UK Tram

Support to UKTram Activity Group 1
Protection and Diversion of Apparatus

Phase 2

Guideline 2: Mitigation of utility diversion requirements

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Preface

UKTram is an organisation that represents the promoters and operators of tramways and light railways in the United Kingdom. It is a limited company owned in equal parts by Transport for London, the Passenger Transport Executives Group, the Confederation of Passenger Transport and the Light Rapid Transit Forum. Its main purpose is to carry out research into a variety of aspects of light railway design, construction and operation. It publishes the results in the interests of improving understanding of the factors involved in the development of light railways and uniformly raising standards throughout the industry. It is supported in its activities by the Department for Transport.

Its purposes are achieved by the establishment of Activity Groups consisting of practitioners having considerable experience in the field of interest. Twelve such groups have been established, and the subjects they cover are listed in Appendix 1. The remit of Activity Group 1 is to review the various approaches that have been adopted by promoters and operators in the UK to the task of protecting and diverting utilities' apparatus.

This Guidance Document is the second in a series of three guidelines that have been developed by Activity Group 1 of UKTram. These are:

Guideline 1: Standard methodology for assessing utilities' works requirements

Guideline 2: Mitigation of Utility Diversion Requirements

Guideline 3: The Causes and Control of Cost Creep and Cost Escalation

Guideline 2 is intended to inform promoters, designers and where appropriate, Concessionaires, of best practice in the following aspects of preparing for the introduction of a tram system:

- Timing and use of topographical surveys
- Timing and use of non-invasive survey techniques
- Timing and use of trial holes and other invasive surveys
- The use of building fixings and shared masts
- The influence of trackform assumptions on diversion requirements
- Highway design measures

1. Introduction

From the beginning of a new project, the promoter is faced with a dilemma. In order to judge the viability of a scheme, it is necessary to know enough about it to assess its likely cost. But the very act of acquiring the information costs money, which the promoter would prefer not to spend on a scheme that may not be viable. A judgment will be needed as to how much time and money to commit to acquiring information at each stage of the project.

The first stage in any scheme is to clearly define its purpose, and assess the different ways of achieving this end. Where it is expected that a tramway will provide the best solution, it will need to be compared to realistic transport alternatives such as heavy rail, guided bus, quality bus corridors and trolley vehicle systems, as well as the do-nothing option.

To make a sensible comparison of the options under consideration, it will be necessary to make a realistic estimate of the lifetime costs of each of them. While it is relatively straightforward to apply a cost to the engineering aspects of the scheme, such as the costs of providing so many cubic metres of concrete, or so many kilometres of rail, at first the major unknown element will be the underground obstructions that will need to be cleared.

This Guideline considers two aspects of the investigation of underground utilities' apparatus in preparation for their diversion. The first requirement is to accurately identify what is present, and where it is. The second is to establish how the apparatus will be affected by the introduction of the tramway

2. Timing and use of topographical surveys

Schemes will need to be assessed on the basis of an alignment, or a range of possible alignments. Maps showing the topography along the potential routes will need to be prepared. Initially these are likely to be based on Ordnance Survey maps at an appropriate scale. The first questions to be answered will focus on, among other things; whether the routes being investigated will serve the intended number of passengers; the level of non-user benefits; and the amount and nature of land needing to be acquired compulsorily. The Ordnance Survey background will be quite adequate for these purposes.

A range of unit costs will be adopted in the assessment of the alternative schemes and routes. These will include assumptions about the cost of diverting apparatus affected by the schemes. At the end of this initial process it should be possible to choose a scheme to proceed with.

Once the preferred scheme has been identified, it will be necessary to prepare a business case. This will set out the stages followed in reaching the conclusion that this is the best choice. The expected costs of the scheme will be itemised, alongside the benefits expected to be obtained. For the costs to be realistic, it will be necessary to investigate the scheme in some detail.

