Support to UKTram Activity Group 1
Protection and Diversion of Apparatus

Summary Report:

Guide to Dealing with Utilities and their Apparatus

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UKTram: Light Rail Projects

Guide to dealing with utilities and their apparatus

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1. Introduction

Light rail systems are expected to play an increasingly important role in the transportation of people at a local level, for both business and leisure purposes. As new promoters begin to consider suitable routes for new systems, they will need to understand the implications of the presence of apparatus belonging to utilities placed along the light rail alignment.

In their report *Improving public transport in England through light rail*, the National Audit Office stated that:

"As a condition of grant, the Department should require promoters of new schemes to have adequate proposals to manage the risks associated with the cost of diverting utilities and the long term maintenance of them by the utility companies. The question of whether utilities need to be diverted at all should be addressed by promoters."

During the process leading to the development and introduction of the New Roads and Street Works Act 1991, the Government expressed the philosophy to be adopted in the following words:

"The Government considers that the fundamental objective [of decisions whether or not to move utilities' apparatus] should be to devise arrangements that will lead to the best overall solution in each case, in particular by minimising the total costs, regardless of who has to meet the costs… In particular, all the parties must acknowledge that it will sometimes be right to accept some detriment to their own interests in the overall interest."

This publication is intended to assist light rail promoters to understand the relationship between the infrastructure constituting their light railway, and the apparatus owned, maintained and operated by utility companies. The overall message is that promoters, in conjunction with the utility companies, should seek ways of minimising the cost of protecting and altering utilities' apparatus, consistent with safe operation and maintenance of both the light railway and the apparatus. In assessing the cost of the works, it will also be necessary to take into account the consequential costs of not altering or protecting apparatus in the vicinity of the light railway that subsequently fails and disrupts operations. As failure of apparatus cannot be foreseen with any certainty, this will involve making an assessment of the probability of failure within the lifetime of the railway, the duration of any disruption caused, the losses and expenses incurred as a result and proposals for mitigation of the same.

1.1. Significance of utilities to light rail projects.

Utilities are private companies who provide an essential service of a kind that requires the establishment of a network of apparatus for its delivery. The services broadly divide into the categories of sewerage, and the provision of water, gas, electricity and communications (telephones and cable services).

The services are provided through the media of pipes and cables. Pipes, and cables in built up areas, are invariably laid in the ground. In rural areas electricity cables may be suspended from pylons, while telecommunication cables providing the final service to properties in suburban and rural areas may also be suspended from poles.

Whenever possible, utility companies lay their apparatus in highways, particularly in urban areas. This is for two reasons: firstly that they do not have to pay the cost of an easement, as they do when laying the apparatus in private land; and secondly because they are generally supplying a service to properties that have a frontage on the highway, so that the highway is the most direct route linking their customers. The main exceptions are high pressure pipes, oil pipelines and extra high voltage electricity cables, which are generally laid across country away from built-up areas.

It should be expected that sections of a light railway placed in highway will encounter some of this apparatus. For some apparatus, this will result in the need to demolish. This will typically be the case for apparatus, such as stop taps, valves, washouts, jointing chambers and shafts giving access to manholes, that breaks the surface of the highway directly in the line of the tracks. Other apparatus may be inaccessible because it lies beneath the tracks, or only accessible when the railway is not operating. Yet other apparatus, while not being directly affected either by construction or operation, may yet present an unacceptable danger to the railway. In all of these cases, some action may need to be taken to divert or protect the apparatus, or reduce the potential danger to an acceptable level.

Since any interference with apparatus will impose a cost on the scheme, the ideal position will be to devise an alignment that requires no diversionary work. In practice this is unlikely to be achievable in an urban area. Nevertheless, every effort should be made to avoid moving apparatus unless it is essential to do so.

1.2. Legislative framework

A light railway can, for practical purposes, only be constructed, maintained and operated if it has been authorised by an order made by the Secretary of State for Transport in England, or in Scotland, by an Act of the Scottish Parliament or an order of the Scottish Ministers.

All utilities are similarly authorised to carry on their businesses by Acts of Parliament relating to the service they provide. As corporate bodies their powers and duties are defined entirely by these Acts. A significant power in each case is the right granted to them to install their apparatus in the highway, without the need to make a payment for the benefit this gives them.

The utilities are also known for statutory purposes as statutory undertakers. Once an order has been made under the Transport and Works Act 1992, the promoter of a light railway also becomes a statutory undertaker for the purposes of installing and maintaining his infrastructure in the highway, and for these purposes is in an identical position to the utilities.

1.2.1. Application to different parts of the UK

In England and Wales control of works in the highway, whether carried out by utilities or light railway constructors and operators, is exercised through Part 3 of the New Roads and Street Works Act 1991 and the Traffic Management Act 2004. In Scotland the same control is through Part 4 of NRSWA and the Transport (Scotland) Act 2005.

1.3. Funding and authorisation through TWA – need for costs.

In addition to obtaining the legal authority to construct a light railway through the Transport and Works Act procedure, a promoter will need to consider how the project is to be funded. Whatever avenues are explored for sources of funds, it will be necessary to prepare a business case to show that the benefits of the scheme outweigh the costs of constructing and running it. The overall cost of the scheme will include any costs associated with the protection or diversion of utilities' apparatus. An estimate of these costs will also need to be made for the purposes of the Transport and Works Act inquiry, as this forms part of the submission to the Secretary of State accompanying the application for an order. This makes it necessary to assess the effects of the scheme on the utilities at an early stage in the planning process.

1.4. The position of the Promoter prior to making an Act or order

The process of estimating the cost of works involving the utilities is complicated by the fact that a promoter has no legal status in respect of a light railway scheme until statutory authority has been obtained. The utility companies have no need to recognise the promoter or the scheme at this stage, and no need to co-operate either in the provision of information or in deciding what action needs to be taken in respect of their apparatus, without payment. Yet a cost estimate must be made before an inquiry can be held. Fortunately the utilities generally will provide records of their apparatus (they have an obligation to make them available for inspection to those having reasonable cause to require to know where the apparatus is, but this is not the same as providing records). They are also often prepared to make initial attempts at planning for the protection of their apparatus so that cost estimates can be made. It is important to be aware, however, that without a clear understanding of the impact of the scheme on the apparatus, and the appropriate action to take to overcome conflicts, the cost estimates will generally bear little relationship to the work that is eventually carried out. For this reason it is generally preferable for the promoter, having collected all available information about the presence of utilities' apparatus, to make their own estimate of the scope and cost of the works to be carried out, based on experience with other, similar, schemes.

1.5. Actions to be taken throughout the project

Appendix 1 sets out a check list of the actions that need to be taken throughout the project to identify and carry out the protection and diversion of utilities' apparatus. This includes a flow chart for ease of reference.

2. Summary of legislation

2.1. Transport and Works Act 1992

This section refers to legislation affecting England and Wales only, but similar provisions now apply to Scotland. Promoters of schemes are required to seek an order relating to the construction or operation of a railway or tramway from the Secretary of State. The award of powers is made in the form of a statutory instrument.

A public inquiry will be held to consider the majority of schemes. A considerable amount of design work will need to be undertaken, to prepare the promoter to meet objections to the scheme. In particular, the implications of the scheme for public utilities will need to be addressed.

2.1.1. The Transport and Works (Model Clauses for Railways and Tramways) Order 2006

The second version of the model clauses order, made pursuant to Section 8 of the Act, came into force on 8th August 2006. It consists of two articles and two schedules. Schedule 1 contains model clauses for railways, while Schedule 2 contains model clauses for tramways. They are intended to form part of any order made under the Transport and Works Act.

The promoter can take powers to alter streets for the purposes of the light railway, and these may not necessarily be limited to streets which contain trackwork.

The streets concerned would be listed in a Schedule to the order (Schedule 3 in the model clauses), accompanied by a note of the proposed changes. Streets which do contain the light railway may also be altered with the consent of the highway authority. Any alterations to streets may put the promoter in conflict with public utilities' apparatus.

Powers may be granted for the stopping up of a street. Utilities may elect, or may be required, to remove their apparatus from the street as a result. This case is dealt with in Schedule 12 to the Model Clauses. Utilities are entitled to full recovery of the costs of removing and relaying apparatus already laid in a street to be stopped up, while customers of the utilities who suffer loss as a result are entitled to be compensated.

