 & 60*) in 1999, made up from commercially available Square D-style components with a laminated paper diagram. A small number of simple IFS[-] and ERS[-] consisting of switches and lamps mounted on a Traffolite fascia, enclosed in a steel box, were also designed. Also designed a set of LOC in 2005 in connection with Paisley SC interlocking renewals, again utilising Square-D switches.



Figures 59a & b - First Engineering OCS[+], Dumfries Station. © Andrew K Overton

Figure 60 - First Engineering OCS[+], Dumfries Station. © Andrew K Overton

General Electric Co. - Alsthom (GEC-Alsthom) [Interfaces commissioned 1990 - 1992]

A trading partnership of the two companies. Split in 1998 with the break up of the GEC group of companies and the acquisition of General Signals by Alsthom.

Figure 61 - GEC-Alsthom NX(PP)[+], Alnmouth. © John Midcalf

Continued to supply the GEC-GS interfaces, retaining GEC or GEC-GS markings, with no reference to Alsthom. A small number of NX(PP)[+] were designed to a new design with separate control and indication panels, albeit combined into one physical unit of equipment (*Figure 61*).

General Electric Co. - General Signal (GEC-GS) [Interfaces commissioned 1971 - 1989]

The new branding of the AEI / SGE partnership (AGS) following the abolition of AEI as a trading name. The GEC-GS brand was used on interfaces from late 1971. GEC formed a trading partnership with Alsthom in 1989.

Sourced their large NX panels from Henry Williams, using the Integra Domino model, following AGS practice. Moulded fibreglass console shells had GEC-GS or GEC markings but the actual interface was a HW product and is described under that company. However, they continued to design their own IFS equipment and small NX(PP) panels utilising normal operation, especially for stageworks use or as LCPs. These used extruded Imoff surrounds with sheet-steel infills and were very similar to contemporary BR(ER) products, although the pattern of indication lamps was different (*Figures 62 & 63*).

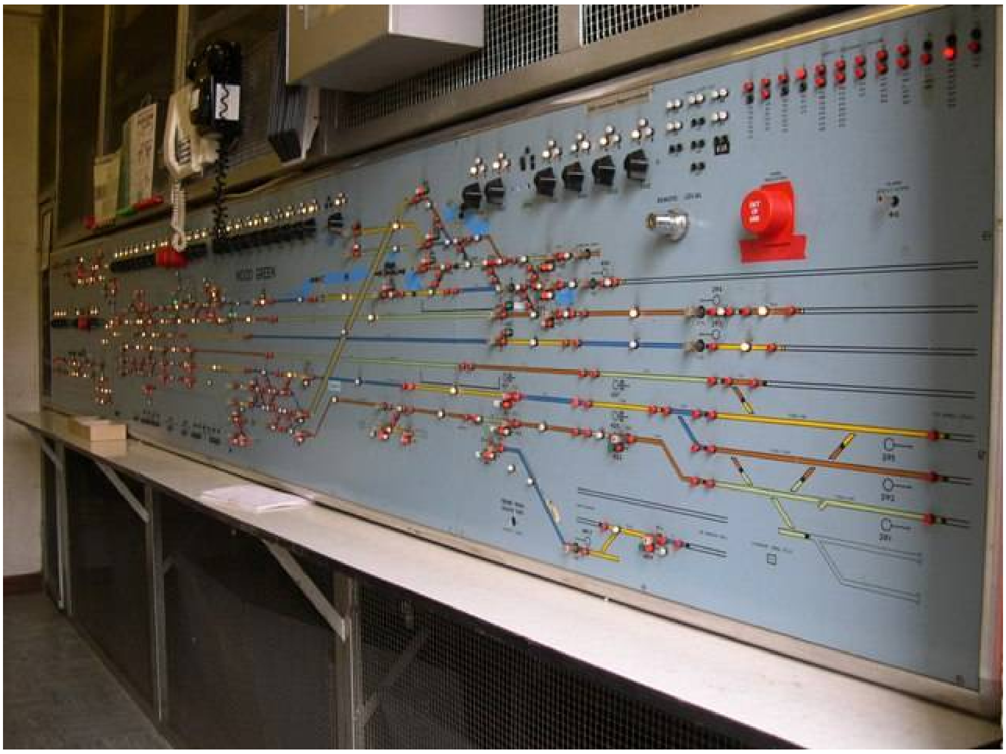


Figure 62 **-** *GEC-GS NX(PP)[+], Wood Green LCP. © David Stansfield*

By 1980 two NX(PP)[+] for BR(SR) at Richmond and Dover Priory were designed and the pattern of IPS had changed, with the console being altered (*Figure 64*). A distinctive IFS[-] installation at Stowmarket in 1985 consisted of an upright indication panel with separate horizontal control panel of switches on a facsimile track diagram. NX(KS)[-] was also employed for stagework panels in a small number of WCML boxes during the Motherwell SC scheme, as well as for LCPs in further schemes in conjunction with Henry Williams Integra Domino maintainer's panels.

Figure 63 **-** *GEC-GS IFS[-], Everton LCP. © David Stansfield*

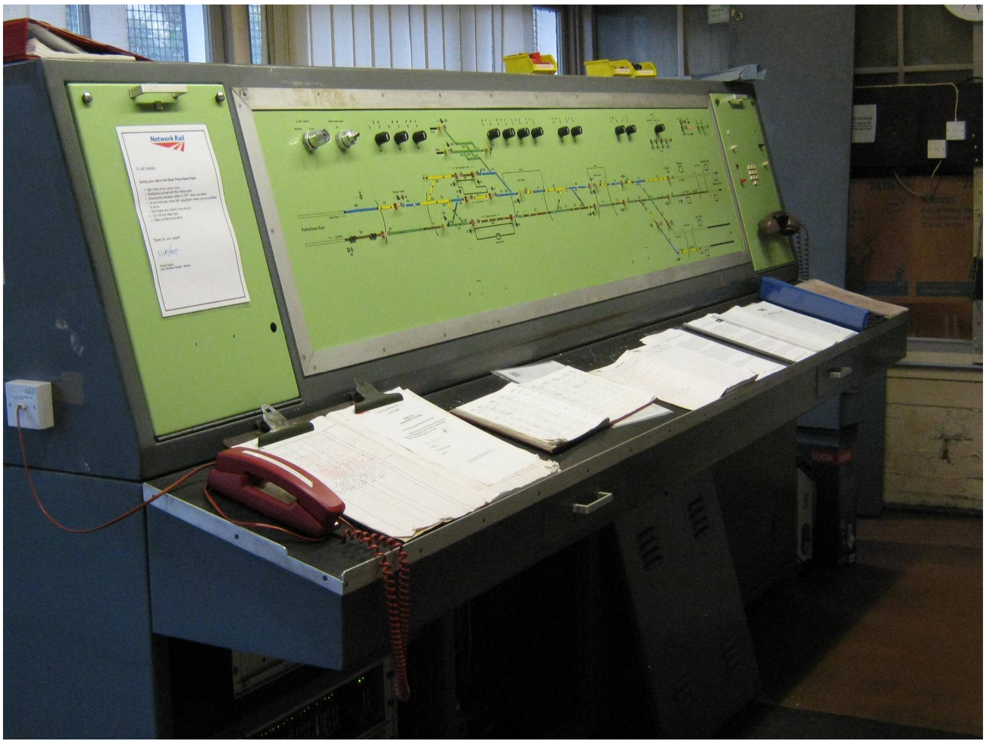


Figure 64 - GEC-GS NX(PP)[+], Dover Priory LCP. © Nick Wellington

A model of ground switch panel (GSP) was introduced in 1976 for the Edinburgh Waverley resignalling consisting of a small lockable cabinet, with the track diagram engraved into an Traffolite plate and with large 'cooker'-style switches and indication lamps inside (*Figure 65*).

Figure 65 - GEC-GS GSP IFS[-], Stenton GSP. © Simon Lowe

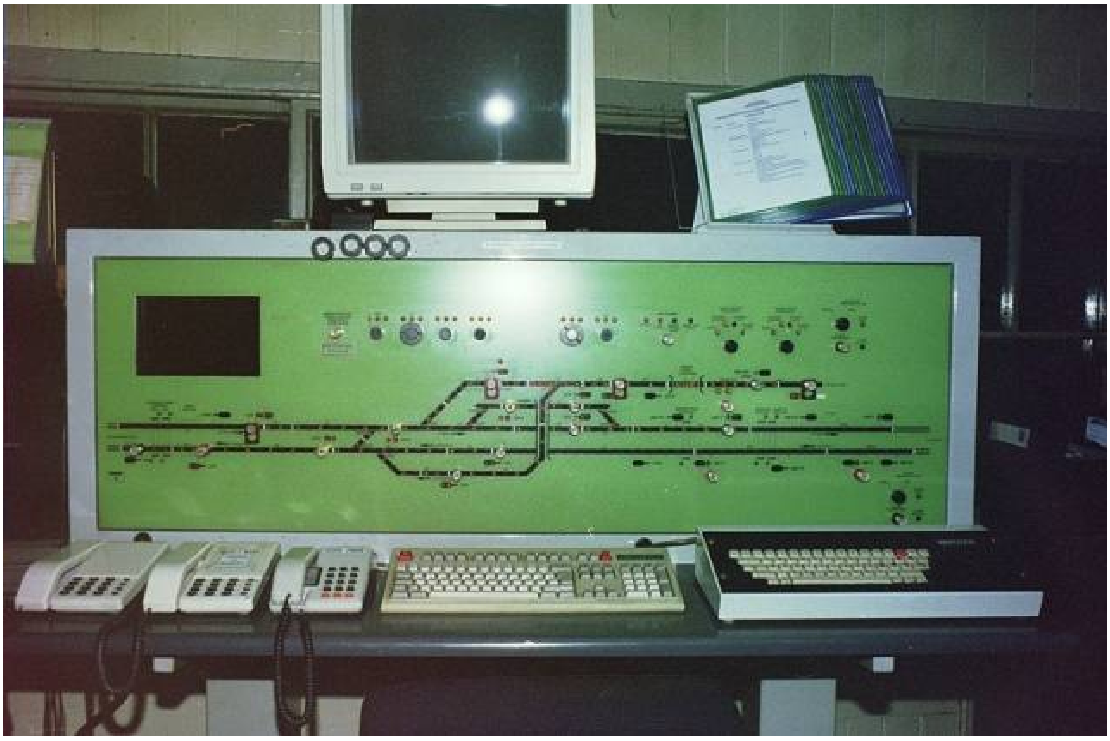


Figure 66 - GEC-GS NX(PP)[+], Banbury South.   © John Francis

In 1988 the NX interface was modernised and the use of HW Integra Domino panels was discontinued. Large Swisstac buttons and yellow LED indication lamps in place of white were employed. In some panels separate route lights (yellow) and track circuit lights were used, with separate On / Off lamps in the head of the signal symbol, but in other installations route and track circuit lights shared common apertures, as did the On / Off indication in the signal head symbol (*Figures 66 & 67*). IPS also had yellow LED indication lights.

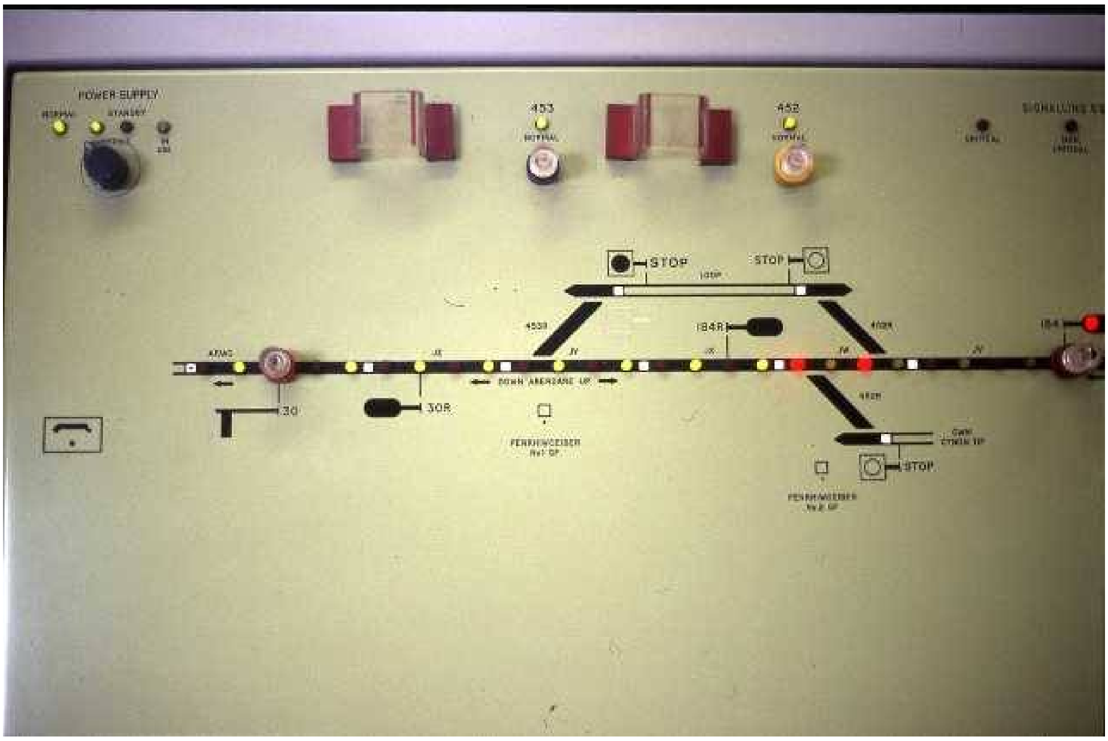


Figure 67 - GEC-GS NX(PP)[+], Abercynon. © CJ Woolstenholmes

General Electric Transportation Systems (GETS) [Interfaces commissioned 2000 - date]

Moved into UK signalling with acquisition of Vaughan-Harmon Systems in 2000. Acquired by Alstom in November 2015.

Not to be confused with the UK GEC, this US company introduced the Modular Control System (MCS) WS operating system, developed by Vaughan-Harmon and successfully trialled at Eastbourne, into operational use at North Kent SC in 2000. The GETS version as subsequently developed for commercial use utilised a completely different SSI interface protocol. Normal WS operation was used but, unlike with IECC, commands and alarms were shown at the bottom of the signalling display screen as well as on a general purpose display screen. The screen background was black. The trackerball and command buttons were not originally inset into the desk but consisted of a desktop peripheral (*Figure 68*), but the installation at South Wales CC in 2013 introduced desk-inset controls. Button commands were as follows - Set, Cancel and Middle. The Set and Cancel buttons were used to initiate or cancel commands, with IPS operation being achieved via the Set (for Normal), Cancel (for Reverse) and Middle (for Centre) buttons. The special keyboard keys of IECC were not provided but certain functions could be performed using the twelve standard function keys at the top of the QWERTY keyboard, these functions being displayed on the signalling display screens. The use of keyboard-typed commands to simulate OCS operation was integral. Several adjacent overview screens could provide a large continuous display area (*Figure 69*).

Figure 68 - GETS MCS WS, Trowse Swing Bridge. © Graham Floyd

Figure 69 - GETS MCS WS, West of Scotland SC. © Alan Mackie

The system included the facility to set 'long routes', whereby the signalman could click on an exit signal etc. several signal sections ahead of the entrance signal, missing out intermediate exit signals, and the whole route would set through several signal sections with this one entrance-exit action. No automatic route setting facility was originally provided with this system but the installation at North Kent SC had a WestCAD CRS system integrated into it. At South Wales CC in 2013 The Railway Engineering Company produced Signallers Assistant automatic route setting system (TRESA) was used with MCS.

A design of NX(KS)[+] LCP was developed to be used in conjunction with the company's VHLC CBI system. This consisted of a brushed-metal fascia upon which the diagram was printed, with a set of geographically located telephone-style key-switches for route selection and IPS operation.

General Railway Signal Co. Ltd. (GRS) [Interfaces commissioned 1937 - 1939]

British Thomson-Houston merged with Metropolitan Vickers in 1928 but the two companies maintained their own identities. In 1929 the combined company was purchased by the Associated Electrical Industries (AEI) holding group. General Railway Signal was an established American company and they worked together as Metropolitan Vickers - GRS (MV-GRS) in the UK from 1926. In 1930 the trading name was changed to GRS but reverted to MV-GRS in 1942.

The NX panel was invented by GRS and the terms 'entrance - exit' and 'NX' were both trademarked by them. The first installation in the world, utilising NX(TP) operation, was commissioned at Brunswick, CLC in 1937 (*Figure 70*). Consisting of a sheet metal black box with the diagram in white, there were two red lights for track circuit occupancy on the line of route and a white route set light next to the exit button. Entrance switches were geographically located with the On / Off indication shining through the Perspex centre, upon which an arrow was engraved denoting the direction of application of the signal. First filament failure of signal lamps was indicated by a dimming of the lamp in the entrance switch. A small white dot on the switch lay normally along line of route and the rim of the switch was turned up to select a main aspect, or down for subs and shunts. Black, flat exit buttons were provided, containing an arrow denoting the direction of application. The panel had no route lights. What was to be

Figure 70 - GRS NX(TP[+], Brunswick. © AEI (Andrew K Overton Collection)

a distinctive feature of all GRS / MV-GRS panels was the electromagnetic motor-rotated sections of panel to indicate the lie of points. There were two indications at the IPS: a flashing red light showed through the centre of the switch when the points were in motion or OOC, and a white light below illuminated when points were locked. There were no point position indications at the IPS (*Figure 71*).

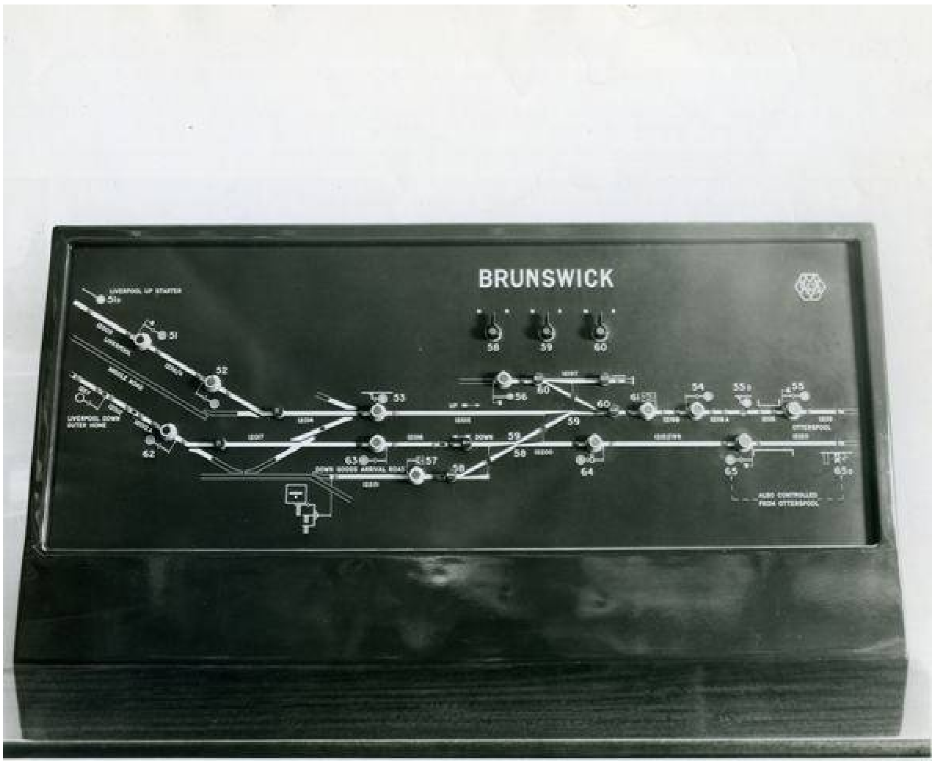


Figure 71 - MV-GRS NX(TP)[+], Brunswick (replacement). © MV-GRS (Andrew K Overton Collection)

In 1939 IFS(Y1)[+] and IFS(Y2)[+] were installed at Toton Down Yard. These were placed in consoles with thumb-switch operation, although there were some general similarities in style with the NX(TP)[+] design.

GrantRail Signalling Ltd [Interface commissioned 2008]

A subsidiary of GrantRail, a company formed in 1996 from the merger of British Steel subsidiary Grant Lyon Eagre Ltd and Railbouw. In late 2008 VolkerWessels bought out the Corus (ex British Steel) share and on 2nd March 2009 the company was renamed VolkerRail.

Designed one interface, at Hull ABP Sidings, a simple IFS[+] made up of industrial switch and LED components on a laminated overlay surface, fixed to a wall.

Great Western Railway (GWR) [Interfaces commissioned circa 1940 - 1943]

This company designed an IFS[-] - the Key Control Instrument (KCI) - for the release of ground frames where a suitable lever was not available in a frame to perform this function (*Figure 72*). The interlocking operated directly on the switch, preventing its being turned inappropriately. Initially the instruments had three positions with a push-button but later a four-position instrument without the button was introduced and became the standard.

Figure 72 - BR(WR) (GWR) Key Control Instrument IFS[-], Par. © Chris Bellett

Henry Williams [Interfaces commissioned 1959 - date]

The Integra Signum company of Switzerland invented the mosaic panel, registering the term Domino to describe it. The licence to manufacture these panels in the UK was obtained by Henry Williams Ltd., who had factories in Darlington and Watford. Panels were made at both sites until the Watford facility closed in 1969. Integra Signum was taken over by Siemens on 01/01/1992, becoming Siemens Integra Verkehrstechnik.

Henry Williams entered the power interface market in 1959 with the installation of a NX(TP) at Pyle West, a stageworks installation for the Port Talbot resignalling. This started a successful run of panels for the Western Region during its major modernisation. Screen-painted metal mosaic tiles of 40mm x 40mm were dark green with all track circuited lines shown in black, as per BR(WR) convention - the only indication of different track circuit sections being a white block at the joint. The mosaic tiles tended not to form such a smooth surface as those later produced by other design manufacturers, sitting a little unevenly. Exit buttons were of a distinctive design of coloured plastic according to the class of signal (red - main aspect, yellow - shunt) with a black arrow on top denoting the direction of application. Entrance switches were also distinctive: black with small red and / or yellow, divergently opposed, arrows on top. IPS were distinctive, being small flat discs a little like a small draughts piece (*Figure 73*).

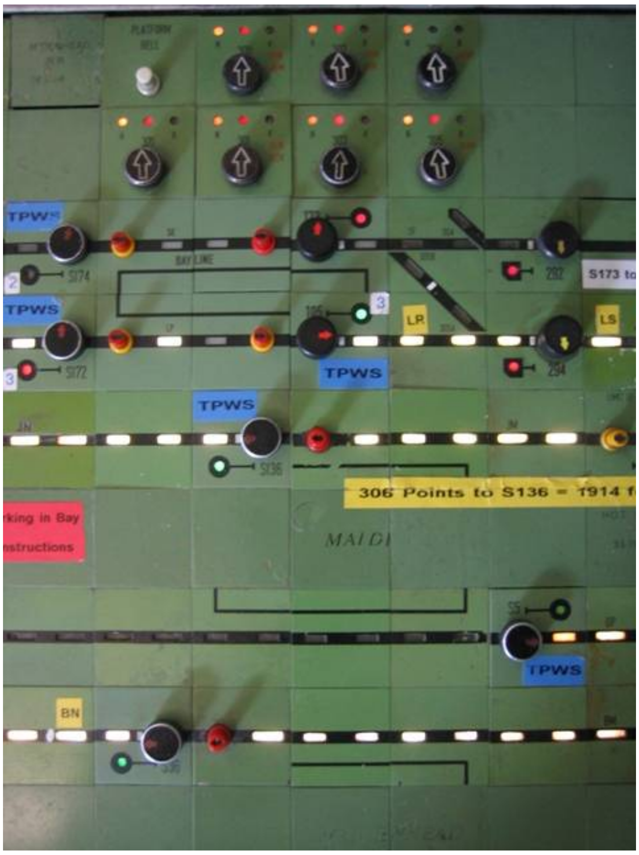


Figure 73 - Henry Williams Integra Domino NX(TP)[+], Slough. © Andrew K Overton

To set the route the switch was turned so that the arrow corresponding with the required signal class pointed along line of route. The panel operation was otherwise normal, with route lights and track circuit lights showing through small rectangular cut-outs in the tiles, but there were several deviations owing to the exclusive use of E10k interlocking circuits, as detailed below-

(i) Red lock lights were provided at each IPS instead of white OOC lights
(ii) OOC was indicated by the pivot lights for Normal and Reverse flashing alternately
(iii) Pivot lights illuminated to indicate those points which were route-locked in an overlap

(iv) The pivot lights could be illuminated by the use of a switch to show the position of points without a route being set through them
(v) After the train had cleared the first track circuit ahead of the entrance signal the first route light flashed until the entrance button was pulled up unless auto working had been selected
(vi) No separate Off indication was provided for subsidiary signals and this was indicated by a green indication in the main signal symbol; the Off indication for shunt signals was also green
(vii) Automatic working was effected by setting a route in the conventional way, then turning an auto-working switch

This style of NX(TP) panel was never used off BR(WR).In 1962 the company designed a prototype NX(PP) panel for BR(NER) at York Yard South (*Figure 74*). This was unusual (for the UK) in that operation required the simultaneous pushing of both entrance and exit buttons to set the route and all buttons were of the distinctive non-illuminating coloured plastic type. Route cancelling was effected by the simultaneous pushing of both the entrance button and a special route cancelling button. Routes set into an occupied section were depicted by alternate white route lights and red track circuit lights. In other respects panel operation was normal. Differentially coloured track circuits were used, as per the convention of every region bar the Western, and tiles were blue. A similar NX(PP) design also saw service on BR(SR) at this time but panel operation was normal with clear Perspex route-setting buttons, seeing its first application at Folkestone Jcn.

Figure 74 - Henry Williams Integra Domino NX(PP)[+], York Yard South. © John Boyes Collection

In 1969 AGS concluded a deal with Integra to use their panels in large signalling consoles and these were to be supplied by Henry Williams. From this date onwards the Integra Domino panels were to be found in consoles bearing the AGS, and later GEC-GS and GEC plaques, but invariably bearing a few tiles at one corner marked with 'Domino' in large, rounded outline letters. The use of coloured plastic buttons for route-setting was discontinued. One NX(TP) was designed to the new style for Temple Mills West and one panel using the BR(WR) tile colouring and track circuiting convention was produced for the 1973 installation at Oxford PSB, whilst adopting NX(PP) operation (*Figure 75*). Panel operation was normal, except at Oxford which retained red 'locked' lights in place of an OOC light and did not have separate Off indications for subsidiary aspects. At this date panel buttons were becoming commercially sourced, the same pattern being used by many design manufacturers, but the distinctive IPS were retained and this distinguishes them from the Westinghouse M1 panel of the pre-1974 period, the only other mosaic in production at that time (*Figures 76 & 77*). The installations at Kings Cross and Peterborough were unusual for the positioning of 'A' buttons on the line of route in rear of the relevant signal entrance buttons, a practice which was to be outlawed by BR Standard Signalling Principles.

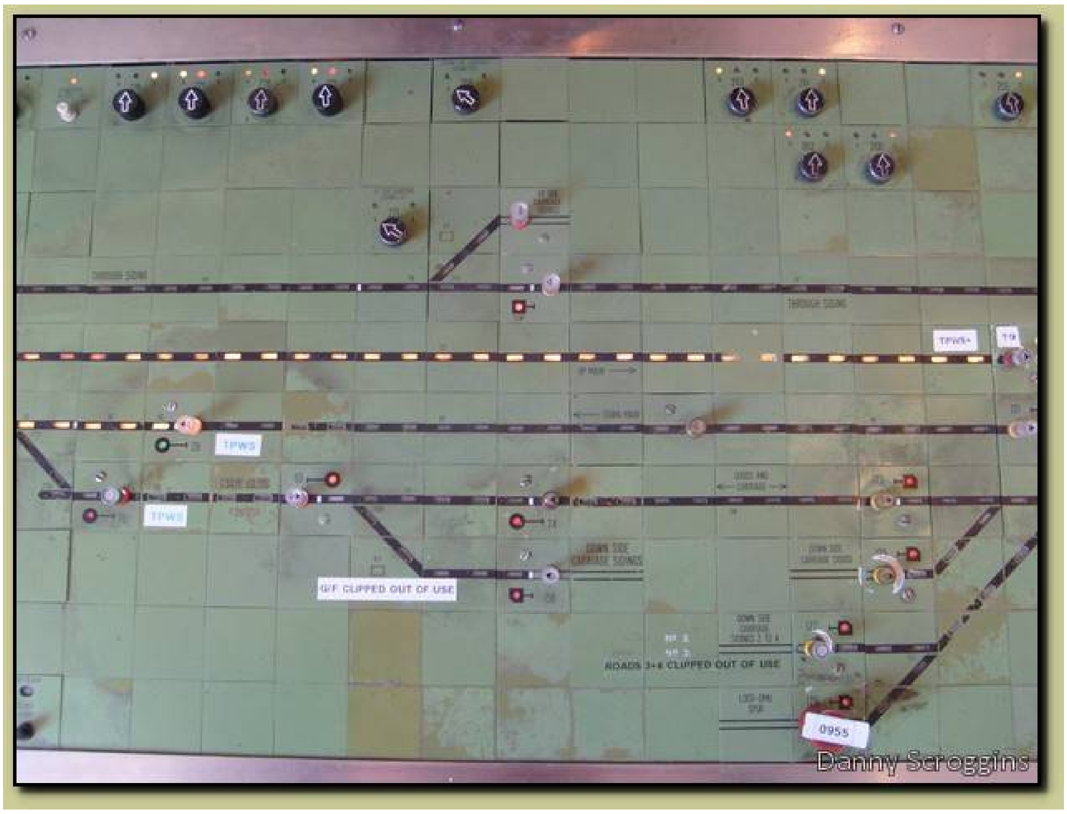


Figure 75 - Henry Williams Integra Domino NX(PP)[+], Oxford. © Danny Scroggins

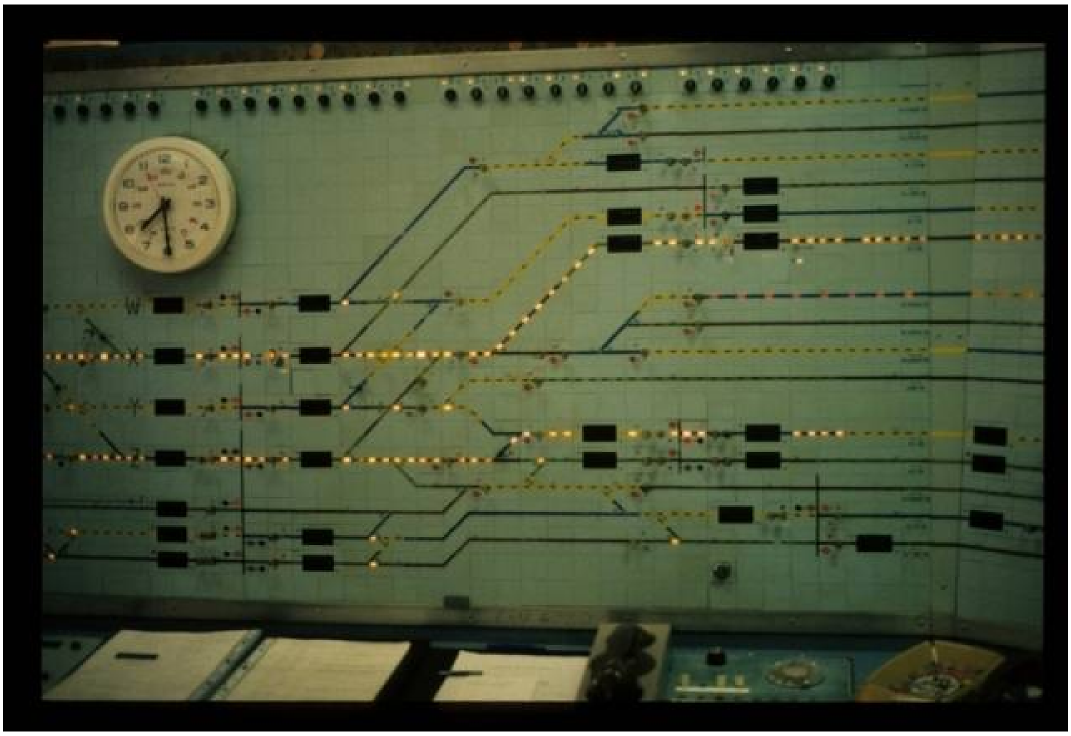


Figure 76 - Henry Williams Integra Domino NX(PP)[+], Glasgow Central SC. © Andrew Gardiner

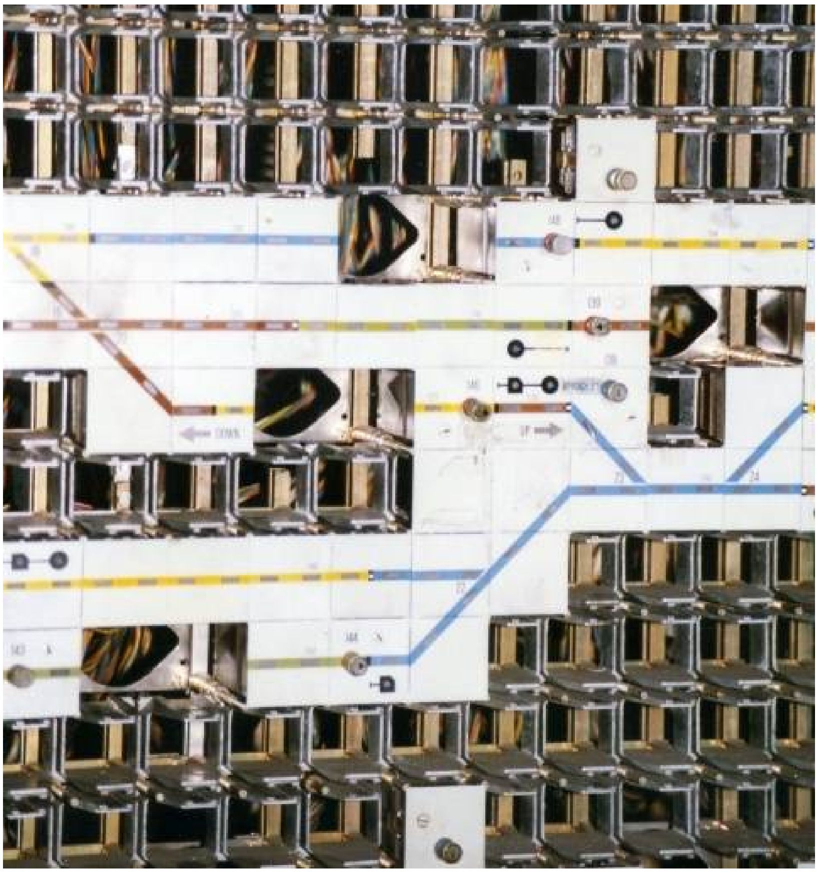


Figure 77 **-** *Henry Williams Integra Domino NX(PP)[+], Motherwell SC (part dismantled to show constructional details). © John Simpson*

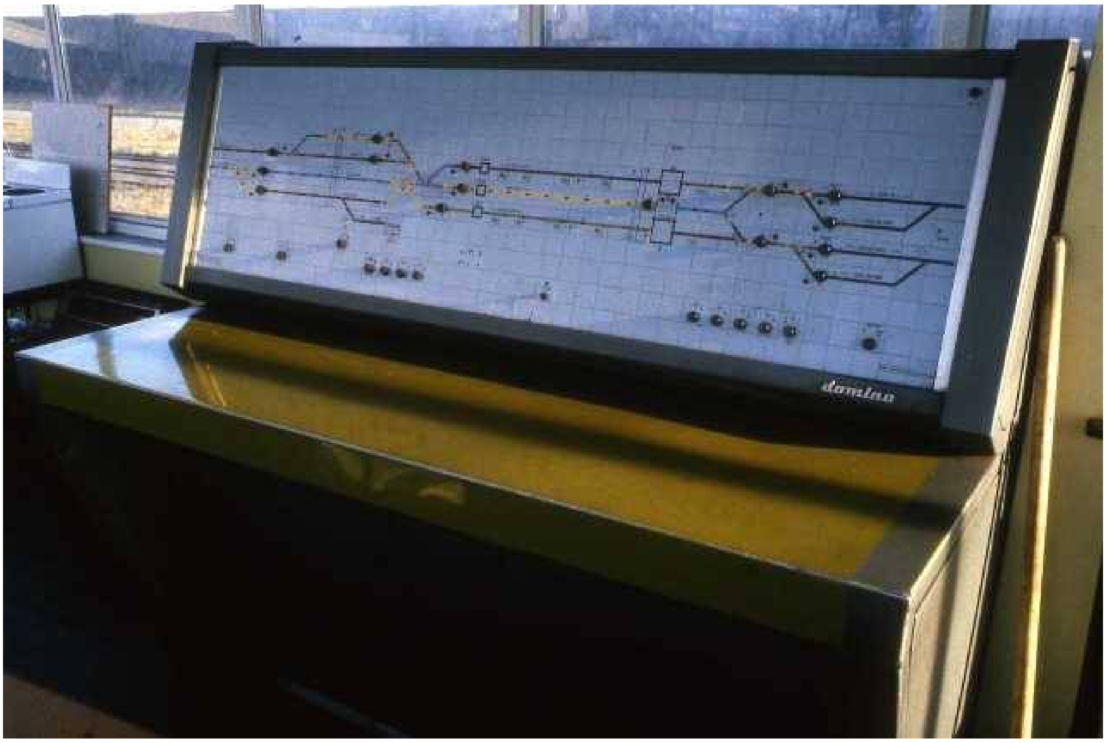


Figure 78 **-** *Henry Williams Integra Domino IFS[+], Redcar Mineral Terminal BSC. © John Boyes*

The 1976 work for the British Steel Corporation at Redcar Ore Terminal saw the same style of panel used as an IFS[+], with the distinctive IPS used to operate geographically positioned signal controls (*Figure 78*). Here two route lights were always illuminated at point ends to show their position and signal switches were turned along the line of route to effect clearance.

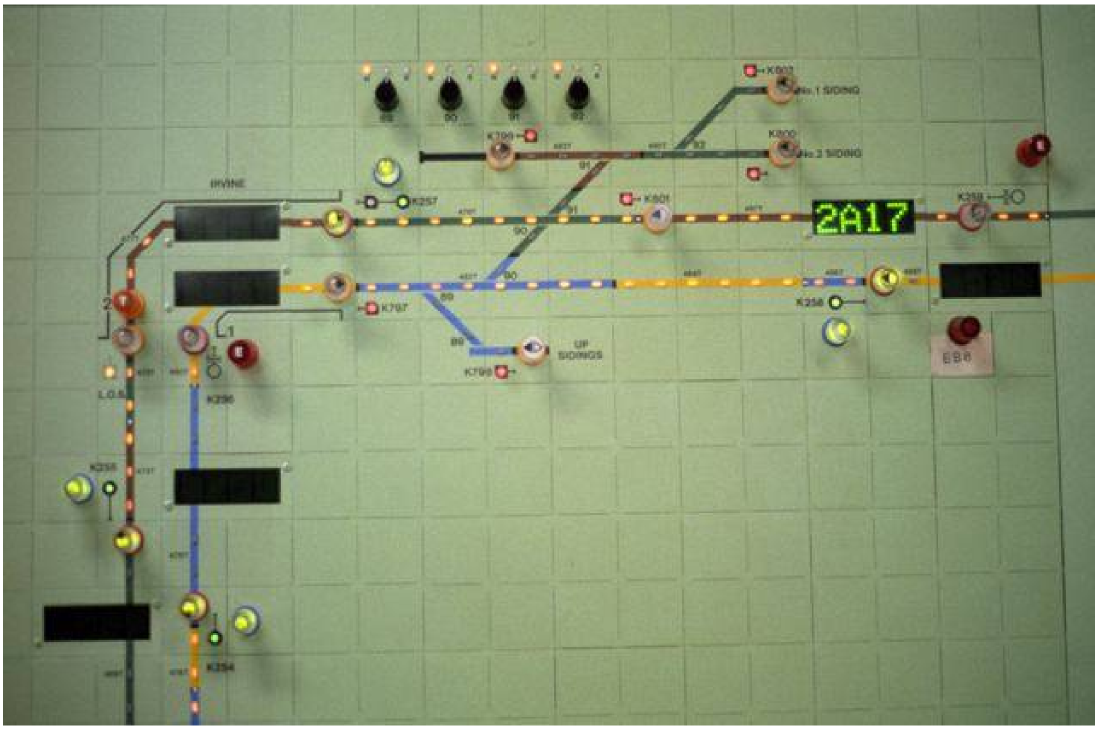


Figure 79 - Henry Williams Integra Domino NX(PP)[+], Paisley SC. © Andrew Gardiner

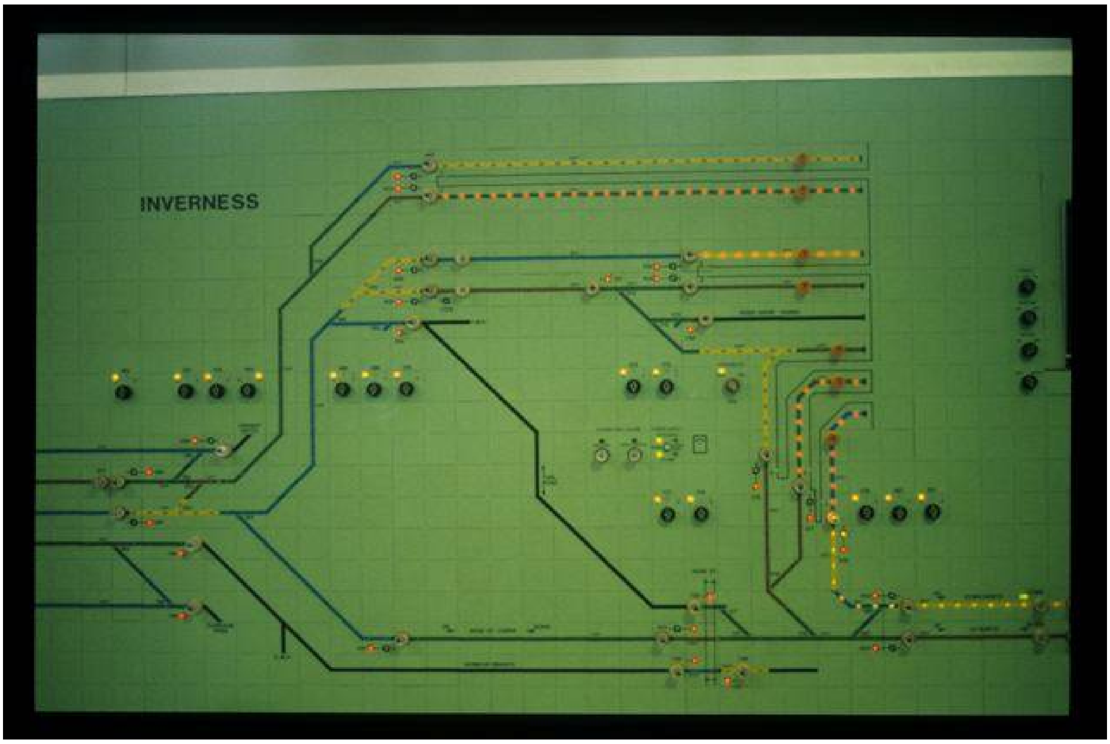


Figure 80 - Henry Williams Integra Domino NX(PP)[+], Inverness SC. © Andrew Gardiner

By the 1985 installation at Paisley SC the standardisation in BR specifications for panel equipment had started to make Henry Williams' panels less easy to distinguish from those from other companies, especially with other design manufacturers starting to produce mosaic tiles. However, by this date the 40mm tile was a unique product. Switches and buttons were now of ubiquitous style (*Figure 79*) with LEDs lamps replacing all bulbs, a greeny-yellow light being used in lieu of white. An 80x80mm tile was introduced (with screen printed lines giving the appearance of four 40mm tiles) to infill blank areas of panel. Inverness in 1987 saw a return to a more recognisable design in general (*Figure 80*). Although in 1991 TEW entered the market with a 40mm tile, Henry Williams' use of a metal top-plate maintained distinction.

