appendices

1. Research and study method

These design guidelines are derived from the results of the following studies and exercises:

Case studies

Over 40 locations across England and Wales were selected in order to examine positive and negative environmental aspects evident in the relationship between pylons and overhead lines and the built form and landscape. The case study locations, identified by National Grid and the consultants, cover a wide geographical spread and include a variety of land uses in urban and urban edge settings.

Each site was visited and information on the characteristics, strengths, weaknesses and opportunities recorded. A photographic record was made and sketches were also prepared. A sample of the case studies can be found in the following pages.

Interviews

Interviews were undertaken with senior development industry figures, particularly housing developers, to understand views, attitudes and general levels of awareness of the issues which the design guidelines seek to address.

Questionnaires

Questionnaires were designed and dispatched to the marketing departments of 20 house builders. The purpose was to identify attitudes and experiences of marketing and selling homes near overhead power lines including any anecdotal evidence on the views of potential purchasers to the presence of overhead power lines.

National Grid Workshops

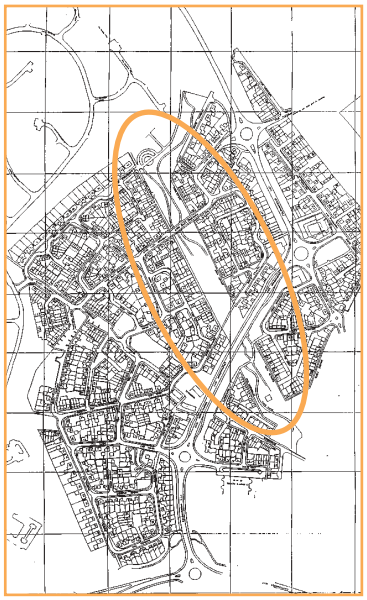
A workshop was held with representatives from a range of disciplines within National Grid to better understand the company's operational requirements.

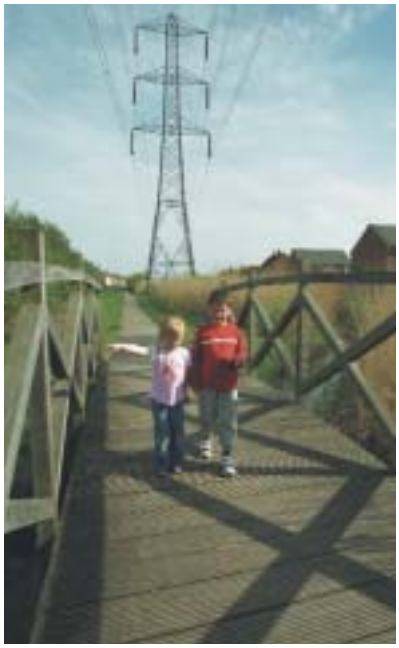
Industry Liaison

The draft design guidelines were taken to key stakeholder groups through a range of media:

- A web site including a feedback form
- Leaflets distributed at professional seminars and other events
- Presentations to key organisations within the planning and development sector
- Exhibitions at targeted events including at the 2002 Urban Summit in Birmingham.

The feedback received has formed an important input into the final Sense of Place design guidelines.





Survey Data

Technical:

Voltage 400kV and 275kV (Two circuits, different voltages)

Land Use:

Fairford Leys is a new residential development situated on the edge of Aylesbury between the A418 and the A41. This is a medium density development based upon a deformed grid layout. The development has a suburban character and is rapidly becoming well established despite some areas still being under construction. The transmission route is accommodated in a number of ways including as part of a riverine corridor running through the development.

Environment:

The landscape of the corridor is based around an area of surface water attenuation and much of the area is taken up with a stream, reed beds and vegetation. The remaining open space is roughly mown grass but, aside from the pathways, is otherwise unstructured. The area is well used by the local residents, especially dog walkers, and has an established wildlife population.

Spatial:

Regarding visual impact, the transmission route is prominent but sits well within an environment that has been specifically designed to accommodate it. The natural vegetation around the stream acts as a screen to the base of the pylons. Road bridges that cross the space create a series of separate landscape cells. The built form consists of terraces with a continuous building line, usually facing into and relating to the open space.

