Foreword

In August 1971, the Government approved British Rail's proposals to electrify Eastern Region's Great Northern Suburban services, linking the London stations of King's Cross and Moorgate (Northern City) with Royston, via Welwyn Garden City and via Hertford North.

Since then, design work has been pressed forward and plans have been laid to carry out this major task with the least possible disruption to train services over the 70 route miles which are to be electrified.

The electrification will be divided into two main stages and will be progressed with the separate project of re-signalling and route improvements which is already under way, between King's Cross and Sandy, in Bedfordshire.

The first stage will be the new 'Inner' Suburban route between Moorgate (Northern City) and Welwyn Garden City and Hertford North, which is expected to be completed by Spring 1976, although some electric services will be introduced late in 1975. The second stage - the 'Outer' Suburban route between King's Cross and Royston - will be completed by Spring 1977.

Electrification will greatly improve standards of comfort and performance for the 20,000 travellers who use the services daily.

This booklet will tell you more about the project - the new railway, the new trains, the new services, and the new or improved stations. As well as describing these new prospects, it also gives an outline of the engineering works involved and how these will be carried out. It illustrates, too, the machines and equipment which you will see rebuilding your railway as you pass by on your train journeys to and from Town.
Things to come...

Better Trains—Better Services

Electric Suburban trains are clean and fast and no other form of railway traction can match them for regularity, reliability and intensity of service. So where quicker journeys and more frequent trains must be combined to give a really improved service to and from London, electrification is the answer.

The new services will be worth waiting for. There will be new trains with swift acceleration and speed, running on improved tracks laid with welded rails. These advantages mean that travel will not merely be quick, smooth and comfortable, but also whisper-quiet.

New Service Patterns

These new services will be different – the overall pattern of trains on the Great Northern Suburban network, which has been much the same for many years, will be changed. Your personal travel plan may alter – but generally journey times will be improved and trains will be more frequent.

All the Inner Suburban trains, from Hertford North and Welwyn Garden City, will run to Moorgate (Northern City) station, in the City of London.

All the Outer Suburban trains, from Royston, or intermediately, will continue to run to King’s Cross station.

When the new electric train services to Moorgate (Northern City) station are introduced, Eastern Region will cease to run trains during peak periods to and from Broad Street or Moorgate (Metropolitan) stations.

Most people travelling to and from the City, the West End, or elsewhere in London, will be able to better their journeys, as:

- The Northern City Line is the shortest route connecting the G.N. Suburban area stations with the City.
- Travellers on Inner Suburban trains will be able to make cross-platform changes at Highbury with London Transport Victoria Line trains when travelling to and from the West End.
- Also at Highbury, there will be convenient interchange between the Inner Suburban trains and the Broad Street-Watford-Richmond services.
- Connections between the new Inner and most of the new Outer Suburban services will be made at Finsbury Park.
- Also at Finsbury Park, there will be interchange with London Transport Piccadilly Line services.

Regular Interval Services

Although the new services are still being planned in detail to meet the introduction of electric trains and the needs of the future, they will be based on a standard interval pattern.

Basically, the off-peak pattern for Inner Suburban trains is expected to be every 15 minutes to and from Moorgate (Northern City) and Welwyn Garden City, with a similar service between Moorgate (Northern City) and the Hertford Line.

Outer Suburban trains are expected to run between King’s Cross and Royston on a 30-minute interval pattern, calling at Finsbury Park, Potters Bar, Hatfield and then all stations to Royston, with similar calls in the reverse direction.

A diesel train service between Cambridge and Royston will connect at Royston with the electric trains. Special track and signalling arrangements at Royston will allow both trains to use the same platform for easy interchanges.

The Inner and Outer Suburban services will be increased considerably in the morning and evening peak hours. In the interests of comfortable and swift journeys, these additional trains will give fast services between Town and certain stations in the Inner and Outer Suburban areas and help to avoid overcrowding.

The peak-period diesel locomotive-hauled Peterborough line services will continue to run to and from King’s Cross. In off-peak hours, there will be connections at Hitchin between Outer Suburban electric trains and a diesel train service between Hitchin and Huntingdon.

The New Trains

Two types of train of the latest designs are being built.