Assuming a tramway has been found to represent the best value for money, the alignment will need to be developed so that it can be related to other features in or adjacent to the highway. Plans will need to be developed for the purposes of an application for an order under the Transport and Works Act 1992. Initial design work will be carried out to ensure that the introduction of the tramway does not prevent the use of highways by such other vehicles as need to be accommodated. More detailed cost estimates will need to be developed for inclusion in the outline business case and the order application.

As the design and cost estimates are refined, it will be necessary to obtain a more accurate picture of the character of the land over which the tramway will pass. This may include segregated areas on land acquired compulsorily, as well as highway. A detailed topographical survey of the proposed route would ideally be carried out at this stage. This might use traditional survey techniques, while aerial surveys are claimed to provide results with a standard deviation of 5 millimetres in measurements of level. The major drawback with aerial surveys in built up locations is the likelihood that important features will be obscured by obstructions such as trees and canopies.

Surveys should serve a number of purposes. They should accurately establish the position of building facades, kerblines, projections from the face of buildings, and street furniture such as signs, lighting, bus stops and shelters and so on. They also have a role in the identification of utilities' apparatus. There are many indications of the presence of apparatus visible at the road surface. Telephone and cable companies invariably run their cables through jointing chambers, while many of BT's trunk cables are connected in deep manholes. The lids of these, which provide a means of access to the cables, are apparent on the surface. Similarly, access to sewers is reached via manholes which break the road surface. Buried electricity cables are generally less apparent at surface level, though they are sometimes connected together in link boxes which are accessible from the surface. Low voltage cables are connected to many items of equipment in the highway, such as street lighting and street signs, though some of the cables will be privately owned. All cables are ultimately connected to substations, which may be contained in buildings alongside the highway, so recording these will help to indicate where concentrations of cables may be found.

Piped services, water and gas, provide fewer clues as to their position, but nevertheless they are present in the form of valves operated from the surface, and in the case of water, fire hydrants and washouts. Most valves are to one side of the main, as they provide a means for isolating supplies to individual properties. However, a proportion will be provided to allow a section of the main itself to be isolated in the event of a pipe bursting and having to be emptied for repair. The positions of the different types of valve will normally be indicated on the records of the water or gas authority.

Other surface boxes will be associated with the operation of traffic lights, and highway drainage will be indicated by the presence of gullies, or occasionally kerb drainage. There will also be above-ground equipment, such as communications and electrical cabinets, mobile phone antennae and telephone kiosks.

All these should be recorded, and identified where possible, as part of the survey. Then, as records of utilities' apparatus are obtained, their accuracy can be improved by relating the records to the observed physical indications of their positions on the ground. This, in conjunction with a detailed alignment design, will then improve the accuracy of predictions about the scope of the diversions needing to be carried out.

3. Timing and use of non-invasive survey techniques

It should be understood that there are limitations on the use that can be made of the information obtained from topographical surveys. The relatively limited detail that can be collected relating to gas and water pipes leaves a degree of uncertainty about their true position. Furthermore, the information collected represents only a snapshot, accurate at the specific location of the cover or valve, but providing no guidance about the possible meanderings of the apparatus between. Manholes appear to provide the clearest indication of the position of sewers or communications cables, but for practical reasons the apparatus served by them does not pass directly beneath the cover, as this would make the descent into the manhole difficult or dangerous. The route of pipes or cables passing through the manhole can be some way offset from the centre of the cover. Standard jointing chambers provide a better indication of the alignment of cables passing through them, as they are normally contained within the width of the cover.

It is important for the accuracy of information concerning apparatus to be gradually refined once the additional expense of doing so can be justified. The usual next stage in this process is the use of non-invasive survey techniques. It may be concluded that this is only justifiable once the order has been granted, and the outline business case has demonstrated that the scheme should proceed.

These techniques have been developed over the last 30 years or so, to the point where they provide a cost-effective means of “looking” beneath the surface along the route of the tramway. The results are reasonably accurate, both horizontally and vertically, while the output can be provided as plans and cross sections in a CAD or GIS format.