In 2008 the first OCS panel was designed for Dumfries, consisting of the usual Integra Domino construction with a desk of route switches of the traditional small IPS style (*Figure 81*). No route lights were provided; point indications were given by illuminated pivot lights on the diagram and signal On / Off indications were given in the head of the signal symbol. 2009 saw a return to NX(TP) design with a panel at Chard Jcn, again using the familiar style of small switch, but with differentially coloured track circuits (*Figure 82*). During the Network Rail era the company also designed some non-Domino panels in individual styles, as well as catering for the panel renewal market by making replacements in other manufacturers' original outward styles for insertion in existing consoles.

Note - it is particularly important to recognise that the term Domino is a registered trade name of the Integra Company. Only Integra-licensed mosaic panels should be referred to as Domino panels, all others being called mosaic.

Figure 81 - Henry Williams Integra Domino OCS[+], Dumfries Station. © Andrew K Overton

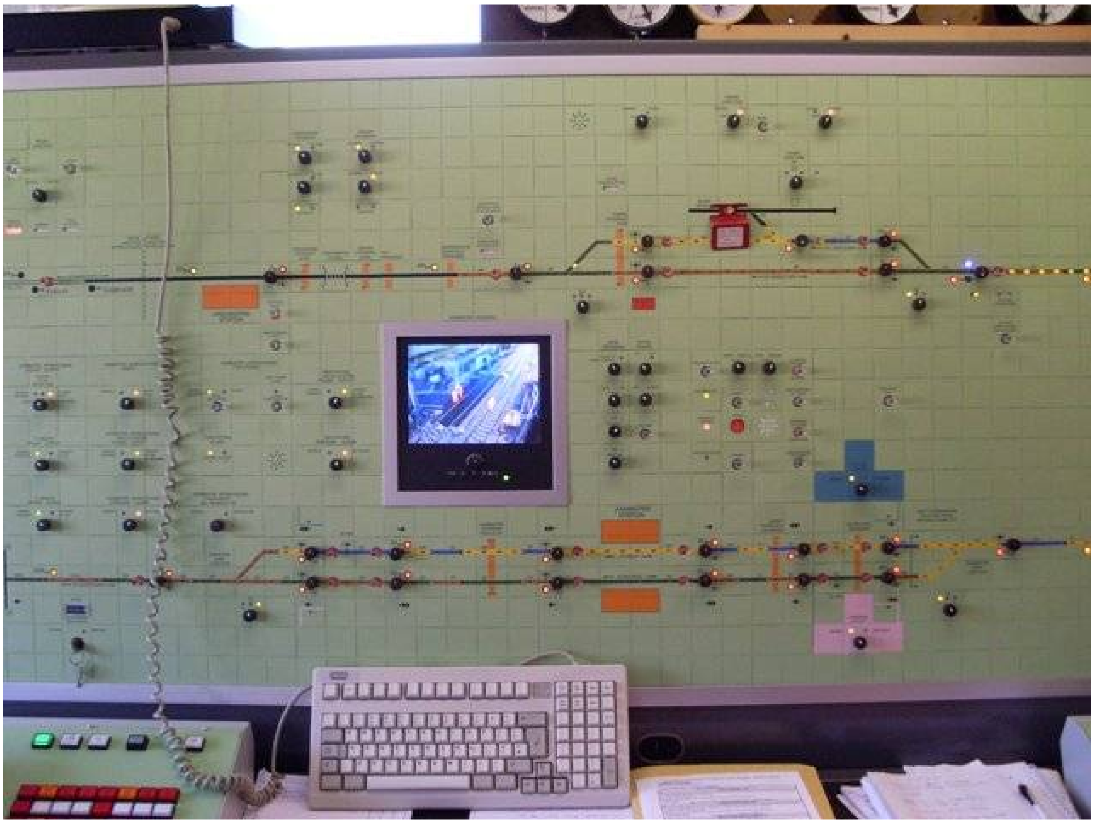


Figure 82 - Henry Williams Integra Domino NX(TP)[+], Chard Jcn. © Anon

Hima Group [Interface commissioned 2024]

Sella Controls was established in 1974 designing non-rail safety control systems and first entered the UK rail market in 2012 with product acceptance by Network Rail with their Tracklink system. Taken over by Hima Group, with whom they had had a close working relationship, from 1 February 2023.

First WS system commissioned by Amey at Transport for Wales's Taff Wells Depot utilising the Tracklink HMI PC SCADA system designed by Sella Controls. This system used industry-standard communications protocols within a Windows-based platform, based on the commercially available Panorama E² SCADA software package supplied by Codra.

Interlogic Control Engineering Ltd [Interface commissioned 1994]

One of the engineering business units set up by British Rail in the lead-up to privatisation. Bought by Adtranz in 1996.

The Birmingham Signalling Projects Group designed a stagework IFS[-] for Rock Ferry in 1994 as part of the Merseyrail IECC resignalling. Consisting of a white painted metal box with Square-D style switches mounted on a light green hinged top, all indications were given on the illuminated diagram by LEDs and included route lights. Auto working switches were provided. It was reused as the LCP in the relay room.

Invensys Rail [Interfaces commissioned 2009 - 2012]

New name of Westinghouse Rail Systems from 01/09/2009. Taken over by Siemens from 02/05/2013.

Continued to supply the Westinghouse range of interfaces.

Jarvis [Interface commissioned 1999]

Moved into rail infrastructure maintenance on privatisation and bought out Fastline in 1996. Went into administration in 2010.

Designed an ERS[+] at Stalybridge in 1999 consisting of industrial-style switches on the laminated paper box diagram.

Kearns-Barker Associates (KBA) [Interfaces commissioned 1984 - 1990]

Active in the design of control panels for the North Sea oil industry, in the mid-1980s this design manufacturer supplied OCS and IFS panels for BR(WR), and one large NX panel for BR(LMR) at Nuneaton late in their life. Went into administration around early 1990.

Used mainly on BR(WR), this small design manufacturer produced several OCS panels, and just one IFS[+] and a NX(PP)[+]. The OCS and IFS panels consisted of a grey-painted steel box, designed to be mounted on a table etc., with an enamelled light-green sheet-steel front and with 'lollypop-style' signal symbols in black. The track depiction was angular with no route lights and with small red LEDs on the line of route for track circuit occupancy. Control switches were in banks on the panel surface, red for main aspects, yellow for shunts and On / Off and point indications are given by LEDs with the switches. IPS had a red 'locked' light, rather than an OOC light (*Figure 83*).

Figure 83 - KBA OCS[+], Crediton. © Network Rail

A KBA makers plate was positioned on the end of panel. The IFS panel was almost identical to the OCS but with switches only performing IFS functions.

The large NX(PP)[+] provided for BR(LMR) at Nuneaton had a similar fascia style but incorporated route lights, with signal symbols containing On / Off indication in conventional fashion. The IPS were to a different pattern.

LB Foster [Interfaces commissioned 2015 - date]

Bought out TEW as a wholly owned subsidiary from 15/01/2015.

Continued to produce TEW interface designs, also with a further SM24 installation at Ferme Park Reception Sidings Control Cabin. In 2022 they produced an IFS[+] GSP for Wilton Jcn, similar in appearance to a standard BRS SW67 pattern GSP but using switches rather than push-buttons.

London & North Eastern Railway (LNER) [Interfaces commissioned 1941 - 1945]

The LNER had provided PF(S) and PF(L) as ERS working in connection with automatic signals from 1925 (see Appendix A) and provision of such signals in colour light form continued after switches had come into use at Goole Swing Bridge and on the York to Darlington stretch of the ECML. It is possible that further ERS for these installations utilised a simple box with a thumb-switch and such an item was certainly provided on the block shelf at Marston Moor to work the Down inner and outer distant signals around 1941 in IFS[-] mode and reappeared in the early days of the North-Eastern Region of BR being used as ERS[-].

The same pattern of switch was used with an IFS[+] at Manors, provided in 1945 to replace a frame damaged by bombing. This appears to have been designed in-house - being untypical of the designs from any known contractor - probably at York. Lines on the diagram were formed of coloured metal strips tacked onto the panel surface. Track circuit indications were provided by two red lamps positioned vertically either side of the line on the diagram, with point indications only shown with their switches and not geographically positioned. Signal On / Off indications were provided in the heads of the diagram symbols. Signal and point switches were grouped together on the panel below the diagram.

Metropolitan Vickers - General Railway Signal Co. (MV-GRS) [Interfaces commissioned 1943 - 1959]

The MV-GRS trading name of this partnership was reinstated, replacing GRS, from 1942. From 1st January 1960 the MV name was formally abandoned in favour of AEI but interfaces had started to appear with AEI-GRS maker's plates from 1959.

The general style of the GRS NX(TP)[+] was perpetuated at Kilburn No.1 in 1943 but with Frame / IFS[+] Hybrid operation. However, the On indication of signals was indicated by a red bar of light across the track and the Off indication by a white bar parallel to the track, with points indications being given by N and R lamps at the IPS without moveable points indicators on the track diagram. A master switch was provided on the panel to set all the main running signals to automatic operation. When Toton Up Yard was modernised in 1950 the style of interface used by GRS at the Down Yard in 1939 was continued.

In 1949 a large contract to resignal the GE lines out of Liverpool Street led to a development of the NX(TP). The method of operation was largely unchanged but the interface was now a large console of ¼" thick aluminium sheet sprayed with black enamel, with a diagram of differentially coloured track circuits on a dark-green background, each with a white lozenge-shaped light to indicate track occupancy. In other respects the Brunswick arrangement was largely unchanged (*Figure 84*).

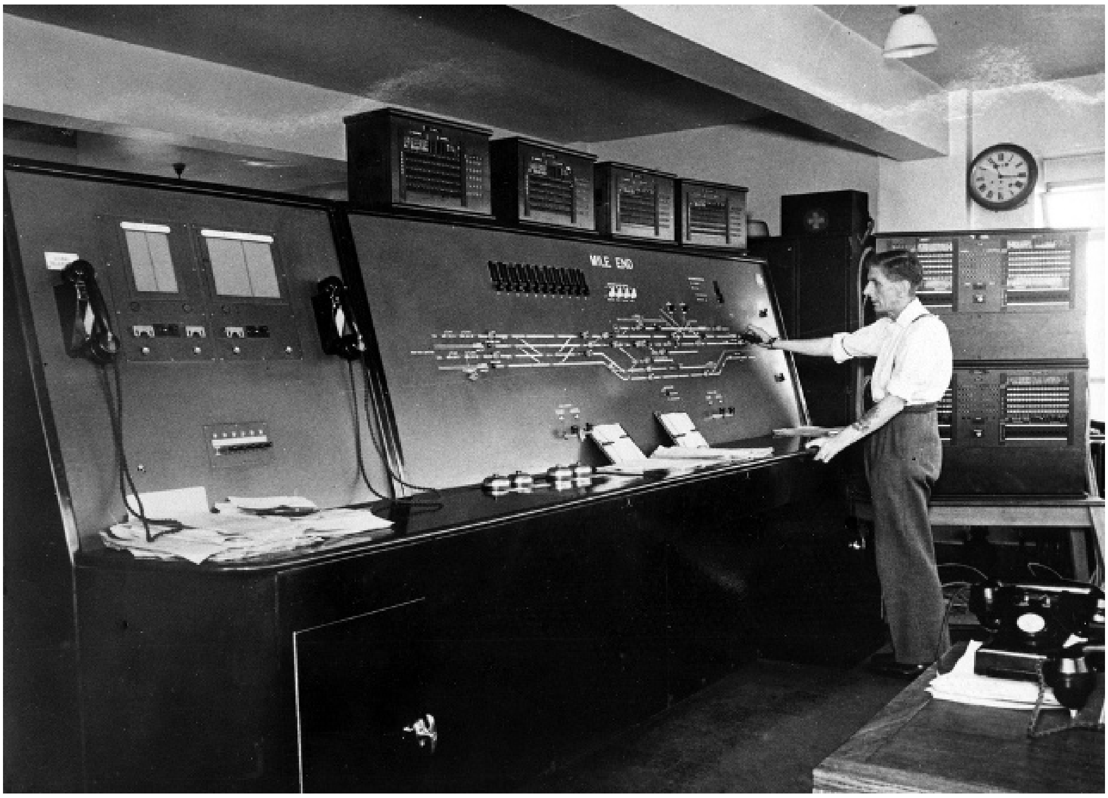


Figure 84 - MV-GRS NX(TP)[+], Mile End. © Beechwood Photography

This style of panel was supplied until 1963 (*Figure 85*) but with some variation in indications and panel background colour, which appear to be based on customer preference rather than a chronological development - Off indications could be given by small lamps in the panel close to the route switch: above the line of route for main aspects (green), below it for shunts and subsidiaries (white or yellow); all On / Off indications could be replaced by indications in the panel, On below the line of route and Off above it for main aspects, with both Off and On displayed below in the case of shunts and subsidiaries, with the switch now showing a white light-out light and being mainly opaque with only a small centre light. Point indications also could be given with the IPS. Another variation was to show On and Off indications in the signal symbol head (actually introduced after absorption into AEI). With the development of the delayed yellow aspect with short overlaps, MV-GRS accommodated this control in their NX(TP) panels by requiring the entrance switch to be pulled out and turned up to select this feature, rather than by providing separate exit buttons, and the facility was highlighted by the exit button being white.

In 1955 a separate control and indication panel was designed for Potters Bar in which the entrance and exit function was provided by a switch with a push-button centre. Signals with only an entrance or exit function had normal switches / buttons. Point indications were given by the usual rotating segments on the separate illuminated diagram, with IPS and other controls positioned on the rear, upright section of desk console. Signal On / Off indications were shown on the separate illuminated diagram in the signal symbol heads: red for On, green for Off (mains or subs) or white (shunts). This design had been specified by BR(ER) but was not adopted by MV-GRS for other UK installations, however the use of a fibreglass moulded console began to take over for new work from this time (only Copper Mill Jcn and Temple Mills West were subsequently designed with sheet-metal consoles).

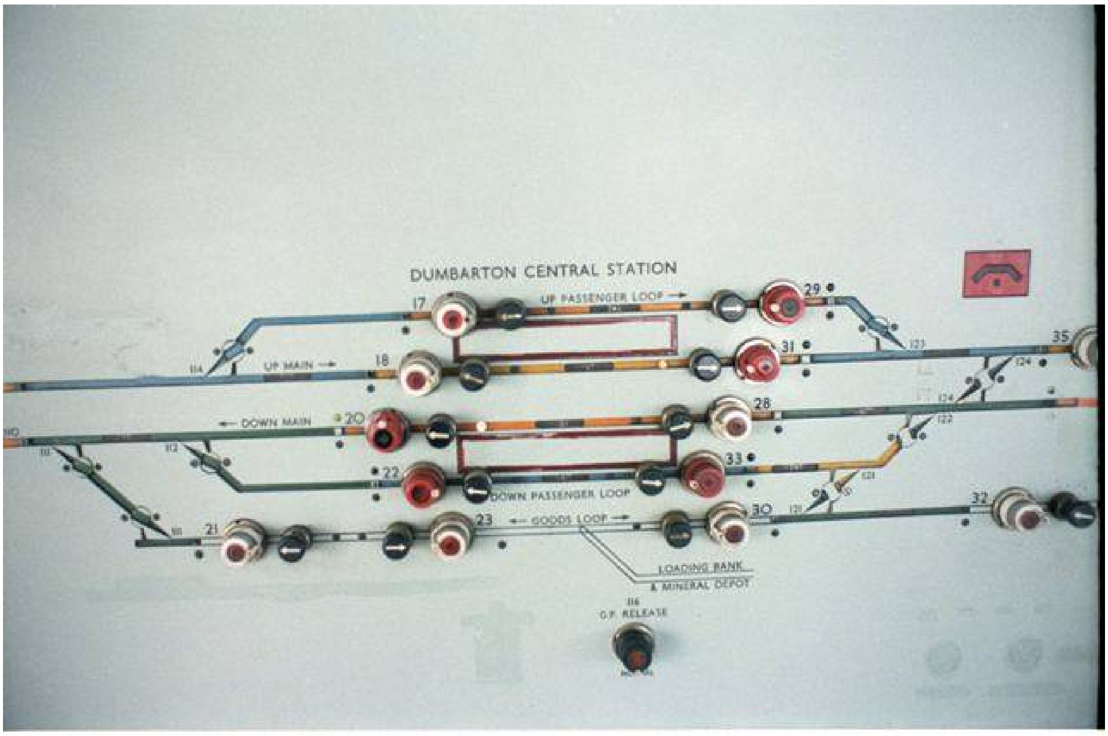


Figure 85 - AEI-GRS (MV-GRS) NX(TP)[+], Dumbarton. © Andrew Gardiner

1955 also saw the company install a Frame / NX(TP)[+] Hybrid at West Ealing. The block shelf-mounted fibreglass console contained an interface which dispensed with movable point indications and replaced them by two white lights at the point ends engraved with N or R, either of which illuminated to represent their position. Only points controlled by the panel were thus indicated, however, not those on the frame, although the panel also acted as illuminated diagram for the entire area of control of the box. Electrically detected mechanically worked points had N and R lamps in a row on the panel. Track circuit occupancy was indicated by a red light lozenge. The IPS had the red locked light in the middle of the switch which did not flash to indicate OOC. A similar installation was made at Acton in 1959. Electromagnetic motor-rotated sections of panel to indicate the lie of points continued to be an option for new work as well as this new design.

1956 saw the installation of a hump yard IFS(Y3)[+] at Thornton, utilising a new style of thumb switch, subsequently used by AEI-GRS in new designs for the Glasgow Suburban electrification and described there.

Mid-Hants Railway (MHR) [Interfaces commissioned 2010 - 2023]

Designed an IFS[+] for Alton in 2010 which mirrored BR(SR) and ML Engineering practice. The panel utilised a third-hand ML Engineering console ex-Three Bridges / Chichester, with the track diagram printed onto the bottom surface of a 3M polycarbonate sheet fascia plate produced by Parc Signs. The result was very similar to a Darvic fascia. All lamps were LEDs with signal On / Off indications given by separate lamps in the heads of the signal symbols, with points indications given at the switches. The Square-D pattern points and signal switches etc. were positioned below the track diagram on Traffolite description plates (*Figure 86*). In 2023 a further IFS[+] was produced for Medstead in a largely similar style with detail differences, this time utilising a new console.

Figure 86 - MHR IFS[+], Alton. © Alan Daniels

Mid-Norfolk Railway (MNR) [Interfaces commissioned 2019 - 2020]

Designed IFS[-] for Kimberley Ballast Pit Sidings and Brick Kiln Grove Jcn GSPs, consisting of a very similar box for the switches as used by BR(ER) and successors for ERS[-] etc.. A separate illuminated diagram was provided.

ML Engineering [Interfaces commissioned 1964 - 1988]

White Waltham company ML Aviation entered the UK signalling market in 1959 with the formation of ML Engineering (Plymouth) Ltd., originally working on BR(WR) resignalling schemes. They continued to trade independently until acquired by EB Signal Ltd in 1989, having built up a position as one of the 'big three' signalling contractors.

Very active during the BR(WR) resignallings of the early 1960s working in conjunction with Henry Williams Ltd., with ML doing the interlocking work, the company first designed its own interface in 1964, an IFS[+], at West Burton. The company used a distinctive panel surface of plastic - an ICI product called Darvic - in large sheets, with the diagram made up of reversed Letraset applied to the back and oversprayed. The surface was intended to present a matt finish but in practice was somewhat reflective. The final appearance was unique and very recognisable (*Figure 87*). Steel consoles of a variety of designs were always used.

Figure 87 - ML Engineering NX(PP)[+], Brockenhurst. © Danny Scroggins

In 1966 the company obtained the contract for a NX(PP) at Stoke on Trent PSB, including the interlocking work. Although BR(LMR) shortly afterwards chose to produce almost all their interfaces in-house they adopted ML Engineering switches and buttons for their own work. In 1967 BR(ER) employed the firm to supply an NX(TP) for the 'C' panel at Stratford. In most respects this panel was typical of their work but the entrance switches were most unusual, being small metal cylinders anodised in colours according to function (red for main aspects, yellow for shunts etc.) and with a small black arrow head towards the edge: a bolt through the centre provided the axle.

An IFS[-] was also designed from 1970, seeing only a small number of applications. Consisting of an angular steel box in Hammerite finish the fascia was inset into the front. 'Cooker switches' were used with the same large coloured lamps as used by BR(ER), but the interface was distinguished by the fact that the Traffolite description plates extended under the switches and up to the lamps (*Figure 88*)

Figure 88 - ML Engineering IFS[-], Hertford North LCP. © David Stansfield

The company did not designed a great number of interfaces, with Stoke on Trent being by some way the largest, and they were more prominent in the provision of interlocking work and outside signalling equipment. However, the same style of panel surface continued to be used until 1982 with installations on all except the NE regions of BR. In connection with their interlockings an NX(KS)[+] design was designed with a Darvic diagram above rows of key switches, in larger installations the whole interface being mounted as a 'wall' amongst the relay racks (*Figure 89*).

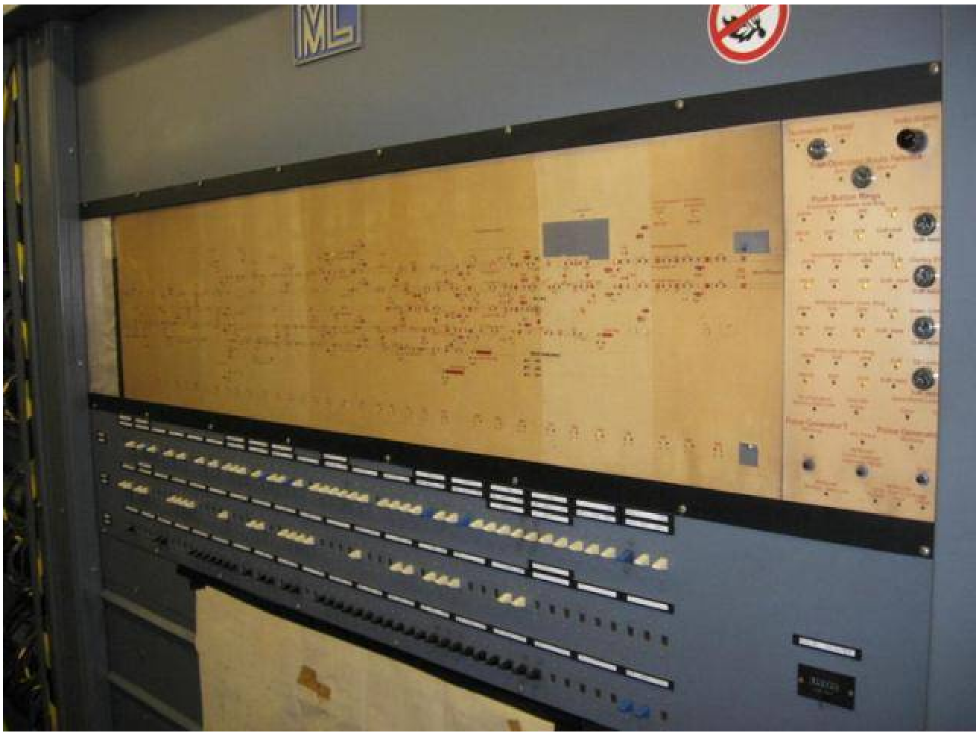


Figure 89 - ML Engineering NX(KS)[+], Southampton LCP. © Chris Bellett

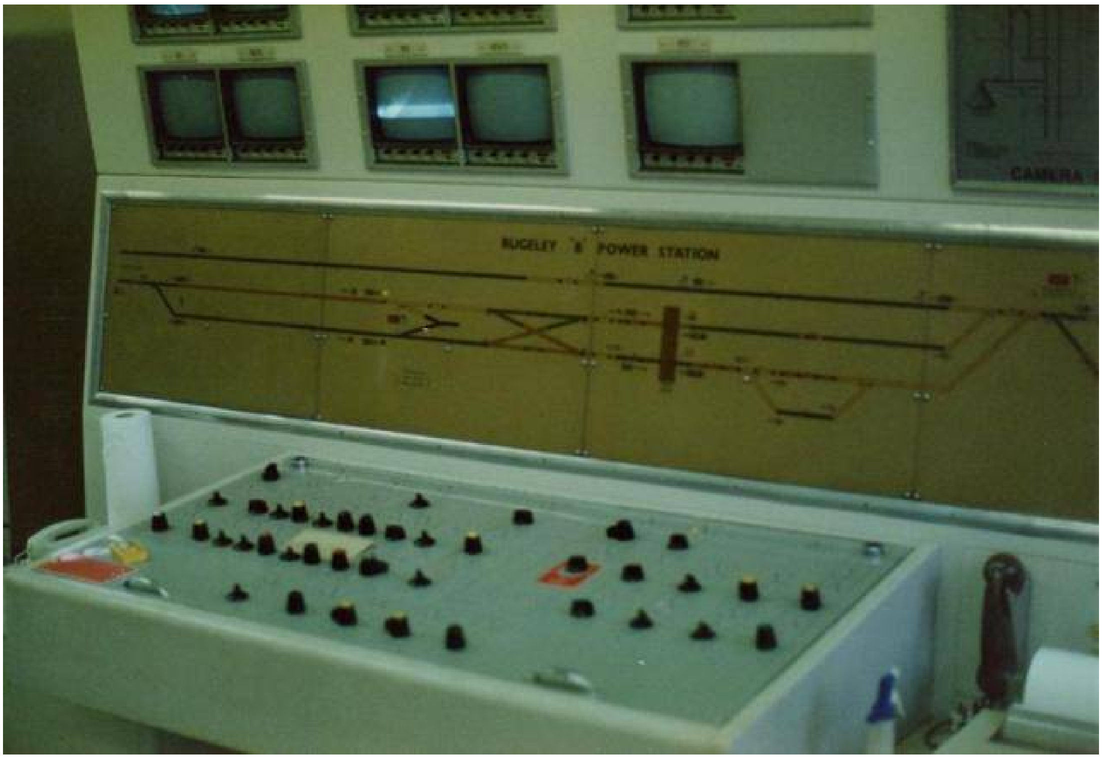


Figure 90 - ML Engineering IFS[+], Rugeley B Power Station. © Chris Bellett

With the advent of merry-go-round operation of coal trains power stations began to install internal signalling on coal discharge lines. ML Engineering were active in this market and designed IFS[+] of a more industrial appearance. Darvic diagrams were sometimes used (*Figure 90*) but sometimes a single moulded fibreglass console had the 'panel' printed onto it (*Figure 91*).

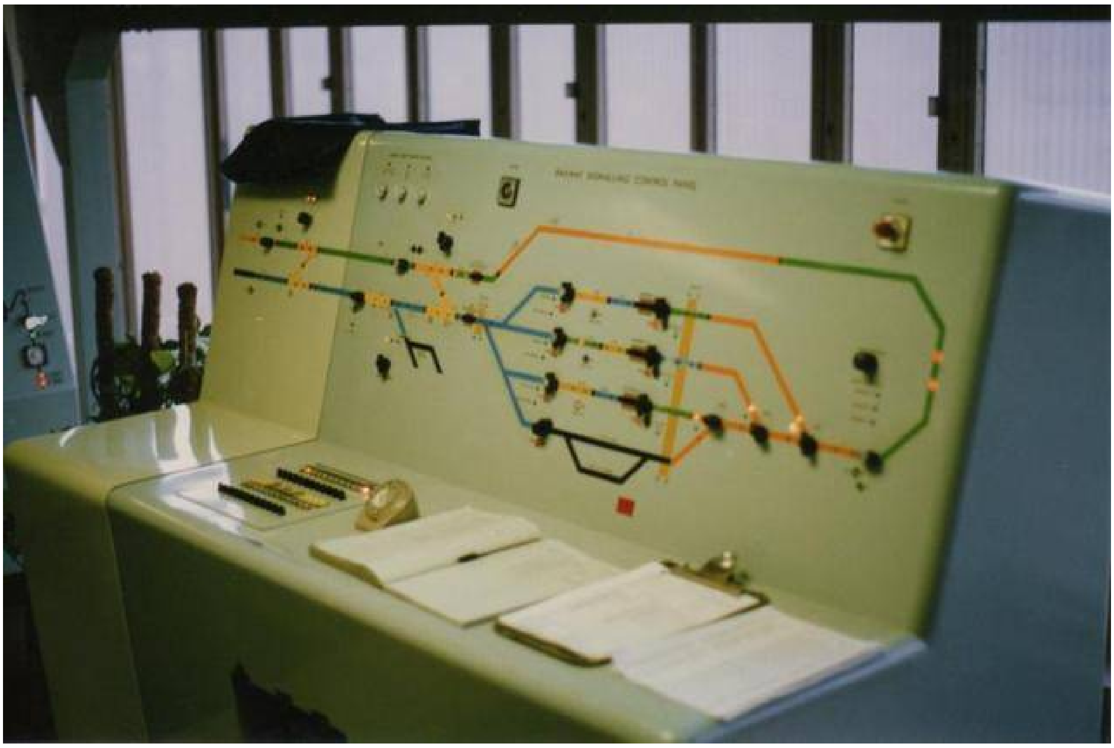


Figure 91 - ML Engineering IFS[+], Drax Power Station Control Room. © Chris Bellett

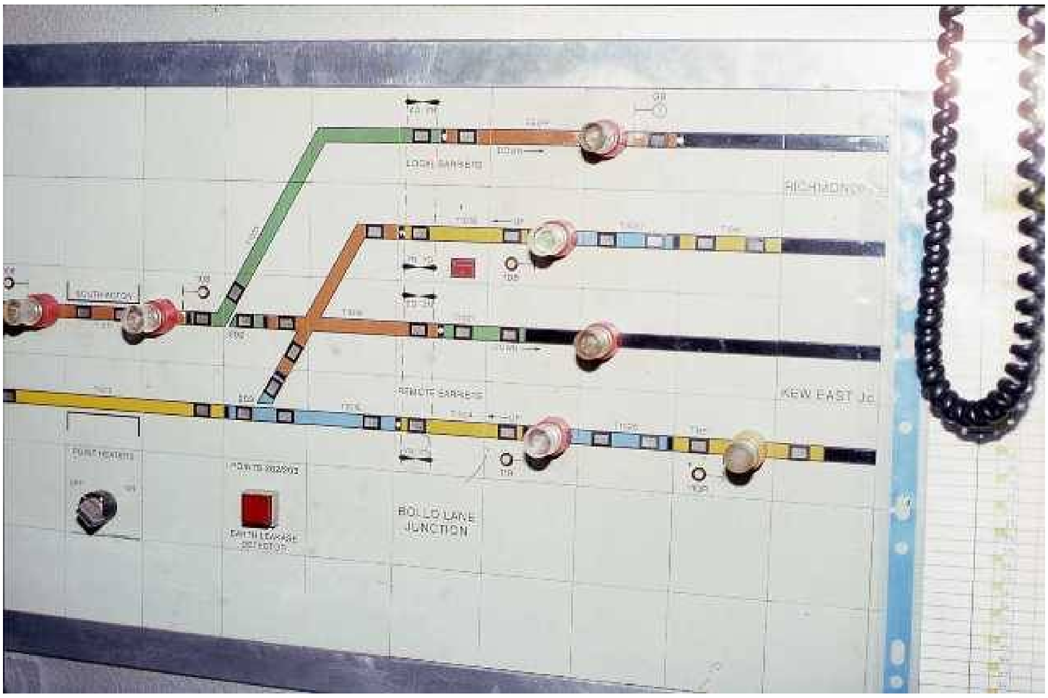


Figure 92 - ML Engineering NX(PP)[+], Bollo Lane Jcn. © CJ Woolstenholmes

1982 saw supply of Darvic panels discontinued and the company started to source a mosaic panel from Swissinco in 1980, albeit that occasional use was made of Henry Williams, with the first installation being at Farnham. The first examples used a different style of LED indication lamps and switches but soon altered to a consistent and recognisable form (*Figure 92*). Only the mosaic diagrams were bought in from Swissinco and ML installed these in separate consoles bought from Alluset UK, wiring the panel up themselves. They are therefore regarded for the purposes of this work as being ML Engineering interfaces but are described under the Swissinco heading below.

Figure 93 - ML Engineering NX(PP)[-], Maidstone East. © David A Ingham

The Maidstone East installation was later notable for the innovative use of VDU monitors in 1985 as a combined indication panel and TD screen, centred around an Intel iSBC processor (*Figure 93*). The 1978 panel at Three Bridges had also used VDU technology for TDs.

The Leicester scheme of 1986 saw the use of ML made IFS(KS)[-] for LCPs.

In 1987 EAO bought out Swissinco and ML continued to source their panel components from the new company, which developed the product into a plastic tiled version (*Figure 94*). This had separate circular track circuit and route lamps and LEDs were used extensively. A distinctive push-button was used which tapered inwards towards the panel surface and had no escutcheon. This panel was also designed in a simplified LCP version, with separate On / Off indications in signal heads and with GPL symbols following the early Westinghouse M4 style of a rectangle with a cut-off corner.

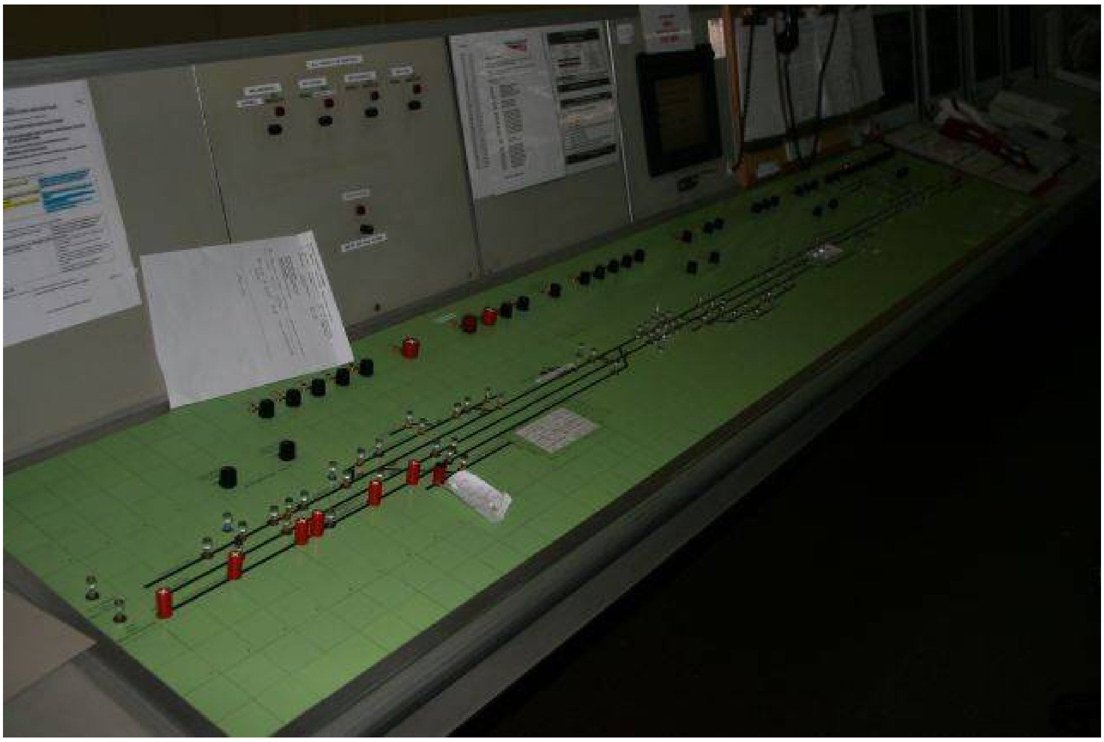


Figure 94 - ML Engineering NX(PP)[-], Leicester. © Andrew Gardiner

National Coal Board (NCB) [Interface commissioned 1973]

In the few locations where 'heavy rail' movements from the national rail network have ventured onto colliery lines some interaction with NCB signalled layouts has been encountered. At Alcan Jcn on the line from Ashington to Lynemouth a rough-and-ready IFS[-] of the most basic kind controlled the signals, consisting of no more than the track layout scratched into the paintwork of a metal relay cabinet cover with the signal switches geographically positioned. No signal repeaters or TC indications were provided.

National Railway Supplies (NRS) [Interfaces commissioned 1994 - 2006]

Formed of the old BR regional S&T Engineering workshops on rail privatisation on 1st April 1994 by a management buyout, with Unipart as a stakeholder. After a very short time production was only retained at the former ER workshops at York. In 2006 the company was fully acquired by Unipart to form Unipart Rail.

The last styles of BR(ER)-style interfaces were continued by NRS at the former BR workshops at York after privatisation, with the vinyl-coated fascia retained and no significant further development. Some interfaces used diffusers on the LED indication lamps which stood quite proud of the surface, giving the effect almost of a miniature version of the generic lamps used from the 1970s in BR(ER) interfaces (*Figure 95*). The design of IFS[-] was significantly modified in some cases by the use of Square-D switches. Redundant KL were refurbished at York and re-used in new installations but at Wye in 2003 a new instrument of a completely different style was made, consisting of a simple sheet steel casing with a single Annetts key (for the crossing GF).

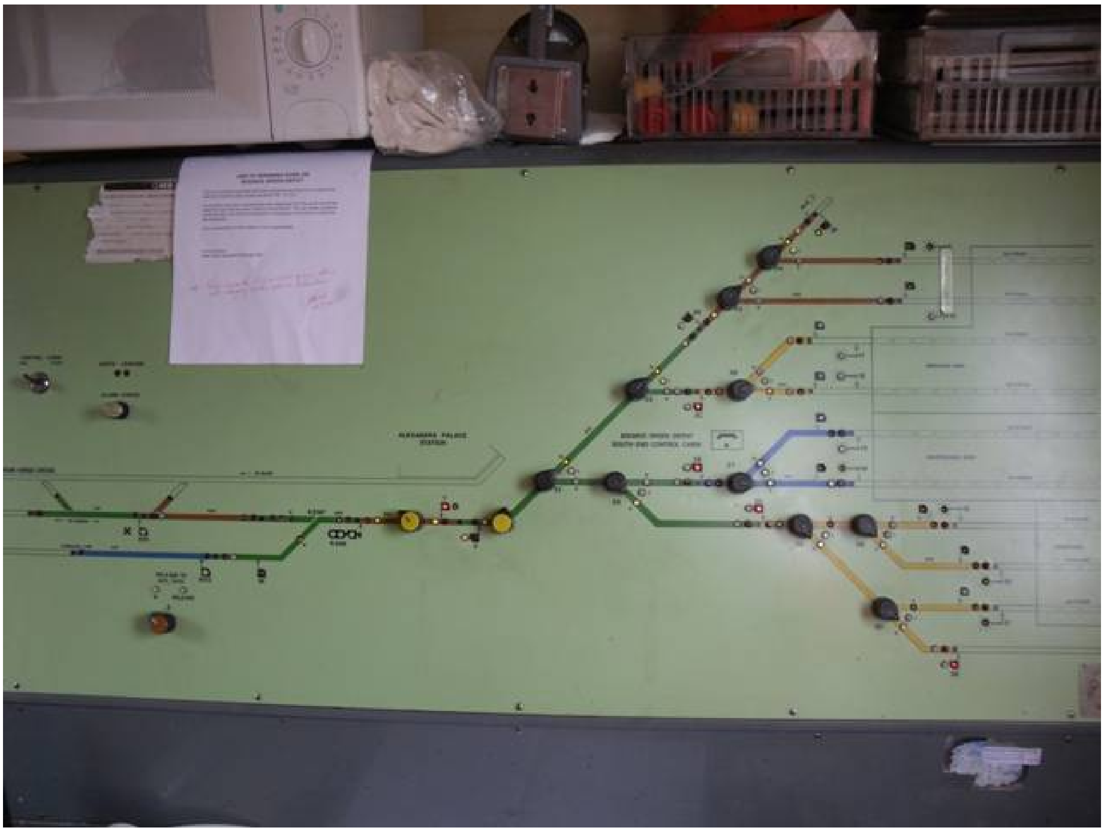


Figure 95 - NRS IFS[+], Bounds Green South End Control Cabin. © David Stansfield

Figure 96 - NRS NX(TP)[+], Worksop. © Andrew K Overton

However, in 1995 the NX(DB) system was introduced in connection with a replacement section of Stratford C Panel, although it was destined to see very few further applications. In 1997 interface production picked up after something of a lull with orders under the Railtrack Efficiency through Replacement of Signalling (EROS) scheme. The familiar general design was retained but with track circuit and route lights now being displayed by the same lamps, where required (*Figure 96*). A new design of OCS[+], NX(DB), NX(TP) and NX(PP) LCPs were also produced for EROS, fixed to relay room walls by brackets. Some of the NX(TP) LCPs had shallow, black non-illuminating exit buttons with an adjacent lamp to indicate the route being set (*Figure 97*), whereas others used illumination of the conventional exit button. Route lights were not provided with these LCPs. Supply of matching replacement and extension sections for existing interfaces was also continued.

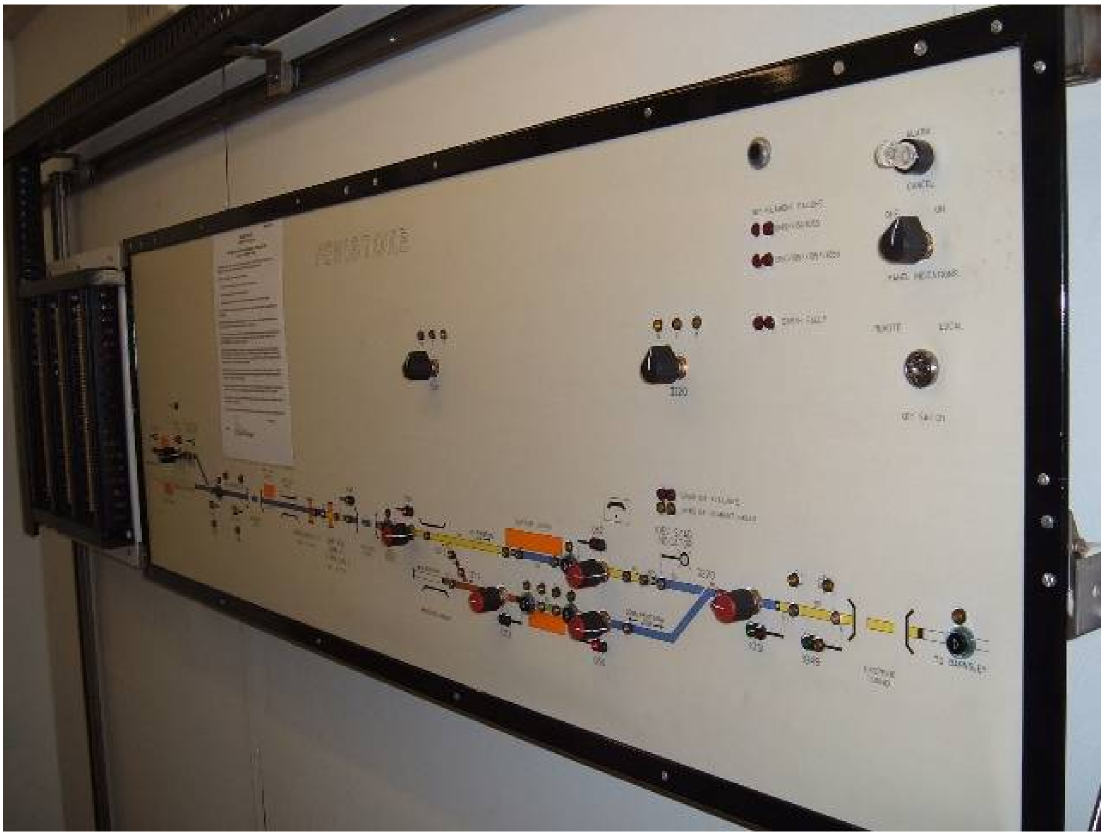


Figure 97 - NRS NX(TP)[+], Penistone LCP. © Mick Charlesworth

Later interfaces, whilst retaining the general style, reverted to enamelled sheet metal fascias rather than card (*Figure 98*), with a minority using separate route and track circuit lamps, and a LCP for Thornhill L&NW Jcn unusually reverted to 'cooker' switches whilst utilising MPK[-] operation. Work off the former BR(ER) saw former regional preferences retained and newly styled interfaces provided. The track circuit / route lamps for NX(PP)[+] interfaces changed to the pattern previously favoured by BR(LMR), first used at Bearley West in 1998 (*Figure 99*). The IFS[-] for Immingham West also used large indication lamps more typical of former BR(LMR) interfaces (*Figure 100*), although in all other respects it showed BR(ER) lineage.