Inner Suburban Trains

For the Inner Suburban service there will be 64 three-car units, which can be coupled to form trains of six cars. These trains will be distinctive in shape and appearance. They will have power-operated sliding doors to conform with the requirements for operating in the 'tube' sections of the Northern City route to Moorgate.

Each of the three-car units will seat 232 persons, and there will be wide circulating spaces in the sliding-door areas to give quick and easy access and additional standing space which might be needed for short distance travellers, especially on the Northern City section.

Capable of quick acceleration and a maximum speed of 75 m.p.h., the trains have been designed for Inner Suburban services with relatively short distances between stations. They will also be capable of running continuously at speed under 'limited stop' conditions.

Special equipment will enable these trains to operate on both the 25kV AC overhead contact and 750V DC third rail systems. On the 'open-line' sections, electrical energy to drive the trains will be taken from the overhead lines by roof-mounted pantographs. The high voltage alternating current will then be reduced by transformers.
Above
New Inner-Suburban electric train – 3-car unit.

Right
New Outer-Suburban electric train – 4-car unit.

Bottom left
Interior of new Inner-Suburban electric train.

Bottom right
Interior of new Outer-Suburban electric train showing second-class accommodation.
and converted to direct current by rectifiers in the train
and fed via the control equipment to the electric traction motors. In the 'tube' section, the trains will
collect direct current electrical energy from a third rail,
laid alongside the running rail, by means of conventional
'shoes'. This dual system has not been employed before
and special changeover equipment is being designed to
enable the trains to change from the overhead line to
third rail system, and vice versa, at Drayton Park.

Outer Suburban Trains
The Outer Suburban services will be operated by a
different type of unit, comprised of four cars. The units
can be coupled to form eight-car trains. The fleet of
26 four-car units will be equipped to run only on the
25kV AC overhead contact system.
Each four-car unit will have 25 first-class and 297
second-class seats, toilet accommodation and walk-
through connections between the cars.
These new trains will run at speeds of up to 90 m.p.h.
to give speedy journeys to and from the outer suburbs.
Their high-speed will allow them to be fitted into the
main-line timetable, giving a journey time of 60 minutes
or less, for Royston travellers.

New and Improved Stations
Improvements are either in hand, or completed, at three
stations. At King’s Cross, the new concourse and Travel
Centre is well advanced and should be open in June
this year. It is then hoped to modernise the toilets and
refreshment rooms. At Hatfield, new buildings were
completed in February and the new station at Stevenage
should be in use by about July this year.
A programme of station improvements complementary
to the electrification project, is now planned for the
33 stations between Moorgate, Finsbury Park, Hertford
North and Royston. Work will be carried out at every
station to achieve uniform standards of accommodation.
New booking halls and ticket offices are planned at six
stations including Herford North, Cuffley and Royston,
with thorough ‘face-lifts’ at another 14 stations. New
platform buildings, including waiting rooms, toilets and
covered waiting accommodation, are planned at eight
stations and at a further 14 the existing buildings will be
improved substantially.
Most of the new buildings will be to a design developed
by the Regional Architect for Eastern Region’s station
improvements programme. Known as ‘Systems for
Change’ (SFC), the design uses a range of standard
components, which are sufficiently flexible to suit different sites and layouts at medium and smaller sized stations. The buildings will be capable of relatively easy alteration during their life to meet changes in circumstances and/or operational methods.

The design comprises an air-conditioned ticket office within a fully glazed booking hall. The ticket office is constructed from prefabricated 'SFC' components in glass reinforced polyester material. The booking hall is a steel-framed structure, with all walls in aluminium framed patent glazing, with glazed doors and illuminated name signs. Platform buildings are also constructed from 'SFC' components under steel-framed canopies. All the new toilets have been designed so that they can be used by disabled travellers.

All stations will have new displays of travel information and new name and direction signs to British Rail's Corporate Identity Programme standards, to give a consistent visual appearance at every station served by the new electric train services.