2.2. Parliamentary procedure in Scotland

The Transport and Works Act 1992 does not apply in Scotland, where future transport schemes will be authorised through the Transport and Works (Scotland) Act 2007. The promoters of the Edinburgh Tram adopted a different approach, and have obtained two Acts of the Scottish Parliament authorising the construction and operation of their system.

2.3. New Roads and Street Works Act 1991

The majority of the sections of the Act dealing with street works and roads works came into force at the beginning of 1993, and it now dictates the method of proceeding with all works carried out in streets, or roads in Scotland. In this respect it is the single most significant piece of legislation to be observed through all stages of construction of light railways on street.

The Act is divided into five parts. The first four are arranged in pairs, with the first of each pair applying to England and Wales, while the second applies to Scotland. Parts I and II are of no direct interest to light railway promoters: they deal with the construction of toll roads, with the emphasis on construction and operation by private companies. Part III deals with street works carried out in England and Wales, part IV covers road works in Scotland and Part V contains provisions of more general application.

The differences between parts III and IV are largely a matter of semantics. As the basis of the law is different in each case, the nomenclature used and cross references to other statutes are different. An example is the use of the word "*street*" in England and Wales, with the same concept being expressed by the word "*road*" in Scotland. However, the principles and effects of the two parts are broadly the same.

The street authority is a body invented for the purposes of the Act, and for most practical purposes will be the same body as the highway authority. The main functions of the street authority are to co-ordinate works carried out in the streets for which it is responsible, and to ensure that the undertaker carrying out the work reinstates the street to a satisfactory standard after it is completed. As such they are required to co-ordinate and control all works in streets associated with the construction of a tram system.

For the purposes of ensuring co-ordination of street works, the street authority is required to keep a street works register. The information to be entered into the register is specified in detail in the Street Works (Registers, Notices, Directions and Designations) (England) Regulations 2007. Guidance is provided to street authorities on how to carry out the co-ordination function by a code of practice, called *Code of Practice for the Co-ordination of Street Works and Works for Road Purposes and Related Matters*.

A number of important amendments to NRSWA are contained in the Traffic Management Act 2004, which emphasises and expands on the local authorities' role in co-ordinating all works carried out in streets in England and Wales.

The authority is entitled to receive advance notice of the intention of all undertakers to carry out work in the street. Where the work proposed is likely to be disruptive to traffic if carried out at certain times, the street authority can direct the times at which the work may be carried out (including limiting works to certain days, or certain times on certain days).

2.4. Traffic Management Act 2004

This applies only to England and Wales. The purpose of the Act is to promote the efficient use of the highway network, in particular by reducing congestion, and thereby reduce journey times and the estimated cost of hold-ups to businesses and private individuals alike.

The Act is divided into seven parts. Part 4 comprises a number of amendments to the New Roads and Street Works Act 1991, aimed at increasing the degree of control exercised by highway authorities over the rights of utilities and others to obstruct the highway.

Part 3 of the Act provides for the introduction of permit schemes. Such schemes will be designed "*to control the carrying out of specified works in specified streets in a specified area*".

The permit will stipulate the conditions under which work can be carried out in the highway, including specifying the geographical scope, the overall duration and the days and times of day on which work can be carried out. Consultation has recently taken place on the form and content of permit schemes, and permit schemes were introduced in the London Boroughs and the County of Kent in 2009.

2.4.1 Transport (Scotland) Act 2005

The Act sets out to accomplish two main aims: to reorganise the manner in which public transport is provided in Scotland, and to improve the operation of the New Roads and Street Works Act 1991 in Scotland, in much the same way as the Traffic Management Act 2004 is intended to do in England and Wales.

2.5. Statutory powers of public utilities

The provision of public utilities services is regulated by several enactments: the Electricity Act 1989; the Gas Acts 1986 and 1995; the Utilities Act 2000; the Telecommunications Act 1984 and the Communications Act 2003; the Water Industry Acts 1991 and 1999, the Water Act 2003; and in Scotland the Water Industry (Scotland) Act 2002 and the Water Services etc (Scotland) Act 2005.

2.5.1. Common features

The aims of the various Acts which authorise and regulate the activities of the public utilities are primarily to ensure that all reasonable demands for services are met by adequately financed companies, while at the same time promoting competition for the efficient provision of those services.

Each of the utilities has powers to carry out works in maintainable highways, although the extent of these powers varies from one enactment to another. The following sections outline the position.

2.5.2. Electricity

The powers of a licence holder to carry out works in the street are contained in Schedule 4 of the Electricity Act 1989. Paragraph 1 deals with England and Wales, while paragraph 2 refers to Scotland. They provide that apparatus can be laid in streets (or roads) for the purposes of the activities which the licence holder is authorised to undertake. In general, the Act does not apply to Northern Ireland, which is governed by the Electricity (Northern Ireland) Order 1992, amended by the Energy (Northern Ireland) Order 2003

Much of the detail regarding installation and use of electrical networks is contained in the Electricity Safety, Quality and Continuity Regulations 2002.

2.5.3. Gas

Schedule 4 of the Gas Act 1986 sets out the powers of public gas suppliers to break up streets for the purposes of installing and maintaining their apparatus. The Act does not apply generally to Northern Ireland, which is governed by the Gas (Northern Ireland) Order 1996, amended by the Energy (Northern Ireland) Order 2003.

2.5.4. Communications networks

Communications are regulated by the Communications Act 2003, which covers not only telephone and cable services, but also functions previously undertaken by the Radiocommunications Agency, the Independent Television Commission, the Radio Authority and the Broadcasting Standards Commission.

The electronic communications code contained within the Act sets out how certain electronic communications service providers are authorised to install apparatus in the highway.

2.5.5. Water and sewerage

Section 158 of the Water Industry Act 1991 sets out the powers of water and sewerage undertakers to lay and maintain apparatus in streets.

3. Utilities

Until the early 1980s, utilities were almost all public sector organisations. A process of privatisation of all utilities began in 1984 with the sale of shares in British Telecommunications, and this was followed over the next decade by the privatisation of British Gas, the electricity companies, and the provision of water and sewerage services. New cable companies were set up and authorised to provide cable services of various kinds, and these now constitute the greatest number of companies in the utilities sector.

Initially, the utility companies maintained a near-monopoly position, either nationally or regionally. British Gas, for example, continued to own the great majority of the pipework, and supply and sell the gas carried in it. The position has changed in more recent times, particularly in the case of gas and electricity supplies.

The gas industry is now separated into shippers, the people who extract and deliver the gas to the terminals, the distributors, who own the pipes in which the gas is carried on land, and the suppliers, who buy the gas from the shippers, insert it into the pipes, and sell it on to the end user. Each of the activities associated with the provision of gas is separately licensed, and it is not permitted for the same company to hold licences in more than one of the activities. The promoter of a light rail project will mainly be concerned with the transporters of gas. The majority of apparatus in the Midlands, the South West and the North West of England is owned by National Grid, with other companies owning the majority of apparatus in the South East, Scotland and west Wales. There are also approximately a dozen small independent gas transporters owning pipes in all parts of the country.

The electricity industry is divided into four sectors – generation, transmission, distribution and supply. Of these, only transmission and distribution are likely to be of interest to a promoter. Transmission involves the transport of electricity through cables from generating stations to grid supply points, at voltages of 275kV and 400kV in England and Wales, and 132kV in Scotland. The great majority of these cables are suspended from pylons and cross open country, and normally present little obstacle to light rail systems. Distribution cables are rated from 132kV down to 240V, and are owned by the Distribution Network Operator licensed for each area of the country. As in the case of gas, the same organisation cannot be licensed as both a distributor and a supplier.

Water supply and sewerage services are provided on a regional basis, in some cases by the same company. The majority of water and sewerage pipes likely to be found in the vicinity of a light railway will be owned by the local water and sewerage undertakers, but it is possible to encounter private pipes of both kinds. Some surface water drainage pipes carry culverted rivers and streams, and these will generally be owned by the people on, or adjacent to, whose property the pipes are laid (the riparian owners). Surface drainage from highways is generally achieved through pipes belonging to the highway authority.