The BR(ER) GSP design was also continued but the painted steel sheet was replaced with an unpainted stainless steel one, still with the track diagram screen-printed onto it. By this time Westinghouse M5 pattern switches and LED lamps were being used.

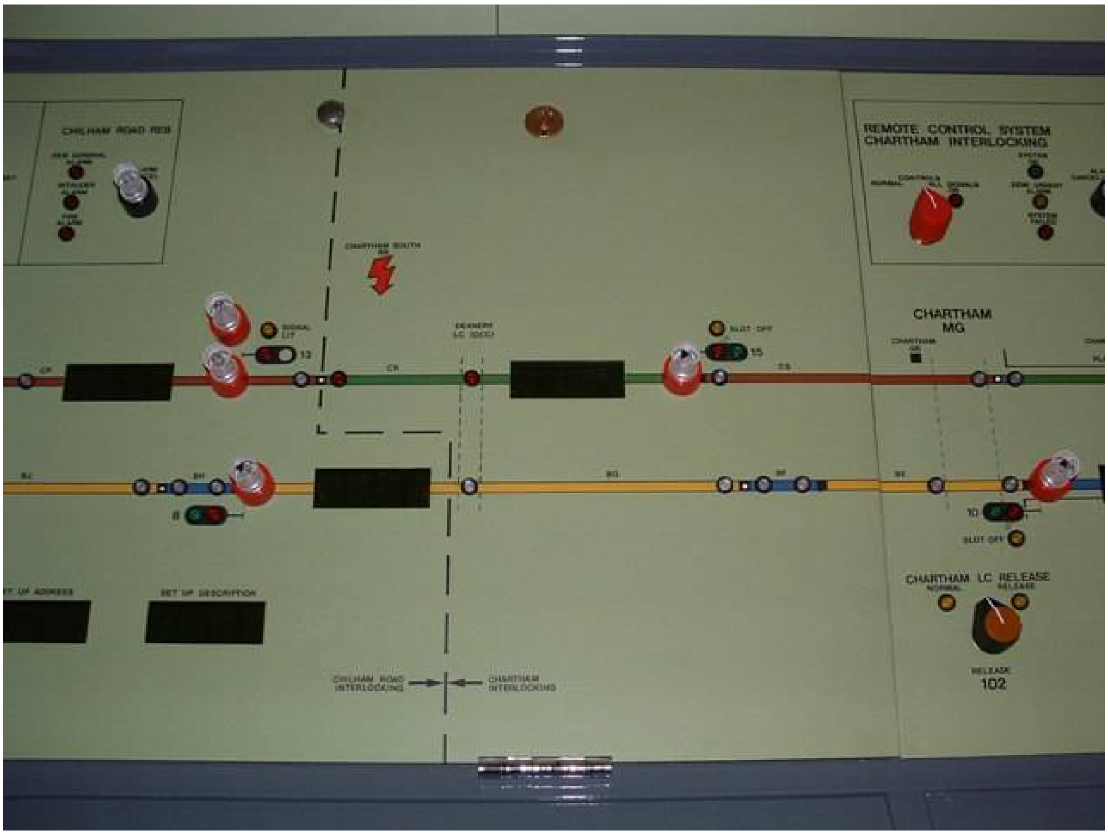


Figure 98 - NRS NX(PP)[+], Canterbury West ACC. © Network Rail

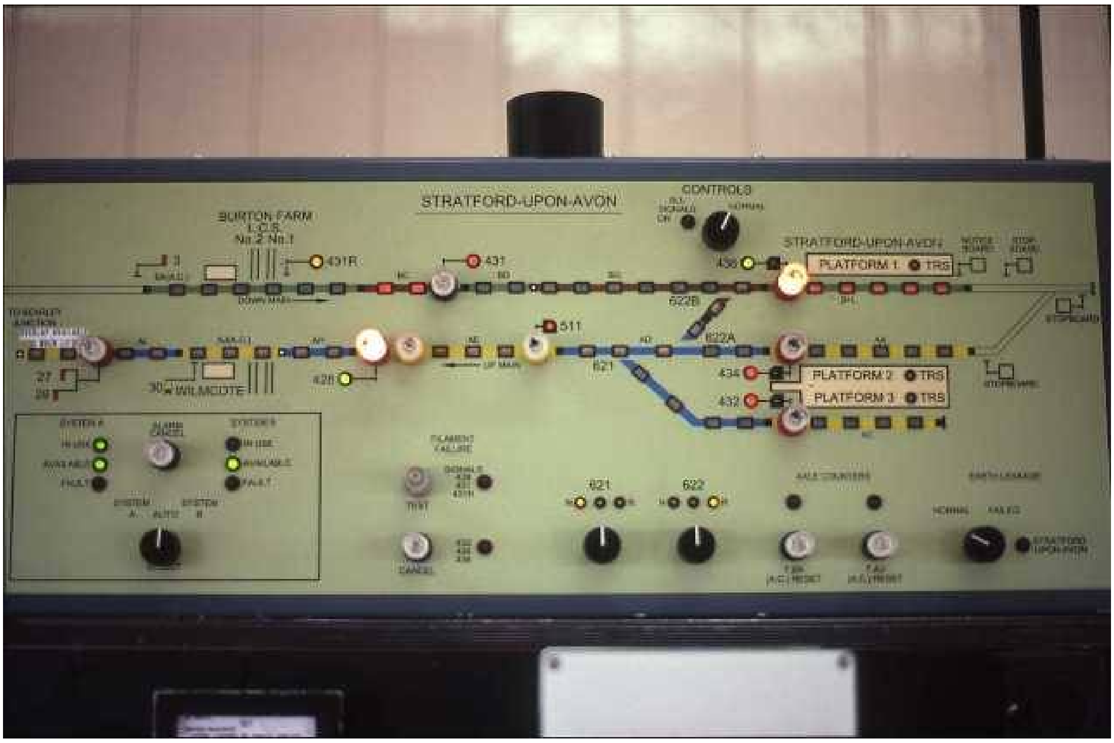


Figure 99 - NRS NX(PP)[+], Bearley West Jcn. © CJ Woolstenholmes

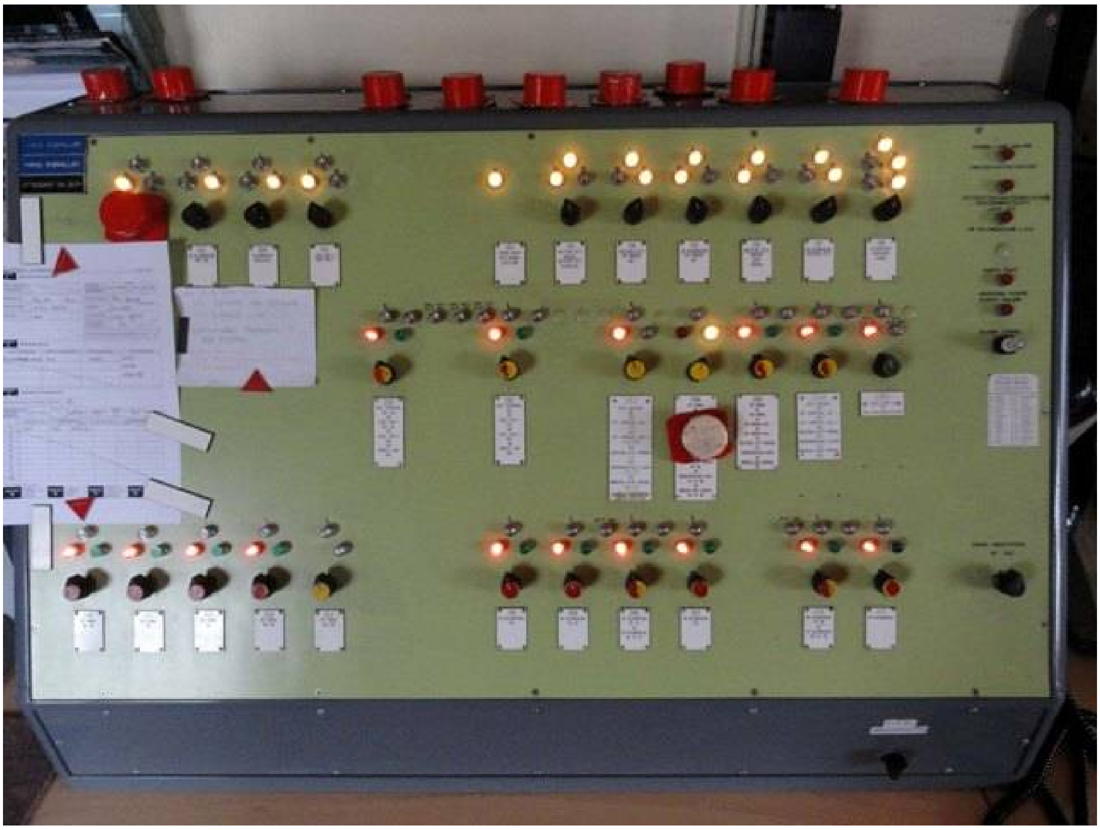


Figure 100 - NRS IFS[-], Immingham West Jcn. © Chris Booth

Network Rail [Interfaces commissioned 2003 - 2011]

Inherited the intellectual property rights to IECC and RETB WS systems, being accredited as joint design manufacturer for AEAT/DeltaRail-produced installations.

For details see BR / AEAT / DeltaRail.

North British Railway (NBR) [Interface commissioned 1912]

Designed an IFS[-] for controlling the Up Distant signal at Banavie Swing Bridge, which consisted of a square wooden box with a brass faceplate stamped with function descriptions and 'pulls', the large brass centre-pivoted handle in the middle of the plate turning one way or the other through about 90º to place the signal On or Off.

OSL Global [Interface commissioned 2021]

Designed a block-shelf-mounted non-mosaic NX(PP)[+] for Ryde St Johns Road utilising LED indication lamps, Swisstac buttons and large 'cooker switch' style IPS on a box-diagram-style fascia. Separate route and track circuit lamps were used.

Park Signalling [Interfaces commissioned 2009 - 2018]

Formed in January 2000 by ex-Alstom staff.

Contracted by Signalling Solutions Ltd in 2009 to develop the upgrade to the RETB operating system, as described under DeltaRail.

Pintsch GmbH

Bought out Tiefenbach in 2012 and traded as Pintsch Tiefenbach until 2019, then as Pitsch following the amalgamation of several subsidiary companies.

Continued to produce the Tiefenbach WS system.

Railtrack [Interfaces commissioned circa 1996 - 2011]

Inherited the intellectual property rights to IECC and RETB WS systems, being accredited as joint design manufacturer for AEAT-produced installations.

For details of WS systems see BR / AEAT.

In around 1996 a design of LOC was produced for WR E10k style interlockings and installed in several locations under Exeter PSB, consisting of a simple three-position switch with LED indications. Further LOCs were produced exactly to this design in later years by Unipart Rail (*Figure 101*). Owing to the highly standardised nature of the design and the entire use of proprietary components the actual manufacturers of LOCs to this design are not shown and they are recorded as 'Railtrack E10k LOC'.

Figure 101 - Railtrack E10k LOC, Wootton Bassett LOC. © Network Rail

Resonate [Interfaces commissioned 2016 - date]

The new trading name of DeltaRail Group Ltd from 15th September 2016.

Continued to supply the interfaces of DeltaRail Group Ltd except for RETB WSs, with which the company had no further involvement.

Sema Group [Interfaces commissioned 1989 - 1996]

Formed by the merger of the British defence software company CAP Scientific Ltd. and the French company Sema-Metra in 1988. Taken over by Schlumberger in 2001.

British Rail entered into a contract with CAP Scientific Ltd in January 1987 to jointly develop the operating system for IECC. The subsequent design produced after the merger into Sema Group was based around Motorolla 68000 micro-processors and VME Bus linked via a Local Area Network.

Siemens and General Electric Railway Signal Co. (SGE) [Interfaces commissioned 1921 - 1966]

Formed after the First World War by Siemens and the railway division of the General Electric Co.. Merged with AEI to form AGS from April 1967.

This company was active from a very early date in this field. The first products of interest here were two IFS(Y1)[+] used in the hump marshalling yard at Feltham. These used geographically positioned, mechanically interlocked push buttons for points and signals operation - one button for Normal / On, one for Reverse / Off. Track circuit indications were given by a red lamp for occupied and a green lamp for clear. The resignalling of the LNER main line between York and Darlington in 1933 saw several installations of Frame / IFS[+] Hybrids. The IFS[+] consisted of an ebony Sindanyo (asbestos sheet) diagram painted green with lines shown by coloured metal strips tacked on. Black switches were positioned on the panel diagram alongside the respective signal on the line of route. Post Office pattern lamps were used for indications. The On indication was shown through the switch and the Off indication by a separate lamp alongside. Switches for signals reading in the Down direction normally pointed up and signals reading in the Up direction normally had their switches pointing down, both being turned 90 degrees to point in the direction of travel to clear them. One or two pairs of track circuit lamps were positioned along the line of route, one above and one below the track. Point positions were shown by geographically positioned, illuminated indications on the line of route light having a dark line in the middle. A different lamp illuminated depending on lie of points with the dark line either straight or inclined 45 degrees. These suspended or block-shelf mounted interfaces in an all-steel surround were designated model EB132.

The company's major claim to fame was the installation of the first British route-setting panel, an OCS[+] commissioned at Thirsk in 1933 (*Figure 102*). This utilised the same style of diagram as the IFS[+] but incorporated in a free-standing, all-steel deskless console, designated model EB131. Black switches for each route were grouped on the panel diagram alongside the respective signal with the On indication only being shown through the switch closest to the signal symbol. Point indications were not shown at the IPS. There were no route lights.

In 1936 or 1937 a small OCS[+] was installed at Lynemouth, the Sindanyo interface being in a teak case mounted on top of an all-teak cabinet containing all the relay interlocking: this design was designated model EB331. Simple telephone exchange-style toggle switches geographically located on the diagram by the signal symbols called the routes, there were no IPS or track circuits (*Figure 103*).

Figure 102 - SGE EB131 OCS[+], Thirsk. © CJ Woolstenholmes

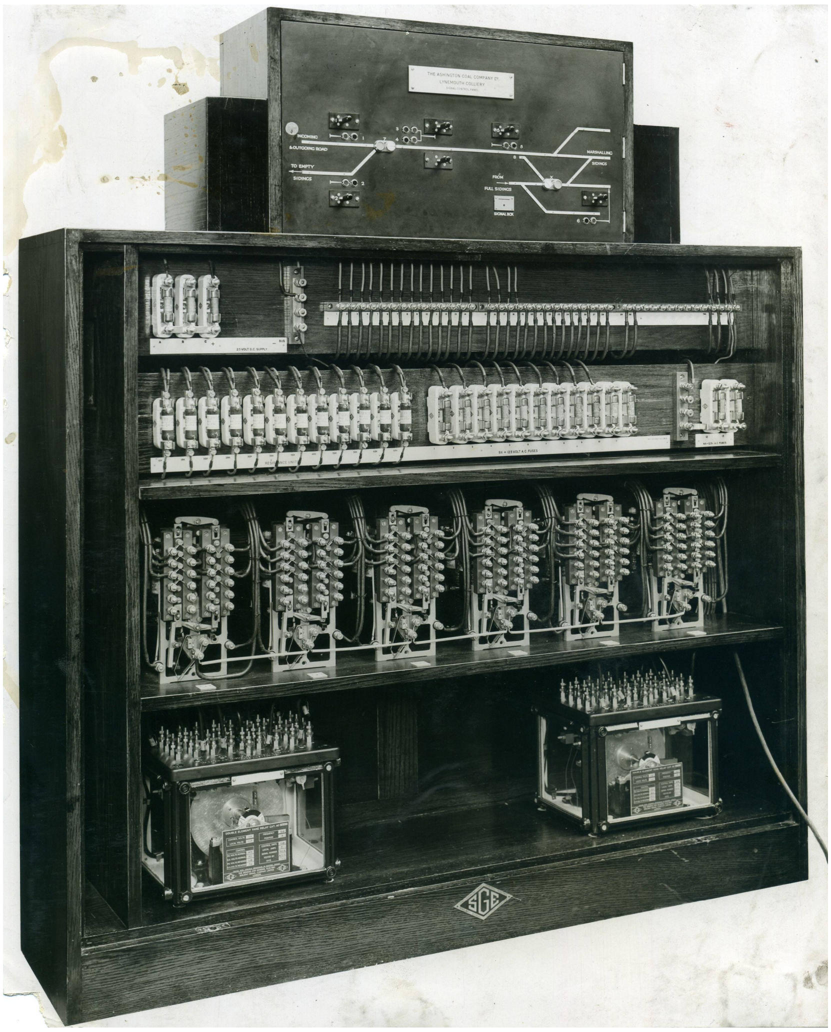


Figure 103 – SGE EB331 OCS[+], Lynemouth. © SGE

In 1941/2 four hybrid installations were installed in boxes at Wigan. No.1 had two frames and two IFS[-] in rows on the block shelves, with No.2 (*Figure 104*) and Wallgate (*Figure 105*) both having one frame and an EB132 IFS[+]. Although both of the latter consisted of a metal box with painted diagram and geographically located switches for main running signals, they were not the same. At Wallgate the point indications were shown on the panel as before but not at No.2, where they were not shown on the panel at all; in both cases track circuits were indicated on the line of route with lamps at the extremities of each section. Turning signal switches in the direction of traffic cleared an unrestricted proceed aspect, turning against the direction of traffic selected a delayed yellow or subsidiary aspect. Bell tappers and block instruments were integral with the panels. The arrangement at No.1 is not known.

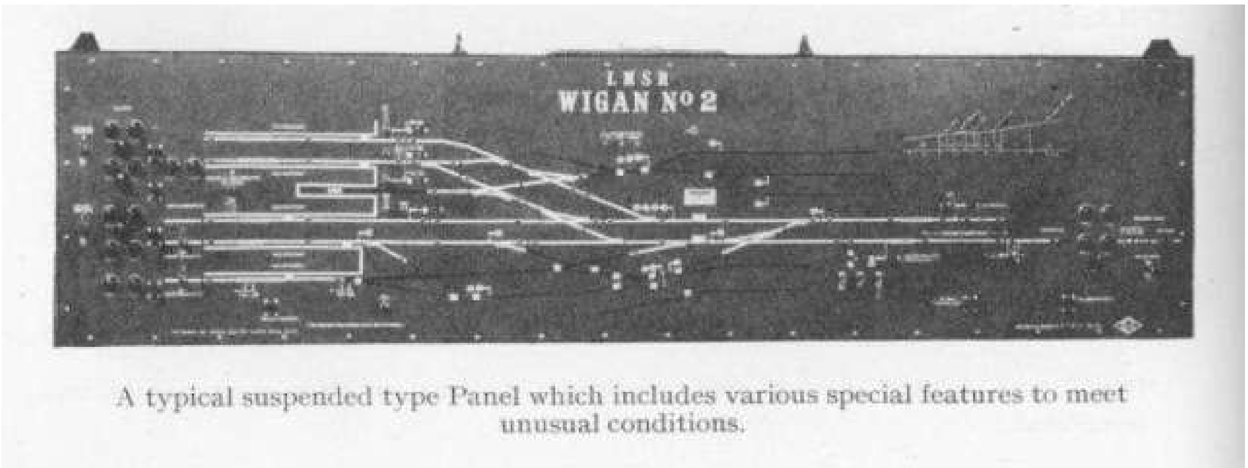


Figure 104 - SGE EB132 Frame / IFS[+] Hybrid, Wigan No.2. © SGE, courtesy Simon Foster

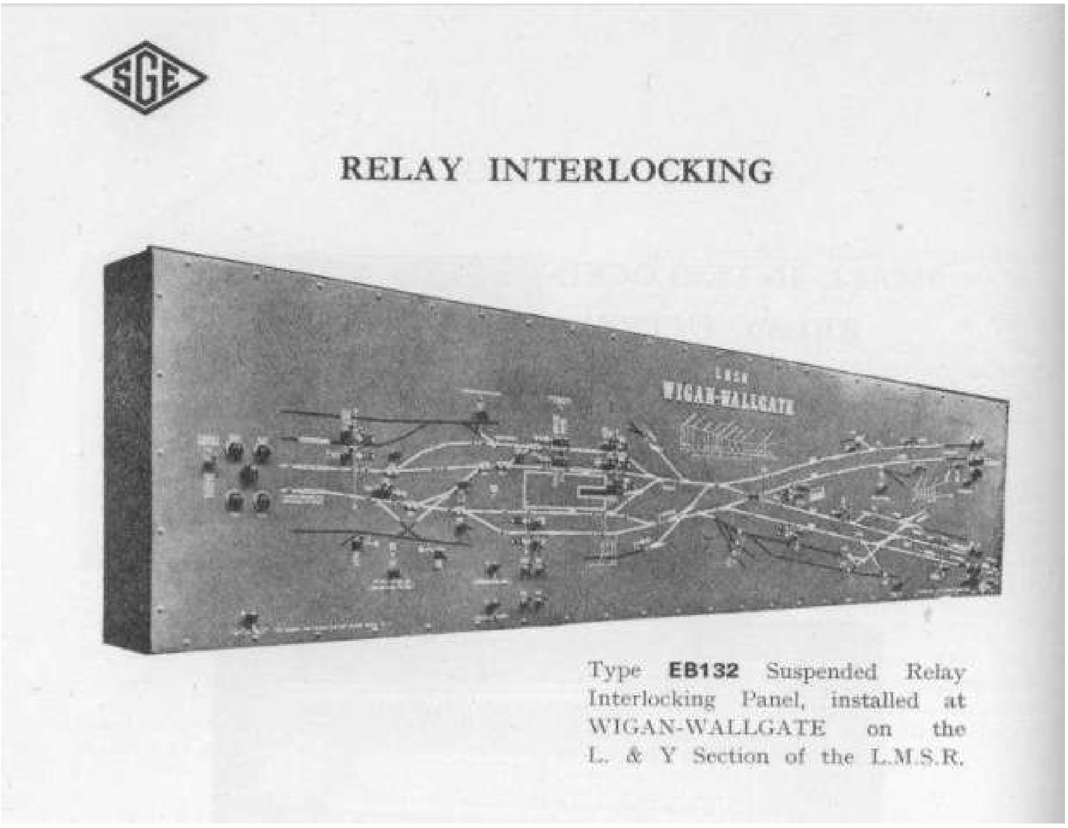


Figure 105 - SGE EB132 Frame / IFS[+] Hybrid, Wigan Wallgate. © SGE, courtesy Simon Foster

The Thirsk interface was developed in 1949 for the GE resignalling with MPK[+] installations at Liverpool Street and Bethnal Green (*Figure 106*). The console-mounted panel diagram was similar, though track occupation was shown by one lozenge-shaped white light in the line of route, but still with no route lights; point position lights were similar but now had a white band on a dark ground, slip connections being shown as strips of light through one large circular window (as used by STC at Doncaster North & South); signal repeaters were shown by On and Off indications as separate lamps on either side of the line of route adjacent to the signal control. A completely different method of signal control was employed, utilising a surrounding selector ring to select one of up to eight routes, with a centre switch turning 90 degrees to clear the signal. Where more than eight routes were available two controls were provided. Signals with only one route just had a simple switch. Controls operating main aspect signals were coloured red and those operating only shunting signals were coloured yellow; there was no split colouring in the case of controls operating both main and subsidiary aspects. A small free-standing IFS[+] was employed at Liverpool Street Yardmaster's hut utilising a similar-style diagram and non-geographically positioned switches.

1956 saw a return to Frame / IFS[+] interfaces with two installations on the Glasgow Central Low Level line. The new style panel's surface was now of green plastic sheet (Warerite) with new style signal switches - as illustrated and described below in connection with NX(TP) - geographically positioned on the fascia.

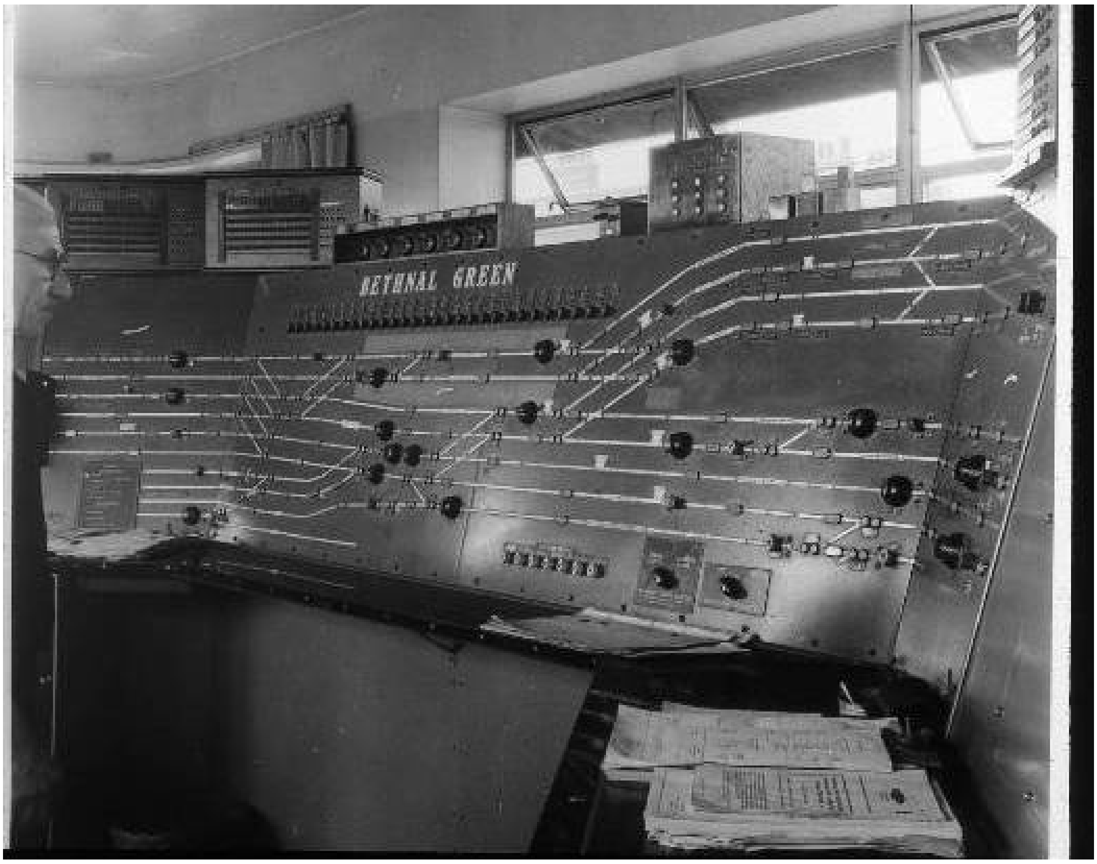


Figure 106 - SGE MPK[+], Bethnal Green. © Invensys Rail Ltd.

MPK was abandoned by SGE after the GE resignalling (although see the description of Rainham below) - with OCS only thereafter being used for LCPs - and attention turned to NX(TP) control in 1958 (*Figure 107*). The interface consisted of an aluminium equipment plate, with fascia plate sheets being of Warerite or metal. Coloured pointed switches for route entrance were large and distinctive, being red for main aspect stop signals, yellow for main aspect distant signals, white for shunts, and green for slots. They were turned up to select main aspects and down to select a shunt or subsidiary, after which the

Perspex exit button - located on the line of route with an arrow inscribed on the head denoting the direction of application - was pushed. Exit buttons for main routes had a black ring, those for shunt routes a white ring. Where a delayed yellow aspect or calling-on facility was provided on a main aspect signal a second exit button, surrounded by a yellow ring, was used. Exit buttons illuminated to indicate a route was set and were never provided where only one route was available; in some cases where only two routes were available the entrance switch turned either up or down to select each one and no exit button was provided (Rainham's panel consisted entirely of signals with no more than two routes so making the true operation MPK[+]). Blue-ringed route option buttons were provided to select alternatives to a destination button, to be pressed simultaneously with it. Running-GPL signals could be placed to danger in emergency after the train had passed the main signal by momentarily turning their switches upwards. Overlap swinging was in accordance with Normal Operation. Signal On / Off indications were shown in a common aperture, either in the signal symbol or near the entrance switch, and flashed if the signal lamp failed. There were no route lights but strip-lights, geographically located in shallow circular insets at each set of points, illuminated showing their position when the route was set. Track circuit occupation was indicated by an illuminating 'lozenge' window on the line of route with generally red lamps, although yellow could be used. Black IPS had N and R indications, as well as a split central indication showing white when the points were locked and a flashing red when OOC. In addition, when points were set by operation of the IPS all associated point position indicators in the line of route illuminated to repeat the position. In later years some of the Kent installations were considerably altered in appearance by the provision of LED indications.

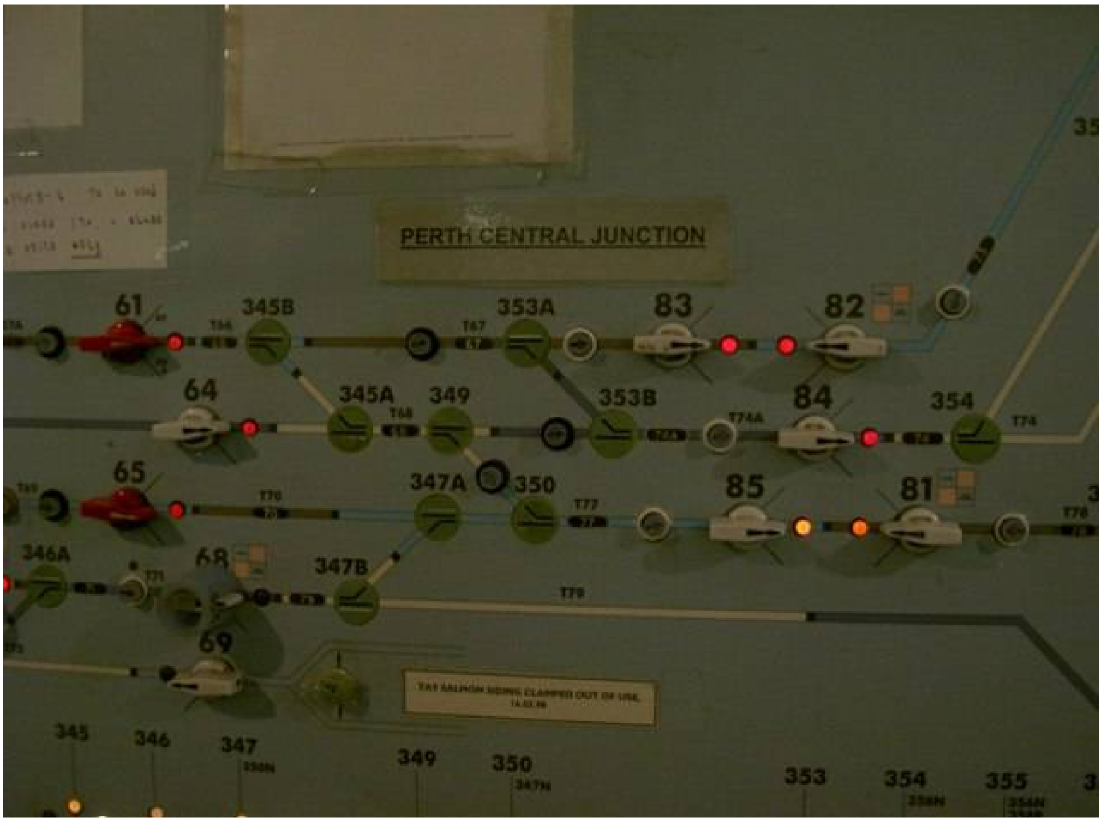


Figure 107 - SGE NX(TP)[+], Perth. © Alan Mackie

Several OCS[-] LCPs were provided for the remote interlockings of Sittingbourne box in 1959 utilising the same style of equipment as the NX(TP)[+] parent panel. The separate illuminated diagram was positioned above the OCS[-] fascia which mounted the pointed points and route switches, all contained within a locked box on the outside wall of the relay room.

The 1958 resignalling of Huddersfield saw an IFS[-] installation consisting of a large desk console of switches with a free-standing illuminated diagram positioned behind (*Figure 108*). The front, horizontal portion of the desk contained the switch descriptions under a glass top in a style reminiscent of an SGE All-Electric PF(L). The switches, of NX(TP) pattern, were positioned on a sloping surface to the rear with points switches at the top, main aspect signal switches below, and shunt and subsidiary signal switches at the bottom, complete with indications. A vertical section at the back contained telephones and block instruments etc. and was fitted out by BR(NER). The illuminated diagram featured route lights.

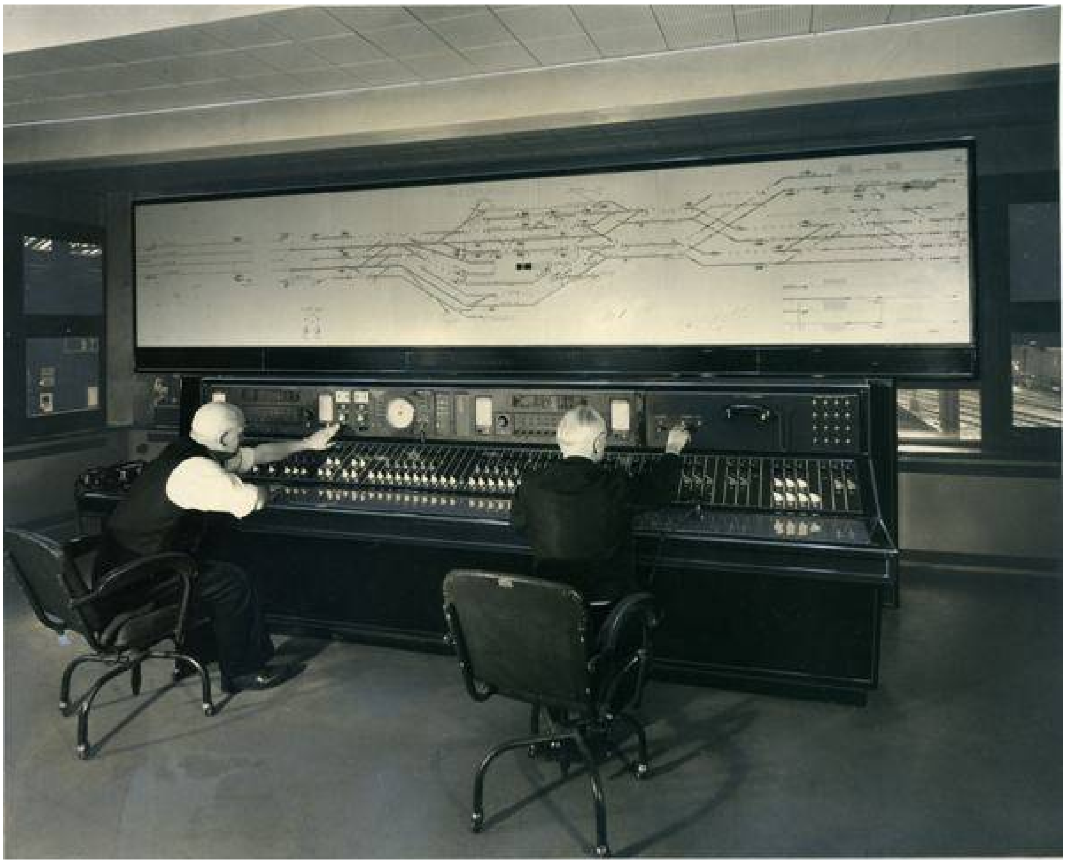


Figure 108 – SGE IFS[-], Huddersfield. © Greaves Photographers Ltd (Andrew K Overton Collection)

In 1959 a blockshelf-mounted IFS[-] at Farningham Road used the NX(TP) switches, mounted on a green fascia and contained within a grey box with rounded edges. Another pattern used in the 1960s utilised slot-in, removable modules for each function contained in an angular, shallow steel box, with block instruments and bell tappers fitted with their own module (*Figure 109*).

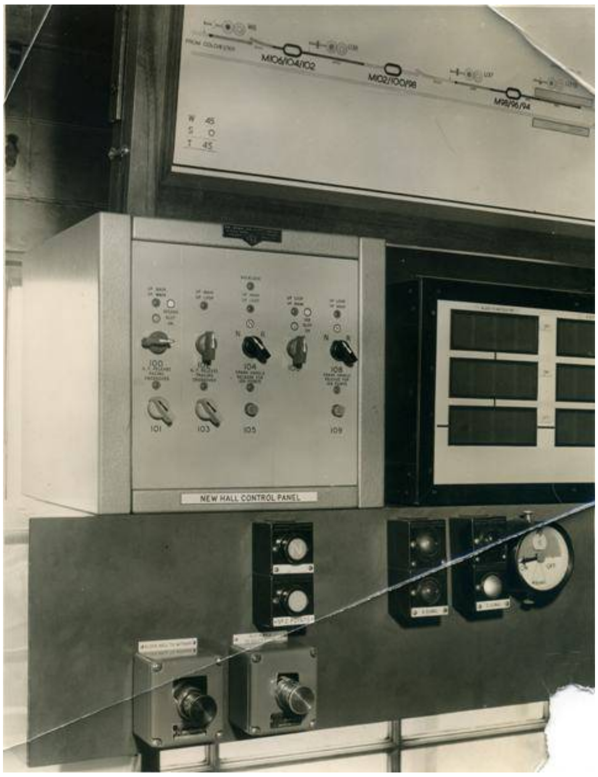


Figure 109 **-** *SGE IFS[-], Chelmsford. © Michael Barnett Photography (Andrew K Overton Collection)*

Late 1960 also saw the provision of blockshelf-mounted IFS[+] at Craiglockhart and Morningside Road (*Figure 110*) in a console of the same design as at Farningham Road. The IFS[+] took the place of the illuminated diagram for the lever frame-operated area, in addition to providing the interface for the IFS-operated area through geographically positioned switches. The style of switch changed to one of smaller, more rounded profile. Main semaphore signal repeaters, block instruments and telephones were all incorporated in the IFS[+]. Track circuit occupation was indicated by white lamps.

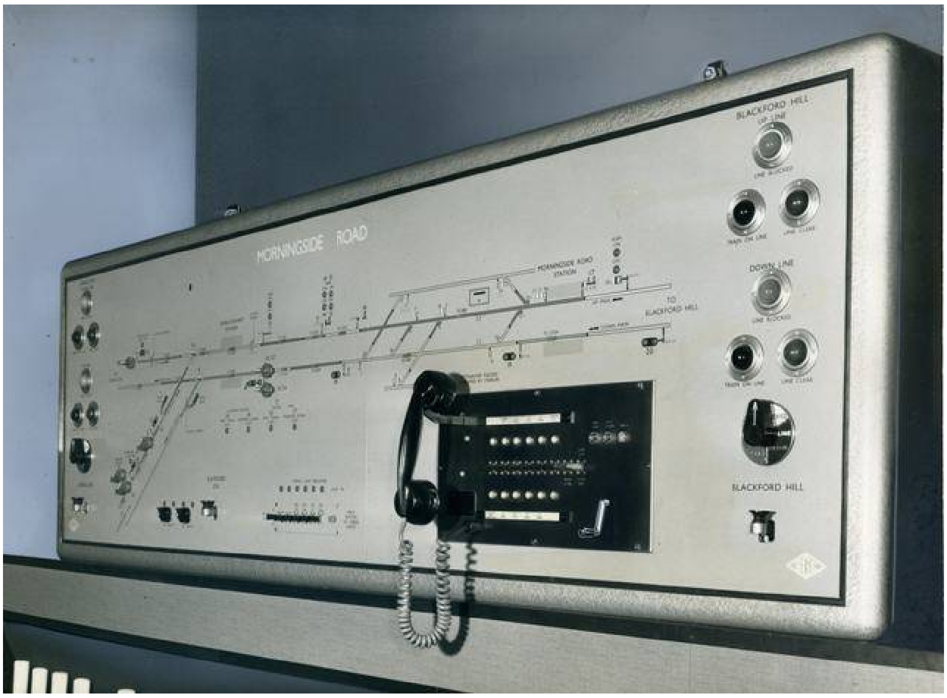


Figure 110 **-** *SGE IFS[+], Morningside Road. © W Ralston Photography (Andrew K Overton Collection)*

A NX(PP) design was introduced in 1961 consisting of separate equipment and fascia plates of large metal sheets mounted in a smooth cornered pressed-metal console (*Figure 111*). The design was unique in utilising two push-buttons in place of each IPS. When used to call the points the respective button illuminated and had to be pulled before the other could be used, or route-setting be reverted to. The usual N and R indications were provided, along with either a white Free (which flashed for OOC) or a flashing red OOC light to suit regional preferences. The route-setting push buttons were of a largely steel construction, having a small window for illumination in the centre of a coloured plastic head and with no escutcheon. Signal On / Off indications showed through a single aperture in the signal symbol head. Alternative overlap selection was effected by IPS operation, or by alternative exit buttons placed at the overlap extremities, to suit regional preferences. Alternative entrance buttons in combination with alternative exit buttons were used to select subsidiary and delayed yellow aspects. In other respects Normal Operation was used. Both combined and separate versions of the panel were manufactured and although installations were at relatively few locations they were at significant Modernisation Plan boxes. These panels were also used as wall-mounted LCPs positioned either within, or without the relay room as with the Sittingbourne installations.

Figure 111 - SGE NX(PP)[+], Witham. © Michael Barnett Photography (Andrew K Overton Collection)

Also on the LT&S, the same style of panel was used for NRNX Hybrid installations with the points worked by a lever frame and indicated by 'N' and 'R' in line with the respective levers on the panel above, NX operation only being used for signal clearance. The moulded fibreglass console box was mounted on columns behind the lever frame, with sealed releases for the points being integral with the fascia. A small IFS[+] was also provided at Rippleside level crossing as part of this scheme, consisting of a desk-style console with NX-type push-button operation of signals.

In 1964 the NX(PP) design was modified for the installations at Bletchley, Rugby (*Figure 112*) and Willesden Jcn. The button-operated IPS arrangement was replaced by a conventional switch of the same design as used in the late-1960 Scottish IFS[+] and also used elsewhere on the panel, but the route setting button design was unchanged (*Figure 113*). These IPS had only Normal and Reverse indications with them and no OOC lamp. With this panel alternative overlaps were selected by the pushing of the required exit button, one of which was provided at each overlap limit. Overlap swinging was effected by pushing an alternative exit button. An IFS[-] was also designed with these switches, consisting of the same grey box described above but with a white Traffolite fascia divided into pull plates, with small flush-mounted indication lamps.