An artist's impression of new station buildings using the 'System for Change' range of standard components.
The Plan – and the sequence of works

Converting a railway to electric traction on the overhead contact system is a big project by any standard. The track must be improved to carry more intensive services, bridges, and sometimes tunnels, have to be altered to give the required electrical clearances. New signalling has to be installed to increase the capacity of the route. Some thousands of supporting structures to carry the overhead wires must be set on concrete foundations. Then the overhead equipment is installed, accurately and precisely, so that the roof-mounted pantograph on the train will follow the wires without loss of contact at speed. Arrangements have to be made to take electric power from the national grid and for this purpose an electric control centre and switching stations have to be built. And all this has to be done before the new trains begin to run.

Co-ordinating and carrying out these works, each of them quite complex engineering operations in themselves, calls for a high degree of sophisticated planning if pre-determined and challenging dates are to be met. The planned timetable of works for the Great Northern Suburban project is based on two major target dates for the introduction of the new services:

Spring 1976 – Inner Suburban service (Moorgate via Drayton Park and Finsbury Park to Hertford North and Welwyn Garden City).

Spring 1977 – Outer Suburban services (King’s Cross to Royston).

Engineering requirements dictate this sequence.
The Overall Plan

Remodelling of the complicated approaches and installing electrification equipment in the immediate vicinity of King's Cross station could not be undertaken while the present intensity of train services continues. To relieve the pressure of traffic in the area it is intended to concentrate first upon introducing an interim Inner Suburban electric service from Moorgate (Northern City) to Welwyn Garden City and Hertford North towards the end of 1975.

Most of the Inner Suburban services from King's Cross and all those from Moorgate (Metropolitan) station will then be discontinued. This will reduce train movements in the vicinity of King's Cross, and allow work in the area to begin in time to achieve the target of introducing the Outer Suburban service in Spring 1977.

The new route from Moorgate will use the Northern City tube line to Drayton Park and then join the King's Cross main line at Finsbury Park. The alterations and improvements needed in the tube will involve its total closure from about Spring 1975 until it reopens with the introduction of the interim Inner Suburban service later the same year.

Some of the works for the Inner Suburban area have already been completed. Work began on the Hertford Loop from Bowes Park to Hertford North in March 1971 and on the main line at Barnet in June the same year. Track relaying and resignalling on the Hertford Loop is now finished but some drainage and station platform works are in hand. On the main line, works between New Southgate and Welwyn Garden City, including a new single track flyover at Welwyn will all be completed by late 1974.

Foundation work for the supporting structures to carry the overhead equipment is due to begin in Spring 1973 on the Hertford Loop and in the New Southgate to Welwyn Garden City area. The erection of the steel masts and wiring will follow so that this section may be energised for testing purposes early in 1975. While this work is in progress the engineers will have possession of sections of one or more lines throughout the day between the morning and evening peaks.

Track remodelling around Wood Green and southwards towards Finsbury Park began early in 1973. In this area the entire track layout is being changed, reducing the number of through lines from eight to six, and the tracks will be repositioned to allow higher speeds. Resignalling work will be staged in parallel with the remodelling of the tracks, but foundation construction for the overhead line equipment will not begin until about Summer 1974, when the tracks are in final position. The works in this section are scheduled to be completed and the overhead line energised for testing by Spring 1975.

North of Welwyn Garden City, track and resignalling work will begin about mid-1973, and move progressively to Hitchin and on to Royston for completion by Autumn 1975. Overhead line work will be finished by the end of the same year and energised for testing early in 1976.

Only the slow lines will have overhead line equipment between Welwyn and Hitchin because with the new signalling, these will have sufficient capacity for the electric train services.

The Engineering Works – Civil Engineering

Alterations to bridges, tracks, tunnels and buildings are the main civil engineering tasks.

Many bridges have to be altered, or even rebuilt, to allow sufficient space for the required electrical clearances, between the underside of the bridge and the train for the overhead equipment. In some cases these clearances can be obtained by lowering the track. Between King's Cross and Royston and on the Hertford Loop, alterations are required at 51 bridges. Of these, 29 have to be rebuilt, seven will have their decks raised, the track will be lowered under eight of them and seven will be demolished. Eight of the reconstructed bridges will be re-aligned or widened, to conform to Highway Authority requirements.

The bridges will be rebuilt by using either pre-stressed concrete beams or, in the case of longer spans, steel girders or composite steel and concrete beams, to form the bridge 'decks' that carry the roads.