In the last twenty years the development of communications has led to an overabundance of companies supplying services. This has recently resulted in a significant rationalisation, which is likely to continue for some time to come. Major companies, apart from BT, include Cable and Wireless, Virgin Media Group and Thus. Each of these has recently absorbed competitors. Companies with smaller quantities of apparatus include Sky (formerly Easynet), Verizon, Diamond Cable (Nottingham) and Salford Cable Television. In addition to cables in the ground or suspended overhead, there is a large number of antennae belonging to mobile phone companies. While many of these are mounted on buildings, a proportion are fixed to items of street furniture, which may be affected by construction of a light railway.

Other apparatus that may be encountered during the construction of a light railway include pipes carrying oil or petrol in rural areas, and street lighting, traffic signals and telephone pay kiosks in urban areas.

3.1. <u>Types of apparatus</u>

Apparatus falls into three categories, either buried, fastened to a structure, or suspended overhead. Apparatus fastened to a structure will seldom be in the way of a light railway, unless the structure itself needs to be removed. However, apparatus is never fixed to the structure in isolation, being connected to other apparatus that is either suspended or buried.

Suspended apparatus will normally be cables carrying an electrical current or communications signals. Occasionally pipes are made into self-supporting bridges spanning a sunken linear obstacle such as a railway or waterway. While suspended pipes and cables may have an impact on a light railway, the majority of apparatus that will be encountered will be buried.

Although apparatus may be buried some distance below the highway surface, it may have associated with it means of access for maintenance or adjustment that breaks the surface of the ground.

3.1.1. Sewers

Sewers traditionally carried both waste produced within properties (foul sewage) and rainfall water shed from hard surfaces (surface water). More recent developments have tended to separate the two functions to reduce the volume of water that needs to be accommodated in sewage treatment works. In some areas, particularly modern housing estates, there will consequently be found two pipes close to each other. The surface water pipe will invariably be larger, as it is designed to carry a large flow of water over a short duration.

Sewers are of two types, either gravity, in which the sewage flows downhill towards a discharge point, or rising main, in which the sewage is pumped uphill either to the treatment works, or to a point where the direction of flow changes to downhill. While rising mains are generally laid at a shallow depth, following the earth’s contours, gravity mains can be very deep, particularly in hilly areas. Means of access to gravity mains are provided by means of manholes, which consist of a sizeable chamber with an access shaft protected by a lid at the surface. These are normally placed at changes of direction of the sewer, to provide a means of inspecting and cleaning it out. Smaller shallow pipes, particularly on housing estates, may be laid through an access chamber where removing the lid reveals the pipe.

Rising mains are not associated with manholes or access chambers, but may be connected to air valves and washouts, at high and low points respectively. These will be accessible from the surface.

Rising mains are normally constructed in cast iron, while gravity sewers may be constructed from a wide range of materials, including cast iron, concrete, brick, plastic, vitreous enamel and asbestos cement.

3.1.1.1. Highway drainage

Highway drains are designed to remove surface water from the highway. The water shed from the surface is collected in gulleys located in the channel formed where the carriageway surface meets the kerb. In cases where the light railway infrastructure is placed close to the kerb, there may be insufficient room for a gully, and the drainage system can be replaced by a channel built into the kerb itself.

Highway drainage is normally owned by the highway authority, not the sewerage authority.

3.1.2. Water

Water supply pipes operate under pressure, so that water can be supplied in adequate quantities to the highest point of buildings. The water companies are obliged to maintain a certain level of pressure at the stop taps associated with each property served by them. Water is distributed over large distances at a higher pressure, which is then reduced locally for delivery to premises. Pipes carrying water may be made of one of a number of materials, including steel, cast, ductile and spun iron, concrete and plastic. Pipe sizes can vary from 63mm to over a metre.

A pipe network will be fitted with valves at strategic points so that water flow can be stopped to allow access to pipes for repair or maintenance. These valves will be accessible from the surface, via a spindle terminating in a small lidded box. Other apparatus connected to water pipes will include stop taps at the junction between the mains and service pipes feeding properties, fire hydrants, air valves and washouts. An air valve will be attached to the high point of a pipeline, to allow air trapped in the pipe to be released, while a washout will be found at a low point, to allow water to be drained from the pipe.

Because the water is under pressure, it exerts a force on the pipe walls. In straight pipe, the forces are balanced, but on bends and at junctions, there is a resultant force that acts on the surrounding ground. If the pipe is of a large diameter, this force can be considerable, and may have to be counteracted by a concrete surround called a thrust block that distributes the force evenly into the surrounding ground. Without this, the pipe could move and the joints could separate.

Mains water pipes are normally laid at a depth of not less than 900mm. This is to ensure that all connected service pipes have a minimum depth of 750mm to guard against frost action on the pipes.

3.1.3. Gas

The transport of gas and water follow similar lines, and use similar materials in their pipework. However, gas is carried at a variety of pressures, classified as high, intermediate, medium and low. The great majority of premises are supplied from low pressure mains, and the correct pressure is obtained in these mains by reduction from the mains carrying gas at higher pressure through gas pressure regulators (or gas governors) which may be housed above or below ground.

As with water pipes, there are various pieces of equipment associated with gas piping, including valves and siphons. Also, because the gas is under pressure, large diameter pipes will normally require thrust blocks at bends to keep the pipes from attempting to straighten and deform.

High pressure mains are most likely to be encountered in rural areas, crossing open fields. For safety reasons they will not be located close to occupied premises. Medium pressure mains may well be found in urban areas however, as may intermediate pressure mains, though less commonly.

Some years ago concerns were raised about the structural integrity of iron mains, many of which have been in the ground for decades. British Gas began the process of replacing these with steel or polyethylene pipes in 1977. However the rate of replacement works since meant that full replacement would not have been achieved until the middle of this century. The Health and Safety Executive instructed Transco, the successors to British Gas, to speed up the replacement process so as to have it completed by 2031. There are on average some 23,000 failures of iron pipes every year. Replacements are carried out according to a prioritisation system which takes into account proximity to buildings, the history of failure and the likely consequences of a major failure of the pipe.

3.1.4. Electricity

Electricity is supplied to premises and various items of street apparatus through a system of cables. The maximum permitted voltage in the UK is 400kV. Cables carrying power at 400 and 275kV are classed as transmission cables, and carry current over long distances across the country, suspended from pylons. Other cables have lower ratings of 132kV, 66kV, 33kV, 11kV, 6.6kV, 450V and 220/240V. These are classed as forming the distribution network. The lower voltages are achieved at substations, where a transformer is used to step down from the grid voltages.

Cables carrying an electric current generate heat, so raising the temperature of the cable. If the temperature becomes too high, the insulation around the metallic core will start to degrade, and the current carrying capacity needs to be reduced to maintain the cable’s integrity. To compensate for this, the quantity of metal in the cable would need to be increased, reducing the resistance of the cable and so reducing the heat loss, but requiring the use of a more expensive cable. For this reason a cable is most efficiently used if it is suspended in the open, or failing this, buried direct in the ground where the heat generated by the current flow can be most quickly dissipated. Least desirable is to encase the cable in a duct, where the heat becomes trapped and raises the cable temperature. For this reason, cables are only contained in short lengths of duct where there is a very good reason to do so. This mainly applies where the cable crosses a carriageway, or runs through a bridge deck, meaning that repairs to and replacement of the cable can be carried out by pulling it through the duct without interfering with traffic flows.

Cables normally consist of a current-carrying core wrapped with a form of insulation, contained within a protective wrapping of metal or polyethylene. Where a metal protection is used, this may also serve as an earthing layer. Older cables were generally wrapped in oiled paper for insulation, with an outer lead sheathing, but modern cables generally use polyethylene and aluminium.

Some high voltage cables are in addition protected and insulated in a steel casing which contains gas or oil under pressure. These have associated with them pumps and reservoirs of the filling fluid.

Where cables are laid directly in the ground, particularly in a highway, it is normal to indicate their presence by placing a tile, or tape, directly above it, to warn someone excavating the ground in the vicinity that there is a live cable beneath.

3.1.4.1. Street lighting and street furniture

Service feeds are taken from electric cables to properties alongside the highway. In addition, it is necessary to serve a large number of items of equipment on the highway itself. Power is required particularly by street lighting, and also by street signs, kiosks, bus shelters and similar items. Some of these will take power directly from cables owned by the Distribution Network Operator. Sometimes however, the DNO may provide a feed to one of several items, such as a street light, and the remaining items will be cabled directly by the street lighting authority from the public feed. These latter cables will be privately owned.