Circulation & Accessibility:

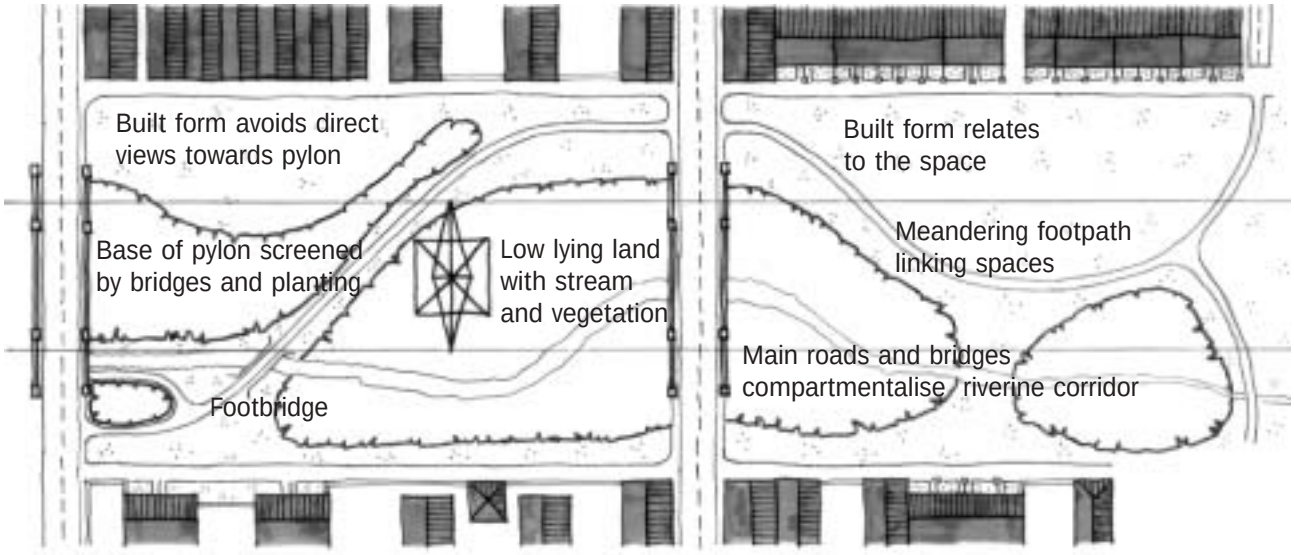
The various forms of circulation define the character of the corridor. The space is compartmentalised by the low road bridges running across the area. There are wide footpaths in front of the houses on both sides of the corridor and other footpaths meander through the space with timber footbridges crossing the stream. The residential cul-de-sacs perpendicular to the transmission route open up views into the area. There are good pedestrian links weaving throughout the built form. There is also street lighting to the residential footpaths on either side of the corridor.

Location: Fairford Leys, Aylesbury

Category: Residential

Local Authority: Aylesbury Vale District Council

Line Name & No: East Claydon-Amersham, ZL382-ZL384



Analysis

Strengths & Weaknesses:

On the whole, this is a well-designed and positive response. The pylons are dominant but are carefully considered and the built form relates well to the open space. There are also residential areas and walled off parking courts which turn their backs to the corridor. Despite the advantages of maintaining a continuous building line, the linearity of the terraces can be monotonous and emphasise the strong linear nature of the overhead power lines. Meandering footpaths provide a counter balance to this so that users are often looking away from the pylons.

Opportunities:

Although this is already a good scheme there are opportunities to create more formal public recreational facilities within the open space. Also, instead of enclosed parking courts, an element of residential parking could be accommodated within the edge of the corridor.

DAVID LOCK ASSOCIATES
TOWN PLANNING AND URBAN DESIGN

Survey Data

Technical:

Voltage 400kV

Land Use:

This is a new residential development on the edge of Didcot, adjoining the A4130, and is a typical suburban low to medium density development based upon a cul-de-sac layout. The transmission route has been accommodated within a linear park running through the development; both the development and the linear park are clearly visible from the main road.

Environment:

The open space flows from the A4130 into the site. The vegetation is well established, with a low-lying area that may possibly include surface water attenuation or an emergency flood area. The surrounding residential areas are screened by large swathes of planting.

Spatial:

The overhead power lines are prominent but sit well within an environment that has been specifically designed around them. The pylon structures are not hidden; instead the vegetation screens the built form rather than the bases of the pylons. The surrounding houses are orientated away from the open space and screened with both fences and planting.