In eight of the 11 tunnels, the track will have to be lowered. This will mean carrying out this operation in 14 out of 20 separate tunnel bores.
Work Well Under Way
Relaying the tracks is well under way. The fast lines out of King's Cross have already been relaid with continuous welded rail. The slow lines are now being relaid similarly in conjunction with the rationalisation and resignalling of the route and associated schemes of realignment for higher speeds, track formation renewal, drainage, and reballasting.

Apart from providing the high standard of permanent way needed on electrified routes, continuous welded rails reduce noise and vibration - the 'clickety-clack' rhythm of the wheels is no longer heard - and maintenance costs are reduced considerably.

Virtually all the slow lines between Holloway and Hitchin, the line from Hitchin to Royston and the Hertford Loop, will all be improved for faster running. At the same time the 100 m.p.h. stretch on the fast lines, which at present begins north of Welwyn, will be extended southwards to Finsbury Park, so that Inter-City and Outer Suburban services can be accelerated. As part of the track work, considerable alterations are in progress to remove points and crossings no longer needed for the new services and in remodelling and improving the layout wherever possible.

New Layout,
King’s Cross to Wood Green
The biggest job in this category, which has now begun and will take over three years to complete, is the virtual rebuilding of the route between King's Cross and Wood Green, including an entirely new layout of the approaches to King’s Cross station from Holloway.

The new layout for the King’s Cross area is designed to eliminate conflicting movements between Suburban and Inter-City services. It will also give space for the proposed rail link between King’s Cross and Maplin Airport. The most important step in achieving these objectives will be the reconstruction of the flyover bridge, just north of Copenhagen tunnel - the second tunnel after leaving King’s Cross. At present this flyover carries a line used only by London-bound freight trains over the main lines. When remodelling is completed the flyover will carry the Up slow line which will be used by Suburban trains and freight trains destined for King’s Cross. The Suburban trains will then leave their present route on the east side of the main lines, just north of Holloway Road, cross the flyover to the west side and pass through the tunnels and into King’s Cross.

Suburban passenger trains and freight trains departing from King’s Cross will continue to run on the Down slow line, which already lies on the west side of the fast lines. The Suburban lines to and from King’s Cross station out to the flyover, will then lie entirely on the west side of the route. This concentration of Suburban lines, together with the diversion of the Inner Suburban services to the more convenient terminal for most City travellers at Moorgate, will make way for a major simplification of the complicated network of tracks immediately outside King’s Cross. The number of points will be reduced from 71 to 37 and only two Suburban platforms will be needed for the London terminal of the Outer Suburban service to Royston.

Proposed Maplin Airport Link
These changes will release the easternmost bore of Copenhagen tunnel at King’s Cross for the proposed Maplin Airport rail link which would be a completely independent route. After passing through the tunnel, the rail link would be carried on another flyover over the passenger lines, between the Copenhagen and Gas Works tunnels, and across the adjoining goods yard and Regent’s Canal to a high-level terminal on the west side of King’s Cross.

The Northern City Tunnels
Further major works will be necessary to adapt and link the present London Transport Northern City line to the main network. In the 1930’s, it was proposed to link this line to the branches from Finsbury Park to Alexandra Palace, High Barnet and Edgware. But plans were changed and London Transport took over only the passenger service from East Finchley to High Barnet and Mill Hill East.

Much of the preparatory work for this link was carried out, including the construction of tunnels to connect the 'tube' lines at Drayton Park with the surface lines at Finsbury Park. The alignment of the connecting lines will now be different but the whole of the 'up' tunnel and most of the 'down' tunnel will be used for the new Inner Suburban service, although the roofs of these tunnels will have to be raised for the required electrical clearances. Between Finsbury Park and the 'up' tunnel, a dive-under bridge will be built to take the line to Moorgate under the slow line and the proposed Airport lines. The Northern City line tunnels are unique as far as bored underground lines in London are concerned, as they are big enough to take main-line trains. Nevertheless some track lowering will be necessary and where this would result in too shallow a bed of ballast the track will be laid on concrete. Most of the tracks have to be relaid with new ballast.