Figure 112 - SGE NX(PP)[-], Rugby. © BR(LMR) (Andrew K Overton Collection)

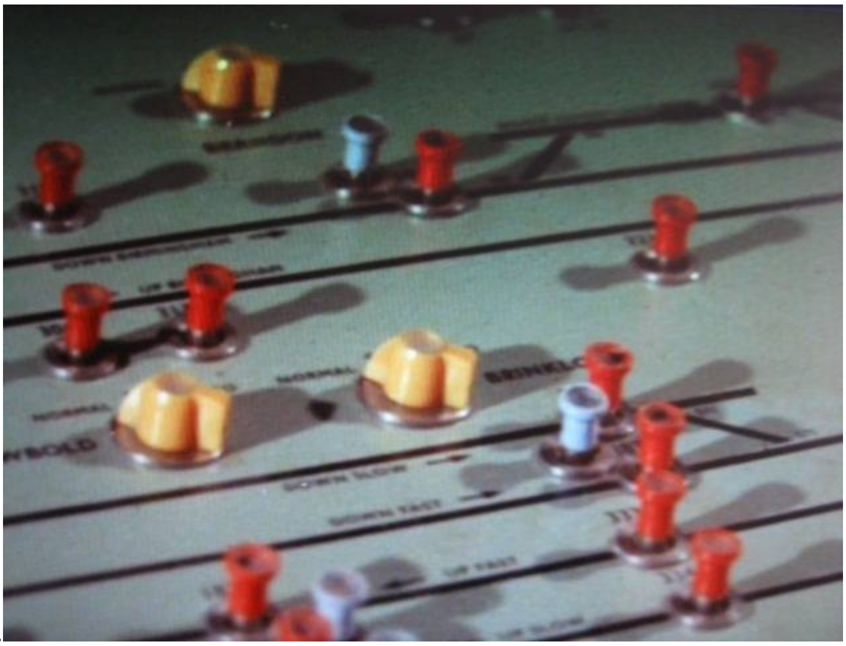


Figure 113 - SGE NX(PP)[-], Rugby. © British Railways

No further SGE panel installations took place after 1965 and with the merger with AEI in 1967 the brand was effectively dead, the latter company having already established its own NX(PP) product. In later years the buttons of the NX panel proved to be flawed and subject to excessive levels of breakage and as spares dried up in the 1980s many were prematurely replaced.

Siemens [Interfaces commissioned 2003 - date]

Initially having limited impact in the UK signalling market but with the takeover of Invensys Rail from 02/05/2013 it gained access to former Westinghouse products, which it continued to produce.

Introduced the VICOS OC (Vehicle & Infrastructure Control & Operating System Operations Control) WS-based system in 2003 at Havant ASC, which was based on PC technology and a Windows operating system (*Figure 114*). The overview screen in this system was a large wall-mounted display and the workstation consoles only had the detailed view screens on them. There were no trackerball or command buttons, all operator commands being via keyboard and mouse. The screen background was light grey and lines were shown black, changing to white and red with routes set and track circuits occupied respectively. The position of all points was shown continuously, whether routes were set or not, by a strip of white light on the line of route corresponding to their lie (*Figure 115*). The signalling display on both the detailed and overview screens was the same. Operation followed normal practice.

This system allowed WSs to be assigned to certain interlockings and could be changed throughout the day as traffic and workloads fluctuate. It was compatible with both electronic and relay interlockings. A timetable processor allowed timetables in electronic format to be imported into the system to be used by an automatic route setting system but this feature has not been used in a British application to date.

Figure 114- Siemens VICOS OC 100 WS, Bournemouth ASC. © Danny Scroggins

Figure 115 **-** *Siemens VICOS OC 100 WS, Bournemouth ASC. © Danny Scroggins*

Around 2014 WestCAD the Mk2 version of WestCAD was replaced by WestCAD MCR (Modular Control Rack). The video and serial port system changeover hardware was now built into the main rack rather than being provided as separate racks within the cubicle, as was the standard for the Mk1 & 2 systems. This meant that multiple WestCAD systems could populate a single equipment room cubicle, or the WestCAD could even be placed into the workstation desk itself. Upgrades to Mk1 & 2 systems to MCR were undertaken as part of other work. The WestCAD installations at Three Bridges ROC from December 2014 saw the UK introduction of trackerball-less controls, with commands now being input via a standard computer mouse (or keyboard).

Signalling Control UK Ltd. [Interface commissioned 1997]

One of the engineering business units set up by British Rail in the lead-up to privatisation. Became a subsidiary to Westinghouse in 1995.

Designed a block-shelf mounted IFS[+] for Woking in 1997 which consisted of a grey box containing an illuminated diagram with a grey fascia plate and small, raised LED indication lamps. Inset into the fascia below the diagram were two boxes of generic switches (one for points, one for signals). This worked Hybrid with the Westinghouse Style L PF(L) for a few months prior to the box's closure.

Standard Telephones and Cables Ltd. (STC) [Interfaces commissioned 1949 - 1961]

This company designed only four panels for the British market, all MPK[+]. All were of distinctive designs - Doncaster North (*Figure 116*) and South boxes in 1949, and Pilmoor and Tollerton in 1960 and 1961 respectively. In the Doncaster installations routes were selected by pulling and turning multi-position, geographically located 'cotton bobbins', setting a pointer to the appropriate route setting on the tear-drop shaped dial, then pushing it home (up to 12 routes were possible). Signal On and Off indications were given by red / green lights positioned ahead of the bobbin in the direction in which the signal applied, straddling the line of route. Point indications were shown at small geographically positioned windows, with illuminated strips of light either straight or inclined 45 degrees along the set line of route. Complex points with slips had one large circular window. No point indications were shown at IPS. Signals with only one route had a switch, normally pointing up, and turned in the direction of travel for clearance. No route lights were provided, with track circuit occupancy indicated by a white light showing through a lozenge-shaped window on the line of route: this also showed the track circuit number. Lines were depicted by different colours painted on a dark green panel of large steel sheets.

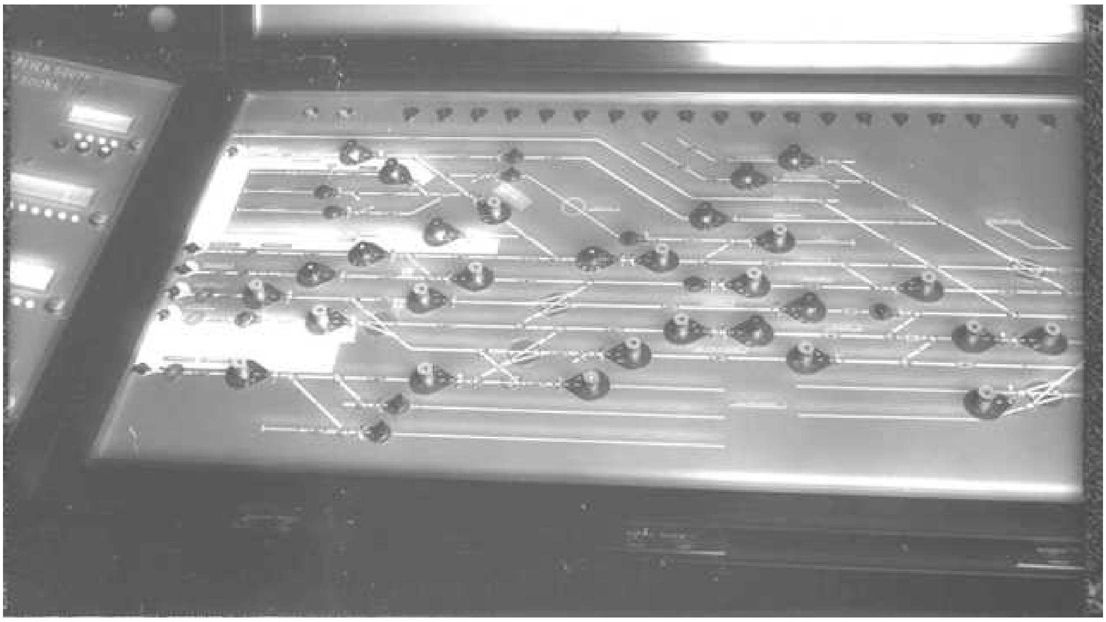


Figure 116 **-** *STC MPK[+], Doncaster North. © Collection Andrew K Overton*

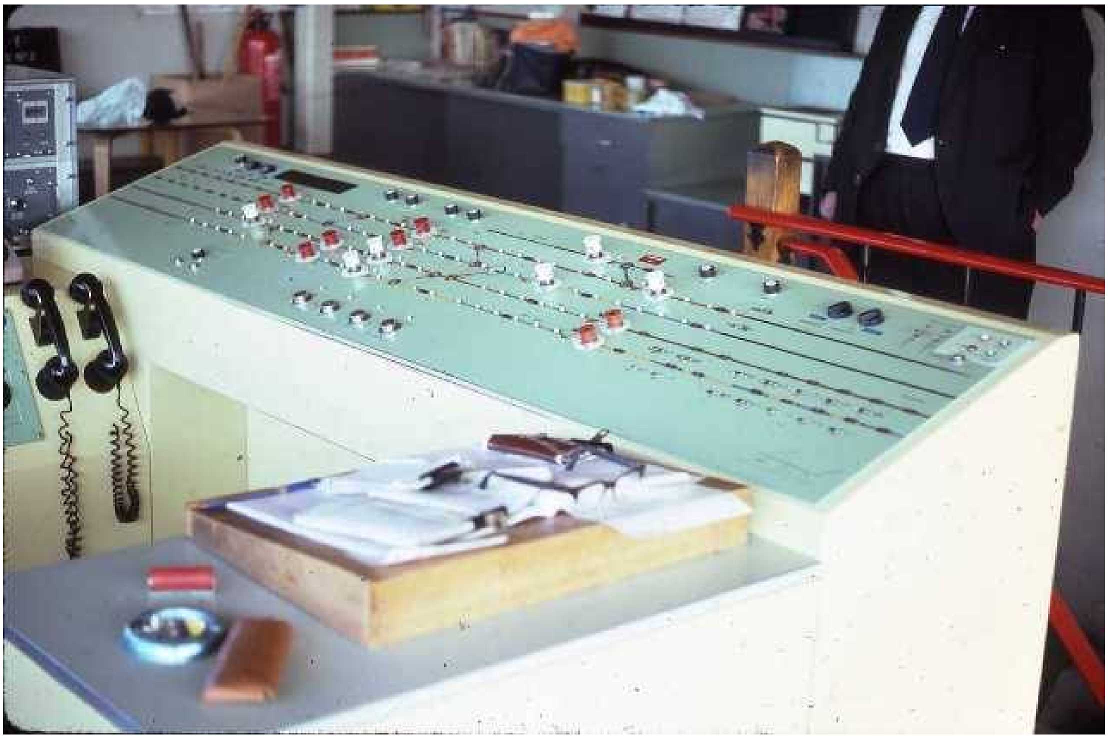


Figure 117 **-** *STC MPK[+], Tollerton. © CJ Woolstenholmes*

The later installations at Pilmoor and Tollerton (*Figure 117*) used 'cotton bobbins' exclusively for all signals. Route lights were now provided as well as the lozenge track circuit lights. The panel surface itself was of more modern sheet steel design in a moulded fibreglass console and the indication lamps were of contemporary design.

Swissinco [Interfaces commissioned 1982]

This company supplied panel components to ML Engineering from 1980 but one installation at least appears to have been entirely their own work.

In 1982 a BR(ScR) led resignalling at Barassie was supplied with an NX(PP)[+] from this company. It would appear that, unlike the situation with the later ML Engineering utilisation of this product, Swissinco provided a complete working interface. The panel utilised distinctive rectangular separate track circuit / route lamp windows and LED indications, with a 48mm square metal tile which was unique at the time. The tile size was based on the DIN (German Standards Institute) specification for mosaic control systems of 24mm, being a multiple thereof. This style of panel was also sourced by ML Engineering from 1980 as described under that design manufacturer and no further direct supply of fully functioning, complete interfaces seems to have been made by Swissinco.

TEW [Interfaces commissioned 1992 - 2015]

Formed in 1914, in 1980 the company obtained the UK license for the German Subklew mosaic control panel system, used predominantly in industrial applications. They entered the UK rail interfaces market with their first installation in 1992. In 2004 they bought out the German company. A lot of work for the privatised railway and the major supplier of panels in Britain today. From 15/01/2015 TEW were bought by L B Foster and subsequently traded as a wholly owned subsidiary.

The main design from this design manufacturer for the rail systems in this Register was their mosaic panel range - the SM series. The most common was the SM48 model with a DIN-standard plastic tile size of 48mm x 48mm (*Figure 118*), although a 40mm x 40mm tile was also produced (SM40 panel). The latter was usually only employed where size constraints, or the need to match to existing interface dimensions in renewals, made it more suitable. The 24mm tile (SM24) was the original industrial applications model and was used in a rail application at Neville Hill Depot. Green and grey tiles have been produced to suit regional preferences. Owing to tile size, following the decision of EB Signal in 1991 to cease sourcing panel components from EAO, TEW SM48 panels were more readily recognised from that date, although Contelec Engraving's arrival from 2007 introduced new identification difficulties. From the mid-1990s by far the most work for interface supply in Britain was assigned to TEW, both acting alone and as sub-contractor any one of the infrastructure renewal companies. Before 2007 TEW interfaces were distinctive in using a matt textured non reflective surface finish, rather than a gloss mirror finish, and a plastic tile, but Contelec Engraving's product was almost identical.

Both IFS, NX(PP), NX(DB) and OCS Panels used their own brand of Series 51 buttons, looking similar to Swisstac buttons, and switches with a distinctive white outlined triangle on the head. Signal On / Off indications were generally given in the head of the signal symbol in a common window, but a smaller number of interfaces had separate On / Off lamps, being used particularly for repeaters or distants (*Figure 119*). Normal operation was employed. Non-standard designs have included: The Neville Hill Depot IFS[+] of 2001 which followed the BR(ER) predecessors here, utilising 'one push' geographically located signal and points-ends buttons; the 2004 OCS[+] at Filton Abbey Wood LCP which utilised metal toggle-switches were for route selection; and the 2005 IFS[+] at Camden Road Jcn, utilising 'one push' geographically located signal buttons but with conventional points switches, being notable for the provision of route lights. The NX(DB) system was employed in only one panel, at Seamer. The SM24 panels were more distinctive owing to the small tile size employing the black-rimmed route / track circuit lamp apertures in the tile reminiscent of later Westinghouse panels.

Figure 118 - TEW SM48 NX(PP)[+], Brocklesby Jcn. © Andrew K Overton

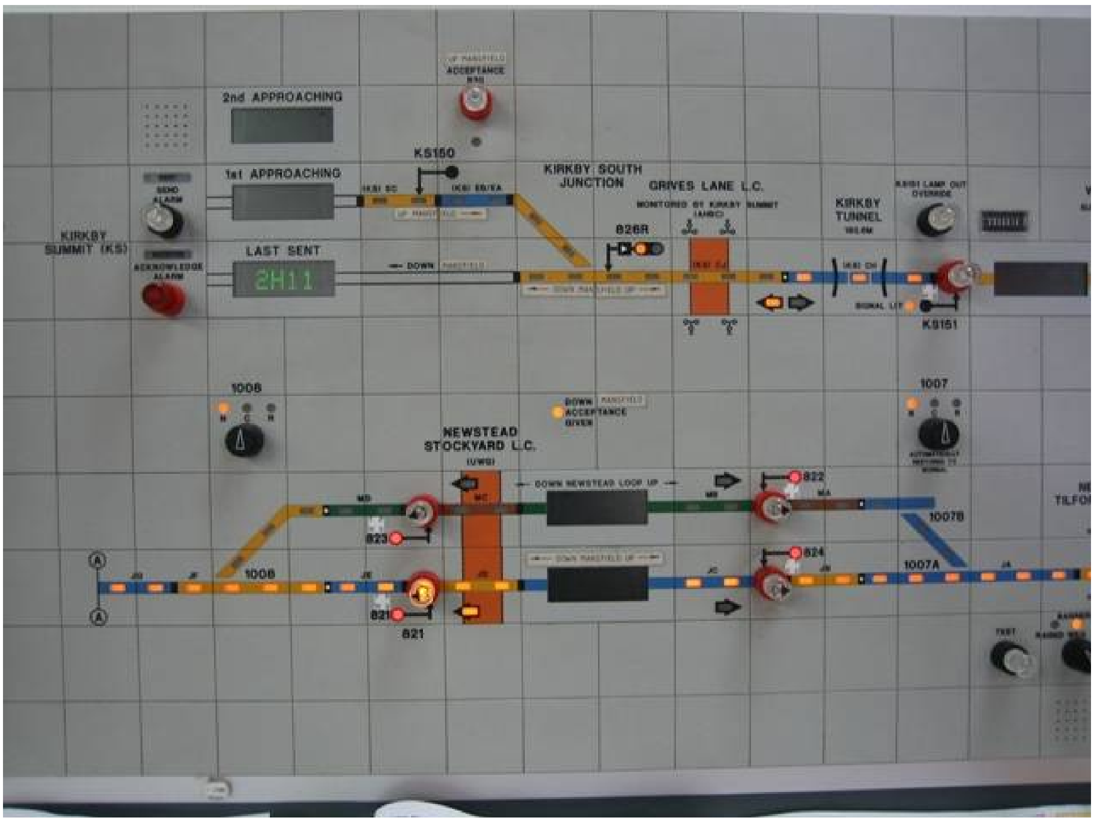


Figure 119 - TEW SM48 NX(PP)[+], Trent (Robin Hood Panel). © Andrew K Overton

The SM range has also been used in small ERS and ROC in connection with WS applications and it should be noted that in the case of those provided for Westinghouse WestCAD installations these often bear this company's logo (*Figure 120*).

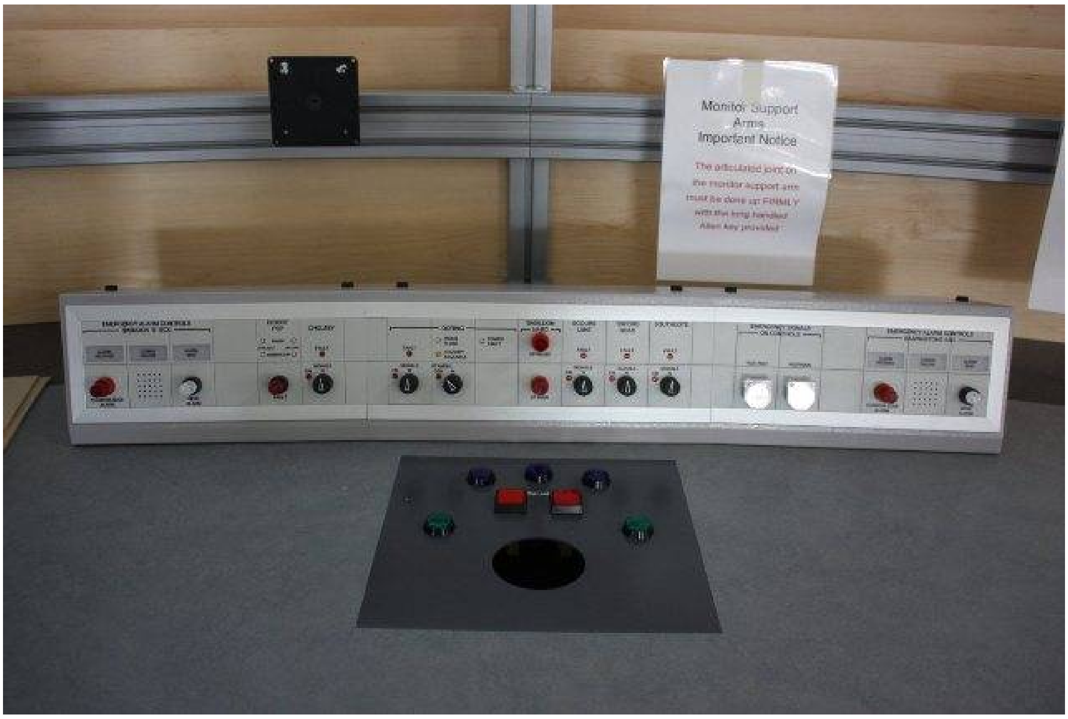


Figure 120 - TEW SM48 ROC, Thames Valley SC (Workstation 4). © Danny Scroggins

A small number of interfaces have been designed with a sheet fascia - of steel, reverse printed polycarbonate, or laminated paper - rather than with mosaic construction (*Figure 121*).

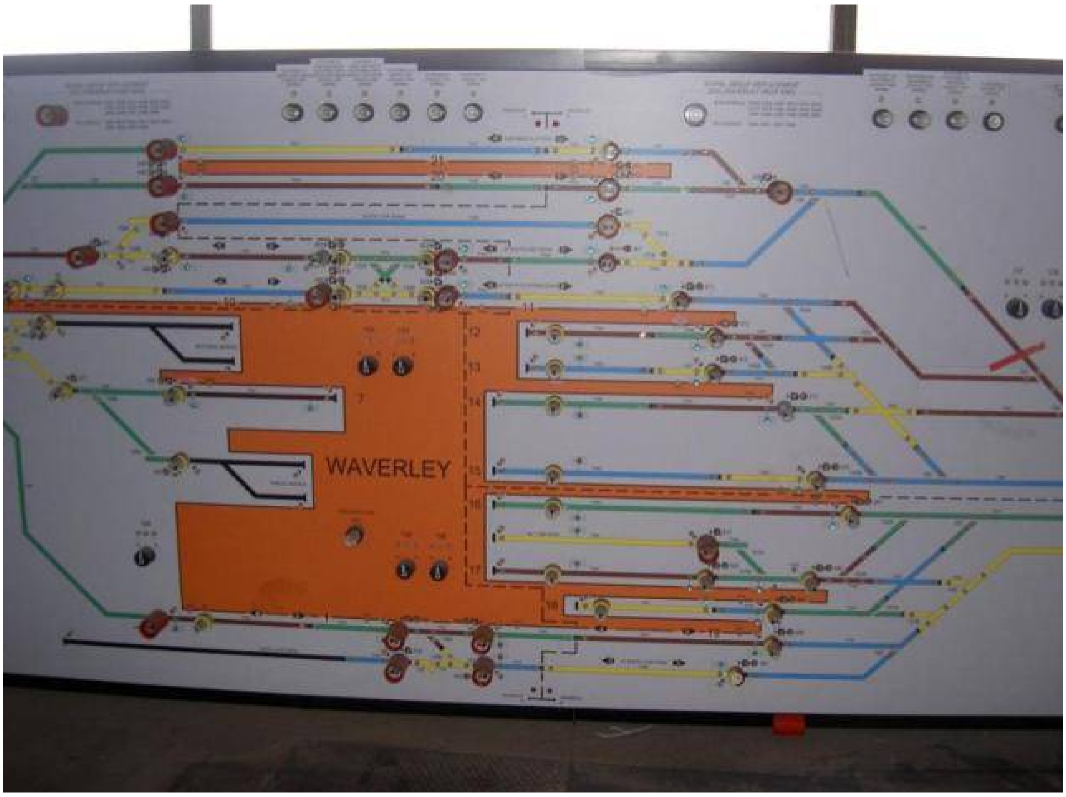


Figure 121 - TEW NX(PP)[+], Edinburgh SC. © Alan Mackie

Figure 122 - TEW SM40 OCS[+], Romiley Jcn. © Andrew Gardiner

The early 21st Century has seen some life expired interfaces being replaced in the existing console shells, either completely or with just new fascias and buttons etc.. TEW have been the major supplier for this work and the replacements have generally followed the style of the replaced panel for convenience and to avoid any need to alter the associated circuitry. Replacement of former BR(LMR) OCS[+] in the NW of England saw this format copied with signal On / Off indications given with the associated switches (*Figure 122*).

The IFS[-] range was introduced at Sleaford East in 2011, utilising black switches for all functions with a coloured disc on the tile around the switch axle to denote function, and with 'pull-plates' engraved below.

Tiefenbach Gmbh [Interfaces commissioned 2001 - date]

West German company specialising in control systems. Bought out by fellow Germans Pintsch Bamag AG in 2012 to become Pintsch Tiefenbach GmbH.

Developed a WS based operating system called TMC RaStw for controlling depots and yards, including some ARS, based on standard PC technology. Operation was achieved by mouse and the clicking of on-screen options.

Unipart Rail [Interfaces commissioned 2006 - date]

Formed from the takeover of NRS by Unipart in 2006. The York workshops closed in late 2019 with production being transferred to Crewe.

Continued supply at the York workshops of the old BR(ER)) and NRS interface designs, as well as design of matching replacement and extension sections for existing interfaces.

Figure 123 **-** *Unipart Rail KL, Denton Village. © Andrew K Overton*

In 2009 they designed a new KL utilising a different style of key lock for new installations. Consisting of Imhoff extrusions with sheet steel infills, pained grey, with a hinged white-painted metal fascia mounting the controls, this could be seen as an evolution of the original design (*Figure 123*). An integral ERS was combined on the same fascia plate.

In connection with TDM replacements on Network Rail Western Area the company supplied a LOC to the BR(WR) E10k LOC design.

Note **-** *Some interfaces bear the names of the customers for whom they were made.*

Vaughan-Harmon Systems [Interfaces commissioned 1986 - 1998]

Originally formed in 1959 as Vaughan Programming & Services this company went on to carve a niche for itself in the train describer equipment market. Taken over as Vaughan Systems by Harmon Industries Inc. in 1996. Taken over by General Electric Transportation in 2000.

The system which was to be rolled out as the GETS Modular Control System (MCS) WS operating system was developed by Vaughan-Harmon Systems in conjunction with Chris Thompson and Kevin Mears of BR The system was trialled at Leicester PSB in 1986 as a combined train describer and workstation operating system, and this enabled the setting of routes using the screens as an alternative to the NX panel (*Figures 124 & 125*). 'Long routes' could be set using the WS system and it was also possible to initiate and end route-setting using either the panel or the WS, i.e set the entrance with the WS and press an NX exit button or vice versa. Controls on the signal box supervisor's desk allowed different components or areas of the WS system to be brought into use, or locked out. However, although the route-setting facility was commissioned it was somewhat ahead of its time and was not entirely satisfactory. After initial regular use it was then used only sporadically and later constantly locked out, although the VDUs were retained for TD purposes.

Figure 124 – Vaughan Harmon WS, Leicester. © Manchester Locomotive Society

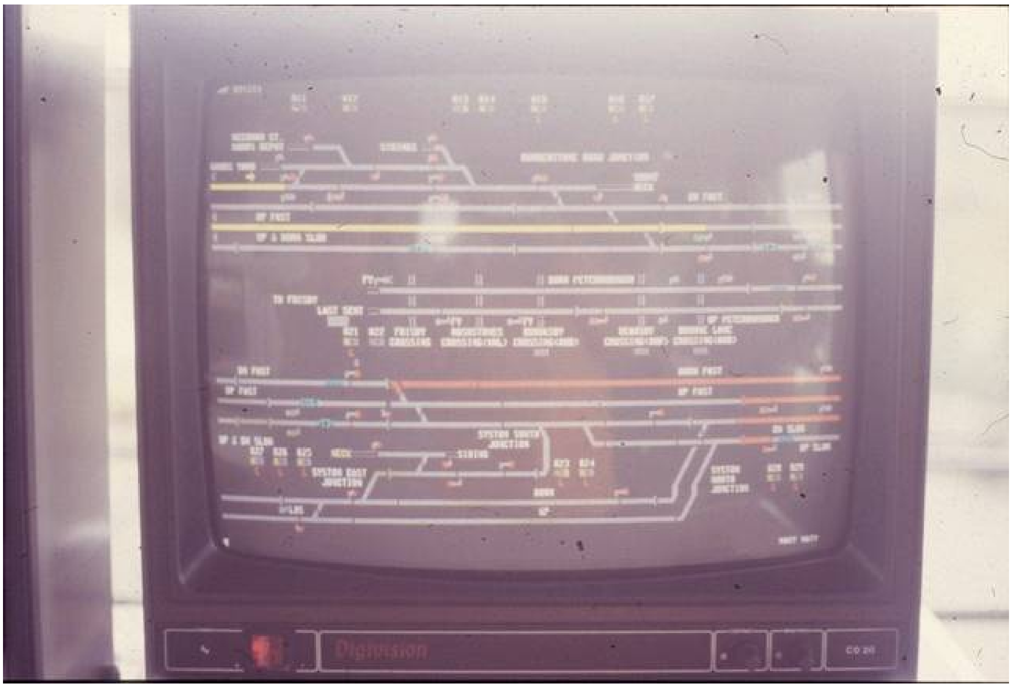


Figure 125 – Vaughan Harmon WS, Leicester. © Manchester Locomotive Society

Further developed in later years into MCS, it was used at Eastbourne in 1998 where it was again installed as an alternative form of control to a pre-existing NX panel. In this form the system used proprietary PC technology for the WS interface, utilising mouse and keyboard controls allied to large flat-screen VDUs, often grouped together to provide a view of a large area. MCS was capable of interfacing with relay interlockings, SSI and later CBI. This installation was a trial and, although successful, was short-lived and the system as subsequently developed for commercial use utilised a completely different SSI interface protocol. No automatic route setting facility was provided.

Also supplied IECC operating system hardware to the original BR Research / Sema Group design without further development for Marylebone IECC in 1991.

Voestalpine [Interface commissioned 2015]

Continued to produce CONTEC Transportation Systems interfaces after combining with that company in 2005.

W R Sykes [Interfaces commissioned 1883 - 1907]

Sykes installed a Frame / IFS[-] Hybrid arrangement at Victoria Hole-in-the-Wall on the LCDR in November 1883. This was an adaptation of a conventional lever frame worked layout, wherein electrical banner signals for shunting movements were selected by the use of a two-way switch (for inward or outward shunts) and cleared by the pressing of a 'key'. Interlocking was mechanical and achieved by the partial movement of the lever of the main semaphore arm prior to operation of the banner signal controls. This system was used again at St Enoch in 1898 before being replaced here in 1902 by the better known Electro-Mechanical system.

The company used a variation of their Lock & Block system on the single line Cairn Valley Light Railway in 1905, consisting of electrical banner-repeater-style signals working in conjunction with the block instruments of the single line sections. The signals could be controlled to danger independently of the instruments by ERS[-] affixed to the block shelf in front of them. Certain other signals were individually controlled by IFS[-] working as Hybrid with the lever frames which worked the points.

Westinghouse [Interfaces commissioned 1929 - 2008]

Underwent various subtle changes of name throughout its history but always 'Westinghouse' in some form. As part of the Invensys group of companies, renamed Invensys Rail Systems from 01/09/2009.

Westinghouse first entered the field with what was claimed to be the first relay interlocking panel in Britain, with the IFS[+] at Goole Bridge (*Figure 126*). This is a somewhat debateable claim given that SGE had commissioned Sessay Wood more than two months earlier, albeit allied to a mechanical frame for point operation, but nevertheless utilising relay interlocking. The style of diagram with white-outlined lines filled in colour to denote TCs, imposed on a black background, was similar to that being used for illuminated box diagrams. TC occupation was shown by two white lights. Black and red thumb switches were positioned below for point and signal operation respectively, along with associated indication lamps. This general style was repeated in the next, much larger, installations at Leeds East and West, but here the panel background was olive green and this was to become the house-style. Thumb switches for points (at West only, East having points worked by a frame) and signal operation were now geographically positioned on the diagram, with On and Off, and N and R, shown next to the signal and point switches respectively. In addition to the red and black switches employed at Goole white switches were used here for shunting signals. No point 'locked' lights were employed.

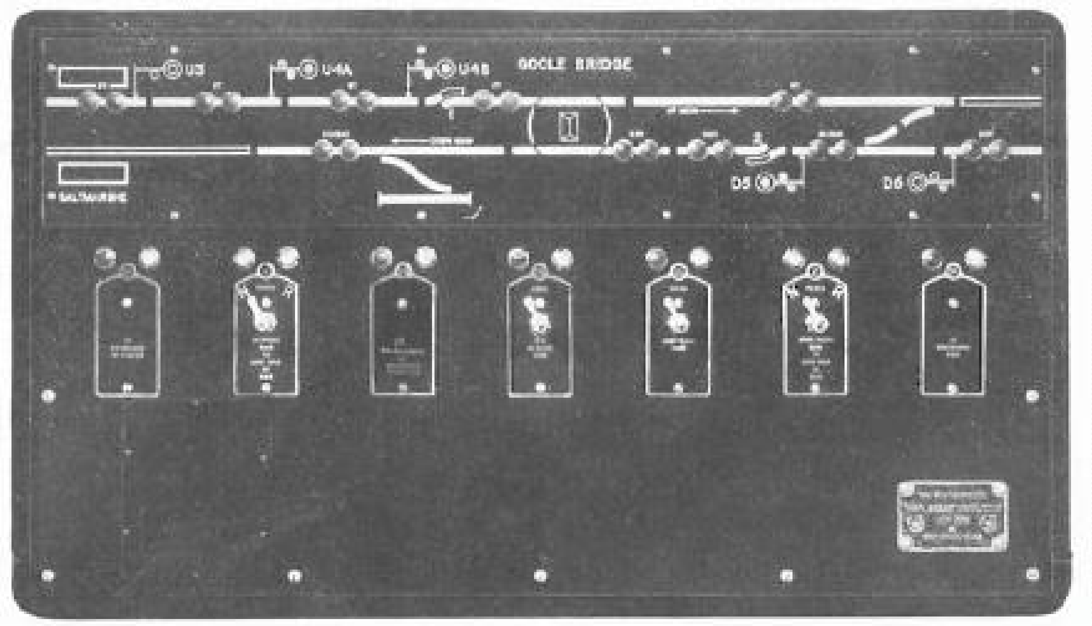


Figure 126 - Westinghouse IFS[+], Goole Swing Bridge. © Siemens.

In 1938 the company's first OCS installation at Hull Paragon was commissioned, destined to become a major product for them. This installation's separate indication panel followed the general style used at Leeds but the white track circuit lights gave way to red, with point detection being given by two windows at the points showing a white light with a black band aligning with the line of route set. The control panel consisted of a black Traffolite desk console on which were mounted the route switches (red for main aspects, white for shunts with signal number engraved on top). On the vertical rear section were positioned black IPS of a different pattern. No point indications or OOC lights were given with the IPS and there were no route lights (*Figure 127*). This was improved with the OCS at Northallerton in 1939, with a similar diagram except that white route lights were provided, rendering the point position windows unnecessary (*Figure 128*). This was the first use of route lights in a route-setting panel and an undisputed first for the company. The track circuit lights were separate, consisting of only two red lamps in contrast to the row of route lights. Normal route-setting panel operation was employed. Signal On / Off and IPS indications were now given with the respective switches rather than on the illuminated diagram, but still no OOC lights were provided. Detonator placer switches were green. In both the Hull and Northallerton installations the indication panel and switch console were one large unit. This new type of diagram was used as a panel mounted above a frame as a Frame / IFS[+] Hybrid on the ECML at Eryholme in 1939 with geographically positioned switches.

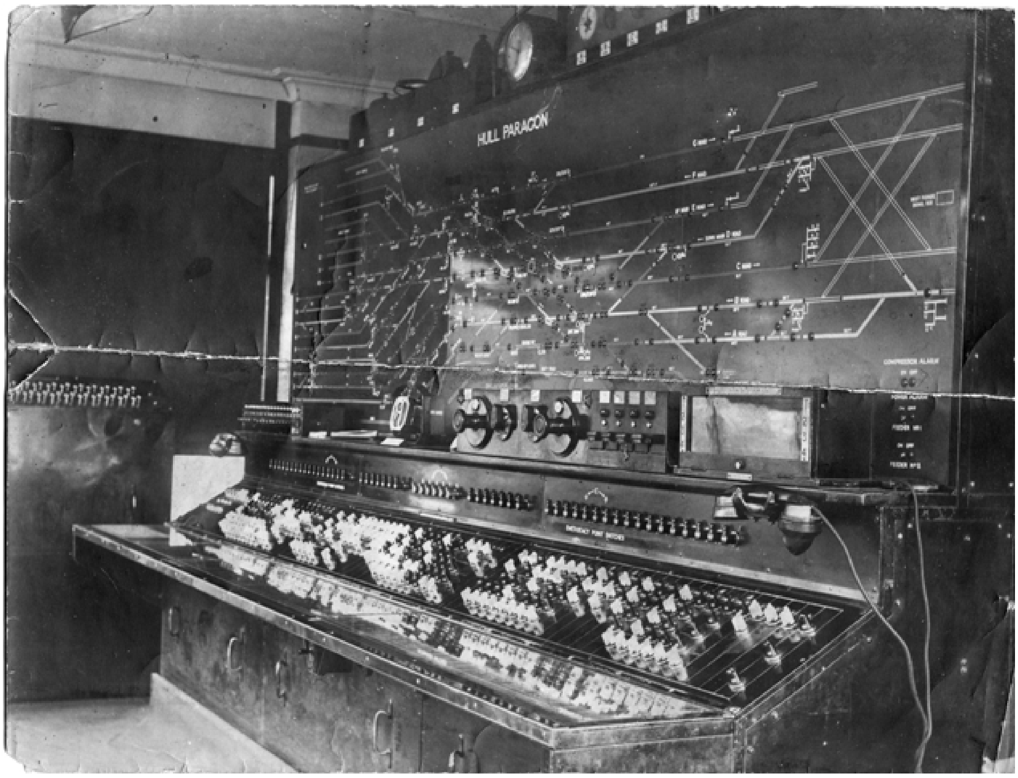


Figure 127 - Westinghouse OCS[+], Hull Paragon. © Nick Fleetwood

Figure 128 - Westinghouse OCS[+], Northallerton. © John Midcalf

Westinghouse were also leading in the field of marshalling yard panels, installing IFS(Y)[+] panels at Whitemoor in 1929 and 1933, Hull Inwards Goods Yard in 1935 and Severn Tunnel Jcn in 1939. The latter two installations had the facility to set routes by operation of siding allocation buttons but presetting of multiple routes was not available. Those at Whitemoor were complex IFS(Y3)[+] with electro-mechanical (Down Yard) and all-electric (Up Yard) storage siding allocation drums, enabling the first seven sets of points in the route to be pre-programmed with further points being operated by thumb-switch: these were the first (Y3) interfaces in the UK. The interface consisted of points thumb-switches geographically positioned on the fascia: those capable of pre-programmed operation having a central position as well as Normal and Reverse. Normal and Reverse indications were shown by geographically positioned lamps on the line of route corresponding to the points switch tip. Track circuit occupation was indicated by a lamp in the centre of the points switch and on the Up Yard interface physically locked the points switches. Eight route setting levers were provided on the Down Yard interface for pre-programming the storage drum, with one multi-position rotary selector handle on the Up Yard interface.

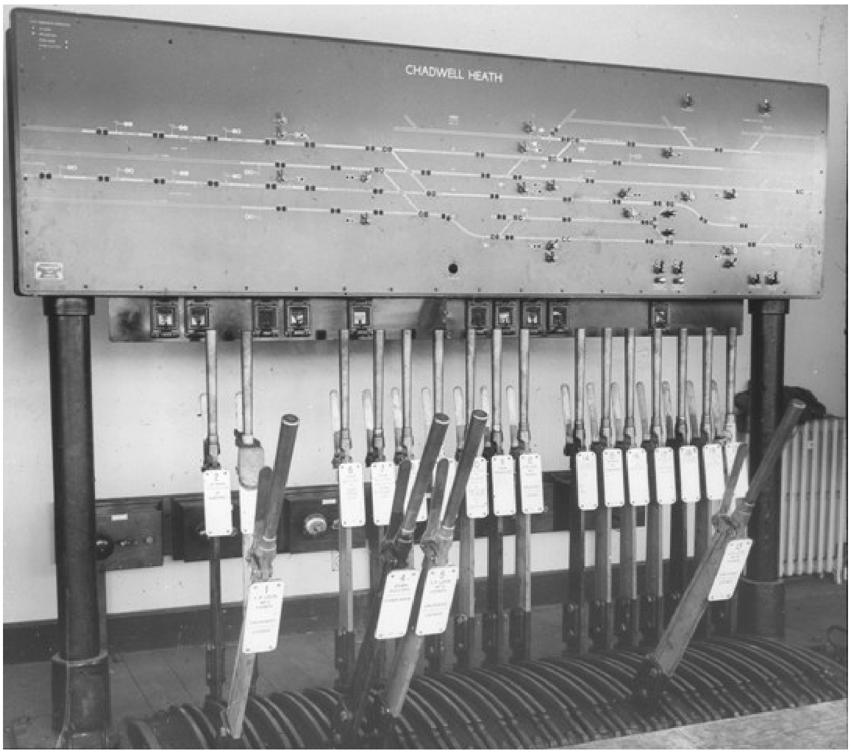


Figure 129 - Westinghouse Frame / IFS[+] Hybrid, Chadwell Heath. © Siemens.

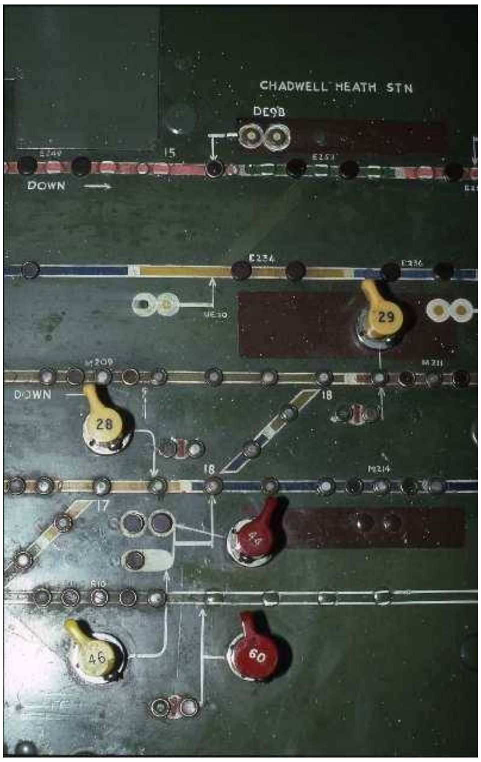


Figure 130 - Westinghouse OCS[+], Goodmayes. © CJ Woolstenholmes

Post-WWII, installations following pre-war style were perpetuated on the GE electrification in 1949 with several Frame / IFS[+] Hybrids. However, the signal On / Off indications were now given in the head of the signal symbol and switches for subsidiary and shunt signals were yellow. (*Figure 129*). A similar panel was used at Goodmayes but this time in a desk console with OCS[+] operation, switches being geographically positioned on the diagram (*Figure 130*).

Figure 131 - Westinghouse OCS[-], Cowlairs. © CJ Woolstenholmes

Figure 132 - Westinghouse OCS[-], Newcastle. © Siemens.

The Modernisation Plan brought orders for large OCS, with Westinghouse making this interface type their own. Some very big consoles of switches were provided, being utilised in conjunction with the associated illuminated diagram technology which developed into newer styles through the 1950s, now free-standing. IPS on these large panels were positioned to the rear of the desk of route switches and a white 'free' light was provided, which also provided the OOC function (*Figure 131*). At Dumfries Station in 1957 another frame hybrid scheme was employed with switches for the IFS and OCS elements non-geographically positioned. Throughout this period the interfaces were largely recognisable from the earliest installations, mainly just increasing in size, with the last of this type being at Newcastle PSB in 1959 (*Figure 132*). This overlapped with the restyling of OCS panels in 1957 as it was such a major project.

Restyled OCS panels were introduced with the first installation at St Pancras, but they remained generally with a separate indication panel (except for LCP use, the only combined installation being Keymer Crossing), with a distinctive tall moulded fibreglass console and a shallower desk of switches (*Figure 133*). Post Office indication lamps were still used initially with the new design but with the 1959 installation at Barnes they gave way to the new miniature light funnel type used the new NX(PP) panels introduced that year. There was also another crossover development in that the use of ERS plungers in the rows of running-GPL route switches, used to place them to danger in an emergency after a train had passed the main aspect, which featured in the new style OCS, had first been used with the Newcastle installation (*Figure 134*). The new consoles were used in a number of major resignallings (Manchester to Crewe etc., which featured route lights in auto sections) and at London Road an innovation was the use of overlap selection switches. In 1960 a newer style of diagram, to become common on NX panels of the era, was used at Pelaw and the old style of thumb switch gave way to a modern miniature style. The practice of using two separate track circuit lamps to the route lights was still retained, however.