Two techniques are commonly used to map apparatus below ground. The first is known as electromagnetics, or radiodetection. This method uses a transmitter which generates electromagnetic pulses. A receiver is tuned to collect the earth’s response to the pulses, and works by distinguishing between the low-level response of the ground and the more prolonged response obtained from metallic apparatus buried in the ground. The signal can also be induced directly in the apparatus by clamping the transmitter to it, and reading the signal transmitted from it. The electromagnetic field created by electric and communications cables can also be detected and interpreted directly, although this will not provide information about the depth of the cables.

The second technique is known as GPR, standing for ground probing radar, alternatively called ground penetrating radar. In this system, a pulse of radio waves is generated from a transmitter. As they bounce back from changes in the character of the materials below ground, they are picked up by an antenna and interpreted by software. The results are drawn to reveal patterns that can be interpreted as indicating obstructions in the ground.

Electromagnetic methods can only be used to trace apparatus made of metal. It is possible to use a piece of apparatus known as a sonde in conjunction with such methods. This is a small transmitter mounted on rodding equipment, which can be pushed along a sewer or through empty ducts and detected at the surface.

Apparatus made from non-conducting materials, such as clayware, unreinforced concrete or plastic, must be traced using GPR. Electromagnetics and GPR will generally be used to complement each other, as electrical equipment will be more readily identified using electromagnetic techniques, but this may not provide information about its depth. Both methods are at their most accurate up to depths of about 3 metres below ground, although greater depths can be reached using GPR by altering the frequency of the signal and changing the antenna accordingly.

The accuracy of results from GPR methods is heavily dependent on the interpretational skills of the people using the equipment. Contractors carrying out this work will always begin with the records of apparatus provided by utility companies, obtained through C2 stage enquiries or otherwise, and adapt their methods to what they expect to find. This will not prevent the finding of unidentified apparatus, which may highlight the need to look further afield for records; for example street lighting cables, traffic light cables and highway drainage are all private services that might show up in the investigation.

The results of surveys of this type can be very useful in identifying the apparatus that will be affected by a proposed tramway. The survey need not be limited to the location of apparatus, and it can be equally useful for establishing the presence of cellars within the highway, or the nature of building foundations. It is as well to be aware however, that results cannot be guaranteed to be 100% reliable: it is important to make use of and combine all available sources of information, including historical records when they can be found. Surveys of this type are a very useful tool, when used sensibly.

4. Timing and use of trial holes and other invasive surveys

By the time tender documents start to be prepared, a good picture of the scope of diversions should be emerging. The majority of conflicts will be clearly identifiable, but even now, there will inevitably be some doubtful areas. In addition, it may be unclear where apparatus can be moved to. If greater certainty is required, the final step will be to excavate trial holes across or along the line of apparatus to establish the precise relationship between it and the proposed tramway alignment.

An investigation will normally be carried out to establish ground conditions along the route as an aid to structural design of the tramway. The excavation of trial holes, generally in the form of narrow slit trenches, can be combined in a single contract with sinking boreholes, and the results of both measures can be read together. The results of non-intrusive surveys can also be calibrated against the findings of the trial holes

Site investigation is relatively expensive, particularly by comparison with non-intrusive surveys. It will not normally be considered acceptable to undertake it until there is a high probability that the scheme will be funded and a contract for construction will be let. At the same time, it will form the final stage before orders can be placed for the diversion of apparatus, and sufficient time must be allowed for the surveys to be carried out, the results to be analysed, final estimates prepared and the diversion works programmed.

The timing of intrusive survey works, when they are carried out in a major conurbation, may be influenced by external events and developments. For example, the ability to survey in some areas may be affected by intrusion onto the highway of hoardings around development sites. Events such as cycle races, Lord Mayor's Parade, Remembrance Sunday and protest marches may have a brief impact, but more significantly, work in certain streets may be banned during the build up to Christmas. Some of the streets affected may be designated as traffic sensitive, which may influence the timing of any works likely to be disruptive to traffic.