Carriage Sidings
At Welwyn Garden City, which will be one of the limits of the Inner Suburban service, a group of nine sidings will be laid to accommodate the trains. Two of the sidings will be long enough to stable eight-car Outer Suburban trains and all will be able to take the Inner Suburban six-car trains. Stabling sidings will also be constructed at Hertford North and at Letchworth - the main out-of-Town depot for the Outer Suburban trains.
Welwyn Garden City Flyover
As the Inner Suburban tram will have to cross to the 'up' side of the fast lines at Welwyn Garden City, before beginning their journeys to London, a flyover will be built to carry them over the main lines to avoid any conflicting movements with Inter-City services. The flyover will be sited in the cutting between Broadwater Road bridge and Welwyn Garden City station so that it will be comparatively unobtrusive.

Maintenance Depots
Depots will also be needed to service and clean the new trains. A new maintenance depot to be built at Hornsey will include an inspection shed to accommodate 48 coaches on six lines. All 90 electric multiple-units will be maintained here. Five of the six eight-coach long lines in the depot will be used for light repairs and interior cleaning and will have raised walkways along-
side them. The sixth line will have jacking equipment for carrying out heavy repairs.

The main building will house maintenance workshops, stores, offices, mess rooms and the Electric Control room, where staff will control remotely, all the power supplies for the electrified system. Outside the main shed, on a siding, there will be an automatic carriage-washing plant. Here trains will be sprayed with detergent and then pass through a washing plant where revolving plastic flaps help to clean the exterior, before a final rinse with plain water.

Carriage washing plants will also be built at Letchworth and at Welwyn Garden City. The site of the former Hornsey engine depot will be adapted as an overhead line equipment maintenance depot. A maintenance and repair train will be kept ready, day or night, to tackle any repairs which may be required to masts or wires and to carry out regular maintenance.

Signalling and Telecommunications

Electric traction alone cannot provide faster and more frequent trains. Apart from good track, new signalling and telecommunications are also needed to raise route capacity to match faster train speeds, and to give railwaymen the means of communicating quickly and controlling signals and points remotely over long distances.

Existing signalling equipment on the King's Cross lines is a mixture of the old semaphore-arm and more modern colour-light types of signals operated from numerous small lineside signal boxes.

As the new permanent way takes shape, the old-type signalling will be swept away, stage by stage, and replaced by signalling equipment of the latest type.

Multiple-Aspect Signalling

The new installation will be continuous multiple-aspect colour-light signalling (M.A.S.) and all tracks will be equipped with British Rail's standard Automatic Warning System (A.W.S.).

These modern signals, of three or four aspects, or lights, give the train driver much more information about running conditions ahead. Sited at driver's-eye level on the track side, the high-powered colour-light signals give much greater penetration during poor visibility and fog than the old types of signals. The warning system is a further aid to drivers, bringing visual and audible warnings of signal aspects right into the driving cab.

Resignalling of the Hertford Loop Line on this new system has already been completed. The rest of the resignalling will be carried out in stages and, eventually, the control of the whole area will be transferred to the new power-operated signal box at King's Cross.
New Signalbox at King’s Cross

The new signalbox building at the end of Platform 1 has been completed but it has yet to be fully equipped. At present it houses a control panel for train working in the local area of King’s Cross in preparation for the complete remodelling of the track layout which will involve the demolition of the old King’s Cross signalbox at the end of Platforms 4 and 5. When the new signalbox is fully commissioned, it will control all the signalling and point movements over 83½ route miles, totalling 2601 single track miles. All train movements will then be under its jurisdiction, from King’s Cross and Moorgate (Northern City) to Sandy and Royston, and on the Hertford Loop line. The new box will replace 57 small signalboxes and, eventually, its area of control will link up with that of the next new power signalbox on the East Coast Main Line at Peterborough.

Within the new box, the ground floor houses the large array of electrical equipment which controls the signalling system, and the first floor the telecommunications installation. The upper storey is the operating floor. Here, the signalling system will be operated from a horse-shoe
shaped console, 72 feet long. The main feature of the console will be a large almost vertical illuminated diagram of all the 260½ miles of track under control, showing in geographical location all the signals and points, and the track circuits, which indicate the actual positions of the trains throughout the area.

Remote Control
Also positioned geographically on the diagram will be push-buttons for remotely operating the signalling system, including switches for the independent operation of points in case of emergencies. Luminous indicators will give a continuous display of the state of the line and monitor all the functions under the signalmen's control.