Figure 132 - Westinghouse OCS[-], Sandbach. © Network Rail

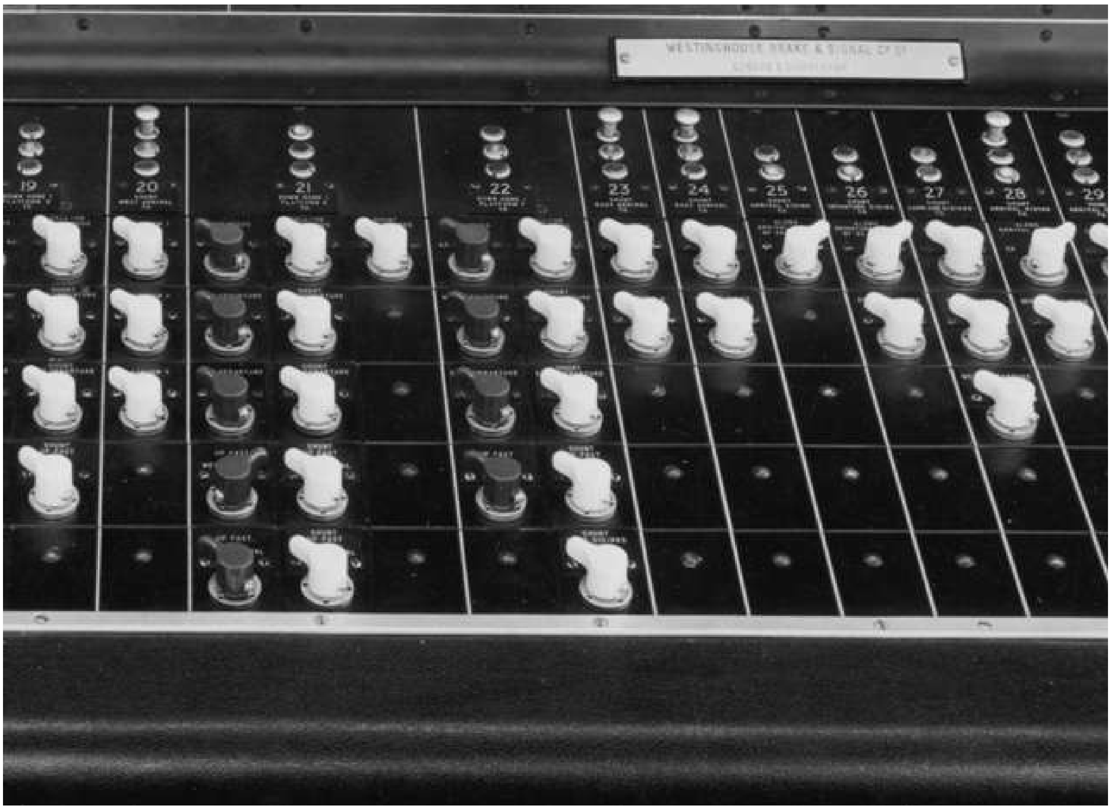


Figure 134 - Westinghouse OCS[-], St Pancras. © Simon Foster

The late 1950s saw big developments in the technology of controls and illuminated diagrams, with Westinghouse being the first to introduce an NX(PP) panel to the UK, being a departure from the NX(TP) technology seen hitherto (although it is unknown whether Westinghouse actually invented NX(PP) operation, as GRS Booklet 188 from October 1954 offers their NX(TP) panel in NX(PP) form, a design which was never used in the UK). Interestingly the company first called their invention the 'entrance - destination system' to circumvent the trademarked term 'entrance - exit'. It should be noted that Westinghouse have never supplied any other kind of NX than NX(PP) (apart from a few NX(KS) provided for LCPs). A new generation of miniature thumb switches and push-buttons were developed, along with light clusters and funnels for diagrams allowing multiple colours to be displayed through a common window (*Figure 135*). Rapid development saw new controls being used on a variety of equipment types produced only a short space of time apart.

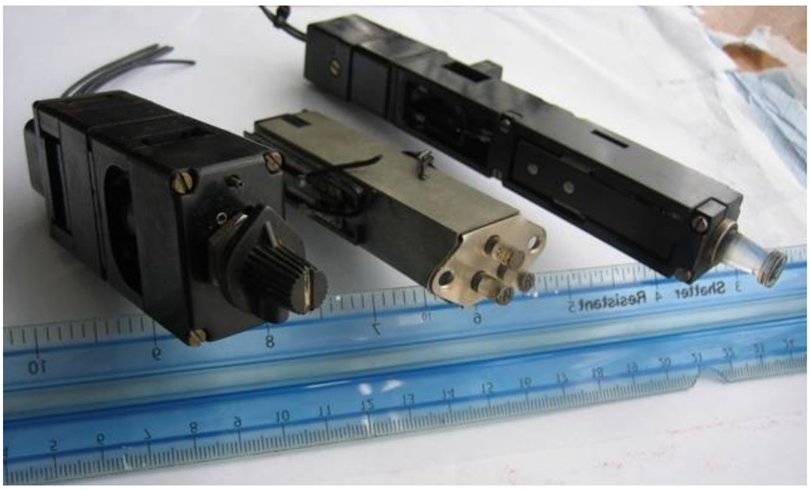


Figure 135 - Westinghouse miniature components, left to right: IPS thumb switch, IPS point indication light funnel unit, NX push-button. © Andrew K Overton

A development of the OCS theme was an MPK installation at Glasgow Central in 1961. Although very much in the OCS style the complexity of the layout, and the parallel advances in NX technology, led to a departure from OCS principles. Here some of the route switches were dispensed with and routes were first selected by push-button and, if an alternative path were available to the same destination, by route selection dial. An available route would then illuminate with magenta lights and alternatives could be selected by turning the selection dial. Finally the route setting was completed by turning the desired signal class switch. Differentially coloured route lights were also used on bi-directional lines with yellow indicating a movement incoming to Glasgow, and white lights for outgoing moves. Track circuit occupation was still indicated by a red light only at the extremity of the track circuit on the panel - presumably to avoid confusion with the magenta route availability lights.

NX panels with largely normal operation in a moulded fibreglass console developed rapidly from their introduction in 1959. The style of diagram used with the new OCS consoles - with curved lines and tracks spaced relatively far apart, plus separate route and track circuit lamps - formed the basis of these panels, only a few being used on BR(SR). Push-buttons had no escutcheon and route cancelling required the entrance button to be pulled out continuously for the full time-out period. IPS had an additional red 'locked' light, indicating when the points were locked by interlocking controls, with what would have been a white 'free' light being used only to flash to indicate OOC. This panel was soon replaced around 1960 with a much more compact diagram, with small push-buttons and combined route and track circuit lamps, at Broxbourne (*Figure 136*), Hackney Downs and Harlow Mill (*Figure 137*), and featured an unusual arrangement whereby signal symbols were not depicted on the panel: On / Off indications were given by a small lamp near the appropriate button. Main and subsidiary aspects had separate entrance buttons. The latter two panels also featured an unusual arrangement of track circuit indication test buttons in the remote interlocking area, which when pressed illuminated the track circuit indications if all was functioning correctly. This arrangement was not continued and signal symbols re-appeared, although the miniaturisation was retained in production of miniature control desks (MCDs) from late 1960 onwards.

Figure 136 - Westinghouse NX(PP)[+], Broxbourne. © Siemens.

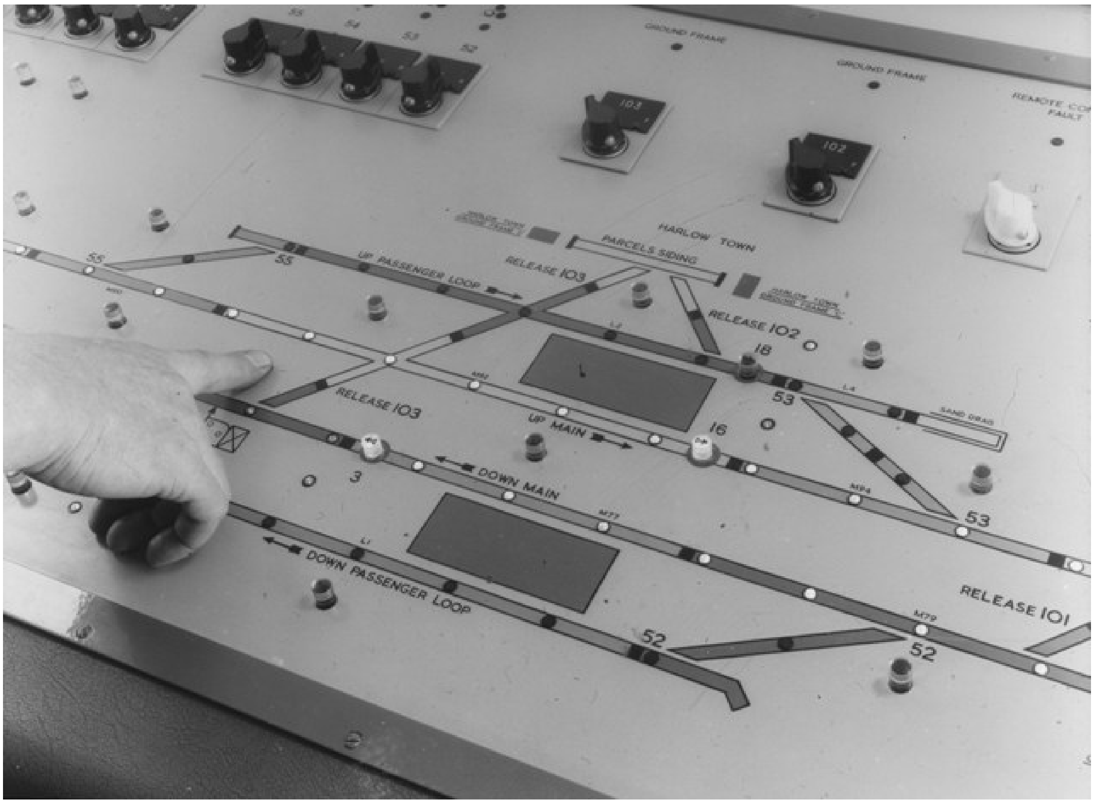


Figure 137 **-** *Westinghouse NX(PP)[+], Harlow Mill. © Siemens.*

Another significant introduction at this point with the associated Westronic remote control system was the provision of LCPs in case of communications failure with the remote interlocking. Westinghouse LCPs were to largely follow the style of the parent interface in terms of buttons, switches and indication lamps in an altogether more compact and simplified package from this introduction and into the M3 era described below.

MCDs (*Figures 138 & 139*) came in six standard console designs depending on whether the signalman was to be seated or standing, and which views from and at the panel were required, but bespoke arrangements could be produced. The MCD used at Weaver Jcn was unusual in that depression of the entrance button lit the route light before every available exit button, something which was not to be perpetuated by Westinghouse but was picked up again in similar form many years later by NRS with its NX(TP) series. 'A' buttons for automatic working also appeared on these panels and they were brought into use by pressing them simultaneously with the exit button, rather than using the normal entrance button. Setting the route again by using the normal entrance button removed the auto working; pulling up the auto button put the signal back altogether. OCS development reached its peak at this point with MCD installations at Tweedmouth and Cathcart, having route switches entirely replaced by push-buttons (*Figure 140*). These were the last Westinghouse OCS to be produced for many years and Cathcart included an OCS[+] LCP with route switches at Kirkhill.

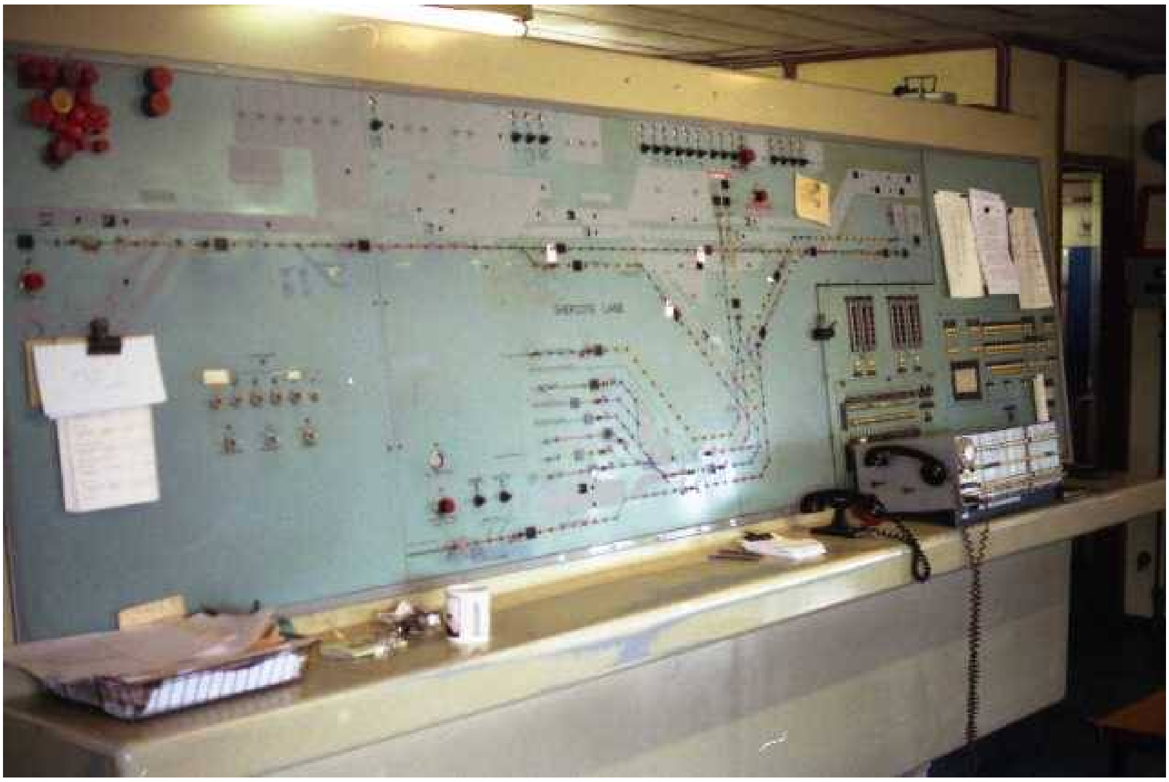


Figure 138 - Westinghouse MCD NX(PP)[+], Shepcote Lane. © Andrew K Overton

Figure 139 - Westinghouse MCD IFS[+], Tinsley Park. © Andrew K Overton

Figure 140 - Westinghouse MCD OCS[+], Tweedmouth. © CJ Woolstenholmes

Other types of interface were being developed at this time to meet other requirements by employing the same miniaturised technology. The IFS was restyled in a moulded fibreglass box. IFS[+] at Hybrid installations on the LT&S and GE used miniature switches and light clusters but with point indications given by one of two white lights at the points on the line of route (*Figure 141*). As part of the Glasgow Suburban and Kingmoor resignallings IFS[-] gained the new miniature light clusters with a distinctive faceplate of switches, bell tappers, block instruments etc. as required, and a few similar examples were used elsewhere throughout the early 1960s (*Figure 142*).

Figure 141 - Westinghouse Frame / IFS[+] Hybrid, Enfield Town. © Chris Booth

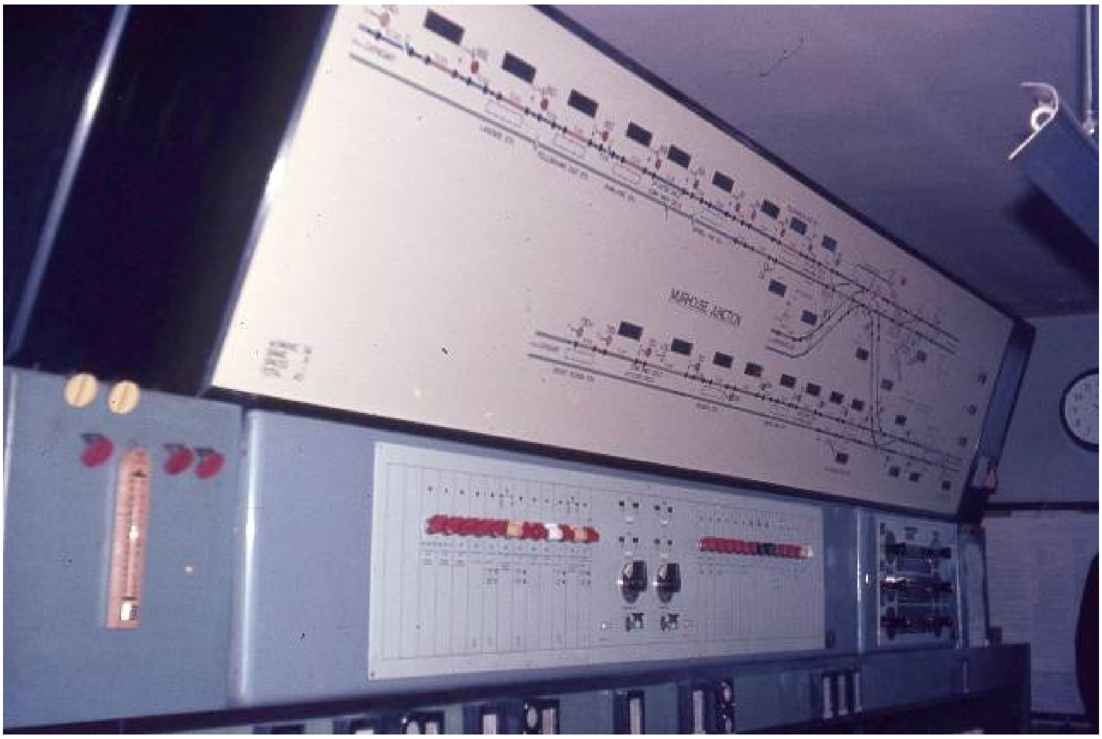


Figure 142 - Westinghouse Frame / IFS[-] Hybrid, Muirhouse Jcn. © Jack Kernahan

Figure 143 - Westinghouse MCD NX(PP) / IFS(Y3)[+] Hybrid, Tees Down Yard Control Tower.
© CJ Woolstenholmes

The Modernisation Plan era saw a resurgence of marshalling yard work with Westinghouse being the major supplier of panels to various newly constructed yards around the country. The company was very much in the vanguard and incorporated new technology, including multiple presetting of routes and programming by punched tape. The style of panels generally followed that used for normal signalling panels, adapted to the specific requirements of yard work, with some installations being hybrids and incorporating NX(PP) and IFS(Y) elements in MCD form (*Figure 143*). A particular feature used in some installations in the 1960s was the use of push-buttons and a four-position switch to call routes off reception lines and over the hump. The push-button for the respective reception siding was pressed to initiate the route with the signal not clearing until the switch for the hump signal was operated. IFS[+] were produced for operation by yard staff in some inspectors' cabins, consisting of geographically located one-push buttons for operation of both signals and points - in the latter case each push moving the points to the alternative position. This was later copied by BR(ER) at Leeds.

A simple IFS[-] GSP design also appeared during this period making use of push-buttons for points operation but saw very limited use.

During 1965 the extreme miniaturisation of the MCD was discontinued and thereafter diagrams were not quite so compact. The increase in panel size also made the MCD appellation inappropriate. All Westinghouse panels up to this time had been made of large steel sheets. The company now entered the mosaic panel market with the M1 design (see *Note 1*), with 40mm x 40mm tiles containing just one route light / track circuit aperture each and with push-buttons having a shallow, rounded-edged escutcheon (*Figure 144*). The first commissioning was in 1966 on the Southern Region at Woking, where two small NX(PP)[-] panels were provided. These were separate panels and worked in conjunction with indications given on a conventional BR(SR)-style box diagram, and also trialled ARS. They were followed by a few other larger combined installations on the same region and a small number elsewhere. Another separated diagram installation was put in at Loughborough Jcn in 1970. The M1 panel was last used in 1973 in the first IFS[+] application for the model at Redcar BSC (No.1 Ore Terminal Panel) (*Figure 145*).

NX(PP) panels controlling MkI Westpac interlockings and requiring swinging overlaps used alternative overlap buttons, identified with a black button surround, although some overlaps were swung with the IPS. The use of alternative overlap buttons was not continued with MkII Westpac installations.

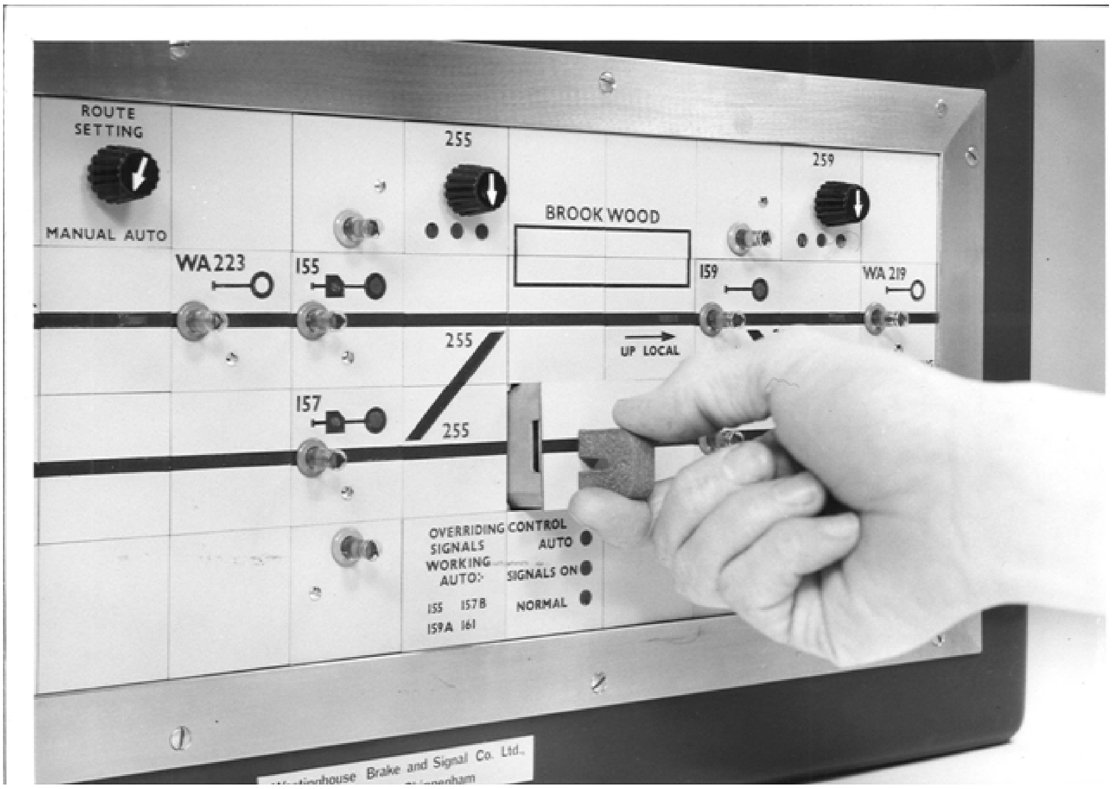


Figure 144 - Westinghouse M1 NX(PP)[-], Woking (Brookwood Up Panel). © Siemens.

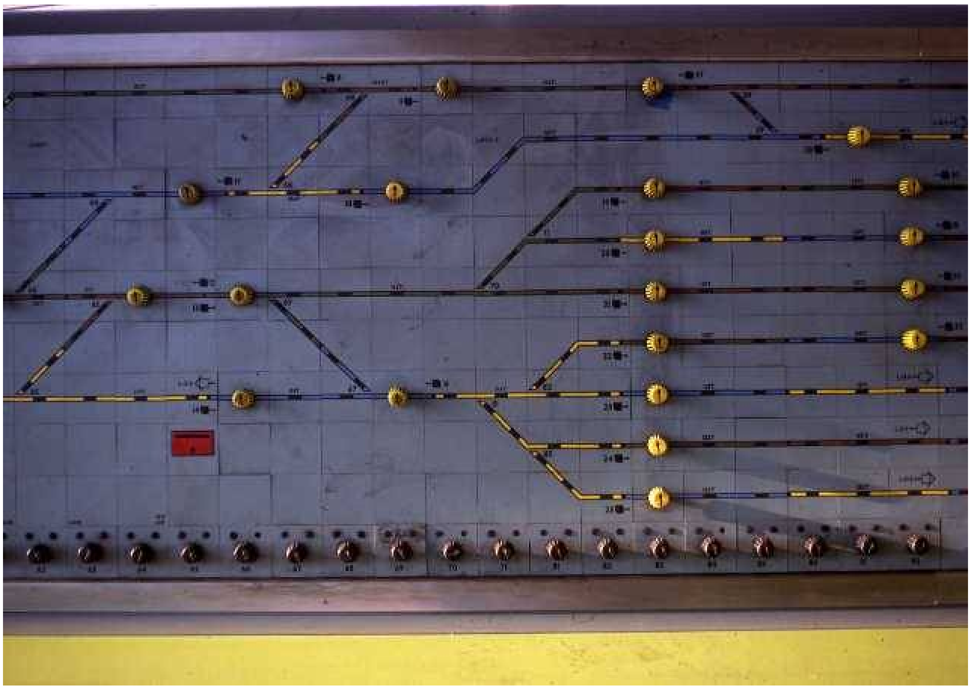


Figure 145 - Westinghouse M1 IFS[+], Redcar BSC (No.1 Ore Terminal Panel). © John Boyes Collection

A steel-sheet panel alternative was also available - the M2 design. The MCD console was changed, with the use of 'hopper' style access doors at the lower front (*Figure 146*). The installation at Leeds in 1967 used alternate red and white lights when routes were set onto occupied lines showing Westinghouse's continuing experimentation with indication displays. Small IFS[-] too were restyled in steel-sheet form, whilst retaining a moulded fibreglass console (*Figure 147*). Both the M1 and M2 NX models dispensed with the red 'locked' light at the IPS, with normal operation being adopted, and it was never reused. At the end of M2 production, starting with Derby PSB in 1969, the 'hopper' style access doors of large consoles were dispensed with as internal air cooling was introduced.

Figure 146 - Westinghouse M2 NX(PP)[+], Aldwarke Jcn LCP (replacement fascia). © Andrew K Overton

Figure 147 - Westinghouse M2 IFS[-], Bowesfield (Eaglescliffe Panel). © John Midcalf

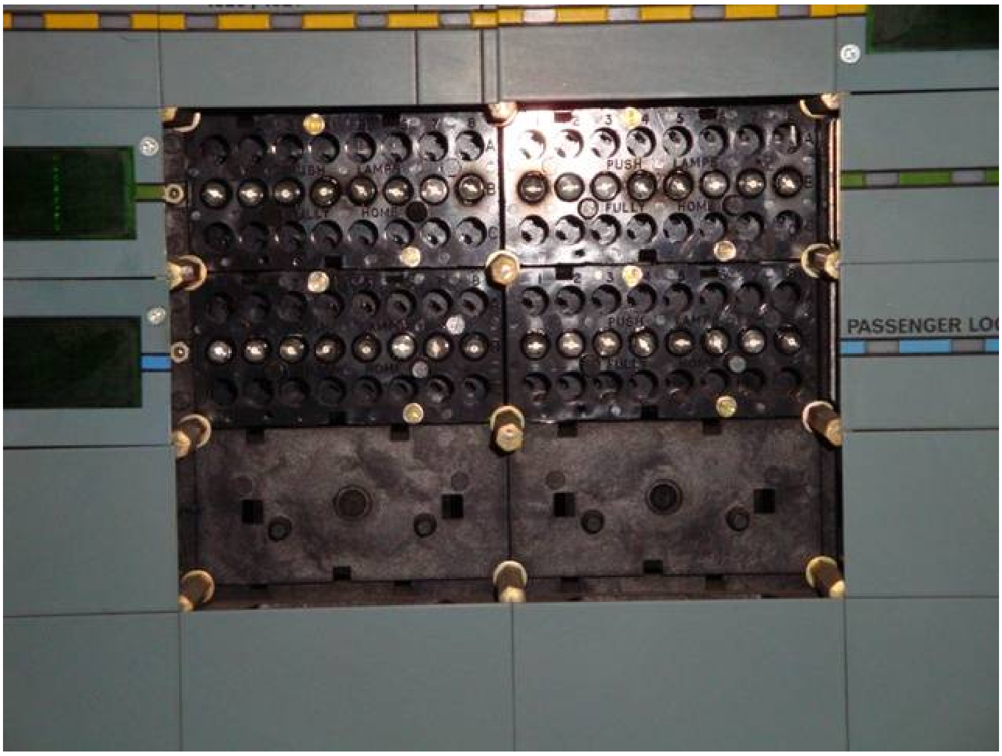


Figure 148 - Westinghouse M3 indication-only tiles, with tiles removed showing the keeper plate.
© Brian Hornsey

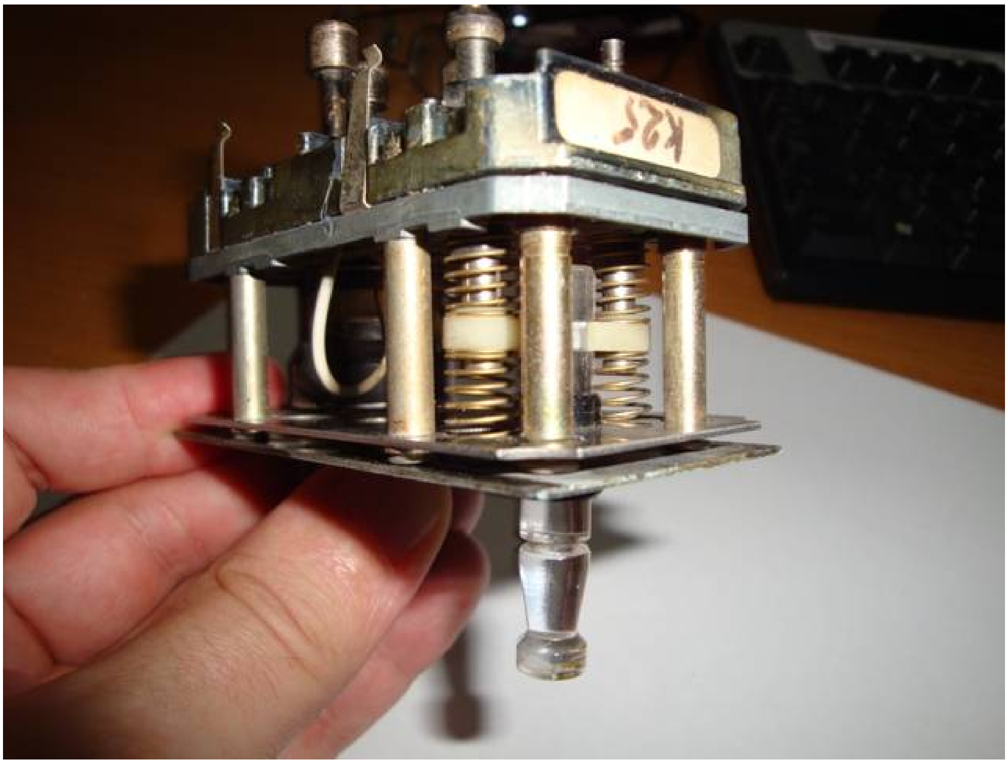


Figure 149 - Westinghouse M3 NX(PP)[+] tile top unit showing push-button assembly. © *Brian Hornsey*

In 1972 the M3 mosaic tile (*Figures 148 & 149)* was introduced at Warrington PSB. This was produced in both NX(PP) (*Figure 150*) and IFS[+] versions (with either one-push buttons, or switches) and had a unique tile size of 80mm x 40mm. The M3 also saw the adoption of more standardised components, with push buttons and escutcheons being of the same pattern as products from Henry Williams. From mid-1973 no further M2 panels were commissioned.

Concurrent with the introduction of the M3, use was made of telephone concentrator switch units as NX(KS)[-]. Separate lamps were used for track circuits and route lights on the non-mosaic indication panel, on which all indications were shown. In other installations small M3 panels were manufactured, very much in the design style of the GEC-GS / BR(ER) versions with Imoff extrusions.

The M3 saw a long production run of units with some very large panels produced, both separate and combined. One of the criticisms of separate indication panels was the difficulty experienced by the signalman in mentally associating the operation of the control panel to the display on the indication panel. To overcome this, Westinghouse developed for their London Bridge installation of 1975 a system whereby depression of an entrance button immediately set flashing the first route light ahead of the signal on the indication panel, which continued to flash until the route was fully set. Normally the flashing would have ceased when an exit button was pressed, leaving only the gap in route lights to indicate a set of points which had failed to respond, but this system was altogether clearer to the signalman. It is not known whether this was perpetuated in other separate-style panel installations. Another innovation at London Bridge was the introduction of automatic cancelling of routes behind a train (Train Operated Route Release - TORR), taking the place of the pulling up of the entrance button.

Figure 150 - Westinghouse M3 NX(PP)[+], Carlton. © CJ Woolstenholmes

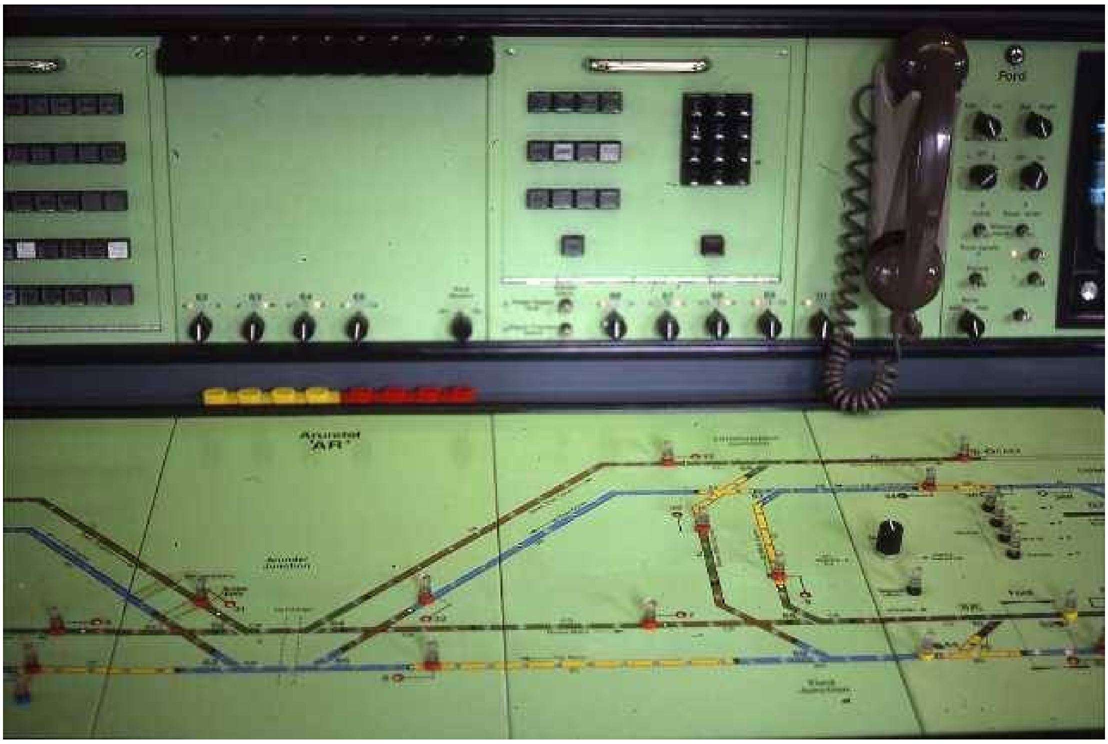


Figure 151 - Westinghouse M5 NX(PP)[+], Arundel. © CJ Woolstenholmes

Figure 152 **-** *Westinghouse M5 NX(PP)[+], Dorchester. © Network Rail*

Owing to the expense of mosaic construction, 1980 saw the end of M3 supply. It was replaced by the M5 with a 258mm x 258mm standard tile with a bevelled edge. Half and three-quarter sized alternatives were also available and these dimensions could also be added to a standard sized tile in the horizontal and / or vertical plane, as Arundel in 1979 (*Figure 151*). However, there was an exception to this rule in 1983 at Three Bridges PSB, where the control panel of the NX(PP)[-] was of M3 construction with M5 tiles used for the indication panel. During the life of M5 production the button, switch and indication designs evolved from those used with the M3, but LED indications appeared in 1984 at Westbury PSB, and Swisstac buttons in 1985 at Leamington Spa - although the latter were infrequently used. One later feature was the use of separate track circuit and route lamps showing through the same rectangular windows in the tiles, so that only half was lit, while another was the use of separate On and Off indications in the signal head (*Figure 152*). In 1990 new track circuit and route indication lamps with a distinctive rectangular LED pattern and a black surround standing slightly proud of the panel surface appeared at Cambridge PSB. Signal repeaters were also by single LED. M5 production ended in 1992 with the Cambridge PSB Ely extension (*Figure 153*).

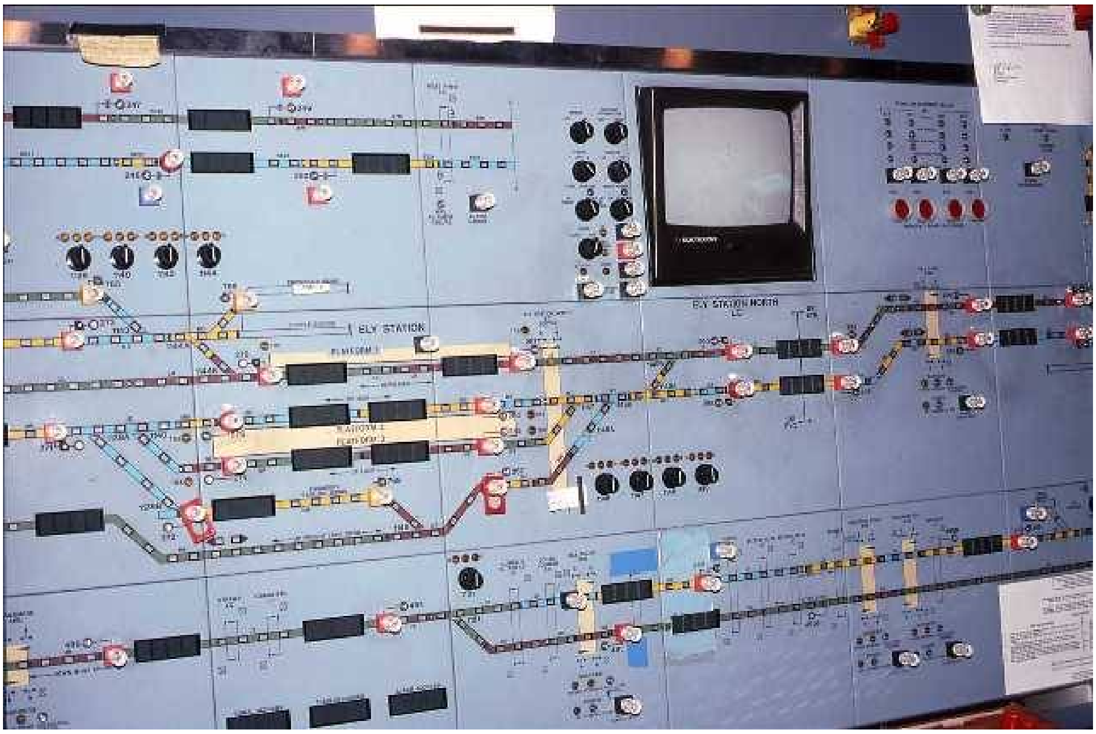


Figure 153 **-** *Westinghouse M5 NX(PP)[+], Cambridge. © CJ Woolstenholmes*

NX(KS)[-] became the preferred LCP type in this period, with mosaic tiles on the indication panel, and with a desk-mounted interface in a roughly triangular section console (*Figure 154*), although some NX(KS)[+] were produced for Feltham PSB with sheet-steel diagram fascias and switches at the bottom.

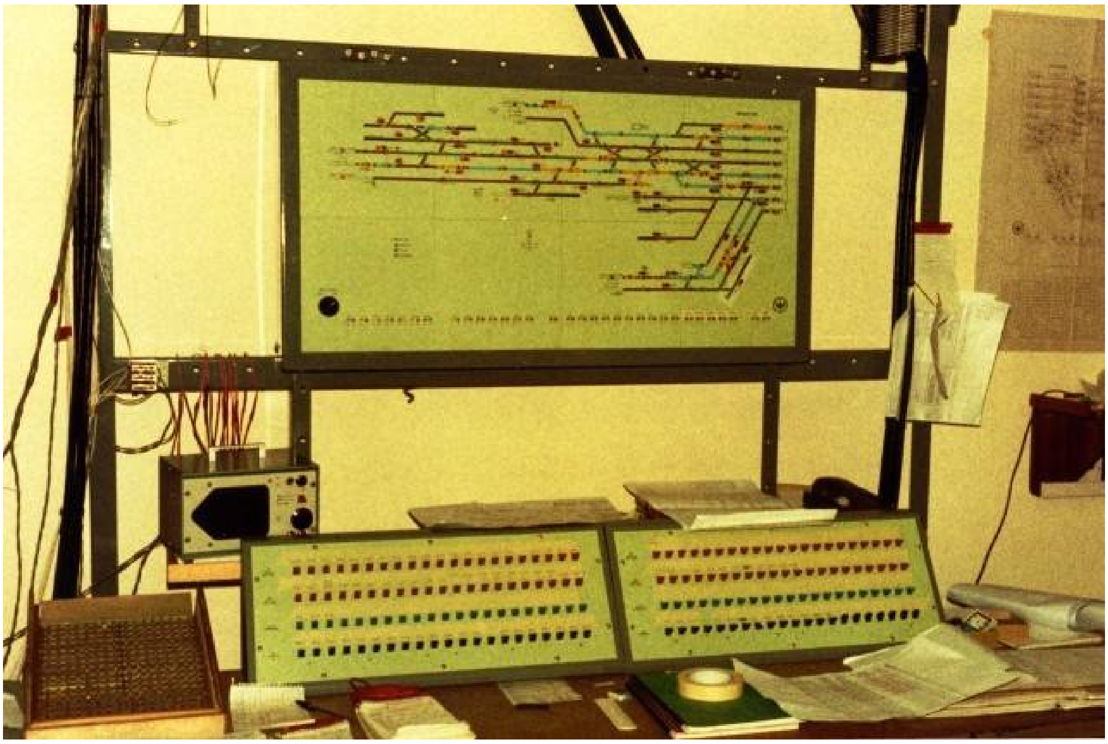


Figure 154 **-** *Westinghouse NX(KS)[-], Brighton LCP. © Peter Gibbons*

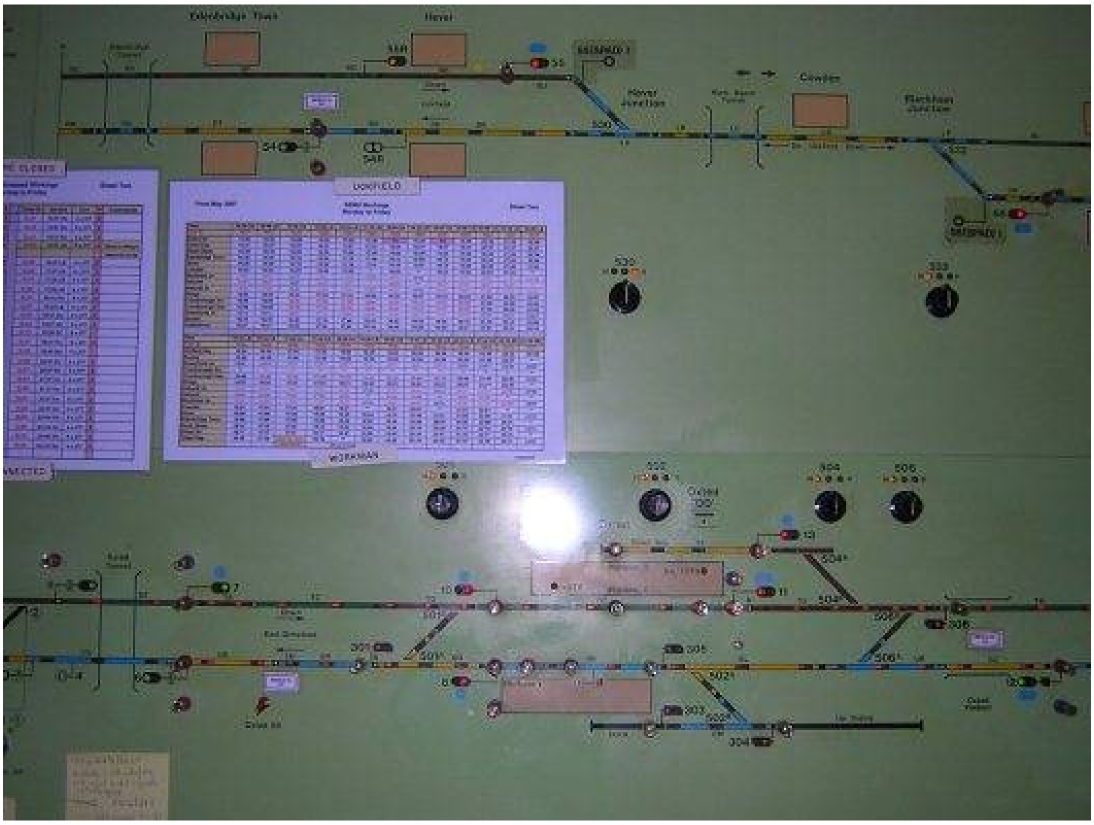


Figure 155 **-** *Westinghouse M4 NX(PP)[+], Oxted. © John Francis*

Westinghouse had actually offered an alternative sheet-steel panel - the M4 - to BR in tenders from around 1978 as an alternative to M3 mosaics but no orders resulted until 1985. Thereafter it was used throughout the later M5 era as a cheaper alternative, and eventually outlasting it to the end of Westinghouse panel production (*Figure 155*). All known interfaces were NX(PP)[+], except for one OCS[+] produced for Windsor Bridge in 1988 which did not employ route lights. Some care is needed to distinguish the desk-console versions of the M4, as these employ rectangular sheet-steel sections which can be mistaken for mosaic tiles: these do not have the bevelled edge of the M5 tile. M4 panels were not very numerous with a good deal of evolution and change being seen in the design of buttons and indications used, features used on the M5 being employed as well as others. The panel surface was almost always a light green (BS Colour - Eau de Nil) with a distinctive pattern IPS being used. A common early feature is that On and Off indications were given by separate lamps in the signal head and the GPL symbol was a distinctive rectangle with a cut-off upper corner; separate indications were later abandoned. In 1985 a small block-shelf-standing version was produced for Farnham with separate LEDs for track circuits and route lights in a very similar style to GEC-GS. This style was perpetuated in the NX(KS)[+] provided for the remote interlockings on this scheme, with the key-switches mounted on the interface fascia (*Figure 156*). The 1988 panel at Millerhill, however, was of a quite different style in many respects - the console, IPS and indication lamps all being untypical (*Figure 156*). Stourbridge Jcn in 1990 was the first to use the rectangular LED track lamps used in the Cambridge M5 panel (*Figure 157*). Of the few panels that were produced in the 1990s only the IPS pattern remained constant. MPK(KS)[-] was also used in this period for the Manchester Piccadilly scheme LCPs.