5. The use of building fixings and shared masts

While the presence of the track slab will have the greatest impact on the scope of diversion works, utilities' apparatus may also be in conflict with other items of tramway infrastructure. The most obvious of these are the masts used to support the electrified overhead line.

Overhead current supply line is supported above the track by a network of insulated cables that serve the dual purpose of lifting it to the desired height above the highway, and registering it, or pulling it into the correct position in relation to the track centreline. There is a legal obligation[1] to maintain uninsulated current-carrying wires at a height of no less than 5.8 metres above a carriageway, or 5.2 metres above a footway, unless a special dispensation is given by the Secretary of State. This means that the loading on the fixing of the support

[1] Regulation 17 and Sch. 2 to the Electricity Safety, Quality and Continuity Regulations 2002, SI 2002/2665

wires acts at a height of around 6.5 metres above road level on a normally trafficked highway.

The overhead wire should ideally be supported from buildings wherever this is possible. The nature of the buildings alongside the highway may make this impossible in some areas, because for example the building is too low, or due to the presence of windows or a canopy at the height where fixings should be made, or the poor structural condition of the façade of the building. In addition the building owner may successfully object to the presence of a fixing, or may be intending to carry out extensive maintenance or demolish the building to redevelop. Whatever the reason, the alternative to fixing to a building is to erect a mast and support or register the wire from it.

A support mast is a cantilever with its fixed end at around ground level. The load applied to the mast may vary considerably, and will depend mainly on the tension applied to the contact wire, and the curvature of the track. The overturning moment applied to the mast through the supporting cables will be resisted by the mast foundation constructed below the ground.

The foundation normally takes one of two forms – either a pile having a diameter in the range of 0.75 to 1 metre with a central hole to contain the mast, or a gravity base or pile to the top of which the mast is bolted. The former is normally preferred as it is less expensive to create: however, the gravity base provides a useful alternative when it is necessary to avoid utilities' apparatus.

The piled base resists overturning by mobilising the passive pressure of the ground on the faces of the pile. For this to happen, the ground should be undisturbed, which will generally mean that the top metre or so beneath the highway surface will need to be disregarded as a supporting material. Clearly an augured or driven pile cannot pass directly through utilities' apparatus without destroying it, so any apparatus within the footprint of the pile will need to be diverted under normal circumstances. In addition, the presence of apparatus indicates ground that has been disturbed, and will not generally provide the necessary passive resistance to overturning of the mast. The length of mast above the base of the excavation in which the apparatus sits will need to be disregarded for the purposes of supporting the mast, and the pile will need to be lengthened to compensate.

The position of the mast in relation to the highway will be constrained by a number of factors, including the highway authority's policy on the positioning of obstructions in the highway, the availability of land off the highway, and the spacing of masts along the highway. This latter will in turn be determined by, amongst other things, the tension in the current supply wire, the horizontal radius of curvature of the alignment, and the track gradient and vertical curvature.

Masts in the highway serve a variety of purposes, including support for road signs, traffic signals and street lighting. As many as possible of these purposes should be served by each mast to avoid cluttering the highway with unnecessary obstructions. Masts have been used successfully for the joint purposes of supporting overhead line, traffic signals and street lights on the Eccles line of Manchester Metrolink. Special arrangements are needed to ensure that each of the bodies responsible for maintenance of the various items of equipment attached to the mast can safely gain access to the items for which they are responsible, without coming into contact with the electrical circuits controlling the other apparatus. Attention is also required in the design to ensure electrical safety when more than one earthing system is applied.

Building fixings will only rarely be in conflict with utilities’ apparatus. Service feeds are sometimes fixed to the face of a building, and these will normally be electricity or telephone cables. Either the service or the overhead line support can simply be moved to another location. Electricity or telephone cables that cross the road between buildings are likely to be in conflict with the live current supply cable, and should be moved below ground.