By merely operating push-buttons in the correct sequence the signalman can set up a route for any one of 715 possible train movements. Provided conditions are safe, all points along the required route will then move into the appropriate positions. When all the points have been electrically detected and proved as having moved into their correct positions and all the safety devices built into the system have been satisfied, the signals for the route will clear to allow the passage of the train.

The signalman will be able to set long sections of route, by selecting and operating the appropriate push-buttons, to allow trains to run on automatic signalling, until a change is needed for a train proceeding to a different route or destination.

Describing the Trains
All trains on British Rail are positively identified by a four digit headcode, usually displayed on the front of the locomotive or train. For example, the headcode of 'The Flying Scotsman' from King's Cross to Edinburgh is 1S17. This describes the train to railwaymen. The first digit '1', shows that it is a passenger express, the second 'S', that it is going to Scotland, and the third and fourth digits '17', indicates its 'path' or timing in the railway's working timetable.

This headcode description of each train will be indicated to the signalman working at the control panel by being displayed on a small cathode-ray tube alongside each signal position on the diagram. As the train moves along through the control area, its description on the panel will move with it, indicating and identifying the train as it passes from signal to signal. It will then be transmitted automatically at the appropriate time, to the next signalbox. The train describer in the signalbox will be electronic, incorporating a general purpose computer.

Telecommunications
A comprehensive telecommunications network covering the whole of the area under control, will radiate from the signalbox. Included in the system will be telephones at each signal, to enable train drivers to call the signalbox if necessary. The signalman's attention will be drawn to incoming calls from these telephones by visual and audible indications, identifying the signal concerned.

The new electronic arrival and departure indicators and the public address system which are to be installed at King's Cross and the public address systems at other selected stations will also be operated from the signalbox.
Before installation work can begin, the first task to complete is a survey. This detailed examination of the entire route is usually carried out on foot by representatives of all departments. Design work can then follow.

Two Systems
The overhead line equipment for the 25 kV (25,000 volt), alternating current, single-phase, 50 cycles system will be installed over 673 route miles, or 215 single track miles, between King’s Cross—Drayton Park and Hertford North and Royston. The remaining 273 route miles between Moorgate (Northern City) and Drayton Park—the ‘tube’ section—is to be equipped with the third-rail contact 750 volt direct current system. A changeover section to enable trains to pass from one system to the other will be installed at Drayton Park station.

Erecting Overhead Power Lines
The first task in the complex sequence of works involved in installing the overhead line equipment, is to produce some 5,500 lineside foundations for the supporting masts. About 17,000 cubic yards of concrete will be used in this operation alone.

Excavation of the holes required for supporting structures is carried out by rail-mounted auger boring machines or rail-mounted mechanical diggers. This operation is followed by the arrival of the concrete train, comprising a battery of rail-mounted concrete mixers, pre-loaded with sand and aggregate. Cement and water, stored separately on the train, are then
The steel masts and associated parts are then loaded on rail vehicles and transported to the site where they are placed in position by cranes. The wires stored on drums are also mounted on rail vehicles so that supplies can be drawn off as needed as the work progresses and the train moves slowly along. Inside, the erection train vehicles are equipped to carry materials, tools and equipment. There is also an office and a mess room. Powerful lights for night work are fitted at roof level.

The overhead contact wire has to be positioned precisely, so that the pantograph, on the roof of the train, may slide along it without loss of electrical contact. To ensure even wear on the metallised carbon inserts in the head of the pantograph, the contact wire is ‘registered’ alternately, first to the left and then to the right. By this arrangement, the contact point moves from side to side across the contact surface as the train goes along.

**Tunnel Work**

In the area to be electrified there are 11 tunnels totalling about 14 single track miles in length. Some 4,500 supporting bolts for the overhead lines have now been inserted into the tunnel roofs. A specially-equipped train was devised for this operation. By projecting an image on to the roof of the tunnel the precise position of the bolts was quickly determined. The bolt holes were then drilled by high-speed rotary percussion drills mounted on height-adjustable rigs. A novel method was devised for securing the bolts in the tunnel. A capsule of epoxy resin and catalyst was inserted in the hole and the bolt was spun in. The spinning bolt broke the capsule and mixed the resin and catalyst, which hardened in minutes to take its full load.