Panel design was discontinued by Westinghouse in 1998, the last being commissioned at Cowlairs, with future interface production being confined to WS-based equipment and panels being sourced from other companies.

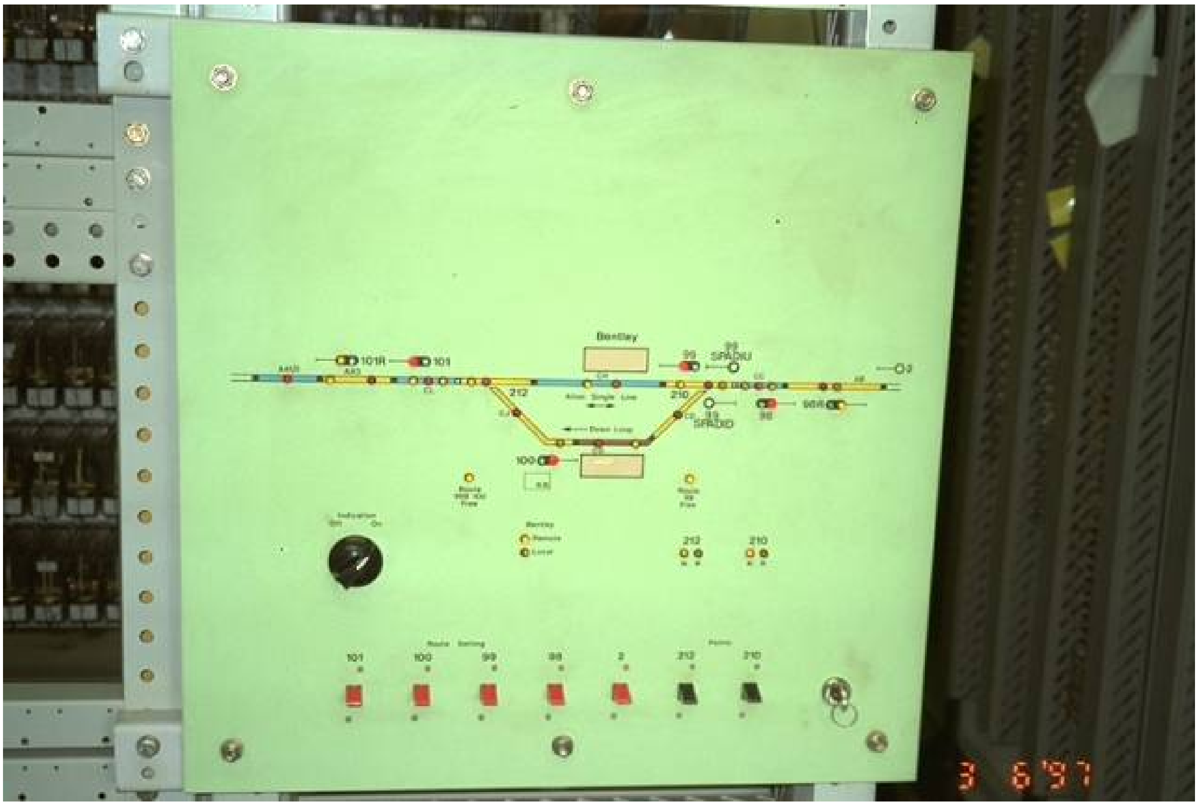


Figure 156 - Westinghouse NX(KS[+], Bentley LCP (Hants). © Chris Bellett

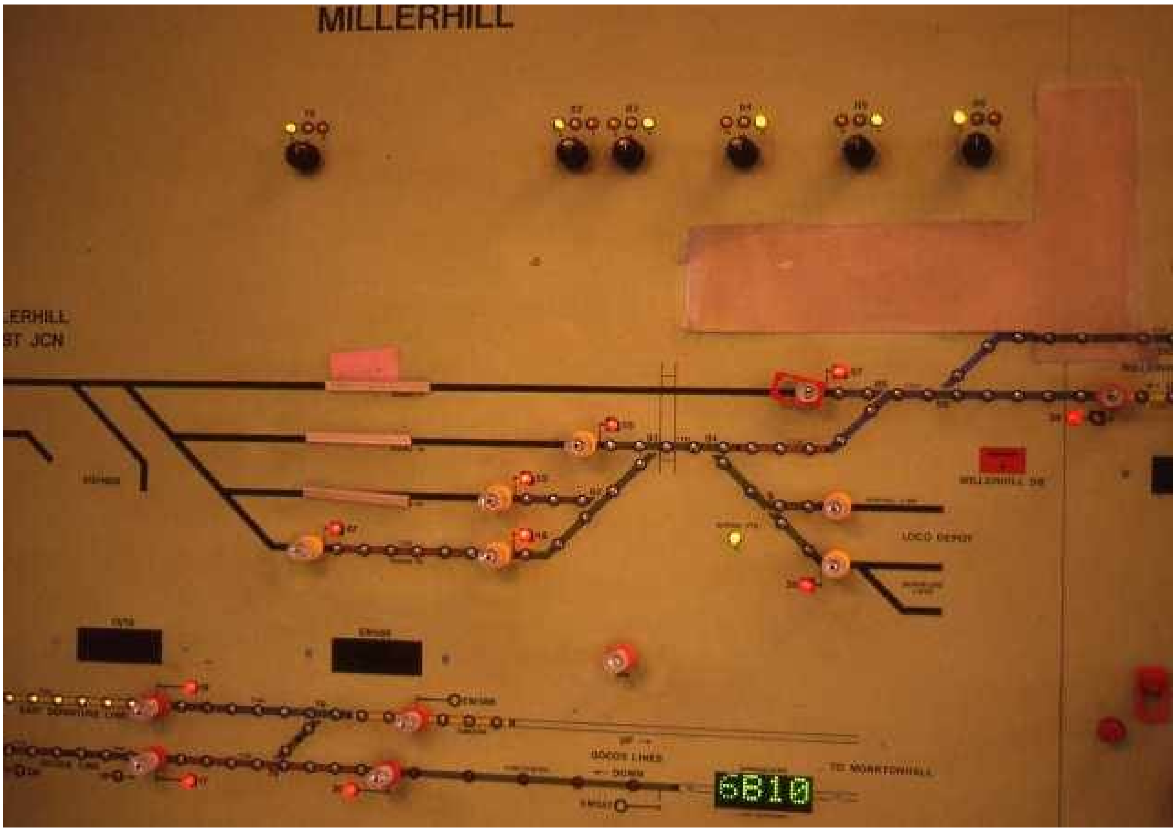


Figure 157 - Westinghouse M4 NX(PP)[+], Millerhill. © John Boyes Collection

Figure 158 - Westinghouse M4 NX(PP)[+], Stourbridge Jcn. © Danny Scroggins

A GSP design was in use by 1986, consisting of a lockable cabinet containing an IFS[-] of very basic design (*Figure 159*).

Figure 159 - Westinghouse GSP IFS[-], Edenbridge 'C' GSP. © Nick Wellington

In 1992 Westinghouse became involved in the supply of IECC operating system hardware to the original BR Research / Sema Group design without further development for installation at Ashford IECC, which they continued with one further project at Swindon B IECC.

The WestCAD (Westinghouse Control and Display) WS operating system, introduced in 1999 at Stratford North London Line, then became the main product in Britain. This had first been used on maintainer's panels with Westrace interlockings on LUL, as well as overseas on the Oslo Metro. Based on a Windows operating system the control and indication software was originally called 'Mimic' but for applications on Railtrack was rebranded as WestCAD using Windows NT. Using desk-mounted peripherals, in terms of display and operation it was very similar to IECC, the only significant difference being that the yellow Computer Route Setting (CRS) keyboard function keys were beneath the red signalling function keys (*Figure 160*). CRS is Westinghouse's automatic route setting system, although it is not currently in use on WestCAD installations. Similar signalling display and general purpose display screens were used to IECC (*Figure 161)*. WestCAD was capable of controlling conventional relay interlockings, SSI or CBI. It should be noted that it was a highly versatile, multifaceted system and could be installed utilising only part of its capabilities (e.g. panel processing (PMUX), train describers, alarms etc.) in a situation where an NX panel was retained. The system evolved through Mk1 and Mk2 versions.

Note **-** *Westinghouse literature has been discovered confirming the allocation of model designations MCD, M3, M4 and M5. The designations M1 and M2 have been deduced but await definite confirmation.*

Figure 160 **-** *Westinghouse WestCAD WS, Port Talbot. © Danny Scroggins*

Figure 161 - Westinghouse WestCAD WS, Leamington Spa. © Danny Scroggins

Power Frames

Introduction

Power frames used in Britain utilise one of three methods of operation: rotary handle (one example), miniature lever or slide - with the two last-named also being used in combination. For the most part they owe far more to mechanical lever frame technology than to the true power signalling era, with the outside equipment being the power element proper. In every case the interlocking is an intrinsic part of the mechanism, acting directly on the lever or slide so as to prevent inappropriate controls from even being operated; unlike with button- or switch-based interfaces where inappropriate controls may be operated but the interlocking within the circuitry refuses to obey the commands. The interlocking technology too is from the mechanical era, consisting of (generally) tappets and / or electro-magnetic lever-locks. This type of equipment fits readily into recording systems based around signalboxes as neither interface nor interlocking can be expected to migrate (with the exception of certain LT miniature frames, which are not dealt with in this publication).

It is, nevertheless, an anomaly to exclude such interfaces from a register of power signalling installations, and from a discussion of technological advances in this field. They are dealt with separately in this section, which consists of a single spreadsheet (where both interface and interlocking details are combined) and a description of each system. As with the main Register, the descriptions below explain the abbreviations and definitions used in the spreadsheet named Power Frames and found with the main Register workbook.

Power Frames - Column Descriptions and Definitions

The spreadsheet lists all power frame installations used on standard gauge lines traversed by 'heavy rail' trains in Great Britain. This includes interfaces in collieries, power stations and other freight terminals, sidings, yards and depots. Excluded is signalling on metro and tram networks, London Underground lines etc., heritage & tourist railways and all lines in Ireland.

To qualify for inclusion the frame must operate either:

i. Points
ii. Signals
iii. Slots
iv. Acceptance releases (where these operate directly on signals as a slot, not through the operation of block signalling apparatus of any kind)
v. Releases or locks for ground frames

Similarly to the main register this is a list of frames, not of signal boxes, so where more than one frame exists at a location each will be listed and its history traced. The rules set out for the recording of button- or switch-based interfaces have been applied to the recording of power frames as necessary. Note that power frames provided solely for the operation of level crossing or lifting / swing bridge equipment are not included.

The signalbox diagram, whether illuminated or not, is not considered to be an essential and integral part of this type of installation and is not recorded.

Where it has not been possible to verify information from a source to the satisfaction of the author such data are shown in *red italic font*.

Column Definitions

Column 1 - Location

The location of the frame is listed under its official name. Where names of locations have changed over time discretion has been used in deciding which to adopt throughout to avoid confusion with other entries and the original has usually been retained. No attempt has been made to change entries to reflect minor changes in nomenclature. Where physically separate frames in one location have official differentiating names these have been used in parentheses but in other cases they are differentiated by numerical reference suffixes, e.g. (1), (2) etc.. Where appropriate to aid in identifying a location additional details are appended in parentheses but it is not implied that this forms part of the official name.

Column 2 - Frame Type

The four types of frame are recorded in accordance with the definitions, designations and type names set out below. The [-] or [+] suffixes applied to switch- and button-based interfaces are not applied to power frames.

Abbreviation	Features
PF(H)	Rotary handle frame
PF(L)	Miniature lever frame
PF(S)	Slide frame
PF(LS)	Miniature lever frame for route-setting functions with slides for individual point operation

All the above types, with the exception of PF(LS), operate on the IFS principle, whereby each set of points and each signal is individually operated by a particular lever or slide, exactly as with a mechanical lever frame. PF(LS) frames are route-setting frames, having separate levers for each route, the operation of which sets all the points and clears all the signals in each route. Slides are provided for each set of points: these are not used during route-setting but if it is required to work points individually (single line working, moving trains during engineering work, etc.) they are released from their mid-way position by operation of king levers on the miniature frame. The king levers lock the affected route levers and allow the slides to be moved to normal or reverse positions.

Hybrid Installations

In some circumstances power frames are combined with other systems. The Sykes Electro-Mechanical system employs a full-sized lever frame for operation of points in connection with slides to operate signals; some use was made of slides to add to the layout of boxes with no spare levers in a conventional frame; and there was an unusual installation of a slave-driven conventional frame at Stobcross. The definition of whether such arrangements shall be considered to give rise to a Hybrid designation is:

- Where the power frame operated equipment is intermixed within or adjacent to the area of control of the conventional lever frame and interlocked with it, the installation is considered to be Hybrid. Examples of this might be where all the points are worked by a conventional lever frame but the signals are worked by slides, or where additional signalling has been added within Station Limits worked by slides - both Frame / PF(S) Hybrid. No attempt is made to categorise the type of conventional frame in use.

- Where the power frame operated equipment is located beyond the area of control of the conventional lever frame and not interlocked with it, the installation is not considered to be Hybrid and is recorded in the usual way. Examples of this might be where Intermediate Block or Distant signals have been provided worked by slides.

The lever frame must operate the type of equipment previously defined in the main Register to decide on the eligible of a switch- or button-based interface for inclusion. In no circumstances do Emergency Replacement Switches give rise to a Hybrid designation.

Column 3 - Interlocking Type

Two types of interlocking are recorded in accordance with the definitions, designations and type names set out below

Abbreviation	Features
E	Electro-magnetic lever locks
M	Mechanical interlocking

It should be noted that electro-magnetic lever locks may also exist on a frame with mechanical interlocking, being used for the control of levers by track circuits etc.. Only where the actual *interlocking* is being performed electro-magnetically is the designation E used. The phrase 'all-electric' was used by design manufacturers to describe the operation of the outside equipment and it should not be inferred that this relates to the type of interlocking employed. The designation 'na' (not applicable) is used in connection with those PF(S) used for emergency replacement of automatic signals.

Descriptions of interlocking systems are not given here as both mechanical and electro-magnetic lever interlocking has been well covered by other authors. Readers requiring more details are directed to the reference list and to currently available books on railway signalling.

Column 4 - Design and Model

The design manufacturer is recorded in accordance with the details set out in the section below headed *Power Frame Designs - Descriptions* for each frame. The design manufacturer is regarded as being the organisation with overall control of production to their specifications, irrespective of whether or not they actually manufactured the frame or its components themselves or sub-contracted the work. Where production of a frame is known to have been sub-contracted to another manufacturer this will be noted, unless this was universal and is detailed in the *Power Frame Designs - Descriptions* section. Where a frame design was produced under license by another manufacturer in overall control of production, they will be regarded as the design manufacturer. Where a design manufacturer applied an official model designation to a particular frame this is also shown. Names have been applied to each frame design based on manufacturers' official model designations, or on contemporary technical press descriptions. Where the design manufacturer changed owing to takeover / merger etc. and a successor organisation inherited the rights to a design, subsequent frames are recorded under the new design manufacturer's name with the original design manufacturer's name appended in brackets: it is under the original design manufacturer's name that the description of the frame is found in the *Power Frame Designs* section. This only applies where no significant further development of the frame was undertaken by the successor organisation, otherwise it is regarded as a new model.

Column 5 - Commissioned

This is the date when the frame was officially signed into operational use at that location. Where it has not been possible to establish the precise date of commissioning in the case of work performed over a weekend etc., the start date of the commissioning weekend has been taken as the frame commissioning date. In the case of large frames brought into full operation over a period of time the commissioning date recorded is the date that any part of it was first brought into use. . Where an actual commissioning date has been used which differs from an officially published date the discrepancy is highlighted in the Notes column to avoid confusion.

Column 6 - Decommissioned

This is the date when the frame was officially signed out of operational use at that location. Where it has not been possible to establish the precise date of decommissioning in the case of work performed over a weekend etc., the start date of the decommissioning weekend has been taken as the frame decommissioning date. In the case of large frames, sections of which were taken out of use over a period of time, the decommissioning date recorded is the date when the last part of it was taken out of use. . Where an actual decommissioning date has been used which differs from an officially published date the discrepancy is highlighted in the Notes column to avoid confusion.

Column 7 - Notes

Further pertinent details are included here.

Power Frame Designs

Power Frame Designs - Descriptions

Commissioning dates refer to equipment commissioned as new, not second-hand installations. Photos of power frames are available in several books as shown below and in the 'References' list.

British Pneumatic Railway Signalling Co. (BPRSCo): Low Pressure Pneumatic [Frames commissioned 1902 - 1912]

The UK branch of the International Pneumatic Railway Signal Co. of Rochester, New York (which was itself a wholly owned subsidiary of the Pneumatic Railway Signal Co.). From 27th February 1902 the US company became the Pneumatic Signal Co. and from 13th June 1904 merged into the new General Railway Signal Co. The company had no UK manufacturing facility of their own and production was totally sub-contracted to Evans O'Donnell / McKenzie & Holland & Westinghouse at Chippenham to their own designs.

This company supplied PRSCo frames under license in the UK. As originally designed it was not possible to return a slide to its former position if the equipment failed to fully respond, in order to try again. This drawback was rectified in the London Road Station (GC) installation of 1909 after improvements by Samuel L Glenn, working for Evans O'Donnell.

Most Low Pressure Pneumatic frames were converted to electro-pneumatic operation in later years, many gaining points indications and signal repeaters in the process. Electro-pneumatic valves in the locking room received the electrical detection from the points and signals and delivered air to the slides to retain dynamic indication stroke completion. The pneumatic link to the outside equipment was replaced by an electrical one working through contacts on the slides, with further electro-pneumatic valves at the points and signals to control the pneumatic motors. The frame at Clapham Jcn West, however, had the pneumatics completely removed and lost its dynamic indication (the points and signals at Clapham Jcn West were also converted to electric operation).

British Pneumatic Railway Signalling Co. (BPRSCo): All-Electric [Frames commissioned 1912 - 1916]
British Power Railway Signalling Co. (BPRSCo): All-Electric [Frames commissioned 1926]

The latter company was incorporated in 1912 but trading continued in the former name until between 1917 & 1919 before liquidation.

This was an adaptation of the Low Pressure Pneumatic frame to electric operation both inside and outside the box by the amalgamation of the electric GRS Taylor System (which used the final movement of the electric point / signal motor to deliver an indication current back to the frame and release the slide check-lock) into the frame whilst retaining dynamic indication. The frame itself was redesigned, including different supporting leg castings. This hybrid arrangement was not used on the US GRS frames (although confusingly the check-lock releasing system was referred to by GRS as dynamic indication) and was a BPRSCo development, being attractive to customers familiar with the Low Pressure Pneumatic frame system of dynamic indication. Production was again sub-contracted out. Electrical check-locking was employed at the intermediate slide positions used with the pneumatic system and the dynamic indication of the slides was effected electro-mechanically. In addition, the box diagrams of the Immingham installations were provided with indications at each set of points which showed white when detection was obtained and red when OOC, the latter condition being accompanied by a buzzer. The frames at Cambridge North and South boxes in 1926 had different slides with a longer thin section behind the handle and the slide numbers were on a glass fitted in a projecting lamp housing with a sloping front.

Electrically locked slides had a push-button above them, the depression of which caused the lamp to illuminate if the slide was free to be moved.

BR [Frames commissioned 1964 & 1972]

In 1964 a PF(S) was designed, probably locally, utilising the Westinghouse Style D Combined Lever Lock & Controller, as usually found on mechanical locking frames, for a temporary installation at Shepcote Lane during the construction of Tinsley Yard, prior to commissioning of the permanent Shepcote Lane box. Mounted horizontally, handles were attached to the lock bars. In another installation in 1972 at Dean the controllers were painted up according to function (*Figure 162*).

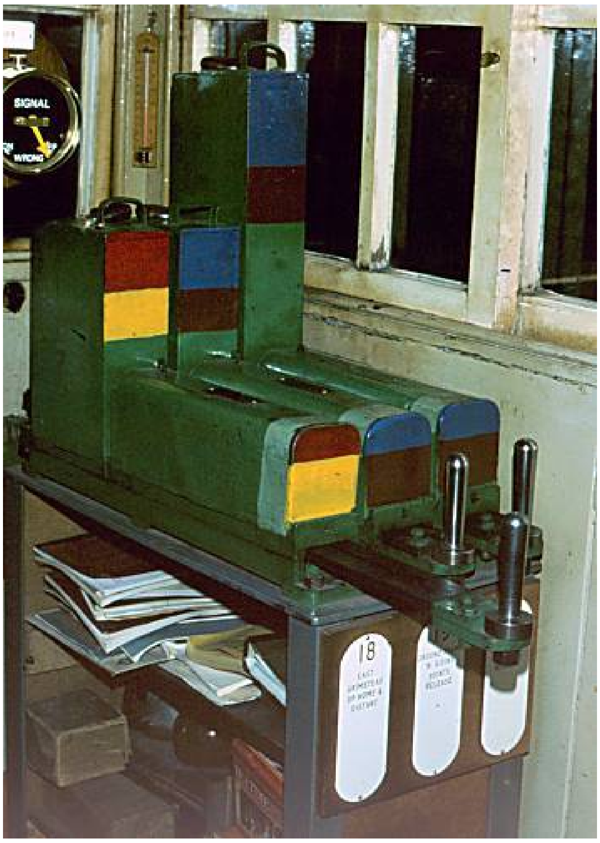


Figure 162 **-** *BR PF(S), Dean. © John Hinson*

General Railway Signal Co. (GRS): [Frames commissioned 1920 - 1935]

GRS were a US company whose products were initially imported or manufactured under license by BPRSCo.. In 1926 Metropolitan Vickers (MV) obtained the license to manufacture GRS products in the UK in Manchester and traded as MV-GRS, although no frames were produced during this period. In 1930 the partnership changed their UK trading name to GRS.

Type A: For its scheme to resignal the SE&CR station at London Victoria BPRSCo, the contractor, chose to use a frame from their parent company - the GRS Model 2 Unit Lever Type, designated the Type A in the UK - working GRS-supplied all electric signalling, rather than their own All-Electric frame. The GRS frame was an established product in the US and of a very distinctive PF(S) design, consisting of a row of slides at 2 inch centres with large pear-shaped pistol-grip handles pointing alternately up and down. The slides had a 'trigger' at the back of each handle which was depressed to release it, triggers being of larger pattern on the downturned handles than on the upturned ones. The horizontal shafts of the slides were painted according to function. The slides projected into a wooden flat-topped cabinet, with a further low set-back wooden cabinet positioned on top, the front face of which had integral flush-mounted points and signal indications. Behind each slide on the front face of the main frame cabinet was a projecting lamp housing with a sloping front, the lamp being a 'free' light and indicating when the slide was free to be moved. No pull-plates were provided but instead a 'manipulation chart' was provided to explain the slide functions to the signalmen.

The Victoria frame was mechanically interlocked, with the vertical trays of mechanical tappet interlocking being mounted at the front. Points slides were electrically check-locked both ways until detection had been obtained and signal slides were check-locked Normal.

Type C: The first Type C was used at Westbourne Bridge in 1932 and was externally similar to the Type A but was manufactured in sections of eight or sixteen slides *(Figure 163*). It was available in both electrically and mechanically interlocked versions but the weakness of the former was that the maximum number of contact sets on a slide was limited to 30, insufficient for complex layouts with bi-directional working. The 'manipulation chart' of the Victoria installation did not pass muster with the GWR and black Traffolite pull-plates were affixed above the 'free' lights. Check-locking of the signal slides moving Normal was employed here, but no check-locks were provided on points slides. It was then externally redesigned for the installations at Paddington Arrival and Departure and here employing mechanical interlocking mounted in a vertical cast-iron locking tray at the front, due to the limitations of the electrical interlocking (*Figure 164*). The main wooden frame cabinet (although sheet-steel could be supplied) was taller, with the top section above the slides sloping back and having all the integral points and signal repeaters, free lights and pull-plates flush-mounted to it, as well as bell tappers and block instrument peggers. The low set-back wooden cabinet on top merely contained bells and block instruments in its front face. Signals having a calling-on facility were provided with buttons on the pull-plate of the slide which, when pressed after the slide had been pulled to the first check-lock position, selected the calling-on aspect after the slide stroke was completed.

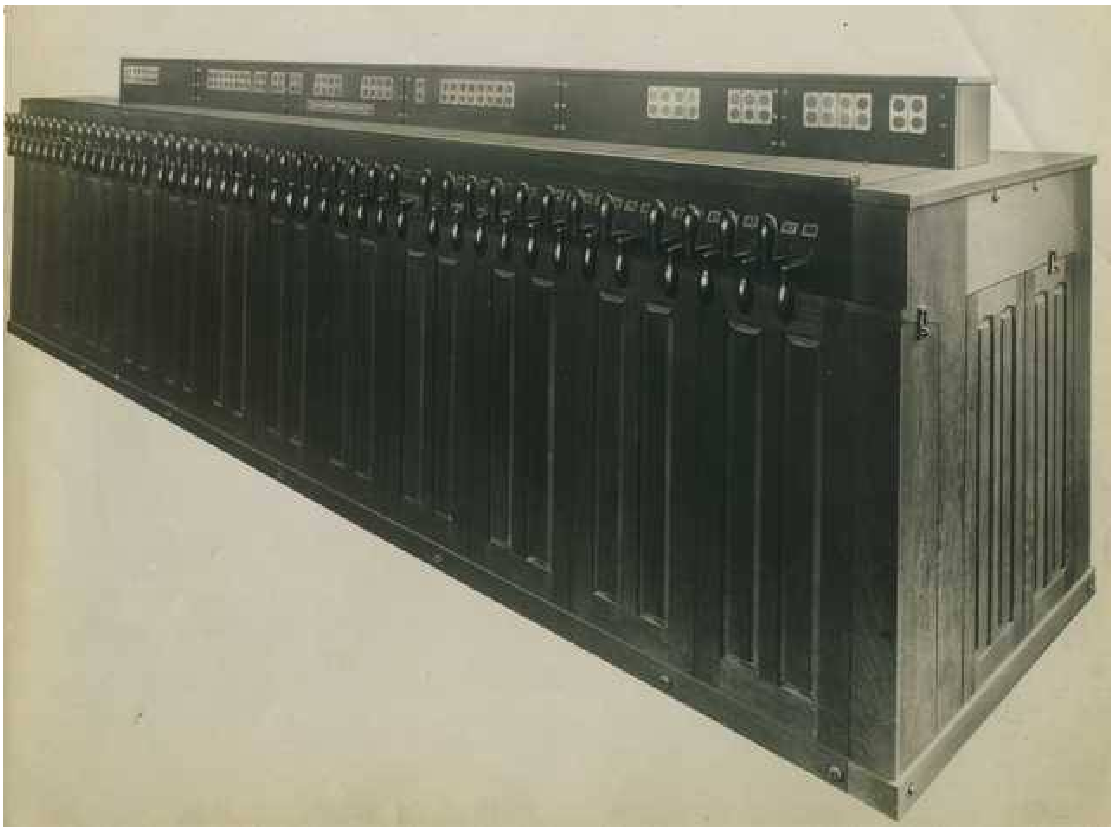


Figure 163 - GRS Type C PF(S), Westbourne Bridge. © AEI-GRS.

Figure 164 - GRS Type C PF(S), Paddington Arrival. © AEI-GRS.

Type D: For the resignalling of Bristol the GWR reverted to electrically interlocked frames. The GRS Type D (*Figure 165*) had a triangular section projection to the front of the frame cabinet (of wood in all UK installations, although sheet-steel cabinets could be supplied), the apex of which was pierced by a slot for the slide shafts to pass through. The sloping front above the slides contained the black Traffolite pull-plates, calling-on selector buttons, and integral points and signal repeaters. However, the only indications given for points and signals was a 'correspondence light' which illuminated when the outside equipment was in the position indicated by the slide. Additionally, each slide had a lower 'free' light. The low set-back wooden cabinet on top was now an integral part of the frame cabinet and contained bells, tappers, block instruments and telephone concentrators on its front face. As with the Type C, the frame came in sections of eight or sixteen slides. Check-locking of both points and signal slides was employed and the slides were fitted with the usual 'triggers'. An unusual feature of the frames at Bristol East and Bristol West was the mechanical operation, via cranks and rodding attached to eight slides in each frame, of emergency detonator placers.

This style of frame was also used at Manchester Central but repeaters for all aspects of signals were used there.

Figure 165 - GRS Type D PF(S), Bristol Locomotive Yard. © F Bromhead (Andrew K Overton Collection)

Great Western Railway (GWR): [Frame commissioned 1931]

A small 3-lever PF(L) was installed at Cannons Marsh signalbox in Bristol. Most probably made at Reading Workshops it had the appearance of an model engineering society's miniature reproduction of a standard GWR conventional lever frame, complete with tiny pull-plates attached to the levers. The frame was inset into a wooden box and the whole assembly sat atop a shelf next to the standard GWR block instrument, which it was only slightly taller than. There is no positive evidence that the frame was manufactured in-house by the company but it is wholly unlike the products of any other design manufacturer so this is strongly suspected to be the case. (*Photo - see A Pictorial Record of Great Western Railway Signalling, p. 98*)

London & North Eastern Railway (LNER) [Frames commissioned 1924 - 1934]

A single slide PF(S) was used as ERS in several installations of automatic signals. Consisting of a shallow wooden box mounted on the block shelf the thin spring loaded slide, which had a small rounded brass knob, was pushed downwards then pulled out to replace the signal to danger. The slide could be mounted on top of the shelf, projecting forward, or on the front of the shelf with the slide sticking up. At the time of writing only a small number of these PF(S) have been positively identified. However, the use of a slide was not universal and a single lever PF(L) - consisting of little more than the lever itself mounted on the blockshelf - is known to have been employed for the same purpose. All of these installations are designated LNER ERS in this Register. They were provided at the box in advance, and although designated as ERS are they are known to have been used in normal working to maintain auto stop signals at danger when using connections ahead of the home signal, and also as fog replacement switches.

London & North Western Railway (LNWR): Crewe System [Frames commissioned 1898 - 1940]

Designed by F W Webb and A M Thompson of the London & North Western Railway this fully electric PF(L) system had miniature levers in two tiers, with the front tier of even-numbered levers being lower than the rear odd-numbered ones and with the lower levers positioned to be opposite the spaces between the upper ones. The equipment on the operating floor of the signalbox consisted merely of an open framework containing the levers with all the tappet interlocking in horizontal trays in the locking room below, along with electrical apparatus, and connected via exposed vertical rods passing through the floor. Levers were at 3½ inch centres and were contained within frame sections of 19 levers each, those on the top tier being generally used for points and having approximately double the travel of those in the lower tier. Check-locking of levers was used to prove detection. Integral signal repeaters and points indications were not elements of this frame design (*Figure 166*).

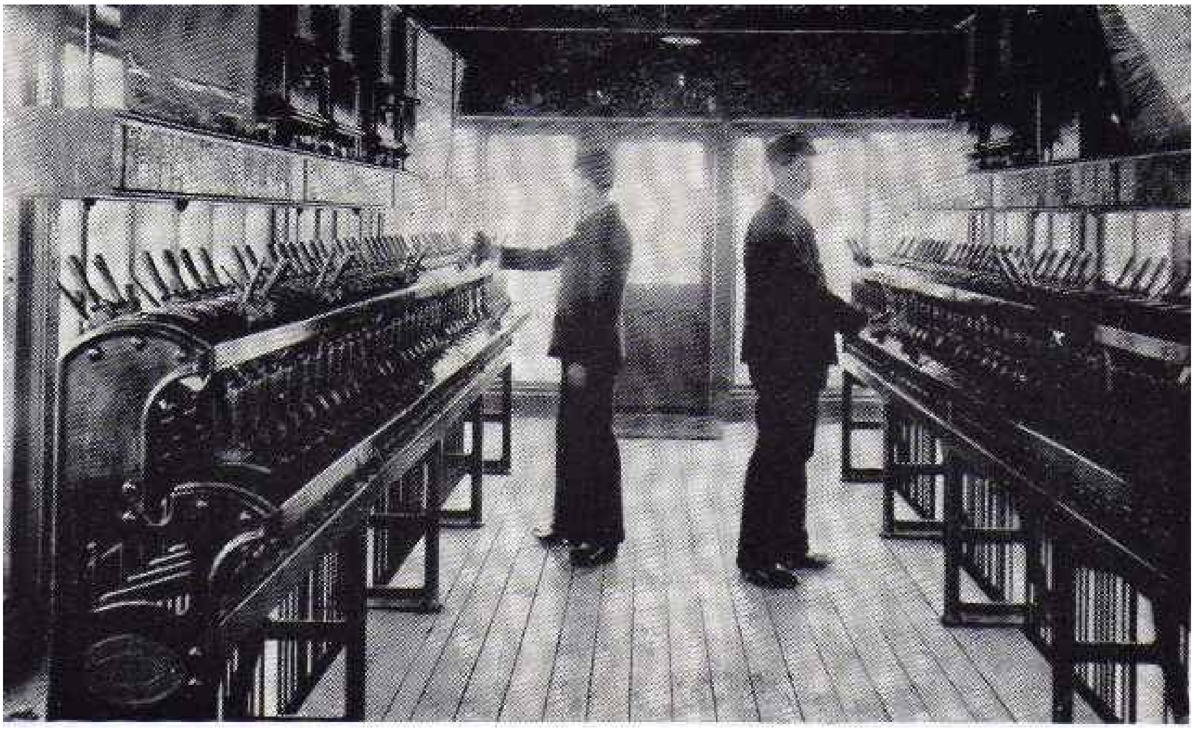


Figure 166 - LNWR Crewe System Two-Tier PF(L), Crewe Sorting Sidings Middle. © Railway Signal Co.

For use in overhead boxes and other locations where a normal locking room was not available an alternative frame was produced with levers in just one tier at 2½ inch centres and in sections of 13 levers each. The interlocking trays were positioned to protrude from the rear of the frame, which was now enclosed in a casing, just above floor-level. A later model used at Manchester had the locking trays positioned just below floor level. All the electrical apparatus was enclosed within the frame casing. (*Figure 167*).

Figure 167 - LNWR Crewe System One-Tier PF(L), Crewe Station A. © Andrew K Overton.

McKenzie, Holland and Westinghouse Power Signal Co. (McKH&W) [Frames commissioned 1902 - 1918]

Having entered the British market with the USSCo frame at Granary Jcn, in 1902 Westinghouse entered into an agreement with McKenzie & Holland to produce power signalling, and formally combined with them in 1907. The latter firm continued the contract to install the actual signalling for Westinghouse which was used on the Granary Jcn scheme. The company name changed to Westinghouse Brake & Saxby Signal Co. Ltd. after the merger with Saxby & Farmer in 1920.

The company designed two models of PF(L) for installations covered by this Register whilst trading under this name:

Style A: The Style A frame was the first to be introduced for the resignalling of the lines serving Tyne Dock on the NER (*Figure 168*). The rotating handles of the USSCo design had drawn objections in Britain so a new design was produced with miniature levers at 2½ inch centres, standing at the top front of a large wood panelling-enclosed frame. The levers stood vertical when Normal as, to economise, signal levers were pushed or pulled to select different signals: associated main or calling-on arms, or opposing shunt signals. The lever quadrants were part of a metal casting resembling an back-to-front 'P' in profile. A raised, sloping surface behind the levers held the pull-plates but integral signal repeaters and points indications were not elements of this frame design. Horizontal tappet interlocking trays were positioned under the glass-fronted panelling to the rear of the levers. The frame itself was designed to operate electrical controls which drove high pressure electro-pneumatic motors at the points and signals, utilising air at 55 - 65 lbs per square inch.

Figure 168 - McKH&W Style A PF(L), Green Lane. © John Boyes Collection

Figure 169 - McKH&W Style B PF(L), Glasgow Central. © Invensys Rail Ltd.

Style B: Continuing with the electrical driving of electro-pneumatic systems the next frame design, the Style B, saw the 'P'-casting and push-pull levers dispensed with. The levers were now set back from the front of the enclosing cabinet with an almost horizontal, shallow desk surface before them. When Normal the 2½ inch centre levers stood about 30 degrees from vertical towards the rear of the frame. The interlocking was redesigned and was now positioned in vertical trays behind the panelling at the front of the frame. A wooden box, which acted as a block shelf, stood to the rear of the levers: sometimes the pull-plates were affixed to the front of this, as well as integral signal repeaters and points indications; sometimes pull-plates were affixed to a board between the levers and the box front with conventional repeaters and indications being affixed to the box front (*Figure 169*). Points levers were check-locked when being moved both ways until the points had correctly detected; signal levers were check-locked when being placed Normal until the signal was detected On.

Style Ground B: This was a Style B frame for ground frame use and was outwardly the same in appearance to the normal Style B frame but with the addition of a wooden lid, hinged at the rear, which covered the levers and the 'block shelf' box behind them when the frame was not in use.

Metropolitan Vickers - General Railway Signal Co. (MV-GRS) [Frame commissioned 1944]

GRS reverted to trading under the MV-GRS banner in 1942.

MV-GRS designed individual slides for block-shelf mounting. These utilised the GRS style of pear-shaped handle pointing upwards, with the workings contained within a tall, slim box, not dissimilar to the Westinghouse Style D. A bull's-eye indication lamp was mounted on the front of the case.

Pneumatic Railway Signal Co. (PRSCo) [Frames commissioned 1901]

This Rochester, New York company supplied two frames direct - for Grateley and Grateley Ground Frame - but thereafter further production was licensed to BPRSCo.

Figure 170 - BPRSCo (PRSCo) PF(S), Moor Road Bridge. © John Midcalf

This frame used slides with upwards pointing handles painted with appropriate colours for function (red for stop signals, black for points etc.) at 3 inch centres. The whole frame mechanism was enclosed in a wooden case with the tappet interlocking mounted vertically behind the front covers (*Figure 170*).

The system used compressed air at 7 lbs per square inch to operate the point and signal mechanism valves: the drive for that equipment being at 15 lbs per square inch. Pulling a point slide 2 inches brought it to the first check-lock position and actuated the interlocking. In this position air was admitted to the valves of the outside apparatus and when it had correctly responded the final 1 inch movement of the slide to the fully out position was effected automatically by pneumatics, indicating to the signalman that Reverse detection had been obtained. In placing points Normal a similar procedure was effected with another automatic final movement of the slide fully in. Signal slides had a similar facility when being placed in, to detect the signal On, but not when pulled Off. Slides were not provided for Distant signals, these operating automatically in conjunction with contacts on the arms of the respective stop signals. Integral signal repeaters and points indications were not elements of this frame design, apart from the indications given by the automatically completed stroke of the slides as described above. The automatic completion of stroke was called dynamic indication.

Railway Signal Company (RSCo) [Frame commissioned 1903]

RSCo were the sole licensees for the LNWR Crewe System and produced one Two Tier frame, used at Severus Jcn on the North Eastern Railway (NER) at York.

Siemens: All-Electric [Frames commissioned 1905 - 1913]

Figure 171 - Siemens All-Electric PF(L), Didcot North.

This PF(L) design had been used in Germany and was modified for British use by the removal of certain unrequired features. It was an all-electric system with both complete electrical interlocking, and mechanical locking by horizontal bars placed on edge, having locks working into shaped portions of circular cams on the lever axles. The mechanical locking was effected through a bolt-catch which stopped a locked lever in mid-stroke: it did not prevent initial movement. In the 1905 installations at Didcot North and Way & Works Sidings the locking trays were in the middle of the frame casing, facing the front, and certain electrical equipment also housed inside conspired to make the frame rather deep. This was the first use of electrical interlocking in the UK.

The miniature catch-handleless levers, standing 4 feet above floor level, were at 2 inch centres and there was no check-locking during their operation. The gently-sloping front of the frame casing had two vertically disposed windows in line with each lever: the upper window displaying a 'locked' or 'free' indication depending on whether the lever was free to be moved, the lower window displaying a 'normal' or 'over' indication for points and 'on' or 'off' for signals. These indications were mechanically driven. In front of the sloping section was a shallow, flat shelf before the casing front (*Figure 171*).

The frame was redesigned after use at Way & Works Sidings by L M G Ferreira of Siemens Bros.. The new design was first used for the installation at Snow Hill North in 1909 (*Figure 172*), the depth of the frame having been reduced by about two-thirds to 12½ inches by the removal of electrical equipment, including the interlocking and the integral point and signal indications. The front of the frame was much shallower with no flat section and the lever pull-plates covered the slope. The frame was constructed in sections of sixteen levers and the locking trays were repositioned to the rear of the frame. Check-locking of points levers when moving through both positions until correct detection was obtained, and for signal levers moving Normal, was introduced. The installation at Snow Hill South was slightly different as points indications were reintroduced. These were given by separate repeaters fixed behind the levers for facing points, being in the form of a flag indicator showing white for Normal, black for Reverse and black & white chevrons for OOC. Neither box was provided with signal repeaters, except for Distants and colour lights.