3.1.4.2. Traffic signals

Many highway junctions in a busy urban area will be controlled by traffic signals. These will generally be powered from the public electricity network, and are also likely to be linked to BT's communications network.

3.1.5. Communications

Communications were the first services to be opened up to a competitive market. Initially full public telephone services were provided by British Telecommunications, Mercury Communications and, within a very limited geographical area, Kingston upon Hull City Council. The number of companies providing cable-related services very quickly expanded, until there are now well over a hundred.

The cables used in communications systems are invariably drawn into plastic or earthenware ducts for their protection and ease of repair and replacement. The ducts are sometimes sub-ducted, and it is not unknown for cable companies to share a single large duct to reduce the cost of setting up their infrastructure.

Cables are generally one of two types – either copper-cored, or fibre optic. Copper has been used for the carriage of telecommunications signals since the late nineteenth century, and some of BT's cables are now very old. Large cables are used to link telephone exchanges, some containing several thousand pairs of thin copper wires, while others containing only a few pairs are used to connect to properties. Older cables are insulated using impregnated paper, and protected by a lead sheath. More recently, long distance cables utilise fibre optics, and the cable companies set up since liberalisation of the industry in 1984 use this type of cable predominantly in their networks. BT now also has plans for the replacement of their mains copper cables by fibre optic cables over a number of years.

Copper cables are supplied on drums in lengths that are related to their diameter, so the larger the cable is, and the more cores it contains, the shorter it will be. The largest cables are only a little over 200 metres long. This means that cables have to be jointed together at regular intervals between telephone exchanges. Jointing may be carried out in manholes, which are accessed via a shaft. In these cases, the cables are likely to be not less than a metre below ground level, and may be considerably deeper. Other cables may be laid at shallower depths, and these will be jointed in chambers where removing the lid gives direct access to the cables, which may be at a depth of between half and one metre.

Fibre optic cables are typically produced in lengths of 2 kilometres, and consequently need to be jointed less frequently. They are on average laid at a shallower depth than the older BT cables, typically between a quarter and half a metre.

Fibre optic cables have a greater signal-carrying capacity than a copper cable of the same diameter, and are cheaper to install. The particular drawback with interference with a large copper cable is that re-making the joints is very labour intensive, and is consequently costly and can take a considerable amount of time, particularly where the jointing chamber or manhole is cramped.

3.1.5.1. Pay phone kiosks

Kiosks may be found close to a proposed light rail route. Considerations concerning the proximity of kiosks will include whether it is possible to enter and leave them safely when the trams are operating, and the impact of the light rail infrastructure on the telephone and electricity cables that are required for their operation.

3.1.5.2. Mobile phone antennae

Mobile phone antennae are present in relatively large numbers in town and city centres. These intercept and transmit the signals from mobile phones in the area. They are also connected through cabinets to provide a link to the cables of traditional telephones operating through landlines. While the majority of antennae are mounted on buildings, a proportion is attached to street furniture, which might be directly or indirectly affected by a light railway.

3.2. Effects of light rail infrastructure on apparatus

There are two principal ways in which utilities' apparatus might be affected by the construction or operation of a light railway:

- The apparatus is destroyed in the process of construction;

- Access to the apparatus is prevented or restricted, either by the presence of the light railway infrastructure, or during the period of operation of the vehicles. This will require an assessment of the management of risk of not moving the apparatus, within the parameters set down in sections 84 and 143 of the New Roads and Street Works Act 1991.

In either of these cases, the utility company is entitled to consider, in conjunction with the promoter, what steps need to be taken to ensure that the company does not suffer a detriment as a result of the introduction of the light railway.

There are several elements of infrastructure that might be in conflict with the utilities' apparatus. The most obvious of these is the track itself, but others include the overhead line equipment supports, ducting placed alongside the tracks to carry cables associated with the operation and control of the railway, and the stopping places.

When designing a light railway, one of the major questions that arises is whether or not it is necessary to divert utilities' apparatus. The cost of doing so can amount to a substantial proportion of the total scheme cost. There will be a number of factors to take into account when making a decision, always having in mind that the decision needs to be made jointly by the promoter and the utility company concerned.

- Will the apparatus be destroyed in the course of construction? Clearly it will have to be replaced if it continues to be an essential part of the utilities' infrastructure network.
- Will the apparatus be covered over by the light railway infrastructure, and hence not accessible without demolishing or dismantling part of it? If this were necessary, could the light railway continue to operate?
- Could work be carried out on apparatus close to the light railway while the railway was in operation? Would equipment used in repairing or maintaining the apparatus be a danger to vehicles on the railway, or would it be endangered by the presence of the live overhead line equipment?
- What is the importance of the apparatus to the utility company, or to the end users? High pressure gas and water pipes, extra high tension electricity cables, large diameter sewers, large diameter copper cables will many pairs of wires, and fibre optic cables forming part of a large ring main will all be crucial to the operation of a utilities' network over a wide geographical area. Loss of the apparatus will need to be corrected immediately to avoid inconvenience to thousands of people. There are also certain facilities that are heavily dependent on the continuous provision of utilities' services, such as hospitals, schools, nursing homes and so on. Police stations and other emergency services may struggle to operate without communications services. The importance of maintaining unobstructed access to apparatus will need to be considered in relation to such matters.
- What dangers will be associated with leaving apparatus beneath or close to the tracks? Some apparatus may actually benefit from being beneath the tracks, as it reduces the danger of it being disrupted by others excavating in the same area. However, there are clear dangers associated with leaving gas pipes beneath or close to the tracks, as a leak from a pipe may be masked over a period, to the point where gas concentrations become lethal. Similarly, a leak from a water pipe might go unnoticed if it is happening beneath the tracks, until a cavity has been created big enough to cause a failure of the track. A leaking sewer can also lead to catastrophic failure of other apparatus by eroding the support from a gas or water pipe, causing it to leak through failed joints.
- How will the utility company expand its network of apparatus in the future? Will they need to make new connections to apparatus left beneath or close to the tracks to supply services to new developments along the railway frontage?
- There is also the consideration of the relationship between responsibility for design of the light railway, the operation and maintenance of the infrastructure, and the control over the initial diversion of apparatus. Clearly all parties need to have a common approach to the question of the need for diversion of a particular piece of apparatus, otherwise problems will result.

3.2.1. Track

Light railway trackwork placed in the street has evolved in the UK over a period of very nearly 150 years. It is very unlikely to have reached the end of that evolutionary period. Track constructed since 1990, when the first new generation of tramway was commenced in Manchester, has adopted a generally uniform approach of encasing the rails in an insulating material, and supporting them on a reinforced concrete slab, having a width approximately the same as that of the light rail vehicles. The encasing material is designed to prevent the electric current flowing through the rails from escaping into the ground. The supporting slab serves a number of purposes, but is foremost a foundation for the tracks and a base for the adjacent carriageway. In situations where no other traffic (and particularly buses) shares a right to run on the railway, the extent of the supporting slab could be greatly reduced to a sleeper system, occupying little more than the width of each rail.

The track slab is clearly a substantial obstruction to access to any utilities' apparatus beneath it. Nevertheless, apparatus is left in place beneath the slab, in cases where access is very unlikely to be needed. This applies particularly in the case of communications apparatus, where cables are invariably contained in ducts, and access to the cables is obtained at manholes or jointing chambers.

Other apparatus might also be left beneath the tracks, by agreement with the utility company concerned, if gaining access to the apparatus would never constitute an emergency, and could be planned some time in advance. In this case, the promoter of the light railway would need to accept the destruction of part of his infrastructure, and cessation or disruption of services for the period of the works. The matter of liability for the increased costs to both parties would need to be resolved before the decision was taken to leave apparatus beneath the tracks, but it is unlikely that agreement would be reached on this course of action unless the utilities' liability for consequential costs for disruption of light rail operations was waived.

The use of a concrete track slab allows for the possibility of apparatus crossing the tracks to be built into the slab. This is only likely to be acceptable, or possible, in the case of ducted cables.