**Power Supplies and Switching Arrangements**

Power supplies for the overhead line part of the electrification will be drawn from the Central Electricity Generating Board’s National Grid substations at Hornsey and Welwyn where electrical energy will be transformed from 132kV to 25kV for supply to the...
railway system. From Hornsey a supply will be transmitted by cable to a railway system feeder station at Wood Green. At Welwyn, the feeder station will take duplicate supplies by short cable connections from the adjacent Grid substation.

In addition to these main-supply points at Wood Green and Welwyn, lineside traction current switching stations, to enable sections to be paralleled or switched out, for maintenance and other purposes, will be located at Holloway, Potters Bar, Langley Junction, Letchworth, Crews Hill and Hertford North.

The switchgear, which controls the electrical energy will be of the vacuum interrupter type, where the electrical contacts are in a vacuum chamber to prevent arcing. Weatherproof steel cubicles will house the interrupters and the ancillary operating equipment. Protective relay equipment will enable any electrical faults in the overhead line system to be detected and cleared quickly.

For the Northern City 'tube' section, which will be electrified on the third-rail 750 volt DC system, a new substation will be built at Moorgate and the existing London Transport substation at Drayton Park will be converted. These DC substations are more complex than the AC feeder stations for the overhead lines, as in these the high-voltage alternating current supply has to be converted to lower voltage direct current by transformers and rectifiers. At both these substations, air-cooled silicon rectifiers will be used and the high voltage supplies will be taken from London Transport. Special arrangements will be made in the tunnels to enable the power supply to be cut off in an emergency and to allow the drivers to communicate with the Electrical and Traffic control centres.

All the equipment in the AC feeder stations and DC substations will be controlled remotely from the Electrical Control Room at Hornsey.

The Electrical Control Room

The Electrical Control Room will be located on the second floor of the electrical train maintenance depot office block at Hornsey. The interior is not unlike that of a power-operated signal-box. A large diagram showing the electrical feeding and sectioning arrangements of the route will occupy one side of the control room to enable the electrical control room operators, from their desk in the centre of the room, to monitor the whole system at a glance.

On this big vertical diagram are minute switches located geographically, which, turned by a finger and thumb, can operate remotely the corresponding circuit breakers controlling the electrical energy supplies, sited at the AC switching stations and DC substations. Visual and audible warnings are given if there is any change in the state of the power supplies to the electrified system. The transmission of control signals between the centre and the out-stations, to operate switches or monitor equipment, is effected on allocated circuits in the railway telecommunications cables. Telephone switchboards and radio will give the operators instant and comprehensive contact with staff at locations throughout the electrified area, including the Northern City tunnelled section.

On the same floor, the electrical supervisory equipment associated with the remote control system and telephone apparatus for monitoring power supplies, will be housed in rooms adjoining the control room. The batteries supplying current for the telephone and electrical control systems, will be accommodated on the ground floor.
Reducing Costs

Research and development work in recent years has reduced the cost of electrification. A simplified but equally efficient form of overhead equipment has been evolved incorporating improvements on the system previously installed on Eastern Region's Lee Valley electrification, completed in 1969. It consists of only two wires, one above the other. The upper cable is known as the catenary, a term which refers to the curve adopted by the wire hanging between the supporting structures. The lower cable is the contact wire which is suspended from the catenary by a series of vertical 'dropper' wires and is maintained level and at a predetermined height above the track. The load-bearing catenary, which also carries electrical current, will be of steel reinforced aluminum instead of copper. Another economy will be the use of headspan wires instead of lattice-steel portal structures to support the overhead wires at some locations over multi-track sections. These new methods effectively reduce the cost of the overhead equipment.

Power supply arrangements have also been modified considerably through experience. Fewer feeder stations, located further apart, with simplified equipment and accommodation have also brought about significant reductions in the cost of supplying power.

The latest type of simplified overhead equipment, employing headspan wires to support the catenary and contact tiers.

An earlier type of overhead line equipment showing the steel portal structures and trolley wire system.