Account will need to be taken of conflicts with utilities’ apparatus when deciding on the placing of overhead line support masts. It will normally be cheaper to adjust the overhead line design in some way than to divert the apparatus, so diversion of utilities to accommodate mast foundations should be considered to be a last resort. Firstly, the possibility of fastening to a building should be considered, if necessary by adjusting the fixing point along the building frontage. If a mast must be used, there will normally be some positional flexibility both parallel to and along the tracks. If the foundation is in the form of a pile, it may be possible to extend the pile downwards to avoid reliance on made ground to resist the overturning moment imposed by the support or registration wire. If the pile cannot be adjusted sufficiently to make it work and avoid apparatus, the use of a gravity base should be considered. This can be cast below shallow apparatus, which is supported across the excavation during the casting process. The mast can be placed on the base with a high degree of eccentricity, giving additional flexibility in design. Swan neck masts can be used, as in Nottingham, in which the visible part of the mast is offset from the fixing point. This may provide additional and sufficient clearance to apparatus, whether used with piles or gravity bases. Finally, in the case of gravity bases, it may be acceptable to some utility companies for ducted services to be cast through the base. Small pipes can also be cast into oversize sleeves, allowing them to be slid out for replacement if necessary.

6. The influence of trackform assumptions on diversion requirements

The form taken by the track and its support structure has relatively little influence on the scope of the diversion works, which will mainly be dictated by the diversion policies of the tramway promoter and the utility companies. These will need to address, in particular:

- The importance of potentially affected apparatus, the length of delay that could be tolerated in repairing it, and whether repair work could be delayed until trams ceased to operate for the day;
- The promoter’s attitude to disruption of tram services at different points in a tramway network;
- The acceptability of demolishing and rebuilding parts of the tramway infrastructure, and what effect this would have on its long-term durability;
- The consequences of the application of, and the possibility of overriding, section 82 of NRSWA, dealing with the payment of compensation by a utility company to a transport authority in the event that street works or failure of apparatus caused damage and disruption to the transport undertaking;
- How close apparatus can be to the operational tramway before work on it becomes impractical while the trams are running normally, and what modifications to operating patterns might be possible to mitigate this.

Diversion of utilities' apparatus takes place because it is affected by the construction of the tramway. S.105(4) of NRSWA states "*For the purposes of this Part apparatus shall be regarded as affected by works if the effect of the works is to prevent or restrict access to the apparatus (for example, by laying other apparatus above or adjacent to it).*"

Apparatus is clearly affected if the process of constructing the tramway leads to its destruction, or the destruction of an essential part of it. The tramway infrastructure will include a number of ducts running alongside the tracks to carry power and communication cables, together with drawpits for initial jointing and subsequent maintenance of the cables. The underside of the track slab will normally be in the region of 450 to 500 millimetres below the highway surface, whereas apparatus in the carriageway should normally be at a depth of 600 millimetres or more. Apparatus in the footway is often at shallower depths, and therefore more likely to be directly affected by the construction process. If the track crosses from the carriageway onto the footway, the footway level will be reduced by around 125 to 150 millimetres, thereby reducing the cover still further.

The effect of the construction process can extend downwards beyond the base of the excavation, due to loadings imposed on the formation level by construction plant. It is therefore normal to consider that apparatus less than 800 millimetres below the surface should be lowered. Apparatus below this level should not be directly affected by the construction process, but it is recommended to place any new apparatus crossing the tracks at a depth of around 1200 millimetres.

Access to apparatus directly below the track slab, at any depth, will be prevented unless the track slab is undermined by excavation, or demolished while repair or maintenance work is carried out, and reconstructed afterwards. This will not normally be acceptable to either the utility company or the tramway operator, as for the utility the access for urgent or emergency works could be delayed for some time, and for the tramway operator tram services could be prevented for a considerable, and unpredictable, length of time.