3.2.2. Overhead line equipment

The overhead line, which provides power to the light rail vehicles, is either supported from buildings alongside the tracks, or from supports erected specially for the purpose. The supports will generally require a substantial foundation to resist the overturning moments developed by the tension in the contact wire. Foundations take one of two forms: either the support pole is encased in a bored or driven pile, or it is bolted to the top of a cast insitu concrete (gravity) base.

If a pile is to be bored or driven, the ground through which it passes will have to be clear of utilities' apparatus, which would otherwise be destroyed by the act of piling. It is also possible that apparatus very close to the pile would be affected by disturbance of the ground, particularly in the case of driven piles.

Cast insitu bases can give greater flexibility, as they can theoretically incorporate apparatus within them, subject to agreement with the utility company. They can also be cast beneath the level of the apparatus, so long as there is room for the pole to pass through.

There is generally scope for some modification of the support layout, both along the track and perpendicular to it. Poles can also be placed on a gravity base with a high degree of eccentricity. This means that placing of poles will not necessarily require a large amount of diversion of apparatus.

3.2.3. Ducting

A modern light railway uses a considerable amount of electrical equipment, spread out along the tracks. This will include public address systems, cctv, communication with passengers and so on, and has to be powered and controlled by cabling. In addition, there will be booster cables to maintain the voltage in the overhead lines. The cables are drawn into ducts running parallel with and close to the tracks. The placing of these ducts and their associated access points may dictate the minimum practical depth of utilities' apparatus crossing the line of the tracks.

3.2.4. Stops

It is normal to provide purpose-built stopping places for light railways, both on highway and off. These can be fairly substantial structures, with their size being determined mainly by the length and floor height of the vehicles. The structural elements may conflict with utilities' apparatus, which may need to be moved, or cast into the structure by agreement. Given careful consideration of the consequences, it may be possible to incorporate access hatches into the platform so that maintenance work can be undertaken while the railway continues to operate safely.

3.2.5. Other equipment

The amount of space in a highway is limited by its boundaries, and the addition of a light railway will inevitably add further pressure on the space. In addition to the track, overhead line equipment and stops, the tramway requires a range of other equipment, including signals and signal cabinets, point motors, detector loops, cabinets to hold isolator switches, and traffic signs for example to indicate speed limits. Space needs to be found for all of these, and their impact on utilities' apparatus assessed.

3.3. <u>Obligations of both parties under legislation</u>

The basic obligations of promoters and utility companies in England and Wales are set out in section 84 of the New Roads and Street Works Act 1991 (section 143 in Scotland). Both sections require the parties (referred to as the transport authority and the undertaker respectively) to consider the effects of the promoter's proposed work on the utility company's apparatus, and agree on the measures that need to be taken to allow the promoter's work to be undertaken. These measures could involve protection, diversion or simply abandonment of the apparatus, possibly with some compensating work elsewhere in the network. Having decided what work is needed, the parties then need to agree who will carry out the work, and the appropriate specification. Agreement is also to be reached on the timing of the works so as to co-ordinate it with the promoter's project.

The Act makes provision for the preparation of a Code of Practice setting out practical ways of interpreting this section and putting it into practice. This was produced by the Highway Authorities and Utilities Committee (HAUC) in conjunction with the Department for Transport, and is called *Measures Necessary Where Apparatus is Affected by Major Works (Diversionary Works)*. While this provides a considerable amount of general information, it should be noted that it was not written with light railways in mind, but was aimed at highway improvements of relatively limited scope. This means it should be treated with some caution when trying to apply it to a light railway scheme.

Payment for the work that needs to be carried out to utilities' apparatus as a result of the introduction of a light railway will be made in accordance with section 85 of NRSWA (section 144 in Scotland). In principle, the promoter of the light railway, being the instigator of the works, pays the cost of diverting or protecting apparatus. However, the utility company is obliged to make a contribution to the works cost, on three separate counts.

- Cost share: there is a standard discount of 7½% allowed against the cost of the works that are made directly necessary by the introduction of the railway infrastructure into the highway, i.e. because the apparatus would be destroyed, or access to it would be restricted. In the case where the need for movement or protection is brought about by an alteration to the highway needed to accommodate the railway, the discount allowed by the utility is increased to 18%.
- Deferment of the time for renewal: this is a further allowance which recognises the fact that the need to replace the utility's apparatus is being postponed as a result of the work carried out and paid for by the tramway promoter. This will often result from the provision of new apparatus in exchange for apparatus which may be nearing the end of its useful life. The life of the apparatus may also be extended by the refurbishment of the apparatus *in* situ, and in the case of the relining of a sewer or water main. The calculation of the amount of the benefit is based on the expected design life of the apparatus concerned, and its age at the time of replacement or refurbishment. There are various exclusions from the calculation, including the cost of connecting new to existing apparatus, and small lengths of diversions.
- Betterment: it is permissible for a utility to take advantage of the need for a diversion to provide apparatus of a greater capacity than that being replaced. In this case, the utility is itself responsible for meeting the additional cost of doing so. In relation to the project, this is cost-neutral, and neither benefits the promoter nor causes him a detriment financially. However, there may be other implications, particularly in terms of the duration of the works, and the time taken for the utility to calculate his additional requirements, that may have an indirect impact on the project.

3.4. Safety

After the railway works have been completed, and any diversions have been carried out, the overriding requirement is that operation of the tramway, use of the highway by others, and maintenance of utilities' apparatus can all be carried out safely. It is the duty of the Office of Rail Regulation to satisfy themselves that the railway can be operated safely. Restrictions will be imposed on the proximity to the railway of work carried out in the street, when the railway is operating or the overhead line equipment is live. Section 65 of NRSWA (section 124 in Scotland) requires that anyone carrying out work in a highway takes into account both the safety of the workers and that of others using the highway. They are expected to carry out their works in accordance with the Code of Practice *Safety at Street Works and Road Works*. Planning of the measures necessary to take account of the introduction of a light railway needs to keep all future safety requirements in mind, because if recommended or mandatory safe working practices cannot be adhered to with the railway in operation, it will be necessary to halt operations while work to the utilities' apparatus is carried out.

3.5. Alternatives to diversion

In many cases the need to divert or protect apparatus will be quite clear, because the railway cannot be built if apparatus remains in its present position. However, in other situations, there may be a choice whether or not to move, or an alternative way of approaching the problem. It may be possible to simply accept the risk that apparatus might fail in future, resulting in a cessation of railway operations while repair work is carried out. Similarly, a need to expand the utilities' network may lead to a new connection being required beneath the railway. It would have to be agreed in advance who is to bear the consequential additional costs to both parties. The promoter in particular would need to consider the effect of loss of public confidence in the railway if it is not available to passengers on a regular basis. Leaving apparatus beneath the railway can only be countenanced if it can be assured that failure would not lead to a serious danger to the public and users of the railway.

Specific measures that should be considered to avoid the need for diversion are as follows:

- Many gas and water pipes have been in the ground for a considerable length of time. Old pipes are generally of cast iron construction, which are likely to have corroded internally, and may well leak at the joints. In the case of gas in particular, the quantities supplied are likely to have reduced over the years, as gas-hungry industries closed up and moved away from town and city centres. The result is that the pipes are carrying less gas, and at the same time friction losses have increased. Where the pipe is oversized as a result, there may be benefits all round from inserting a smaller diameter plastic sleeve in the pipe, as it may then be acceptable for the pipe not to be moved. The situation with water pipes is more complicated, as the overall per capita use of water has increased over the years. Locally, this may be compensated for by transfer of usage from industrial to domestic. There is also a considerable loss of water through pipe joints, and a reduction in pipe size as a result of sleeving may be justifiable under some circumstances.
- In the case of gas supplies, where pipes must be diverted, it may be possible to introduce additional medium pressure pipes and a gas regulator, if this would result in replacement low pressure pipes being of a smaller diameter. This will result in a cheaper scheme overall, particularly where previously large pipes can be reduced to 305mm diameter or less.
- Electricity cables are sometimes jointed in a chamber, but are more often jointed in the ground with no special means of access. Over the years, as cables fail, sections are replaced at the point of failure. However, the cables are normally ducted beneath carriageways. In this way, if the cable fails beneath the carriageway, the section in the duct can be drawn out and replaced without having to stop traffic. The diameter of the cable placed in the duct will be chosen to counteract the increased temperature that results from its encasement in the duct. The same benefits can be obtained by the use of a split duct, where a cylinder made of a suitable material, but separated into two halves longitudinally, is wrapped around the cable. Distribution Network Operators will not necessarily accept this solution if it has to be applied to live high voltage cables. In addition, it may lead to a downrating of the cable due to the increase in operating temperature resulting from enclosing the cable, and would therefore only be possible if such a downrating did not interfere with the correct operation of the electricity network.
- The BT network largely consists of copper cables, some consisting of a large number of separate wires. These are costly and time-consuming to replace, compared to the cost of altering the civils infrastructure, i.e. the ducts, manholes and chambers required to support the cables. The older and larger cables are often laid at a depth of several metres, and are jointed in large underground chambers accessed by a manhole. Once inside the manhole, the cable jointers are unaffected by activity in the street above. Chambers beneath the carriageway are designed to support highway loadings, and even if the chamber lies directly beneath the tracks, work can be undertaken inside it so long as the means of access to it lies outside the direct influence of the railway. It will generally be cheaper and quicker to move the access to the manhole, even if this means rebuilding and enlarging the chamber, than to divert the cables, which would in any case require the provision of new chambers.
- Cables belonging to the new generation of cable companies are generally fibre optics, which are typically laid at depths of between 250mm and 450mm to the crown of the ducts. The latter depth normally applies to road crossings, where the cables are most likely to be encountered in the course of constructing a light railway. As the cable depths are often restrained by the presence of jointing chambers on either side of the carriageway, and also by the presence of other utilities' apparatus directly below them, a suitable way of accommodating the apparatus may be to enclose the ducts within the track slab, specially thickened locally. The trackside ducts required by the railway will normally have to pass underneath the utility's cables.
- All light railway schemes should provide a number of spare ducts crossing beneath the tracks at strategic points. This will allow for additional cables, and possibly small pipes, to be inserted beneath the tracks while the railway is operating in the future. It may also avoid the need for an immediate diversion of some apparatus, as, in the event of failure, it can be replaced by pulling through the spare ducts.

3.5.1. Risk assessments

A promoter and a utility company may by agreement wish to adopt an approach to diversions based on an assessment of the risk of leaving it in place. It is normal business practice to balance two or more courses of action by reference to the probable cost of each of them, and adopting the course estimated to provide the best return on investment. In principle this approach could be applied to the question of whether or not to move a particular piece of apparatus. On the one hand would be the cost of moving the apparatus, and on the other would be the cost over the lifetime of operating the railway of the consequences of the apparatus failing, including compensation paid for injuries, damage to the infrastructure resulting directly from the failure or from gaining access to the failed apparatus, the immediate loss of profit resulting from suspended railway operations, and the long term damage to the system from loss of customer confidence.

The utility company would have good reason to insist on moving the apparatus if he were to be held liable for these costs, so the promoter should be prepared to make this assessment himself. The particular problem he will face in carrying out this exercise is the lack of reliable data relating to the probability of failure of the apparatus.

4. Scheme authorisation

A light railway will in almost all cases be authorised through an order following a public inquiry. The process of obtaining an order is laid out in regulations, and involves consultation with people potentially affected by the proposals, the preparation of a draft order and supporting documents and drawings. The merits of the scheme are debated and objections aired at the public inquiry.

4.1. Objections from utility companies

Among the other documents that have to be submitted with the application for the order is an estimate of the costs of the scheme, including the cost of dealing with utilities' apparatus. This means that a reasonable attempt must be made at an early stage in the project to identify all the apparatus likely to be affected, and the measures necessary for dealing with it. The utility companies, having been informed of the proposed scheme, will seek to safeguard their apparatus, and may lodge an objection against the scheme until they are satisfied that their interests will be taken into account.

While many utility companies have successfully sought and obtained undertakings and agreements from promoters in exchange for withdrawing their objections, BT are generally conspicuous in refraining from raising objections. This is because they consider that they are adequately safeguarded by existing legislation, and there would need to be unusual circumstances to make it necessary to seek further protection. Promoters should consequently consider carefully before giving onerous undertakings in order to remove utilities' objections to a scheme. This was highlighted in the House of Lords Committee stage of Leeds Supertram Bill, where many of the utility companies combined to attempt to overturn the provision of the New Roads and Street Works Act 1991 requiring them to contribute 18% of the cost of diversions. The committee declared that it was not the place to consider and seek to amend public legislation, and the arguments were rejected. Similarly, any attempt by a utility to alter or bypass the provisions of the New Roads and Street Act 1991 or the Town and Country Planning Act 1990, which governs the effect of a light railway on utilities' apparatus in private land, should be rejected by the Inspector for the same reasons.

5. Carrying out the works under NRSWA and the Traffic Management Act 2004

The New Roads and Street Works Act 1991 provides the main framework under which work is carried out in the highway. It applies equally to the construction of a light railway as it does to the installation, alteration, repair and maintenance of apparatus belonging to utility companies.

When apparatus, or railway infrastructure, is to be installed or worked on, advance notice of three months is to be provided to the street authority, or road works authority in Scotland. At least ten days before beginning work, a further notice is required to be given, and the notice is also to be provided to all other utilities with apparatus likely to be affected by the works.

The street or road works authority has a duty to co-ordinate works being undertaken in the streets so as to cause as little disruption as reasonably possible. Once the works have been completed, the utility must reinstate the highway to a satisfactory standard. The authority has the right to inspect the works at various stages, including after reinstatement has been carried out.

The timing of works can be controlled to a certain extent by designating highways as traffic-sensitive for all or part of the day, and over all or part of their length. This allows work to be prevented during periods when a highway is most congested. Where work takes longer than a reasonable period, the authority can issue a notice requiring it to be accelerated. They can also charge for excessively long occupation of the highway.

Under the amendments to NRSWA introduced by the Traffic Management Act 2004, further powers have been given to the authority to direct where and when street works can be carried out. In addition, they have powers to introduce permit schemes that will specify all the details of where and when works can be carried out, and for how long. Similar alterations to NRSWA are contained in the Transport (Scotland) Act 2005, but these do not include powers to introduce permit schemes.

6. Stray current and EMC

The majority of light railway vehicles, particularly those that operate on highway, are powered by electricity drawn from overhead contact wire. The current is fed from the positive terminal of a substation into the contact wire, passes through the motors of a light rail vehicle, and returns through the rails to the negative terminal of the substation.

The rails are, indirectly at least, in contact with the general mass of earth, and there will therefore be a tendency for current to be attracted from the rails into the ground, finding alternative paths back to the substation. Near to the substation, any escaped current must return to the rails in order to complete the circuit.

Current that does not stay wholly within the rails is referred to as stray current. There is clearly no means of controlling what paths may be followed between the points of leaving and re-entering the rails, and stray current will often find a route through metallic utilities' apparatus. A consequence of this is that the metal contained in the apparatus will be corroded at the point where the current leaves it, either to return to the rails or to transfer to another piece of apparatus. Eventually a hole will be created in the apparatus, leading to the contents escaping in the case of a pipe, or to probable burn-out in the case of a cable.

Railway Safety Publication 2– Guidance on Tramways at paragraph 196 says that:

"The design of the electric traction supply system should ensure that leakage of stray current is normally minimised."

This is to ensure that the danger of corrosion of metallic apparatus should be kept as low as possible. A number of steps are taken in the design of the railway to minimise stray current, including keeping substations at reasonably close spacings, providing an adequately sized rail to offer as little resistance to the passage of current as practically possible, using continuously welded rail for the same reason, maximising the resistance between the rail and the surrounding ground by encapsulating it in an insulating polymer, and providing means for trapping any current that does escape so that it can be directed away from any nearby utilities' apparatus.

It must be stressed that utilities' apparatus should NOT be diverted because of any perceived possibility that it might be affected by stray currents, for two reasons. Firstly, the pathways and effects of stray current are unpredictable in relation to any given piece of apparatus, and removing one piece of apparatus may simply shift the problem elsewhere. Secondly, the design of the tramway is required to adopt means of minimising stray current, and it is therefore intended that problems with utilities apparatus will not arise. It should always be remembered that, so long as the promoter of the tramway has adopted all reasonable means to limit the production of stray current, they will not be responsible for the effects of any residual stray current on the apparatus of nearby utilities. Reference should be made to the court case *National Telephone Co v Baker* (1893) for the judge's reasoning in this respect, which acknowledged that the tramway design would need to balance a variety of competing requirements, of which the minimisation of stray current was just one.