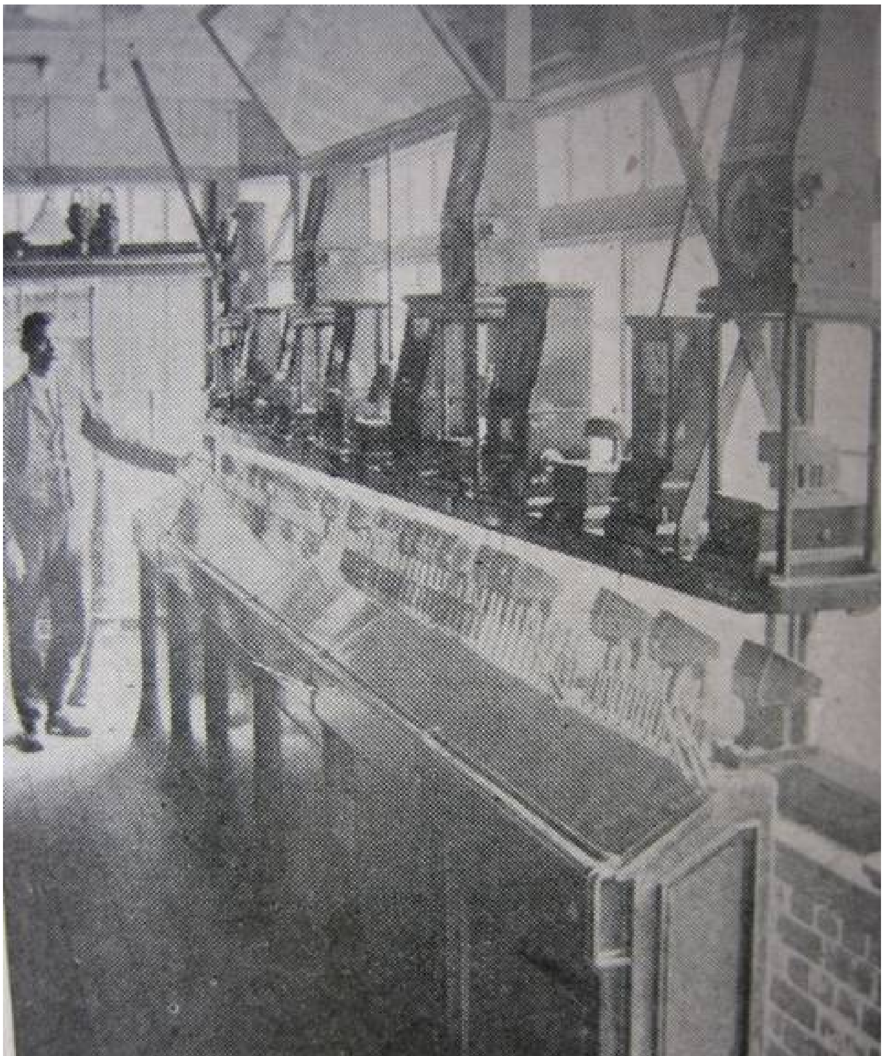


Figure 172 - Siemens All-Electric PF(L), Snow Hill North.

Siemens and General Electric Railway Signal Co. (SGE): All-Electric [Frames commissioned 1926 - 1941]

After 1918 Siemens formed a partnership with the General Electric Company (US), becoming SGE.

The 1926 installations at Holborn and Blackfriars Jcn (*Figure 173*) saw a slight redesign of the Siemens All-Electric frame and the sloping front was now a shallow, flat shelf with the pull-plates mounted thereon. The levers themselves changed to a shorter, fatter design with a catch-handle and the handles themselves could be covered with Doverite (a type of PVC) of a colour corresponding to their function, although never supplied as new on a UK installation. Mechanical interlocking was retained. Integral main signal aspect, route indication and point repeaters were inset into a sloping cabinet face behind the levers. Shunting disc signals were not repeated but their levers were check-locked when being placed Normal until the signal was proved On. This frame was also used at Kings Cross in 1932.

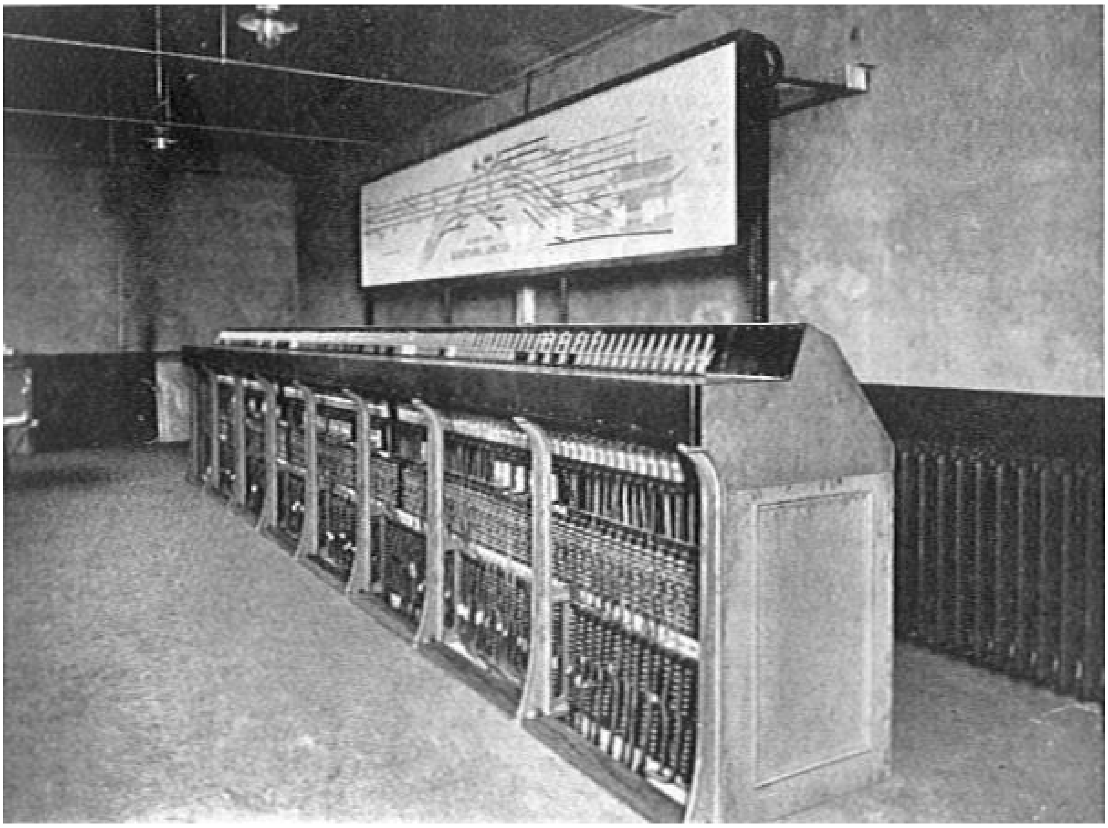


Figure 173 **-** *SGE All-Electric PF(L), Blackfriars Jcn. © C J Allen.*

The 1935 installation at Fenchurch Street saw the frame further redesigned with electric interlocking (*Figure 174*), although a mechanically interlocked version could be supplied. This version of the frame was constructed in 8 or 12 lever sections at 2½ inch centres. Lever handles were now covered with a non-flammable cellulose called Firmoid. The shelf in front of the levers had semi-transparent printed-linen pull-plates between glass as a surface and could be softly illuminated internally. Behind the levers was a vertical frontage topped with a shelf, upon which were positioned bells, telephones etc.. The face had integral points indicators and signal repeaters positioned in vertical rows behind each lever as required. Main signal repeaters showed red for On and white for Off; only the On position of shunt signals was repeated, with a red lamp; 'N' and 'R' indications and 'free' lights were provided for points. The electrical interlocking was positioned to the rear of the levers, engaging with horizontal bars worked by the levers. The lower front of the frame casing consisted of glass doors through which the contactor bands could be seen at the front and – if required – the rear of the frame, with vertical mechanical interlocking either at the front or rear instead in the mechanically interlocked version. This model of frame was reused at Edinburgh Waverley in 1936/8 and Reading Main Line East in 1941.

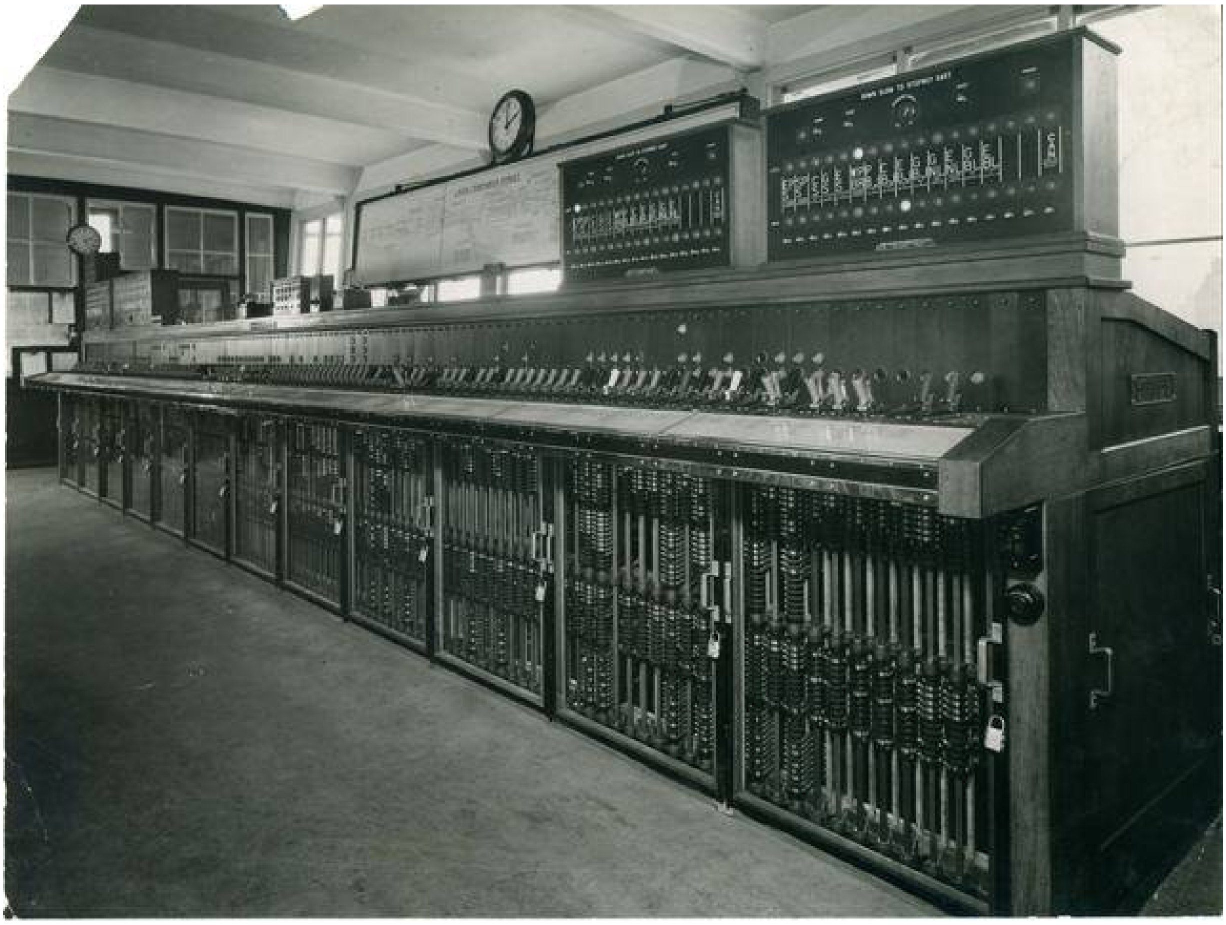


Figure 174 - SGE All-Electric PF(L), Fenchurch Street.

SGE: Ferreira - Insell Route-Signalling [Frames commissioned 1922 - 1928]

This was the first, and only, route-setting power frame to be used in Britain. Designed by R J Insell of the GWR and L M G Ferreira it was fully electric and consisted of a combination of route levers and points slides forming a PF(LS) system. Used experimentally at Winchester Cheesehill from late 1922 (*Figure 175*), it was put into permanent operation at Newport East and West in 1927/8. The miniature route levers had individual points slides grouped in the centre of the frame below a set of king levers. Mechanical interlocking was by tappets and the horizontal trays were positioned in the rear part of the frame casing.

Behind each route lever was positioned a vertical row of four lights. With the lever in the normal position the top (red) light was displayed. To set a main route the lever was pulled to the first check-lock position and if all track circuits were clear the bottom (white) light illuminated. The points required to move in the route now operated and once in the correct position the third from top (orange / yellow) light illuminated, the check-lock on the lever was released allowing it to be fully reversed, passing through the second check-lock position without stopping. Once reversed the signals cleared and the red light was replaced by a green light (second from top). When the train had occupied track circuits in the route the signal automatically reverted to danger, the green light was replaced by red and the white light extinguished. To cancel the route the lever was first replaced to the second check-lock position. Once signals had been proved at danger and all point controlling track circuits clear the white light illuminated and the lever could be moved to the normal position, passing through the first check-lock position without stopping. If points in the route needed to be restored for trapping they would do so at this point but otherwise they remained in the last position set. Shunt route levers operated in the same way except that track circuit locking was not provided at the first check-lock position.

Points indications with this system were provided over the points slides: a green light for Normal above an orange / yellow light for Reverse, except in the case of points which were automatically restored which had a red light for Reverse. To operate points individually in case of failure etc. the king levers applying to those lines were pulled, thus locking normal the route levers for those lines. This released the relevant points slides, which were normally in the centre Neutral position, allowing them to be pushed in (to move the points Normal) or pulled out (to move the points Reverse). Restored points left in the Reverse position automatically moved Normal when the king levers were replaced. King levers were to be used by signal inspectors and linemen only and not by signalmen.

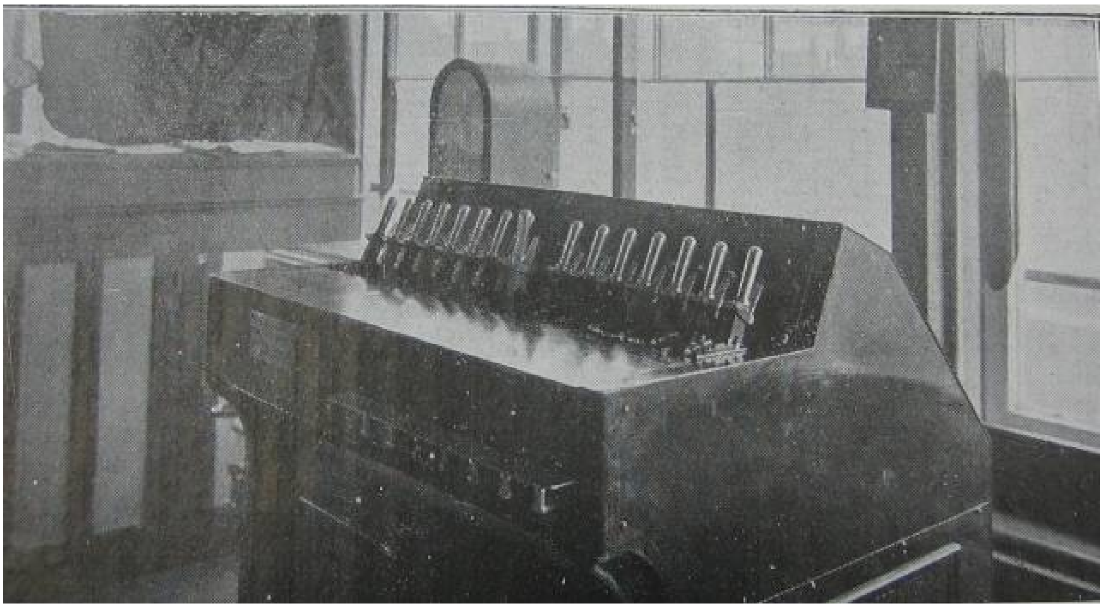


Figure 175 - SGE Insell-Ferreira Route-Signalling PF(LS), Winchester Cheesehill.

Stevens: Hydraulic [Frame commissioned 1896]

A one-off frame was commissioned at Stobcross East No.1, owing to the impossibility, as a consequence of space restrictions, of siting the signal box at Stobcross East Jcn in a position in which the signalman could obtain a good view of the lines under his control. Stobcross East No.2 - a normally unmanned box with conventional lever frame to which the outside signalling equipment was attached - was sited where space allowed and a narrow manned box, Stobcross East No.1, was sited in a position of good visibility. No.1 box contained a Stevens PF(L), with 18 inch tall levers of typical Stevens appearance at 3 inch centres in two rows, giving 6 inches between each lever in the same row, the levers being raised above floor level to about knee height by the frame construction. The levers were linked by rods to the hydraulic apparatus which connected to the conventional lever frame in the unmanned No.2 box, operation of the miniature frame driving the conventional frame by hydraulic rams. Response of the conventional frame levers was repeated to No.1 box by way of bells behind the miniature frame indicating Normal and Reverse positions. Both frames were interlocked. Block signalling apparatus was situated at both boxes and the hydraulic apparatus could be disconnected and No.2 box brought into direct operation if required.

Union Switch & Signal Co. (USSCo): Electro-Pneumatic [Frame commissioned 1899]

Westinghouse wished to enter the UK market but had no signalling base in the country, so traded through the brake division at King's Cross, the frame being made by their US subsidiary USSCo and imported. McKenzie & Holland did the actual installation of the signalling.

The frame used on the GER at Whitechapel (later renamed Granary Jcn) was of a unique style in Britain, although similar to those in use on the US railways (*Figure 176*). It consisted of an enclosed deep 'tray' mounted on girders, with rotating handles at the front to operate points and signals etc. and driving a horizontal locking shaft. The horizontal locking tray was positioned inside the front of the apparatus with electro-magnetic locks for the handles to the rear. The frame itself operated electrical controls which drove high pressure electro-pneumatic motors at the points and signals. Integral signal repeaters and points indications were not elements of this frame design. Being of an unfamiliar type to conservative British signalling engineers it did not find much favour and no further examples were used here, Westinghouse going on to produce its Style A miniature lever frame for the British market.

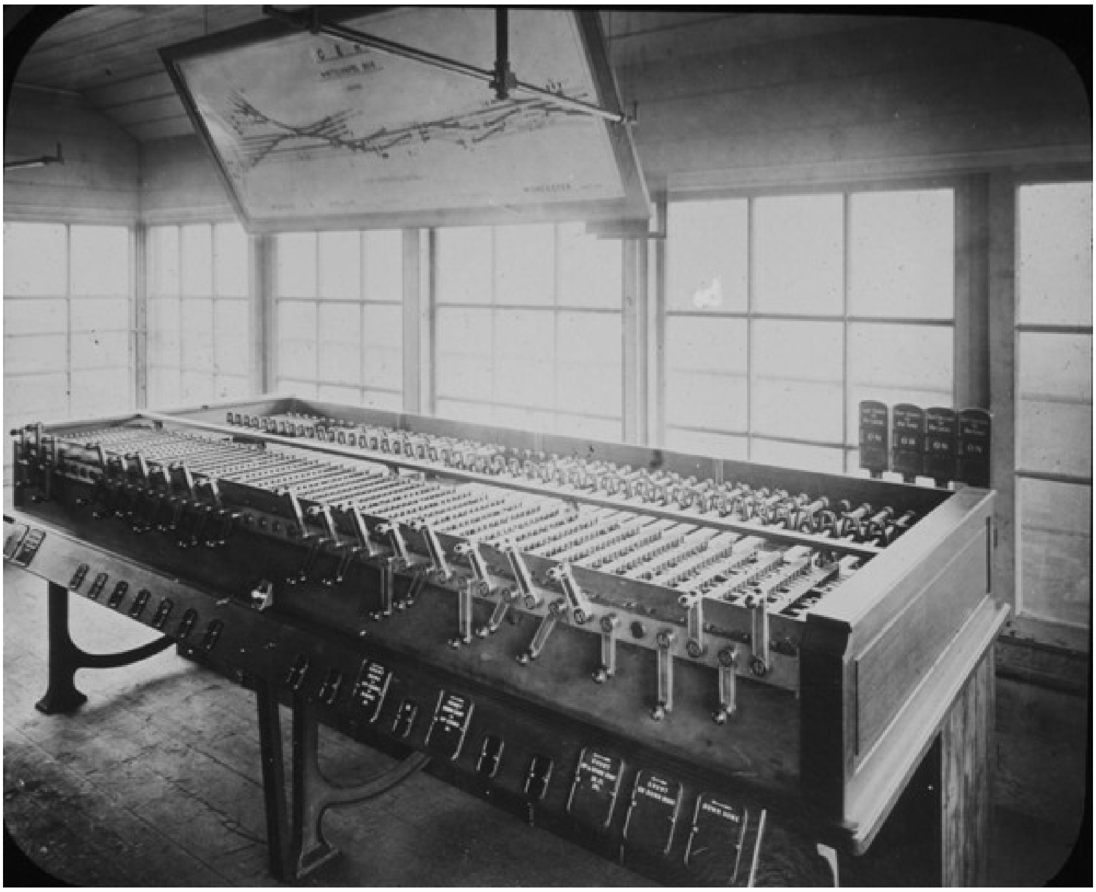


Figure 176 - USSCo PF(L), Whitechapel. © Siemens.

W R Sykes: Electro-Mechanical [Frames commissioned 1902 – between 1916 and 1927]

This was the only PF(S) system to employ a Hybrid arrangement of conventional mechanical lever frame for the operation of points, coupled with slides for the electric operation of signals (although there were examples of blockshelf mounted individual PF(S) being added to a conventional lever frame at a later date owing to lack of spare levers and thereby forming Hybrid arrangements). The slides were positioned in a box on the blockshelf at 2 inch centres, with signals positioned approximately above the point levers through which they read, and the two elements were mechanically interlocked by vertical rotating shafts to the rear of the slide box (*Figure 177*). Tappets placed on edge in the locking trays were actuated by rack and pinion drive owing to their close proximity to each other. The railway company's preferred design of lever frame was adapted for use with this system. Integral signal repeaters and points indications were not elements of this frame design.

Points levers were used in the normal way to set routes in most cases but in the installations at Glasgow route levers were also employed. These were push-pull levers and interlocked with the points levers, with the signal slides only being interlocked through the route levers. Slides were operated by first pressing a button on the handle, which released a catch and energised the electrical circuitry, allowing reversal if the route was clear through the check-lock position.

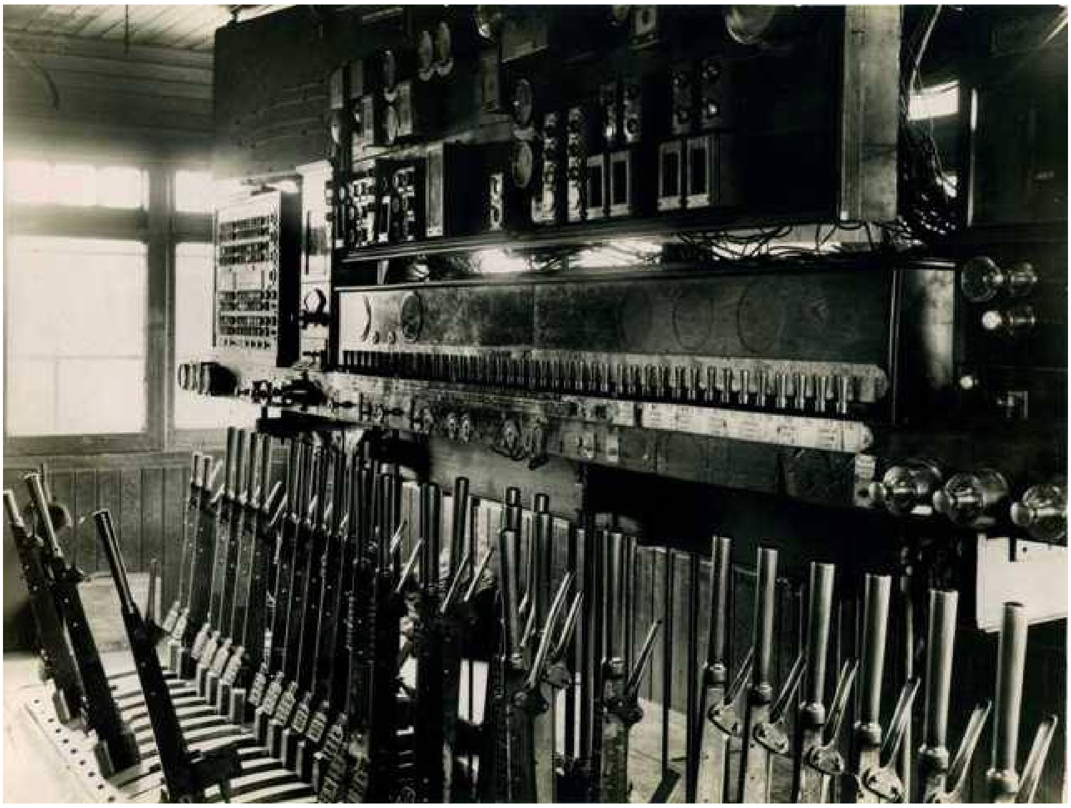


Figure 177 - W R Sykes Frame / PF(S) Hybrid, Port Eglinton. © British Rail

The last installation, at Burleigh Street on the H&BR, was much later than the others but its commissioning date is not known exactly, being sometime between 1916 and 1927. It may possibly have consisted of second hand equipment from Cudworth North.

In 1905 the Single Line Lock & Block system was introduced on the Cairn Valley Light Railway. The principle was similar to that of the Electro-Mechanical system, with a conventional lever frame to operate points but this time the signal slides were incorporated in the single line block instruments and also operated the block indications - accepting instruments operated the Home signal, sending instruments the Starting signal.

Westinghouse Brake & Saxby Signal Co. Ltd. (Westinghouse) [Frames commissioned 1923 - 1962]

The new name of McKenzie, Holland & Westinghouse Power Signal Co. after the merger with Saxby & Farmer in 1920.

The company supplied one further Style B PF(L) before turning to new products:

Style D: This was a single slide design of PF(S) intended for mounting on a blockshelf where additional equipment needed to be added to a conventional lever frame with no spare levers (*Figure 178*). It consisted of a metal box (6½ inch wide, 13⅜ inch high, 15⅜ inch long) with rounded top corners containing the electrical slide lock and contacts. The slide, with downturned handle and catch-handle, protruded from the bottom front and had a stroke of 2 inches. The pull-plate was affixed to the box above it.

Figure 178 - Westinghouse Style D PF(S). © Siemens.

Style D2: This was a wider two-slide version of the Style D with integral needle indicators towards the top-front of the casing for use as a simple ground frame (release and points) (*Figure 179*). These frames were commissioned new as late as 1960, being used in OCS resignalling schemes.

Style D3: Similar to the Style D this had an integral signal repeater towards the top-front of the casing in the form of a three-position needle indicator (On, Off, Out).

Style K: The Style K frame was designed for all-electric operation of outside equipment. The general appearance of the Style B was retained but integral signal repeaters and points indications were provided on the front of the 'blockshelf box' to the rear of the levers, which now had a slightly inclined front surface and a gently sloping rear. The 'blockshelf box' could be made taller where there was a need to incorporate additional instruments within the front. The lever pull-plates were repositioned on the desk in front of the levers, which were still at 2½ inch centres. Points and signal lever check-locking was provided as with the Style B frame.

Repeaters for signals consisted of a vertical row of four coloured-lights, mimicking the actual aspects of the signals outside, with vertically disposed 'N' and 'R' indications for points. The signal repeater lamps were used to indicate signal lamp filament failure: if the lamp was 50% as bright as usual this indicated a first filament failure; 25% as bright indicated the lamp in the main or close-range aspect had failed completely; if unlit this indicated the lamps in the main and close-range aspects had failed. (*Photo - see http://www.wbsframe.mste.co.uk/public/Manchester_Victoria_West.html)*

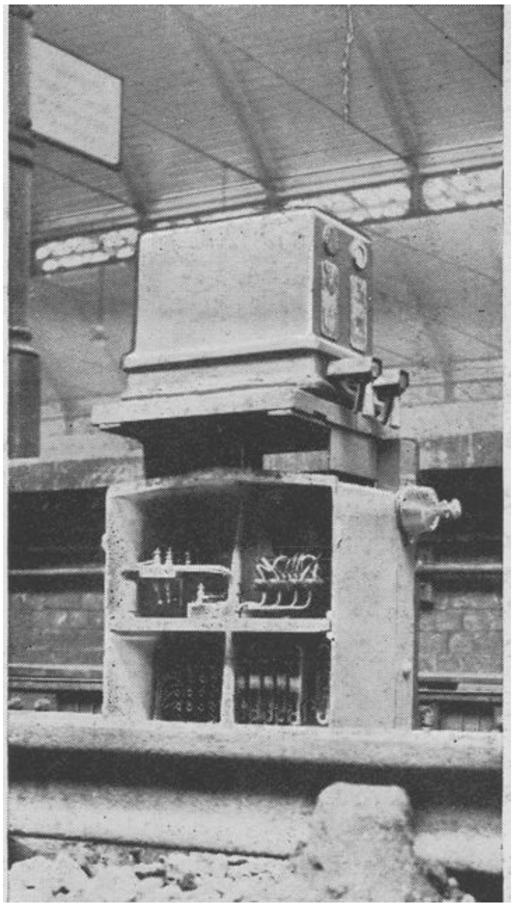


Figure 179 - Westinghouse Style D2 PF(S), Hull Paragon. © Siemens.

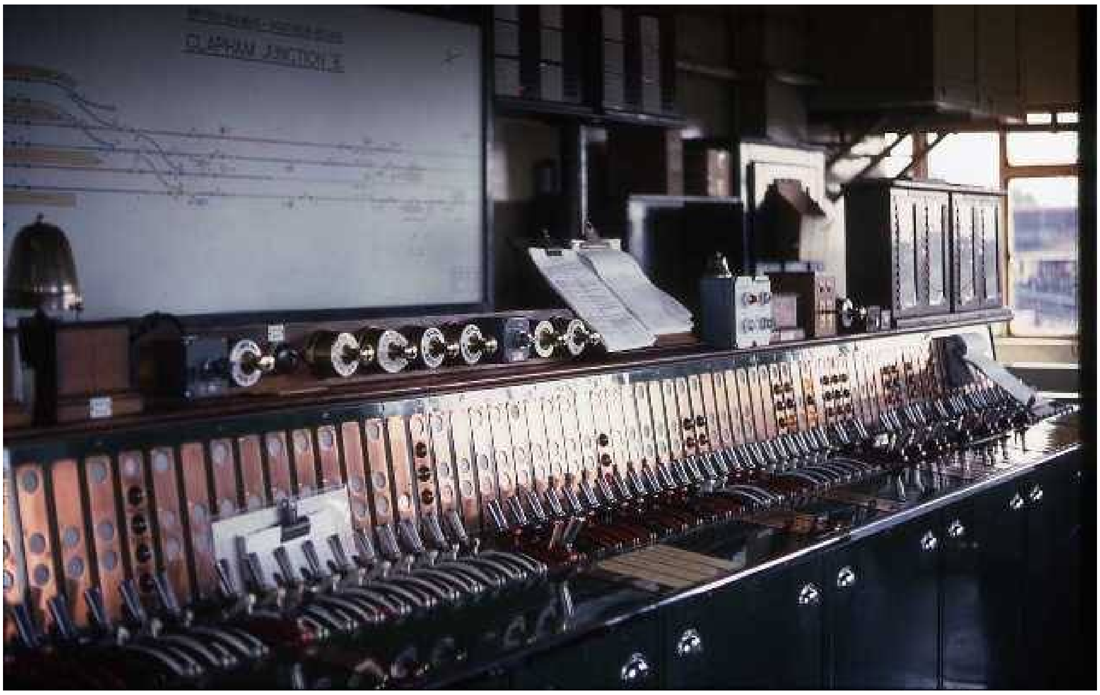


Figure 180 - Westinghouse Style L PF(L), Clapham Jcn B. © CJ Woolstenholmes

Style L: The Style L (*Figure 180*) saw a departure from mechanical interlocking and new electrical lever locks engaging with a horizontal locking bar were positioned towards the top-middle of the cabinet, which could be of steel instead of wood. This was the first power frame to exclusively employ electrical interlocking. The front of the cabinet now housed the electrical contactors. The 2½ inch centre levers traversed prominent raised individual quadrants but were much shorter than previously, leading to the quadrants themselves being painted according to lever function. Check-locking of levers when travelling in both directions was introduced, as was back-locking. The frames came in 12 or 8 lever sections with the last section being one lever short. The front desk, with the pull-plates mounted thereon, now projected from the front of the cabinet. The integral signal and point repeaters of the Style K were retained. The use of running ground position light signals was also introduced with a Style L frame, being first used at Liverpool Lime Street in 1948.

Style M1: In 1909 a Style M1 frame was installed at Yarnton Jcn (*Figure 181*). Chronologically this design followed that of the Style A but was produced concurrently with the Style B. It was, however, an all-electric frame so appears to be the alternative product to the Style B where an all-electric installation was requested. In appearance it was much closer to the Style A, with a metal casting for the levers projecting from the top-front of the wooden frame cabinet. The shape of the casting was different, though, with the top now being of rounded lever quadrants with the underside flat. The top-front of the cabinet had a sloping section. The levers too stood differently in the Normal position, being inclined towards the rear of the frame with no push-pull facility. Mechanical tappet interlocking was employed. Integral points and signal indications were not provided. Check-locking of points levers was not employed but signal levers were check-locked when being placed Normal.

Figure 181 - Westinghouse M1 PF(L), Yarnton Jcn. © Siemens.

Style N: One Style N frame was used as a temporary replacement for a fire damaged MV-GRS frame at Paddington Arrival box in 1938/9. The style N frame was a mechanical tappet interlocked version of the Style L used on LT, which it was identical to in both outward appearance and operation, and the vertical interlocking trays were positioned at the front of the frame in place of the Style L's contactors. (*Photos - see http://www.wbsframe.mste.co.uk/public/Harrow_on_the_hill.html*)

Interlockings

Interlockings - Column Descriptions & Definitions

Each interlocking has its own entry to correspond to the controlling interface. For the purposes of recording here an interlocking is defined as an installation where electrical or electronic circuitry exists to ensure that signalling equipment controlled by an interface cannot be operated in conflict. Any signal which can be controlled by an interface is considered to be worked through an interlocking and no account is taken of the actual designation of such signals on the signal post identification plates. However, exception is made in respect of interfaces which only operate ERS and Yard interfaces, and neither of these are considered to have associated interlockings. In the case of Yard Hybrid interfaces the interlocking recorded is that associated with the non-hump-shunting element. Yard interfaces are complex and although route-setting off the hump and into the sidings is often a feature it does not follow that interlocking, as commonly understood, is associated with this. For example, sorting siding points move whilst the hump shunting signal remains Off and the hump panel operator may manually operate points irrespective of a route having been set through them etc. - both features being fundamentally against interlocking principles. No interlocking is shown for KL as the interlocking functions are performed electro-mechanically. Interfaces which are positioned on the ground for the operation of single signals in yards and sidings etc, or interfaces provided in connection with loading / unloading bunkers / hoppers and associated signals without points, are generally by default considered to have no associated interlocking functions, except where the specifics of the layout suggest otherwise. Interlockings provided in connection with automatic level crossings (AHB / MCB-OD etc.) and having no function other than the control of the level crossing and protecting signals are not included, as they are considered to be automatic interlockings. All GSPs are considered to have interlockings owing to the requirement to normalise the controls before the release can be relinquished.

Former interlockings which have been reduced to the status of relay rooms owing to the loss of their interlocking functions (signals converted to automatics) are listed as decommissioned at the date of conversion.

In understanding power signalling installations it is important to appreciate that there may be several different interlockings controlled by the one interface. These may be located at the same location as the interface, some distance away, or a combination of both. It is also not necessary for these interlockings to be designed by the same manufacturer or to be of the same type. Furthermore, interlockings may predate the interface, having previously been controlled by another box since abolished; they may postdate the interface if the area of control expanded gradually under stageworks or by much later absorption of areas previously controlled by another box; they may also be new installations of more modern type provided long after the introduction of the interface as older interlocking systems become life expired. It is, therefore, important to establish the details of each interlocking independently of the others, tracking the history of control without assuming a history based on the dating of the interface currently in control.

Where an interlocking has been modified or extended without a major change of type no new entry has been generated. However, if an interlocking has been entirely replaced at that location, either by the same or another type, then a new entry has been made.

Where it has not been possible to verify information from a source to the satisfaction of the author such data are shown in *red italic font*.

Note - It should be understood when making reference to signalling plans and viewing buildings on the ground that there is a difference between a 'relay room' and an 'interlocking', although the former term is often used in a generic fashion to include the latter installation. Relay rooms contain equipment used for the transmission of indications from points, signals, track circuits etc. and range in size from the smallest - location cabinets - to the largest buildings, which may be bigger than some which house *interlockings. This equipment is not interlocking circuitry. Interlockings contain the actual interlocking circuitry and they too range in size exactly as do relay rooms. It should never be inferred that the presence of a significant lineside building guarantees the existence of an interlocking, or vice versa. When studying signalling plans care should be taken to differentiate between relay rooms and interlockings, both of which may be shown by the generic term 'relay room'.*

Column Definitions

Column 1 - Name

This is the official name of the actual interlocking. In the case of SSI / CBI the capitalised official Central Interlocking Identity codename is used, as shown in the National Software Register 8150E and SSI Configuration Guides. Where separate interlockings in the same location have official differentiating names these have been used in parentheses but in other cases they are differentiated by alphabetical reference suffixes, e.g. (A), (B) etc.. Where interlocking controlling more than one area is housed within the same building it will normally be considered to be a single interlocking if it is controlled by one interface through, if necessary, a single remote control system. Where multiple interfaces and / or, if necessary, remote control systems are provided and the interlocking is physically separated into different areas then it may be considered to be multiple interlockings within a common building.

Column 2 - Interlocking Type

Four individual types of interlocking are recorded in accordance with the descriptions and definitions given below:

Computer Based Interlocking (CBI)

Computer Based Interlockings are used with route-setting interfaces. CBI embraces all electronic processor based systems from second-generation onwards. Types of CBI include WESTLOCK, Westrace, Smartlock and VHLC.

Electronic Logic Unit (ELU)

Electronic Logic Unit interlockings are now obsolete and were only manufactured and used on a trial basis by Mullard Equipment Ltd at Henley on Thames and by Westinghouse at Norton Bridge.

Relay Interlocking (RI)

Relay interlockings are controlled by all types of interface. They may consist entirely of relay circuitry performing both vital- and non-vital functions, or the non-vital circuitry may be replaced by electronics (Electronic Route Selection Equipment (ERSE), panel processors etc.). Provided the actual interlocking between points and signals etc. is carried out by relays then the installation is defined as a RI.

Solid State Interlocking (SSI)

Solid State Interlockings are used with route-setting interfaces. SSI is a first-generation electronic processor based system originally developed jointly by BR, GEC-General Signal and Westinghouse, although improved versions have been developed subsequently.

Confusion often occurs in categorising SSI and CBI. It should be understood that both are 'computer based' in that they use micro-chip technology. SSI is a specific type of CBI - almost a trade name - and should only be used to describe equipment made to the original design principles. The only authorised manufacturers were GEC-General Signal, GEC-Alsthom and Westinghouse; now just Alstom and Invensys Rail / Siemens. No type of CBI systems must be recorded as SSI. CBI is a later, more complex development of SSI. It is faster and has greater capacity, but SSI is still used for new work as it is cheaper and quite adequate for many interlockings.

Column 3 - Interlocking Designs

There are two general types of RI: freewired and geographical. Geographical installations are all-relay interlockings and do not employ electronic non-vital circuitry. The design of the interlocking is noted where known, as is any official design-type designation. Geographical packages may have a proprietary name and model, and CBI installations invariably do. In the case of SSI the hardware design manufacturer and version is shown. In the case of freewired installations only nationally recognised BR standard designs are shown, pre-standardisation installations being shown just as 'Freewired', although it is recognised that a degree of proprietary standardisation in circuit design was adopted by the contractors and regionally by the railway companies and British Rail. Where a geographical, SSI or CBI interlocking design has been produced by more than one design manufacturer the name of the organisation originally producing it is appended in brackets, i.e. GEC - Alsthom (BRR): it is under the original design manufacturer's name that the description of the interlocking is found in the *Interlocking Designs* section.

Freewired Relay Interlockings

A freewired interlocking consists of separate relays performing the vital functions which are interconnected in a design which is specific to that location. The non-vital functions may also be performed by relays or by an electronic system such as ERSE or a panel processor. Freewired interlockings are controlled by all types of interface.

Geographical Relay Interlockings

Geographical circuitry was invented in the early 1930s by GRS in the United States. Swiss and German engineers developed and installed their systems and the first installation was at Dillingen in Germany in 1956. Due to differing practices in continental Europe in respect of the use of shunt routes, and the control of multiple point ends and flank protection, the systems in use there were not economic to employ in Britain. The first geographical interlockings designed specifically for British market conditions appeared in 1962. AEI-GRS commissioned three interlockings associated with the Folkestone resignalling on 18th February of that year, SGE commissioned Paddock Wood interlocking on 1st April and Millerhill on 16th May, and the only Integra geographical interlocking to be used in the UK commissioned on 29th July at York Yard South. However, it is worthy of note that SGE had employed their geographical packs for route and signal selection purposes in non-vital circuits - the 1960 Route Selection System - driving freewired interlockings, in a number of locations from 1961 (Ashford, Colchester, Coventry, Gas Factory Jcn / Stepney East, Tilbury Riverside / Tilbury Town North Jcn, Witham). Around 1960 the company had developed a fully geographical system used in continental Europe - the SpDrS60 system, the most common geographical interlocking system in Germany - but it is not known whether there was any development connection between the 1960 Route Selection System and SpDrS60. The last all-new geographical interlocking was installed at Redhill, worked by Three Bridges SC, in 1985, although some like-for-like replacements of life expired equipment continues today.

Geographical interlockings are only controlled by route-setting interfaces. They consist of factory made packages of relays which control certain common elements in typical layouts (i.e. main signal unit, shunt signal unit, crossover unit), and they are added together to control a complete interlocking, the only wiring being the interconnecting jumpers. They are mounted in the relay room in a configuration which broadly mirrors the layout controlled - hence the term 'geographical'. Un-needed functions are left redundant. Both vital- and non-vital functions are performed by relay circuitry. These interlockings are easier to design and quicker to install but have inbuilt wasted capacity as in reality not every function in each package is used. They are factory checked, so reducing the amount of testing required on commissioning. They are only economical for reasonably large or complicated interlockings. Fault finding can be facilitated by analysis through maintainer's panels or indications on the units, which indicate the faulty package.

A disadvantage of geographical interlockings is that when any entrance button is pressed all other buttons are set to act as potential exit buttons. This means that if more than one signalman is to work the same interlocking it must be split into parts corresponding to the signalmen's areas of control. These parts each have their own 'push button rings' so that the signalmen's actions do not conflict with those of their colleagues. With freewired interlockings only the available exit buttons are activated, which makes them more flexible.

Only standard interlocking requirements can be fully met by a geographical package and although facilities exist to customise them to an extent to cater for special conditions it is frequently necessary to provide an element of freewired circuitry for certain functions; in complicated layouts the amount of such circuitry may be significant. An element of freewired circuitry in a predominantly geographical installation should be expected and is not recorded.

Column 4 - Commissioned

This is the date when any part of the interlocking hardware was officially signed into operational use at that location. Where it has not been possible to establish the precise date of commissioning in the case of schemes which were brought into use over a weekend etc., the start date of the commissioning weekend has been taken as the interlocking commissioning date. Where an actual commissioning date has been used which differs from an officially published date the discrepancy is highlighted in the Notes column to avoid confusion.

It must be understood that, unlike interfaces, interlocking equipment is often replaced over time bit by bit as, for example, relays fail or are renewed as part of preventative maintenance. Frequently, when a migration of control to a new interface occurs, there are alterations or additions to pre-existing circuitry. So, over many years the actual equipment of an interlocking may become much like Granny's old broom, which has had three new heads and two new handles. Any interlocking shown as being more than approximately 40 years old is highly unlikely to consist of much original equipment, it will have been renewed piecemeal over the years, or as a one-off job, the date of which has escaped record. However, such renewals will generally be like-for-like and the original design principles will be maintained. The commissioning date of an interlocking should be read in these terms. Where an organised and wholesale replacement of the interlocking takes place as part of a renewal project and this event is known, this is recorded as a new commissioning.