The structure used to support the rails, whether it be track slab or some other means, needs to satisfactorily fulfil a number of purposes, the sum of which will dictate the design. Firstly it must safely transmit the load imposed by the trams to the ground beneath without causing unacceptable settlement. It must provide a stable base to which the rails can be secured in a predetermined location and at a predetermined distance apart. Where appropriate, it must provide a secure foundation for a carriageway surface, and support for all vehicles permitted to use it. In some areas, where settlement of the ground is anticipated, the structure may need to be designed to span a certain distance unsupported.

The structure will need to be rigid enough to maintain the connection between the rails and the adjacent carriageway surface, to avoid ingress of water which will eventually soften the ground and damage the highway surfacing. At the same time, some flexibility will need to be introduced between the rails and the structure to dampen noise and vibration. Where stray current is expected to be an issue, concrete reinforcement may be used as a conductor to help prevent the current reaching susceptible utilities' apparatus beneath it.

7. Highway design measures

Introducing a tramway into an existing highway will normally require some modification to the highway. A number of factors may lead to this, and these are described here in some detail. One of the consequences of highway modifications may be the need to divert utilities' apparatus.

A normal highway incorporating a carriageway is open to all traffic, subject to the Construction and Use Regulations. Vehicles over a certain width or axle weight may be constrained to use certain roads. The use of a highway may be further restricted by the introduction of a Traffic Regulation Order. This may impose a wide range of limitations, such as only allowing vehicles to travel in a particular direction (a "one-way" street), preventing traffic of any, or of particular kinds, to pass beyond a certain point, directing traffic to turn a particular way or proceed straight ahead at a junction, preventing parking or loading in all or part of the street, providing for loading or parking by specific classes of traffic or at specific times, and so on.

The use of bus lanes is increasingly common, whereby a traffic lane is dedicated to the use of buses, and possibly taxis and other public service vehicles, either at all times or at certain times of the day. When a tramway is introduced into a street, the traffic authority may similarly reserve the section of highway covered by the tram as a tram-only lane, while other parts of the route may be shared with other permitted traffic. As a complementary measure, additional bus lanes and quality bus corridors may be introduced to integrate bus and tram services. If this results in widening of carriageways, diversion of apparatus may be required.

In a town or city centre, the widths of highways are generally fixed by the presence of long-established buildings, offering little opportunity to widen the road. The use of the highway needs to be apportioned between the trams and other traffic in the most appropriate way, which will often see the tramway shared with the other traffic allowed to use the road. As the tramway moves out of the most built up areas, there may be more scope to alter the way in which the highway is apportioned to make best use of the available space.

Trams will operate most efficiently if they are able to run in a section of highway dedicated to them. This could be along the inside lane ("gutter-running") or in a central reserve ("centre-running"). This separation can only be achieved by reducing the amount of space available to traffic other than trams, widening the carriageway, or making use of an existing reserved area, subject to the acceptability of removing any trees affected by the project. By contrast, if a road is closed to all vehicular traffic other than trams, it may be possible to make the carriageway narrower and provide more room for pedestrians, since the width of the tramway vehicles using it will be controlled, and their positions fixed in relation to other highway features.

Introduction of trams will frequently have an impact on parking and servicing arrangements in a street. If the footways are wide enough, they may be reduced in width locally to form lay-bys for bus stops, taxi stands, disabled or residents' parking. It is obviously essential for the space provided to be wide enough to allow them to be used without preventing trams from passing. It may also be necessary to provide lay-bys for vehicles belonging to utility companies used in the course of maintaining their apparatus, or for emergency, refuse and other service vehicles.

If the introduction of a tramway has a marked impact on the capacity of a highway to carry other traffic, the highway authority may introduce other measures designed to reduce the amount of traffic desiring or needing to use the affected highway. This may take the form of measures to encourage the use of alternative routes, combined with measures to discourage the use of the affected highway. The former will generally be junction improvements and carriageway widening some distance from the tramway, while the latter may involve narrowing the carriageway and the implementation of a one-way system that may take some time to negotiate. The overall effect of these changes will have an impact on the scheme's business case, so it is important to minimise adverse effects.