Should problems with corrosion of apparatus be detected once a light railway comes into operation, the first course of action will be to check that all design aspects of the built-in stray current minimisation measures are operating as they should. If this is found to be satisfactory, a range of corrective measures can be considered, such as cathodic protection, or bonding the apparatus to the track. This expedient can, however, simply transfer the problem elsewhere. Only as a last resort should the apparatus be replaced in a non-conducting material, but this action should not be at the expense of the promoter so long as they have taken all reasonable steps to minimise stray current through the design of the tramway.

EMC (electromagnetic compatibility) requires that different items of equipment operated by electricity can function satisfactorily in each others presence. This places an obligation on manufacturers to ensure that their equipment does not produce an unreasonable degree of electromagnetic interference, and is also designed robustly enough to resist the effects of normal electromagnetic interference produced by other equipment nearby.

Electromagnetic interference occurs when an unwanted electrical current is induced in a conductor. This happens either when a conductor is moved through a static, unvarying magnetic field, or a fixed conductor lies within a varying magnetic field (or some combination of the two). Thus, any metallic utilities apparatus close to a light railway can have a current induced in it as a result of the varying currents running in the rails, the overhead line or the vehicles. The main concern arising from this is that the signal in a communications cable could become corrupted. This would be of particular concern if the cable carried a control signal, which could be misinterpreted as a result of spurious currents. However, there is no evidence that any apparatus has failed as a result of interference from a light railway, and the possibility of electromagnetic interference is not a reason for the diversion of apparatus.

APPENDIX 1

During the life of a light rail project there will be several bodies taking responsibility for different aspects. These will include the promoter of the scheme, possibly a different client to see it through the construction phase, a designer, a contractor and/or concessionaire and an operator. The allocation of responsibilities may vary from one project to another, and this will apply to the diversion and protection of utilities apparatus. Regardless of how the responsibilities are allocated, the following stages will need to be accomplished throughout the project.

1. Define alignment.
   A firm definition of the alignment will be required. Without this, any work on diversion of utilities will potentially either lead to unnecessary cost and time being expended on moving apparatus that does not need to be diverted, or miss diversions that are necessary. If the promoter defines the alignment himself, this will theoretically limit the future Concessionaire's freedom to choose the alignment. In practice this is of no real significance in a congested urban area, where the choice is dictated by external factors such as restraints imposed by buildings, and traffic management considerations. The alignment will in any case be restricted to the streets set out in the order authorising the system.

2. Define changes to highway due to permanent changes to traffic management.
   The need for diversions does not only result from the construction of the track, but also from changes to the carriageway alignment. There will be places where the kerbline will be set back in relation to its current position, in order to accommodate the tracks. This is likely to expose shallow utilities apparatus to additional loading, and such items will need to be diverted, protected or lowered. Diversions for this purpose only, will attract a different rate of contribution from the utility companies.

3. Define temporary and permanent changes to highway due to traffic management during construction.
   The programme of diversions identified from 1 and 2 above will inevitably result in traffic movement patterns being modified while the diversion work is carried out. A wide range of changes might be introduced, including road closures, one way systems, reversal of one way systems, introduction or lifting of parking restrictions, restrictions on straight ahead or turning movements at junctions, prohibitions on access or driving and so on. In some cases such changes can only be introduced by modifying the highway layout, particularly by junction improvements. This may in turn lead to diversion of apparatus exposed for the first time to highway loadings, at locations quite remote from the tramway.

4. Establish relationship between apparatus and the works identified in steps 1 to 3
   Records should be obtained from all utilities identified as having apparatus in the streets affected by the tramway. These should be transposed onto composite plans overlaid by the chosen alignment. The initial composite service plans will make use of evidence of the lines of apparatus provided by a detailed survey of the utilities' ironwork. This is useful for apparatus that breaks the ground, such as BT and other communications and cable companies' chambers and manholes, various valves associated with water and gas pipes, and sewer manholes. There is generally little evidence of main gas and water pipes however, or electricity cables. It will therefore be necessary to refine information about this apparatus, either by digging trial holes, or carrying out non-invasive electronic or radar tracing. Where appropriate, the composite drawings should be modified to reflect the results obtained from these investigations.

5. Develop proposals for managing risk associated with the cost of diverting utilities/long term maintenance by utilities
   The preferred solution to any conflict between the light railway and utilities' apparatus will always be to leave the apparatus in place, subject to agreements being reached on the methods to be used to maintain and extend it when necessary. This will avoid unnecessarily increasing the cost of introducing the railway. It has always to be remembered however that the lifetime costs of the railway must be assessed, and not just those of the construction. A realistic attempt needs to be made to calculate the costs associated with the risks of leaving apparatus beneath or close to the tracks, in terms of the consequences of failure of the apparatus, the frequency and additional costs of maintaining it, the visible and hidden costs of suspending railway operations, and the safety of all involved in working near to an operational railway.

6. Identify all apparatus to be moved as a result of steps 1 to 5
   Section 84 of the New Roads and Street Works Act 1991 requires the transport authority and the statutory undertaker owning apparatus affected by the proposed changes to identify the apparatus and the "*measures necessary*" to be taken to allow the tramway construction to proceed. The steps to be taken include agreement on a specification for the works and the timing of the works.

7. Identify new locations for apparatus to be moved.
   Having identified what apparatus needs to be moved, it is then necessary to find a new location for it. It may not always be appropriate to replace like for like. For example, there is a considerable amount of electric cabling in any city street that is no longer in use (frequently more than 50%). While this still belongs to the electricity company, and they could theoretically require it to be moved, it would not be economically sensible to do so. In the case of all services, there may be an opportunity to rationalise networks, resulting in one new pipe or cable providing the capacity of several existing. However, this may be moderated by other considerations, including security of supply (for example maintenance of redundant supplies to a hospital) or different purposes served by apparent duplication of supply (for example, separation of potable water supplies from fire fighting supplies).

   The new location will not necessarily be in the same street as the existing. Trunk mains may not provide a service to the buildings in a particular street, and the route originally chosen may have simply been the most direct and convenient route available when the apparatus was installed. Other apparatus can only serve its purpose by remaining in the same street. Even then, there may be an opportunity to re-route service feeds to a building to reduce or eliminate apparatus from a particular street or part of a street. This may be possible when a building has access onto two different streets.

8. Prepare composite plans showing positions of new apparatus.
   Once the apparatus to be moved, and its new positions, have been identified, a further set of composite plans needs to be prepared locating each item accurately, showing its point of connection to the existing apparatus, and identifying the lengths of apparatus to be decommissioned. This supposes that there is a detailed knowledge of the positions of the existing apparatus, and hence a detailed knowledge of the available space in the ground.

9. Prepare programme of diversions.
   The utilities will each provide estimates of the duration of their works. It is unlikely that the utilities' own initial ideas will be acceptable without modification, so this information will need to be assembled into a master programme, designed to minimise disruption to general users of the highway. The programme will also need to be regularly updated to reflect actual progress.

   Apart from items relating directly to the diversion works, the programme will also take account of external factors (various parades and events such as Remembrance Day, as well as development of sites alongside the route), enforced gaps in work schedules such as Christmas blockades, and other schemes affecting nearby highways (e.g. sewer renewals, other works by statutory undertakers, highway improvements, etc).

10. Prepare cost estimates.
    Once the extent and duration of the works has been established, it will be possible for the utility companies to provide reasonably accurate estimates of the costs.

11. From programming work, identify apparatus that should be moved before the Concession contract is let.
    The programme will be tied into a notional programme of the main construction works, from which it will be possible to identify any specific items that will need to be undertaken before the Concessionaire will be in a position to procure and manage the works (assuming that this is the procurement method adopted). This implies a need to presume a knowledge of the Concessionaire's programme, and may lead to the need to impose an order of working on the Concessionaire.

12. Set up a working group of utilities, highway authority, police and the promoter to oversee the project.
    Most of the detailed work of identifying diversions will be carried out in one-to-one meetings with each of the utility companies. However, revision to the programme may be best carried out in a group, which will also need to meet to ensure that general requirements are identified and disseminated.