Circulation & Accessibility:

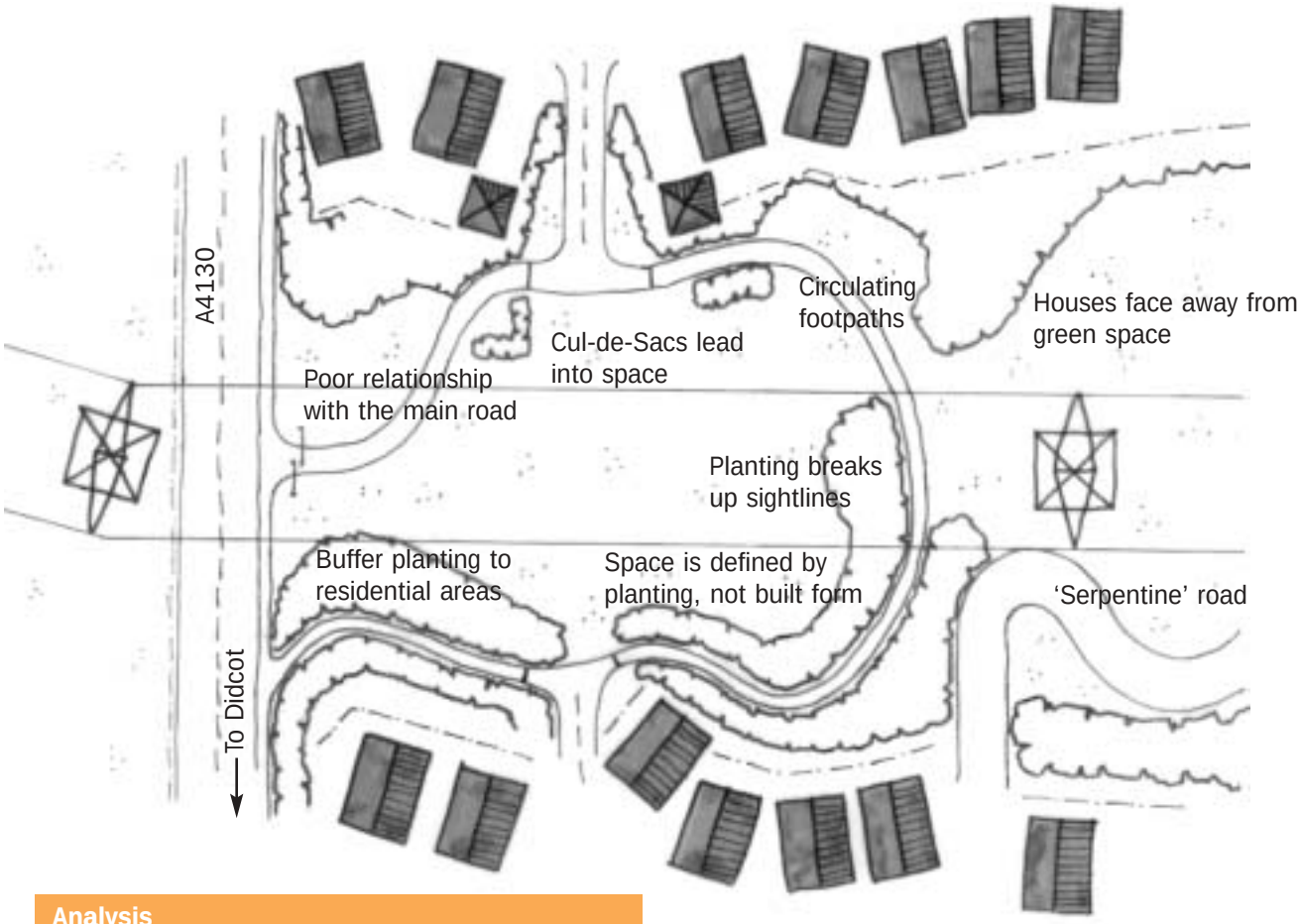
The cul-de-sacs lead into the linear park area rather than simply terminating at the edge, with footpaths meandering around the perimeter of the park. However, the layout of these pathways appears to be a convoluted circumnavigation around the space rather than linking specific nodes. There is also a serpentine road along part of the park edge.

Location: Didcot (off A4130)

Category: Residential

Local Authority: South Oxfordshire

Line Name & No: Didcot-Moulsford Down, 4YG009



Analysis

Strengths & Weaknesses:

On the whole this is a pleasing and successfully planned open space. However large areas of planting segregate the built form from the open space and reduce opportunities for natural surveillance and activity within the space. Furthermore, some of the pedestrian links are rather weak. The transmission route although prominent, sits well within this large scale space and pylons are partially screened at the base by planting.