This principle extends to electronic interlockings (SSI and CBI). In these cases the interlocking itself is actually a software program and this can be altered many times without any change to the interlocking hardware. In the case of SSI and CBI the date recorded will be the date that version of electronic hardware was first commissioned or subsequently replaced wholesale.

Column 5 - Decommissioned

This is the date when the last part of the interlocking was officially signed out of operational use at that location owing to abolition or renewal, consistent with the guidelines in Column 4. Where it has not been possible to establish the precise date of decommissioning in the case of schemes which took place over a weekend etc., the start date of the resignalling weekend has been taken as the interlocking decommissioning date. Where an actual decommissioning date has been used which differs from an officially published date the discrepancy is highlighted in the Notes column to avoid confusion.

Decommissioning of 'non-railway-organisation' interlockings, i.e. those at power stations, collieries etc, is rarely, if ever, formally notified and they tend to simply fall into disuse with the closure of the rail connection. In the case of these installations the closure of the rail connection or location itself will be taken to be the decommissioning date.

Column 6 - Controlling Interface

All the interfaces which have had control over the interlocking are given here. It should not be assumed that these will be concurrent, as interlockings may migrate between interfaces as resignalling schemes lead to the introduction and abolition of interfaces. More detail about the dates of control of the interfaces listed can be found in the notes.

Column 7 - Notes

Further pertinent details are given here. In the case of interlockings which have migrated between interfaces during their lives, the history of control is noted.

Interlocking Designs

Associated Developments

Certain developments in interlocking practice have followed advances made by the wider profession of signal engineering, rather than being the invention of any one design manufacturer, being subsequently widely adopted. It is appropriate to detail these developments separately from the descriptions of proprietary interlocking designs.

Automatic Route Setting / Automatic Routing Facility / Junction Route Setting - The facility for the automated setting of routes can come in several forms of varying complexity, from Automatic Routing Facility (ARF) and Junction Route Setting (JRS) - which basically set routes on a first-come, first-served basis in conjunction with train descriptions - to automatic route setting, which works with TDs and regulating instructions to achieve optimal control. The abbreviation ARS is a trademarked term, standing for Automatic Routesetting Subsystem (owned by the design manufacturers of IECC, with BR successors having intellectual property rights to usage) and should not be used to refer to other proprietary automatic route setting systems.

ARF / JRS was first introduced by Westinghouse in 1966 on the two Brookwood panels in Woking box, with diverging routes being set at Pirbright Jcn in accordance with TDs and converging routes on a first come, first served basis. AEI-GRS produced a version of ARF / JRS for working the New Lines station at Watford Jcn in 1967, also being linked to TDs: incoming routes were set into a clear platform at Watford Junction and outgoing routes were set up on receipt of the 'train ready to start' indication from the platform staff, with Watford High Street Jcn being regulated on a first-come, first-served basis. There were a small number of other examples of ARF and JRS systems over the following years, e.g. at terminal stations and on single line branches. There were no real advances in application until Westinghouse incorporated true automatic route setting in conjunction with a sophisticated computer program in its Three Bridges scheme of 1983, this being the first use of the system on a truly modern scale on the 'main line' rail network. However, its further use with panels was still minimal, even though it is easy to incorporate into SSI, and it was not until the development of IECC that it found widespread application.

Comprehensive Approach Locking - Comprehensive Approach Locking (CAL) has been a feature of interlocking since the beginning of the period covered by this Register, although it has always been used sparingly and where operationally advantageous, owing to the additional complexity introduced into the circuit design and the additional equipment required. All CAL is provided by freewired circuitry, added on to geographical systems where required, with the exception of Westinghouse Westpac MkIV and MkIVA, which incorporate it as a built-in feature. This is not to imply that all MkIV and MkIVA Westpac installations have CAL enabled - it is a feature which may or may not be used. This situation means that no assumptions can be made about the presence or otherwise of CAL in relay-based interlocking installations. Although CAL is far more common with SSI and CBI, even here its use is not universal.

Electronic Route Selection Equipment - Although not a feature of the actual interlocking circuits, Electronic Route Selection Equipment **(**ERSE) works closely with it. Developed by Chris Majer during his tenure as Electronics Assistant on BR(SR) it first saw service in 1978 at Brockenhurst, being subsequently used at several interlockings on its parent region. Chris Thompson on BR(LMR) was responsible for its cross-boundary migration.

Consisting of plug-in printed circuit board (PCB) cards (one per route), Monitor Unit and Buffer Output Relay Units (BORUs) it replaced the non-vital push-button ring relay circuitry in RI installations.

The units were produced and maintained at Wimbledon Workshops. There were two versions: the MkI was only used at Brockenhurst and the first MkII installation was at Dover Priory. MkII was split into type A (for small systems) and type B (for large systems). The two versions differed in respect of the Monitor Unit and the input and output PCB cards. A MkIII micro-processor based version was also developed in 1982 but did not enter service. The last original installations took place around 1985, by which time panel processors had superseded its capabilities. However, in 2006 Network Rail issued a specification for a modern MkIV version to replace existing life-expired systems.

Panel Processors - The panel processor (PP) is a solid state replacement for the non-vital relay circuitry in a route-setting interlocking and controls all push-button and switch interlocking, as well as handling all incoming indications, and also acts as a TDM link between interface and interlocking(s). It is usually duplicated to ensure security in case of system failure. PPs are always used with SSI / CBI. PPs require serial input and in order to interface a non-WS interface - which produces parallel input - to a PP a panel multiplexer (PMUX) is required. A PMUX is a parallel to series signal converter.

The first PPs dealt with indications only and GEC-GS introduced their Serial Data Transmission (SDT) model at Cambridge PSB in 1982 working in conjunction with NX(PP) technology. In 1985 Westinghouse installed their Westronic System Two (S2) PP at Crewe PSB. This was the first PP to not only handle indications but also push-button and switch interlocking. GEC-GS developed their own PP to this stage in 1986 when it was used to interface the NX(PP) at Exeter PSB and the Tiverton Jcn interlocking. ML Engineering introduced their TEML40 system used with NX(PP) at Leicester PSB and its interlockings in the same year.

Route Lights - When first provided route lights only extended to the exit signal. From at least 1964 all geographical RI packages extended the route lights into those overlaps which contained points, but only as far as the area of the points and not to the extreme of the overlap termination where this was further. The SGE system, however, had extended route lights to the full overlap of all exit signals which involved points from inception in 1961. By the 1972/73 period it became more common for route lights to extend to the termination point of all overlaps, whether points were situated therein or not, but this was by no means universal and often provided by freewired circuits. With SSI and CBI it became standard practice. In the case of freewired relay interlockings overlap route lights were frequently omitted until the mid-1980s, except to maintain consistency on an interface working a mixture of freewired and geographical interlockings. From that period onwards overlap route lights began to become common, but not universal - for example, BR(WR) E10k interlockings never using them.

Train Operated Route Release (TORR) - TORR was treated with suspicion by the railway operators, wary of false premature releasing of routes, and not initially employed in power-signalling schemes. It was a necessary component of automatic route setting / ARF / JRS, however, and applications coincided with their use. TORR has seldom been used with panels and relay interlockings but it can be easily incorporated into SSI / CBI and has seen widespread application with workstation-based signalling systems. The first major panel-based application was at London Bridge PSB in 1975.

Interlocking Designs - Descriptions

These descriptions apply to geographical and electronic interlocking packages, and freewired installations made to a standard design. The design names have been used to define these systems. No attempt has been made to record the actual relay equipment used in freewired installations, as a variety of relays from different manufacturers may be used, either initially, subsequently, or both. Commissioning dates refer to equipment commissioned as new, not second-hand installations.

For design manufacturer histories see *Interface Designs* above.

Alstom

Solid State Interlocking (SSI) [Interlockings commissioned 1998 - date] - continued to produce SSI under their new name after the break-up of the GEC-Alsthom partnership. SSI is described fully under BR, GEC-GS and GEC-Alsthom.

Smartlock 400T [Interlockings commissioned 2008 - date] - A CBI system developed from SSI, first used to control the Horsham area at Three Bridges SC, replacing the SSI there. This interlocking uses SSI architectures and offers a reduction in physical size over SSI and a greater speed of operation (especially over heavily loaded SSI), whilst retaining its trackside functional modules. The interlocking is subdivided into up to eight 'virtual' interlockings (VIXLs) within the processor - each being equivalent to a conventional SSI - leading to a reduction in cross-boundary communications. When controlled by a panel processor six of these VIXLs can be used but with a WS system all eight can be used, and 64 VIXLs in total. Each virtual interlocking is capable of controlling 63 trackside modules, can process tasks simultaneously and work with its own WS. The system is compatible with both WS and NX.

Ansaldo Signal
Ansaldo STS

ACC [Interlockings commissioned 2003] - A combined WS interface and CBI interlocking system used only at Manchester South SC to date. As well as a main interlocking at the interface location there are also remote interlockings, called peripherals, linked by fibre-optic cable. Further satellite interlockings called distributed peripheral rooms can be linked to the remote interlockings where equipment requirements exceed the limits of one remote interlocking. Control signals pass through an area controller and this filters commands applicable to that relay room, passing them through field device controllers to the trackside equipment after conversion to a 110v or 220v output voltage.

SEI [Interlockings commissioned 2010 - date] - A CBI system first used with the ERTMS installation on the Cambrian Coast and designed to be used in conjunction with Ansaldo's WS operating systems. It was later used on the Ferriby - Gilberdyke resignalling controlled by York ROC in 2018.

Associated Electrical Industries - General Railway Signalling (AEI-GRS)

AEI-GRS Geographical [Interlockings commissioned 1962 -1967] - A geographical package used mainly with the company's NX(PP) installations (*Figure 182*), first introduced at Folkestone with a Henry Williams Integra Domino panel. It came in two versions and included CAL, the later one was used only in the Paisley resignalling and formed the basis of the BR(ScR) geographical system.

In the initial version the termination boards were at the top-front and back of the relay racks and all functions were on vital M series BR930-style relays. It had pre-wired relay frames on rubber mounts, to avoid vibration from passing trains, with the relays on plugboards, but the frame connections were soldered terminals rather than plugcouplers. The terminals were mounted at the top of the frame on the front and back. If a function was not required in a particular circuit the contact was strapped out on the relay plugboard with green coloured wire, rather than strapping out on the terminal rack board. Unlike the other contemporary geographical systems the AEI-GRS version did not make use of latched relays but instead relied on stick-circuits, with some relays fitted with double coils to facilitate this. There were four geographical 'levels': initiation, completion, locking and proving.

Figure 182 - AEI-GRS geographical interlocking, Watford Junction. © Alstom, courtesy Chris Bellett.

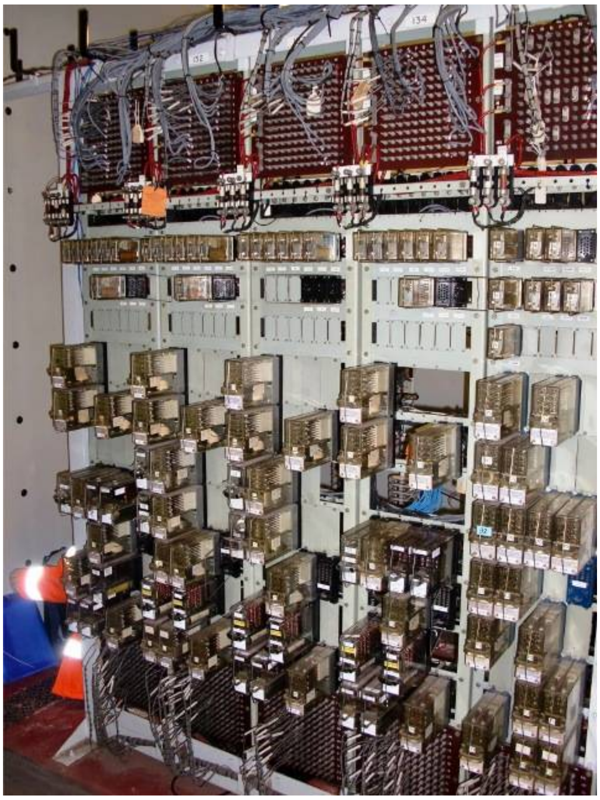


Figure 183 - AEI-GRS geographical interlocking, Dunrod. © Peter Ramsay.

The development for the Paisley interlockings saw all non-vital functions carried out by Post Office keyswitch type relays mounted below the top termination board with a lower termination board at the front-bottom of the rack (*Figure 1823*).

Associated General Signals (AGS)

AGS Geographical [Interlockings commissioned 1968 - 1971] - A development of the SGE geographical system following the merger of SGE and AEI-GS (*Figure 184*). It used the same Type Reference system for the sets but there was rationalisation of those available and they were renumbered. Sets numbered ZR1001 to ZR1499 were 6-way sets, those numbered ZR1501 to ZR1799 were 12-way sets. Sets included – common control sets, entrance sets, exit sets, entrance-exit sets, countermove & route sets, route sets, aspect sets, overlap sets, release sets, points sets – interlocking, points sets – control, points overlap sets, ground frame sets, and miscellaneous sets. Overlap route lights were provided.

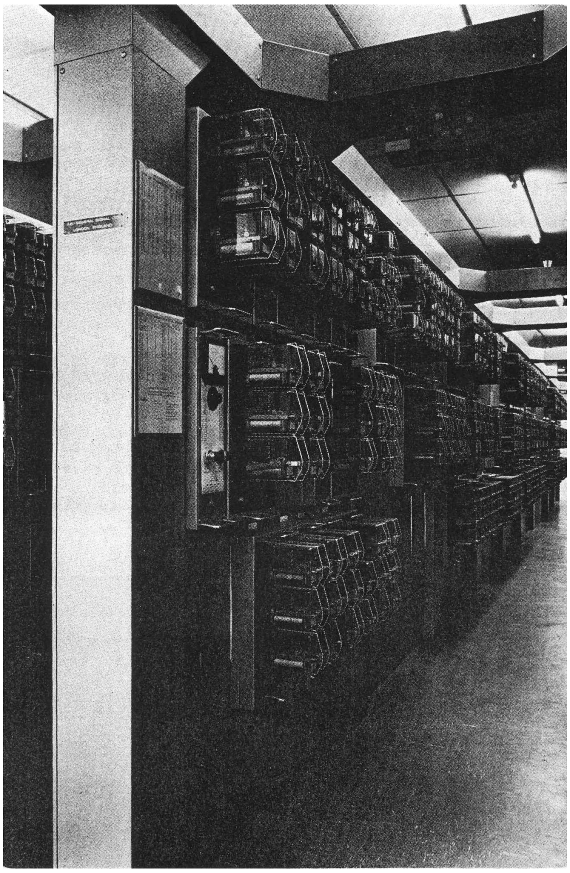


Figure 184 - AGS geographical interlocking, Dartford. © Alstom.

Bombardier Transportation

*EBI*Lock 400 [Interlockings commissioned 2014 - date] - a CBI system for use in depots and yards. Two computers are used, one on hot standby, and all communication is via ethernet.

BR

BRS SW67 freewired [Interlockings commissioned 1985 - date] - In January 1985 the BR Board decided to adopt the BR(SR) Yellow Book system (see below) as the national BR standard and it was renamed and reissued as BRS SW67. For convenience all interlockings based on this standard commissioned from 1985 are called BRS SW67. This designation encompasses derivations such as Charles Weightman's modified circuits as used in several EROS resignalling schemes for Railtrack in the mid-1990s, and for subsequent extensions. Along with BR(WR) E10k these circuits continue to be used as the basis for freewired interlockings to the present day.

BR (ScR)

BR(ScR) Geographical [Interlockings commissioned 1973 - 1985] - The Scottish Region produced a geographical system based on the AEI-GRS system used in the Paisley 1966/7 resignalling (*Figure 185*). The circuitry of both systems uses the same four levels - Initiation, Completion, Locking and Proving - and the ScR development made greater use of latched relays. CAL was never incorporated into this system. A total of thirteen interlockings were assembled at Irvine workshops, the first installation being Portobello in 1973 and the last at Dundee in 1985.

Figure 185 - BR(ScR) geographical interlocking, Hunterston. © Peter Ramsay.

BR(SR)

BR(SR) Pink Book freewired [Interlockings commissioned 1979] - In the 1970s Philip Higley at BR HQ drew up the BR850 specification. This was originally intended to be a detailed specification for a BR geographical system based on Westpac MkIV principles but was scaled back to emerge only as the interlocking requirements applicable to both geographical and freewired systems. Separately and independently, Gordon Callander was tasked by Derek Lamb to develop typical interlocking circuits for use in various schemes, including the Gatwick interlocking of Three Bridges box in 1978, and specified to GEC-GS (who were contracted for the interlocking work but not the signalling panel) for use in the

Arundel resignalling of 1979. For the latter scheme they were issued in a book with pink covers, hence the name of the system. Route lights extended to the full extent of all overlaps.
BR(SR) Yellow Book freewired [Interlockings commissioned 1981 - 1984] - After the Pink Book resignalling at Arundel the circuits were fine-tuned and the specification reissued as the Yellow Book. The first application was on the Eastleigh PSB extension of 1981/82 and it was then used universally on BR(SR).

BR (WR)

BR(WR) E10000 (E10k) freewired [Interlockings commissioned 1955 - date] - The standard E10k series of drawings were produced by this region for RIs. The design was first used at West Ealing in 1955, being a development of MV- GRS interlocking circuit design. It was subsequently very extensively used as the region never employed geographical RI packages. Overlap route lights are not provided with the system but the pivot light of any route-locked points in the overlap does illuminate. Although the facility to 'swing' an overlap can be incorporated into this interlocking design it is not a standard feature and is rarely used. Automatic route setting/ARF/JRS, CAL and TORR can be incorporated in this system, ARF and TORR being used on the Henley branch in 1972. E10k is still used for new work.

British Rail Research (BRR)

Figure 186 - Westinghouse (BRR) MkIIB SSI, Slough New. © Andrew K Overton.

Solid State Interlocking (SSI) [Interlockings commissioned 1985 - 2003] - Developed as part of a tri-partite agreement between BR Research, GEC-GS and Westinghouse, SSI has been produced in three main versions. MkIA was the prototype product and only used at Leamington Spa and in RETB applications, the very first installation at Dingwall being an experimental version produced by BR. The RETB version uses completely different software from the other MkI version as the workstation operating system is integral to it. MkIB was the first production version but only used for a short time - at

Inverness, Oxted and Dorchester - before the MkII version replaced it. MkIIA was used at Willesden Suburban and Millerhill before the MkIIB version, the main production model, replaced it, being used extensively in many subsequent schemes (*Figure 186*). This version was also developed into an optional extended memory model, allowing more extensive interlocking. All Mk I & II versions operate at a processing speed of 1MHz.

BR were responsible for the overall concept and they developed the system architecture, including the triplication and the data links, all the software and hardware circuit design. GEC and Westinghouse developed the package into mainstream production and manufacture. In 1997 it was independently developed into a 2Mhz version by the design manufacturers and is described under their names.

The basics of SSI operation consist of three interlocking processors at the interface location which are programmed with the interlocking for the particular layout they control. Before any command from the interface is obeyed all three processors compare their results and the command is obeyed only if at least two of them agree (if one disagrees it is turned off-line with a suspected fault for attention). Commands to operate points, signals etc. are then sent down a trackside datalink to datalink modules, which in turn connect to trackside functional modules (TFMs) (two types: points - coloured black, signals - coloured red). In certain circumstances when an existing RI has been replaced by SSI the TFMs may be positioned together in a lineside building or location cabinets and connected to the points and signals via conventional trackside cabling. This is called interfaced SSI.

The advantages of digital transmission mean that TFMs can be given a unique address, ensuring that only the commands meant for them will be obeyed. Thus, data for the whole signalling layout can be communicated along one cable, obviating the need for remote interlockings and TDM systems, and it is only in exceptional circumstances that SSI is not located with the controlling interface. Trackside data links can extend up to 25 miles from the controlling interlocking and with additional long-line links for several hundred miles. The maximum number of trackside modules which can be controlled by one interlocking is 63 and this governs how many interlockings are required for a given signalling layout, explaining why some interlocking locations are controlled by multiple SSI processors.

It should be noted that where SSI upgrades have taken place SSI cubicles may be labelled with a different Mk number to the SSI currently plugged in to them. Care should be taken to ensure this does not cause confusion between the versions as described above.

CONTEC Transportation Systems

<u>TCS 300</u> – A SIL-4 compliant CBI system with a modular system architecture

GEC - Alsthom

<u>Solid State Interlocking (SSI) [Interlockings commissioned 1989 - 1997]</u> - continued to produce SSI, GEC-GS having been one of the development partners and Alsthom having taken over GS. SSI is described fully under BR and GEC-GS.

In November 1997 type approval was obtained for the roll-out of a 2MHz version of SSI, the MkIIIA. The faster processing speed enabled more functions to be incorporated within one interlocking and increased reliability in complex situations. MkIIB SSI can be upgraded to MkIIIA. MkIIIB is currently the latest version available.

General Electric Co. - General Signals (GEC-GS)

GEC-GS Geographical [Interlockings commissioned 1971 - 1984] - GEC-GS continued to develop the AGS geographical RI package in their own installations until the development of SSI (*Figure 187*). The same ZR Type Reference code was used for the sets but with altered numbers and included - common control sets, entrance sets, exit sets, entrance-exit sets, countermove & route sets, additional route sets, auxiliary aspect sets, points sets - interlocking, points sets - control, points overlap sets, ground frame sets, alternative routes sets, special locking sets, and route release sets. Alternative sets were available in later years with increased or altered functionality, although older sets could be used in later installations as required but were not interchangeable. There is evidence that AGS sets with the required functionality could also be intermixed with later GEC-GS sets.

Figure 187 - GEC-GS geographical interlocking, Stewarts Lane. © Simon Foster.

In 1985 geographical circuitry was abandoned for new installations and no further development was undertaken. Progress with SSI had resulted in a production version and this was used in new work.

Solid State Interlocking (SSI) [Interlockings commissioned 1985 - 1988] - See also description given under BR.

General Electric Transportation Systems (GETS)

Vital Harmon Logic Controller (VHLC) [Interlockings commissioned 2000 - date] - This CBI system is programmed by the use of relay logic diagrams and consists of a chassis in which various plug-in modules for different functions are inserted. It uses Intel 80C186 processors with an application memory size of 128Kb. Unlike other CBI systems housed with the interface the VHLC system uses remote interlockings which are provided with LCPs. The modular nature of the system leads to each interlocking only covering a very small area.

ElectrologIXS VLC [Interlockings commissioned 2017 – date] – A CBI system developed from VHLC and ElectroCode – the latter not used in the UK - but unlike VHLC this interlocking is normally located with the interface and not remotely. The system uses a redundant bus structure, as opposed to VHLC's two redundant processors, and uses Motorola Coldfire processors with increased processing power and application memory size. Input / output (I / O) connections are on the front of the module as opposed to the rear on VHLC. There are additional graceful degradation features over VHLC – with VHLC an error on any vital I/ O point of any I / O module causes a system reset; with ElectrologIXS any vital module can be shut down without causing a reset, and vital I/ O points are grouped into two banks which can be shut down independently of other banks.

Henry Williams Integra

Henry Williams Integra Geographical [Interlocking commissioned 1962] - This system was only used at York Yard South and was an adaptation of Integra's system for British use. It was based around six groups of miniature relay sets: main-signal starting, main-signal finishing, subsidiary signal, point control, point detection, and point locking. These were of standard size, with transparent covers and plug-in couplers. An indication lamp was provided on each set to indicate when it was free to be withdrawn. Each relay rack accommodated eight relay-set socket frames. The sequence of working of the circuitry was as follows:

i. Command of points
ii. Acknowledgement of command
iii. Storage of the command to set up desired route, dependent on direction of traffic
iv. Transmitting of orders to shunt signals
v. Storage of above
vi. Proving desired end position of points
vii. Control of point locking
viii. Proving of point locking
ix. Command of shunt signals into Off position if part of through route
x. Transmitting of command to main signal
xi. Proving shunt route had been established
xii. Locking shunt route
xiii. Command of main route into Off position

The auxiliary function of cancelling a route resulted in:
i. Placing signals to danger
ii. Release of the route providing approach locking had not been established
iii. Time release if approach locking had been established
iv. Cancellation of route by passage of train

It was hoped that, if successful, this design could be beneficially rolled out with large installations on passenger lines. Initially there were problems with the relays but after this was resolved the installation was very reliable. However, no further installations of this system took place.

Hima Group

Sella Controls Hima HIMatrix PLC [Interlocking commissioned 2024] – German company Hima supplied the HIMatrix PLC to many safety-critical industries and it was used outside the UK as an interlocking and level crossing controller. The first UK use, as part of gaining Network Rail approval, was in the latter role at Magdalen Road and it was then first used as an interlocking at Transport for Wales's Taff Wells Depot. The PLC is programmed and configured using Hima SILworX software.

Invensys Rail

Production of SSI, WESTRACE and WESTLOCK, as well as the supply of Westpac refurbishments, continued with Invensys Rail as the successor company to Westinghouse from 2009 to 2013. Details of these interlockings are found under Westinghouse.

Mullard Equipment Ltd.

[Interlockings commissioned 1961] - This company produced the first version of solid state interlocking in Britain. This is recorded as a form of ELU Interlocking but appears to have had no official name. A system of And, Or, etc., logic gates formed out of Mullard transistors, semi-conductor diodes and ferrite cores was combined into plug-in units, from which the interlocking system was constructed. It was only used experimentally at Henley on Thames.

Pintsch GmbH

Continued to produce Tiefenbach COMPEX CBIs described under that company's name.

Siemens and General Electric Railway Signal Co. (SGE)

SGE Geographical [Interlockings commissioned 1962 - 1966] - SGE originally adapted its 1958 freewired RI system partly to geographical specifications by interposing route initiating and indicating relays on the non-vital side between the push-buttons of its NX(PP) interface and the interlocking. These Post Office 3000 type relays were mounted in groups of ten, grouped as signal sets, combined signal sets (for main and subsidiary aspects), points sets, track circuit sets and common control sets. The interlocking itself, however, remained freewired. This was known as the 1960 Route Selection System (*Figure 188*).

A fully packaged geographical system was first introduced at the Paddock Wood interlocking of Tonbridge box in 1962 (Tonbridge itself was a Westinghouse contract but the Paddock Wood area was part of SGE's adjacent Ashford resignalling contract), with packages consisting of the BR930 compliant Type Z miniature plug-in relays, in sets of 24 in a horizontal row, with jack-in plug-coupler connections to the relay racks (*Figure 189*). Sets were configured with an arrangement of pins which ensured that incorrect sets could not be fitted to a rack. Eight packages could be accommodated on each rack. These were based around two groups - points and signals. Signal sets comprised main, shunt and composite packages and auxiliary sets were added to provide signal aspect controls, exit only buttons, countermoves, route indications, flank protection, alternative routes and selective overlaps.

Figure 188 – SGE 1960 Route Selection System, Ashford. © SGE (Andrew K Overton Collection)

Figure 189 - SGE geographical interlocking, Paddock Wood. © Alstom.

The system was redesigned after Paddock Wood and the next installations from 1964 onwards saw packages subdivided into units containing six or twelve relay positions, configured in three rows of two or four relays (*Figure 190*). The sets were given a Type Reference code, preceded by the letters ZR and followed by three digits. Sets numbered ZR001 to ZR499 were 6-way sets, those numbered ZR501 to ZR799 were 12-way sets. Sets included – common control sets, entrance sets, exit sets, entrance-exit sets, countermove sets, countermove & route sets, route sets, aspect sets, aspect control sets, lamp proving sets, overlap sets, release sets, points sets – interlocking, points sets – control, points overlap sets, ground frame sets, and miscellaneous sets. Twin relays could also be used, comprising two independent relays in a miniature case, where contact requirements were limited. The system used five geographical 'levels' in the following order: selection level, locking level, selection level release, locking level release and aspect level. The principle of operation was that a voltage was sent out from the entrance button and 'marked' every possible 'points' set in every alternative route providing it was free. Having completed this action the voltage then returned from the selected exit point, 're-marking' the chosen route's sets on its passage and locking them, then activating the appropriate signal set. Once the selected route was locked the sets marked on the outward pass only were released. After the merger with AEI in 1967 this system was further developed by that partnership.

Figure 190 - SGE geographical interlocking, Rugby. © Michael Barnett Photography (Andrew K Overton Collection)

Siemens

SIMIS W [Interlockings commissioned 2003 - date] - This is a CBI system based on geographic principles, with the interlocking programme written in standard logic blocks which can be added together to match the actual physical infrastructure. Only a small amount of bespoke programming is then required to complete the interlocking installation. The on-track equipment utilises axle counters rather than track circuits. Unlike with SSI the system whereby the trackside equipment is connected to the interlocking necessitates a maximum distance between them of 6.5km and a system of remote interlockings.

Production of SSI, WESTRACE and WESTLOCK, as well as the supply of Westpac refurbishments, continued with Siemens after takeover of Invensys Rail in 2013. Details of these interlockings are found under Westinghouse. Siemens developed WESTRACE into a MkII version first used at Reading Depot in 2013. This had better processing power, input and output options, and utilised standard Ethernet communications. Used in modular signalling applications WESTRACE was different to other SSI / CBI installations utilising a centrally located interlocking by having multiple WESTRACEs distributed remotely along the route in REBs. The development of high-speed Ethernet data link communications led to the appearance of Front End Processors (FEPs), actually WESTRACE CBIs but not used for interlocking purposes. An FEP would be located trackside in an REB at the remote end of the datalink from the actual CBI, with local datalinks onwards to location cases controlling trackside signalling equipment.

Standard Telephones and Cables Ltd., (STC)

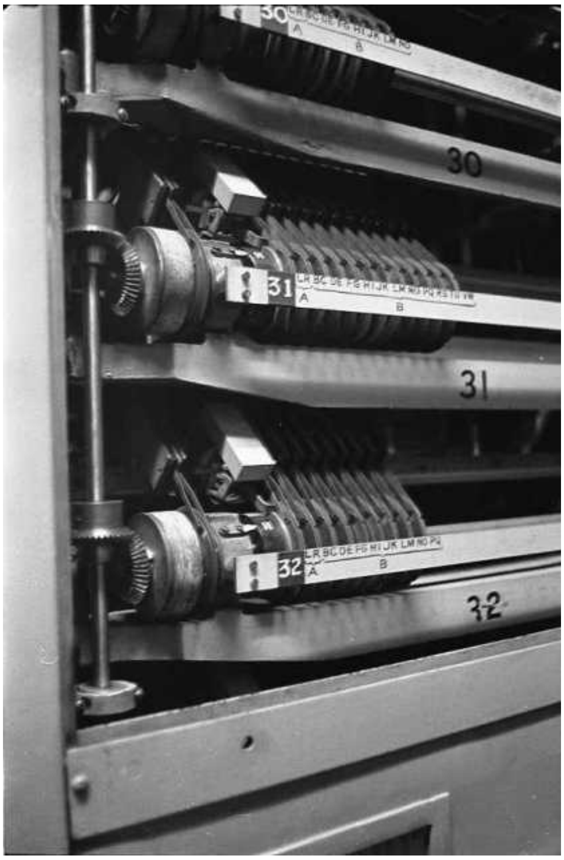


Figure 191 - STC sequence switch interlocking, Doncaster South. © British Railways.

<u>Sequence Switch Interlocking (SS) [Interlockings commissioned 1949]</u> - This system was only used in two boxes, Doncaster North and South (*Figure 191*). Installed in 1949 it employed telephone-exchange style rotary sequence switches, with a number of interlocking routes allocated to one switch. The controls for each route were set up in a pre-determined angular position of the rotating part of the mechanism, with each switch dealing with eleven conflicting routes. As the switch could only be in one position at a time only one route could be set up, with additional interlocking being achieved by interconnections between the switches. The switches were locked in position and only able to move by the action of a proved circuit. The system effected a considerable saving in relays - the manufacturer claiming typically only one seventh of those for a conventional relay interlocking would be required - but was abandoned after closure of the boxes in 1979.

Tiefenbach Gmbh

<u>COMPEX [Interlockings commissioned 2001 - date]</u> - A simple CBI system used for the control of yard and depot layouts, having been originally developed for industrial non-signalling applications.

Voestalpine

Continued to produce CONTEC Transportation Systems interlockings after grouping with that company, with the first UK installation commissioning in 2015.

Westinghouse

Static Switching Interlocking [Interlocking commissioned 1963] - A similar system to Mullard Equipment Ltd's but of Westinghouse's own design utilising mainly wound cores and silicon diodes, with transistors kept to a minimum. Installed at Norton Bridge Jcn in 1963 controlling Great Bridgeford crossovers, to be trialled alongside part of the existing RI, and housed in a separate glass-fibre hut adjacent to the main relay room. No further installations were made and it is not known when the equipment was decommissioned. Recorded as a form of ELU Interlocking

Westpac [Interlockings commissioned 1965- 1985] - Westinghouse produced a series of geographical packages over a number of years of ongoing development which were based around two relay groups: signal and track. The principle of operation of the Westpac system centres around route calling through a CUR relay in the 'track' units. These coils of these relays were joined in series via the inter-set plug couplers, following the line of route, with relay contacts proving point availability. Route calling causes each CUR relay's coils to be energised, then bypassed, in turn provided the set is free. Providing all sets are free the voltage reaches the end of the chain and passes to the signal unit. Fault finding is effected by connecting a voltmeter to the CUR circuit, pressing an appropriate test button and observing the reading. The loss of voltage pinpoints the location of any fault.

Westpac versions were allocated a 'Mark' designation but there was also ongoing development within Marks, so not all sets were interchangeable. Sets were configured with an arrangement of pins which ensured that incorrect sets could not be fitted to a rack and were connected via plug-couplers. The function type and track configuration was shown on the set.

Figure 192 - Westinghouse Westpac MkI geographical interlocking, Birmingham New Street. © Andrew K Overton.

- Westpac MkI - The first installation of Westpac was at Wolverhampton PSB in 1965 and comprised sets of fully enclosed R-series miniature relays (without cases) and fuses (*Figure 192*). The sets were not designed to be opened by the customer to facilitate changing of relays, which were not of the plug-in type. The front of the set had red (busy) and green (free) indication lights and a voltmeter, with push buttons to operate the unit for testing and faulting purposes. Overlap route lights were provided. Three sizes of set were available - small, medium and large - holding a maximum of 14, 28 and 42 relays respectively. The set sizes varied by height but were of a standard width.

- Westpac MkII - This version quickly superseded MkI in 1966 (*Figure 193*) and utilised separate standard-sized Q-series plug-in BR 930 relays in the now unenclosed sets, which could be individually changed by the customer in case a fault developed. The three set sizes now held a maximum of 15, 30 and 40 relays, and were of a standard height, varying in width. The use of sets of 15, 30 and 40 Q-series relays varying in width only would be a standard in all future Westpac versions. Fuses were removed from the package and separately positioned.

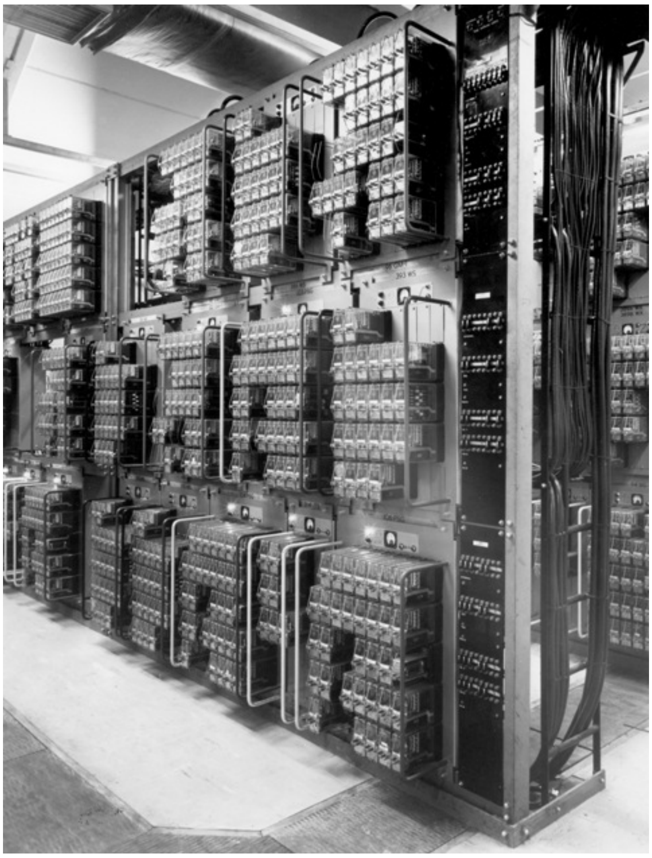


Figure 193 - Westinghouse Westpac MkII geographical interlocking, Leeds. © British Railways

- Westpac MkIII - The MkII version lasted until replacement by MkIII in 1969. This omitted the rear cover of the packaged unit, so giving easier access to relay connectors for maintenance (*Figures 194 & 195*). There was now a technician's monitoring panel for fault-finding, replacing the indication lights and voltmeter on the set.
- Westpac MkIIIA - This was a modification introduced at Warrington PSB in 1972 which enclosed the separate fuses in a fusebox. The monitoring panel was simplified with only one voltmeter button per set and no 'busy' light (*Figure 196*).
- Westpac MkIIIB - Identical to MkIIIA but packaged in what was to become the MkIV case and saw only one installation, at Birmingham International interlocking in 1975.

Figure 194 - Westinghouse Westpac MkIII geographical interlocking, Derby. © Andrew K Overton.

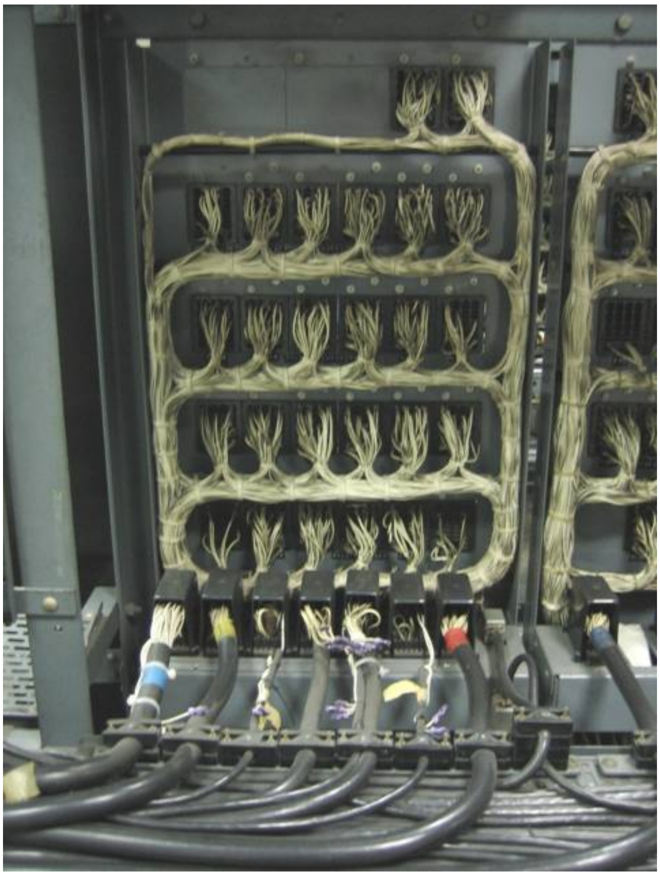


Figure 195 - Westinghouse Westpac MkIII geographical interlocking, Derby. © Andrew K Overton.

Figure 196 - Westinghouse Westpac MkIIIA geographical interlocking, Warrington. © Siemens.

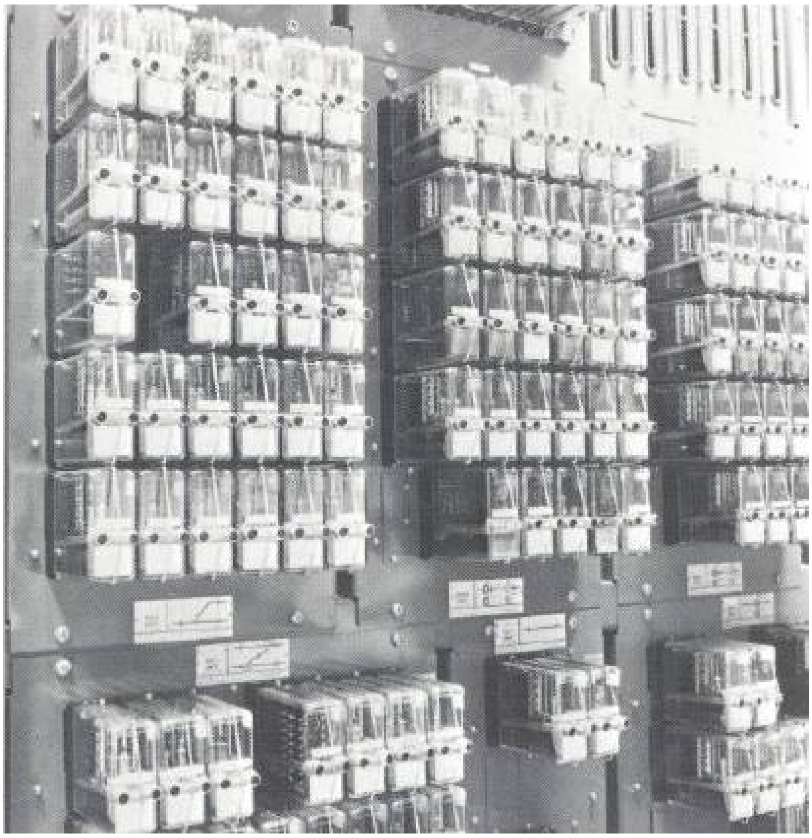


Figure 197 - Westinghouse Westpac MkIV geographical interlocking, Doncaster. © Siemens.

- Westpac MkIV - This was introduced in 1975 and was a response to the publication by BR of a standard specification for geographical systems. Better indications of route locking and overlap swinging, along with TORR and CAL were introduced (*Figure 197*).
- Westpac MkIVA - The final version introduced 1976 which brought differences in the couplers and the GEC step-timers of the MkIV version were replaced by synchronous motor timers with their associated circuitry, although the other circuitry was unaltered for all practical purposes (*Figure 198*).

Figure 198 - Westinghouse Westpac MkIVA geographical interlocking, Bedford. © Siemens.

The MkIII and MkIV versions are still available for refurbishment works.

Solid State Interlocking (SSI) [Interlockings commissioned 1985 - date] - See descriptions given under BR and GEC-GS. Also developed its own 2MHz version of SSI, the MkIIIA (*Figure 199*).

Figure 199 - Siemens (Westinghouse) MkIIIA SSI NQFERRY at Edinburgh SC. © Andrew K Overton.

Westinghouse Train Radio & Advanced Control Equipment (WESTRACE) [Interlockings commissioned 2000 - date] - A multi-functional CBI system, first used as an interlocking in Britain at Nairn. Utilising ladder logic it can be programmed using standard PC software and consists of several plug-in modules for different functions. The original system was later designated MkI.

WESTLOCK [Interlockings commissioned 2004 - date] - This CBI system was first trialled at Leamington Spa, being put on-line periodically between periods of SSI control. Once satisfactory results had been achieved in operational service it was used permanently from 2007 and then elsewhere. Developed from SSI it uses that system's architectures and it is capable of interfacing with SSIs. The processor is split into four trackside interface (TIF) areas and these may be controlled by separate workstations, giving it the capacity to do the work of four SSI. One WESTLOCK can control a maximum of 252 TFMs, with faster route-setting capabilities, utilising the same requirement for two out of three processors to agree as used with SSI. Programming is on SSI design principles but using Windows based PC software.