13. Place orders for diversion works to be carried out in advance, and make advance payments in accordance with regulations.
    Once the promoter has been granted the status of transport authority by the making of an order, he will have the benefit of the sharing of costs of works regulations. This means that the utility companies will contribute 7½% of the cost of diverting apparatus affected directly by the tramway construction, and 18% of the costs of diverting apparatus for associated highway works. To qualify for this contribution, the utility company must be given an advance payment of 75% of the estimated net cost of the works.

14. Plan temporary traffic management and associated temporary TROs.
    The work is likely to proceed most efficiently if roads can be closed while diversions are undertaken. In many cases this is unlikely to be acceptable to the highway authority, although partial closures and other modifications to traffic movements may be. Road closures and other alterations will need to be brought about using temporary Traffic Regulation Orders. The highway authority will prepare these through their powers under the Road Traffic Regulation Act 1984, unless the promoter has specifically taken powers for themselves for this purpose, through the Transport and Works Act order. In addition to the normal methods of advertising these orders, notice of the details of the orders should be provided to an appropriate list of those most likely to be affected by them.

15. Carry out any necessary changes to highway to carry out the works, or changes that are not essential at this stage but that would simplify the process.
    The first works carried out as part of the advance diversion project may well be modifications to highway layouts to facilitate movement of diverted traffic. This may include bringing forward works that are due to be carried out in the future that would assist the process.

16. Set up a public relations unit to inform the general public and businesses about the works.
    One of the most important components of the work is public relations. Good timely communication of the various stages of the work will generate goodwill that will help the tramway to be accepted and operate to its full potential. This includes talks to a wide variety of organisations about general plans, as well as more specific discussions on the long and short term effects on individual businesses. In particular, businesses will wish to know how servicing will be affected, particularly if the normal servicing routes to their business are interfered with. There should also be an enquiry point located centrally for the general public.

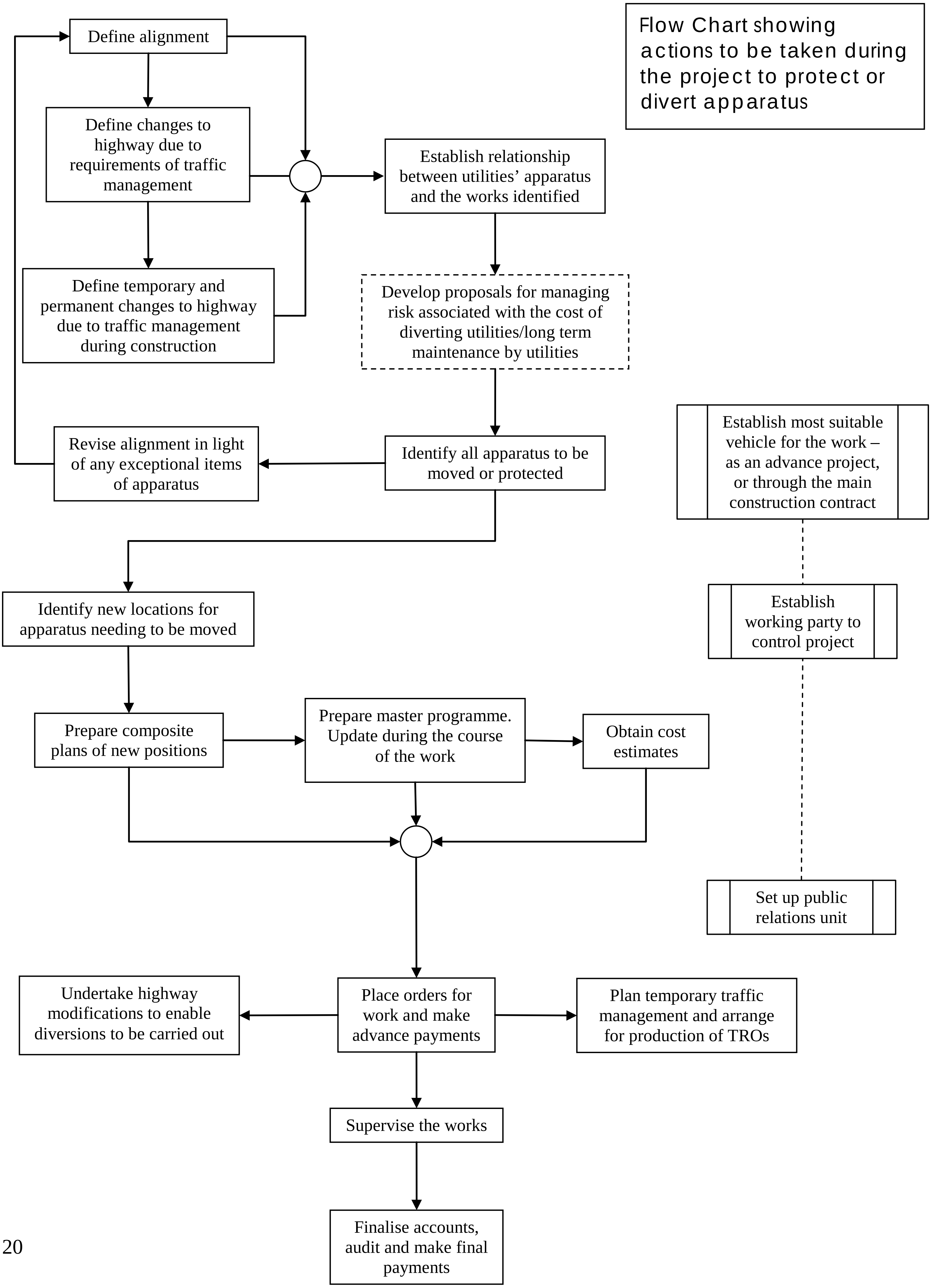
17. Supervise works to ensure that apparatus is located as planned. Revise plans to reflect necessary changes.
    Diversion of the apparatus will generally be the responsibility of the utility company concerned. They will in some instances allow other approved contractors to carry out certain works (e.g. installation of ducts for cables to be pulled into subsequently). However, the promoter will need to provide an overseer of the works to monitor progress and ensure that utilities do not alter agreed routes without justification and approval of the modification. Quality of works carried out will not generally be the concern of the promoter, except where it might affect the integrity of works carried out under the main contract.

18. Update programme during process of diversions to reflect actual progress.
    It is unlikely that the initial programme will be adhered to in all its details. The initial programme will be based on an estimate of the duration of many individual items, not all of which will be accomplished in the estimated time. Other incidents that might affect the programme include the discovery that the movement (particularly lowering) of apparatus is temporarily prevented by the presence of other apparatus in the same location. Events external to the project might also have an impact, whether pre-planned or arising during the currency of the programme.

19. Finalise accounts and make final payments.
    Advance payments will have been made, amounting to 75% of the net estimated cost (i.e. 69.4% of the gross estimated cost of diversions for tramway construction works, and 61.5% of gross estimated costs of diversions for associated highway works). The actual costs will have to be established once the work is finished, and the balance paid by (or to) the tramway promoter, or the Concessionaire if the works have been ordered and paid for by him.

    The tramway promoter, or the Concessionaire, will be entitled to audit the costs to establish that a fair charge has been made. Ideally, the basis for charging, particularly in respect of overheads and supervision charges, will have been agreed before work is ordered.

    The promoter will also be entitled to compensation if agreed programmes are not achieved and this has a cost implication. The converse is also true, in that the undertaker is entitled to compensation if the failure to meet the programme is the fault of the promoter.


Flow Chart showing actions to be taken during the project to protect or divert apparatus
Define alignment
Define changes to highway due to requirements of traffic management
Define temporary and permanent changes to highway due to traffic management during construction
Establish relationship between utilities' apparatus and the works identified
Develop proposals for managing risk associated with the cost of diverting utilities/long term maintenance by utilities
Identify all apparatus to be moved or protected
Revise alignment in light of any exceptional items of apparatus
Establish most suitable vehicle for the work – as an advance project, or through the main construction contract
Establish working party to control project
Set up public relations unit
Identify new locations for apparatus needing to be moved
Prepare composite plans of new positions
Prepare master programme. Update during the course of the work
Obtain cost estimates
Undertake highway modifications to enable diversions to be carried out
Place orders for work and make advance payments
Plan temporary traffic management and arrange for production of TROs
Supervise the works
Finalise accounts, audit and make final payments