Conclusion

The Great Northern Suburban electrification, when completed in Spring 1977, will be the beginning of a new era in Suburban travel for many thousands of people who journey from and to the area to be served by the electric trains. Some significant developments are already taking place in this area and the greatly improved services will prove to be attractive to the present 20,000 daily travellers and, no doubt, to others. Many will be persuaded by the speed and ease of the rail journey by electric train, and the easy interchange facilities with London Transport and other rail services to forsake competing forms of transport, including the private car, and thus help to relieve pressures on the roads. Other benefits to the community could flow from such decisions, in lowering demands for parking space, traffic engineering schemes and similar alterations which change the face of familiar areas to accommodate the increasing flows of vehicles. Air pollution too, will be lessened, not only by the reduction in road vehicles, although this would be the greater contribution, but also because the excellent performance of the electric trains will be obtained without exhaust fumes of any kind.

The improved train services to and from Town will also be achieved without making further demands on valuable land resources: without further damage to the environment, and at a lower cost than increasing the capacity of other forms of transport.
Facts and Figures

Electrification (King’s Cross/Moorgate (Northern City) to Royston via Welwyn Garden City and via Hertford North)

Route Miles to be electrified: 70.03
Overhead Collector System 67.30
Third Rail Collector System 2.73
Single Track Miles to be electrified: 220.46
Overhead Collector System 215.00
Third Rail Collector System 5.46
No. of Bridges to be reconstructed 29
No. of Bridges to be raised, or track lowered beneath them 15
No. of Bridges to be demolished 7
No. of Tunnel Bores where track has to be lowered 14
No. of Level Crossings 15
No. of Feeder Stations (25kV AC) 2
No. of Track Sectioning Cabins (25kV AC) 6
No. of C.E.G.B. Supplies (25kV AC) 3
No. of London Transport Supplies (11kV AC) 2
No. of Substations (750V DC) 2
No. of Foundations for Overhead Line Structures 5,500
Concrete for Foundations 17,000 cu. yds.
Steel for Structures 2,460 tons
Total length of Overhead Contact Wire 269 miles
No. of 3-car Inner Suburban Train Units 64
No. of 4-car Outer Suburban Train Units 26
No. of Stations served 36

Signalling (King’s Cross/Moorgate (Northern City) to Sandy and Royston)

No. of New Power Signal Boxes 1
Route Miles controlled 83.5
Single Track Miles controlled 260.25
No. of Track Circuits 1.013
No. of Multiple Aspect Signals 464
No. of Point Machines 374
No. of Old Signal Boxes to be displaced 57
Supplementary Information

This booklet, describing British Rail's plans to electrify the Eastern Region's Great Northern Suburban Services, was issued in May 1973.

Since then, in common with most other industries, British Rail have experienced delays in deliveries of materials and in the execution of works owing to the industrial disputes and three-day working weeks in the winter of 1973-74.

Although considerable progress has been made, the scheme as a whole is not as advanced as originally planned, and in May 1974 it was announced that the introduction dates had been deferred by six months in each case.

The new target dates are:

REVISED STAGES AND PHASES OF WORK
(see pages 3, 8 and 9)

Stage 1 Partial electric Inner Suburban service
Phase 1 (Moorgate via Drayton Park and Finsbury Park to Hertford North and Welwyn Garden City) Spring 1976

Stage 1 Full Inner Suburban electric service Autumn 1976
Phase 2

Stage 2 Full Outer Suburban electric service Autumn 1977
(King's Cross to Royston)

Inner-Suburban Trains

The illustrations on the cover of the booklet and on page 5 are of an early impression of the electric trains for the Inner-Suburban services between Welwyn Garden City, Hertford North and London, Moorgate (N.C). A prototype is undergoing trials on Southern Region and as a result of these trials and other modifications in design, the new trains for these services will incorporate many improvements and will have an altered appearance.

The latest artist's impression of the new trains as they will appear on the Great Northern Inner-Suburban routes in 1976 is, therefore, reproduced below.

Station Design

On pages 6 and 7 the description of the new design of ticket offices and booking halls is no longer applicable since it has now been agreed that a more conventional approach will be adopted for these structures.

Maplin Airport Link

On page 10 of the booklet reference is made to the proposed Maplin Airport rail link. This proposal has, of course, been shelved by Government decision.

General

A number of other amendments would be required to bring this booklet fully up to date but they do not significantly affect the validity of the document.