On the tramway itself, there is the option to introduce or modify Traffic Regulation Orders within the limits of deviation or on roads adjacent to or directly affected by it. TROs may make streets one way in either direction, introduce or lift parking and loading restrictions, prevent vehicles other than specified types from using a road, and so on. Driving may be prohibited across a junction between the road containing the trams and a side street. TROs will normally be specified in the Transport and Works Act order authorising the construction and operation of the tramway. Streets may also be stopped up, either permanently or temporarily, with or without a substitute being provided. Powers may be granted to alter the alignment of a highway. It will also often be necessary to vary the level of the carriageway, particularly at intersections. This follows from the difference between the construction of trams and normal highway vehicles, the former requiring a larger radius of vertical curvature. It is also necessary to eliminate negative superelevation, or cant, wherever possible.

The introduction of stops, masts and other tramway infrastructure will have an impact on traffic management. Stops may have one or two platforms, placed between or either side of the tracks. They may be in the centre of the highway, or to the edges. In some locations, trams share carriageway space with other traffic except at the stops, where the tracks swing off the carriageway onto reserved track. The location of masts may be constrained by local authority policy designed to maintain a clutter-free space for the movement of pedestrians, and particularly the disabled. This may influence the width given to footways in an area used by a large number of pedestrians. At the same time, there must be a clearance, normally 450 millimetres, between fixed obstructions and the edge of a carriageway. This means that masts supporting street signs or traffic signals will need to be placed some distance further into the footway, particularly if it is supporting a green filter signal head. Masts placed between the tramway, whether to support the overhead line, street lights or signals, will require the tracks to be placed further apart. It is clear therefore that the detailed design of the traffic management measures will have a major impact on the apportionment of highway space. Although these are fairly detailed issues, it is essential that they are considered in the early stages of preliminary design so that junction layouts will remain feasible as the designs are developed.

The ideal location for a tramway in a town or city centre is in a pedestrianised street. Operation of the tramway cannot be affected by the presence of other traffic, and there is no serious consideration of apportionment of space. It is normal to raise the top of rail level to around the same as the footway. However there should still be a small level difference, possibly no more than 25 millimetres, to provide an indication to blind or partially sighted people that they have reached the edge of the tramway.

Occasionally the tramway will cross from the carriageway onto the footway. This has two significant implications: firstly, the footway level will need to be reduced to the same level as the carriageway at the point of entry onto the footway; secondly, the cover to apparatus in the footway is generally less than in the carriageway, and it will be further reduced when the footway is lowered.

If a tramway is designed as gutter-running, the developed kinematic envelope may be as little as 300 millimetres from the kerb (or the top of the kerb if it is battered). If appropriate, a cycle lane may be introduced between the kerb and the tram; this will require a distance between the kerb and the tram dke in the region of 1450mm.[2] Otherwise, a minimum distance of 1 metre should be left between the kerb and the nearest tram rail where cyclists may be expected but there is insufficient space for a full cycle lane.[3] This will allow the cyclist to avoid coming in contact with the rails, where they might slip or become trapped in the rail groove. However, the cyclist in this position would interfere with tram operations by slowing the tram to cycling speed. Where there is no dedicated cycle lane, obstruction to cycles should be avoided. Gullies will generally not be used when gutter-running is employed, as the drainage of the highway will normally be accomplished by incorporating a drainage channel into the kerb.

In addition to permanent modifications of the highway, it may be necessary to carry out temporary modifications to allow diversion of utilities' apparatus, or the main construction works to be undertaken. In general, it is preferable for the permanent traffic management measures consequent on the presence of the tramway to be in place before the construction of the tramway begins. Sometimes this is not possible, but even when it is, there may be a need to introduce temporary junction modifications and other changes. It should readily be appreciated that work to divert apparatus takes place in a different part of the highway from the construction of the tramway, and some works may be carried out in streets other than those containing the tramway. Works of this kind may also give rise to the need for diversions to be carried out.