Opportunities:

Both the residential area and the park function well but in isolation to each other. Much more could have been made of the interaction between the two areas. In general, there are opportunities for both the development of more formal public recreational facilities and also resident or visitor parking to the edge of the open space.

The pylons could be further screened with foreground planting in order to break down the linear sightlines within the space.

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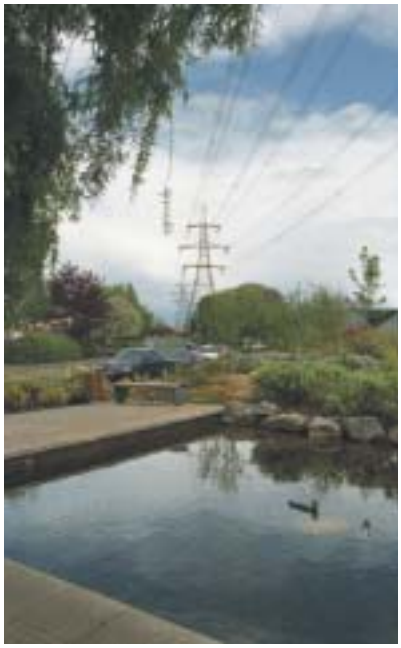


Survey Data

Technical:

Voltage 275kV

Land Use:

The site is located adjacent to the M6 in a predominantly industrial area with the M6 flyover to the south and the transmission corridor to the north. The site comprises large scale distribution warehouses, although there are some smaller business units. A small line of terrace houses remains on the site along Standard Way. These look onto the site and over the transmission route.

Environment:

Mature vegetation exists around the base of the pylons, occurring mainly adjacent the motorway. Travelling north, the transmission route forms a green corridor alongside Standard Way. A pond is located within the area beneath one of the pylons.

Spatial:

The transmission route initially follows the M6, where the impact is mitigated by the scale of the other elements of infrastructure. When the transmission route moves away from the motorway the pylons become more prominent but are successfully incorporated into the environment as a result of substantial screening and landscaping.

The green corridor along Standard Way with industrial units set back from the road creates a pleasant environment with units and residential buildings fronting the space.

There is a high proportion of screening which is relatively mature. One pylon on the route is hidden by a small hill and another pylon is located on private land, in an area used for storage.

Circulation & Accessibility:

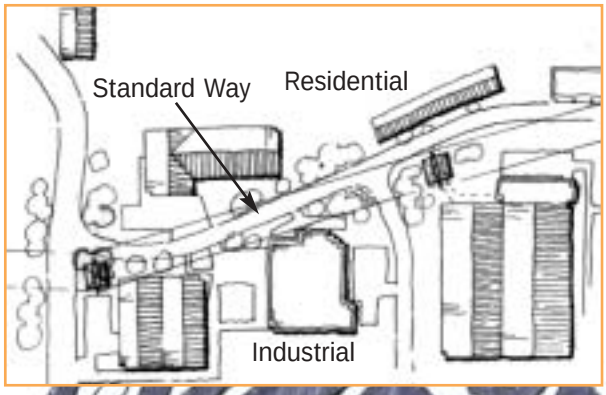
In Gravelly Industrial Park there is good vehicular and pedestrian access to and alongside the transmission route. In other areas the pylons are either on private land, traffic islands or on an island between the motorway and the canal. Here the transmission route cannot be followed by pedestrians as it steps away from the motorway.

Location: Gravelly Industrial Park

Category: Industrial

Local Authority: Birmingham City Council

Line Name & No: Hams Hall-Nechells, 4VU029-4VU035



Analysis

Strengths & Weaknesses:

The pylons, where possible, have been addressed with good landscaping and utilise building frontages to form a positive space. Near the motorway other pieces of large-scale infrastructure help lessen the impact.

The industrial site relates positively in terms of scale to the pylons. The taller street lighting columns also relate well to the vertical impact of the pylons.

Opportunities:

There is an opportunity to further enhance and continue the efforts made along Standard Way to integrate the transmission route.

The site illustrates that a well landscaped environment with a degree of thought regarding the layout and form reduces the visual impact of the overhead power lines. The scale of the buildings and roads within an industrial area also relate better to the scale of the pylons.

DAVID LOCK ASSOCIATES
TOWN PLANNING AND URBAN DESIGN

Survey Data

Technical:

Voltage 275kV

Land Use:

The site is located to the south of Quinton near Lapal in the West Midlands. It is adjacent to the M5 with the A456 running through the northern part of the site.

North of the A456 the site is grazing land and accommodates a pylon.

South of the A456 and east of the M5 is a residential development of detached properties sheltered from the M5 by mature trees creating a leafy suburb. The houses date from the1980s.

Environment:

North of the A456 the site is characterised by cattle grazed pasture.

The southern area of the site is a housing estate surrounded by mature trees which provide a wildlife habitat as well as sheltering the houses from the noise of the motorway.

Spatial:

There is a contrast between the north and the south of the site. The pylons have a significant visual impact in both areas but the impact in the housing estate is more marked as pylons appear more intrusive in a residential environment.

In the housing estate, the transmission route has essentially been ignored by the developers with dwellings directly underneath cables. Pylon YJ021 is placed in private property behind the building line in two privately owned gardens.

Circulation & Accessibility:

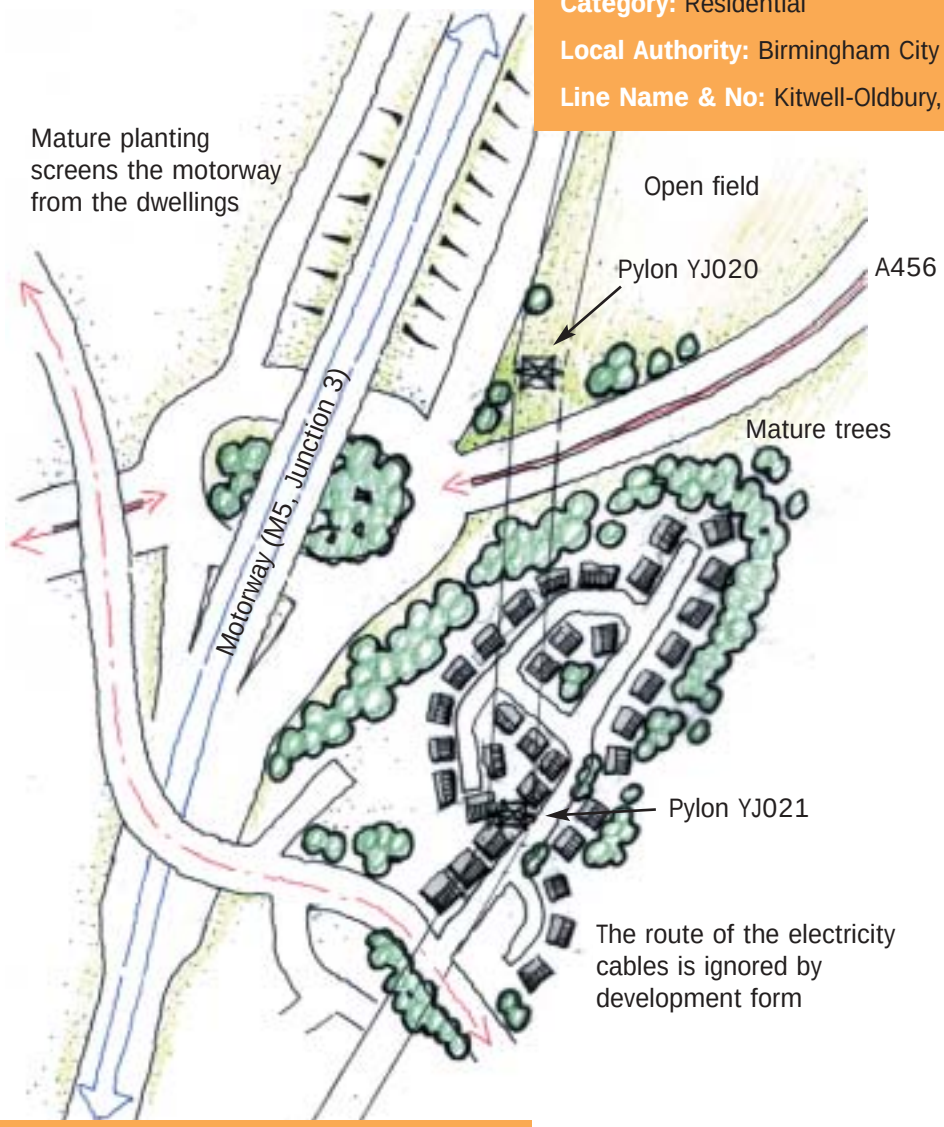
Both pylons are on private land and there is no defined route between them. The access road for the site is to the south, with the development form based upon a series of cul-de-sacs.