Promoters need to monitor developments along or near the route that may have an impact on the scope of diversions. Developments may be precipitated by the prospect of the introduction of the tramway, or may have been planned for some time. They may include works that are directly related to the tramway, such as construction of a new bus station to replace facilities displaced by the tramway. If a new vehicular access is needed to the development, there will inevitably be modifications to the highway leading to diversion or protection of apparatus. These works should not be allowed to increase the burden of diversions on the tramway, or become confused with the works carried out for the tramway.

There are many considerations in designing the permanent traffic management arrangements associated with a tramway, but its impact on utilities' apparatus will generally fall into one of four categories.

- A significant change of cover, whether an increase or a decrease, may result in the affected apparatus having to be raised or lowered. Further guidance on changes to cover is contained in the HAUC Code of Practice *Measures Necessary Where Apparatus is Affected by Major Works (Diversionary Works)*. It should be borne in mind that changes to level may sometimes simply return the highway to its original condition. As an example, roundabouts are frequently constructions added on top of an original carriageway. Removing them and replacing them with a crossroads would be unlikely to subject older apparatus (e.g. sewers, gas and water mains) to loadings to which they have not been subjected in the past. In a similar way, the removal of projections in the highway

[2] Railway Safety Publication 2, Guidance on Tramways, Office of Rail Regulation, para. 78
[3] Ibid. para.76

associated with guiding traffic in a one-way system will normally return the highway to an earlier configuration.

- Manholes and chambers in a footway are generally not designed to be run over at speed by heavy traffic (although there must normally be a presumption that traffic may park on them or run over them at low speed on occasions). If the kerbline is set back to accommodate a tramway, it may be necessary to rebuild structures thereby exposed to carriageway loadings. This will not inevitably involve the diversion of the apparatus passing through them.

- Repositioning a kerb may cause it to intersect a manhole, chamber or other apparatus that breaks the highway surface. This will consequently have to be moved, with the result that the apparatus associated with it may also need to be diverted.

- Setting back a kerbline, particularly if it is to make way for an additional traffic lane, will alter the relationship of apparatus to the carriageway. A manhole that was formerly in the inside lane, and reasonably accessible, may now find itself in the outside lane of the carriageway. Access will consequently have worsened. Whether this is significant enough to call for a diversion of the apparatus will need to be considered in each individual case.

It is probable that widening of a highway to introduce a tramway, or changing its alignment, can only be achieved by compulsory acquisition or appropriation of land. Acquisition of land will also be necessary if a tramway is to follow a completely new route away from any existing highway. If this is the case, and utilities' apparatus not in the highway is affected, diversions will be carried out in accordance with Part XI of the Town and Country Planning Act 1990, not the New Roads and Street Works Act 1991.

Payment by the tramway promoter for the diversion of apparatus in the highway will be for the total costs of the work, less allowances for betterment, deferment of renewal, and a contribution by the utility company. Where the diversion is required simply because of the introduction of the tramway, the contribution will be 7½% of the allowable costs. Where the diversion results from modifications to the highway layout however, the contribution will be 18%. Diversions carried out off-highway will be valued in accordance with the Town and Country Planning Act 1990, or the specific terms of the enabling order, where these are different.

APPENDIX 1

UKTram Activity Groups

Activity 1 – Protection and Diversion of Apparatus

Activity 2 – Tram Design Standards and DDA/RVA Issues

Activity 3 – Signing and Highway Interface

Activity 4 – Noise and Vibration

Activity 5 – Network Rail Interface

Activity 6 – Trackform Design

Activity 7 – Benefits included in the Appraisal Process

Activity 8 – Commercial Structure

Activity 9 – Operational Performance Measures

Activity 10 – Tender Documentation

Activity 11 – Wheel/Rail Interface

Activity 12 – Traction Power Supplies