Location: Nr Lapal, Halesowen, West Midlands

Category: Residential

Local Authority: Birmingham City Council

Line Name & No: Kitwell-Oldbury, YJ020-YJ021



Analysis

Strengths & Weaknesses:

Whilst still prominent, the visual impact of the northern pylon is lessened by large scale infrastructure elements in close proximity.

Despite the fact that the pylons relate well to the surrounding mature trees, the lasting image of the estate is of housing closely abutting and beneath high voltage overhead lines.

Opportunities:

Due to the layout of the development, which essentially ignores the transmission route, little can be done to improve the residential site to the south. To the north some planting around the base of the pylon would screen it at eye level. Combined with improved landscaping, this would improve the visitor's first impressions of Lapal.

DAVID LOCK ASSOCIATES
TOWN PLANNING AND URBAN DESIGN

Survey Data

Technical:

Voltage 275kV

Land Use:

The transmission route follows an undeveloped land corridor adjacent to a housing development on the outskirts of Bedworth at Bedworth Heath. It forms a concrete corridor from the countryside into the suburban housing estate. The corridor serves as an incidental space and is used by children as informal play space. The housing types of the surrounding areas include semi-detached and terraced developments with some social housing.

Environment:

The transmission route is predominantly concrete hardstanding. However, significant areas of wild vegetation are beginning to become established. The area beneath the high voltage overhead lines is almost an accidental space; no attempt has been made to incorporate it into the existing built form and it serves no obvious function. There are a number of concrete floor slabs in this area, although the history behind these features is not known. One pylon also terminates a view along a street, highlighting its prominence.

Spatial:

The predominance of concrete and the visual dominance of the pylons serve as the key negative features of this estate. The development form ignores the space completely, buildings look away from the space and roads on either side of the corridor do not join, although cars frequently cross the hardstanding areas.

Circulation & Accessibility:

Cars are able to cross the space in certain areas despite there being no road within the corridor. Bollards have been put in place to stop cars travelling down the corridor. Circulation is predominantly pedestrian.

Location: Nr Bedworth, Warwickshire

Category: Residential

Local Authority: Nuneaton and Bedworth District Council

Line Name & No: Hams Hall-Coventry, 4ZWW049-4ZWW050

Analysis

Strengths & Weaknesses:

The land beneath the overhead power lines is a very poor environment, with no obvious function resulting in an oppressive dumping ground with no natural surveillance. The urban form does address the power lines but in such a manner that they are greatly emphasised, as opposed to their effect being minimised.

Opportunities:

There is an opportunity to create a usable and attractive open space, which could be either in the form of a green corridor extending into the estate or a more formalised children's play area.

DAVID LOCK ASSOCIATES
TOWN PLANNING AND URBAN DESIGN

Survey Data

Technical:

Voltage 400kv and 275kv (Two circuits, different voltages)

Land Use:

This is a low density post-war housing development based upon a grid layout. The development is located in a rural area on the outskirts of Greater Manchester. The houses are mainly terraces or semi-detached and the area is exhibiting some signs of neglect.

Environment:

The pylons in this area are located in corner/roadside sites, garage courts or back gardens. There has been very little effort to integrate these structures into their environment. The example shown is sited on a small plot to one side of a crossroads behind a bus stop.

Spatial:

The terraced nature of the built form and the long sightlines in all directions make this pylon very prominent and invasive. Also, no effort has been made to screen the pylon at ground level.

Circulation & Accessibility:

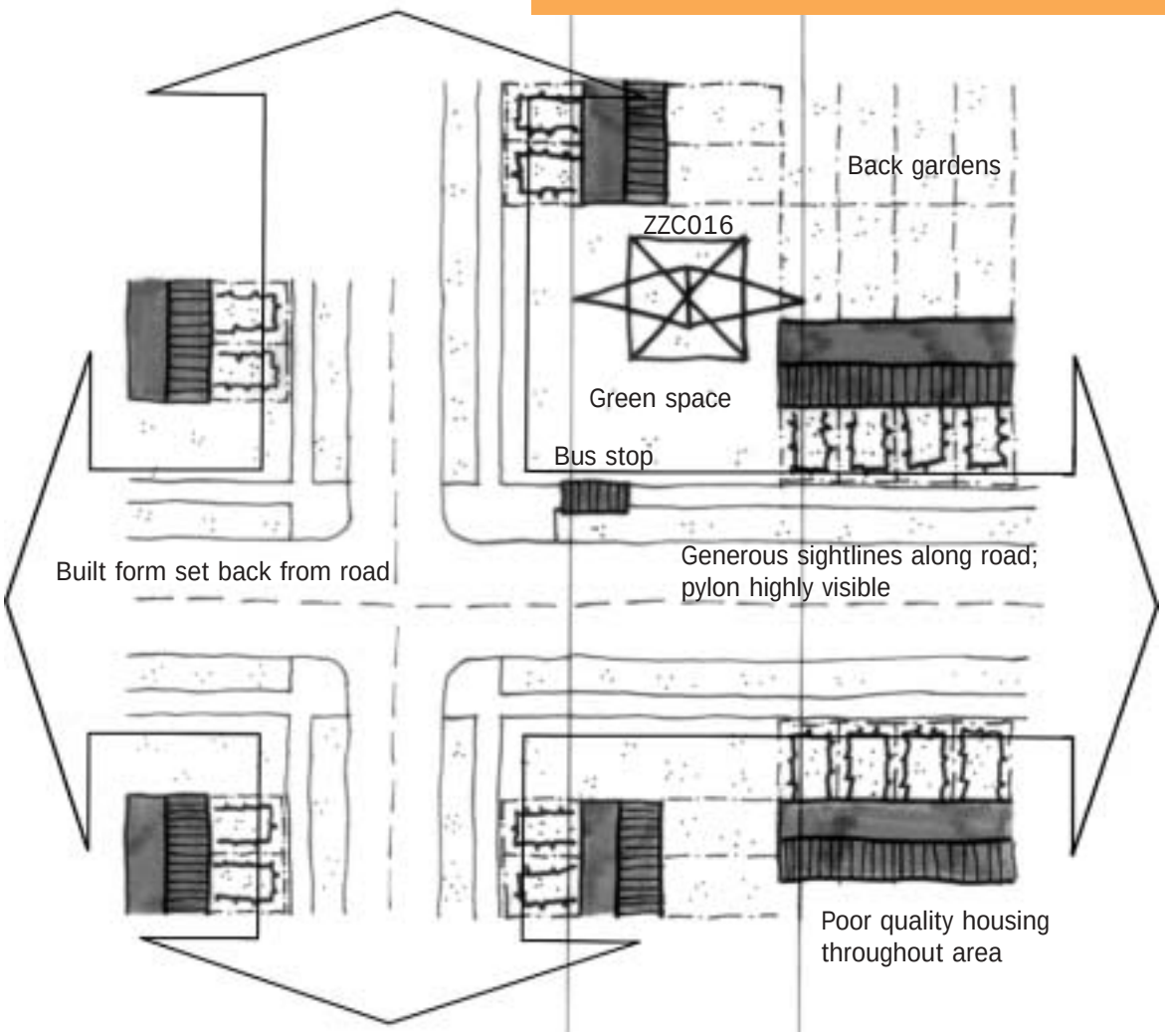
The site is accessible on foot and incorporates a bus stop.

Location: Broadbottom, Nr Stalybridge, Manchester

Category: Residential

Local Authority: Tameside Metropolitan Borough Council

Line Name & No: Stalybridge-Stockport Tee, ZZC016



Analysis

Strengths & Weaknesses:

The development response to the pylon is poor and has placed the pylon in a prominent corner site at a crossroads. This location emphasis the visual impact of the pylon from four directions.

Opportunities:

There are limited opportunities to make more of the green space, eg. the proximity of the bus stop as an arrival point within the public realm, and to provide screening or planting at ground level.

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TOWN PLANNING AND URBAN DESIGN

3. Planting near high voltage overhead lines

Trees grow, bend and flex in the wind and even fall; as a result they can come into contact with the live conductors of an overhead power line. Specified distances (electrical safety clearances) between overhead power lines and obstructions such as trees have been nationally determined to ensure safety to the public and to prevent electrical flashover of the line, which could result in power failures (see appendix 9). National Grid undertakes regular assessments of the likely danger to its system and the public arising from overhead power lines near to trees. Where woody vegetation is found to infringe statutory safety clearances then it must be cut and/or removed such that reasonable growth and safe access for future works can be achieved without returning every year to the same site.

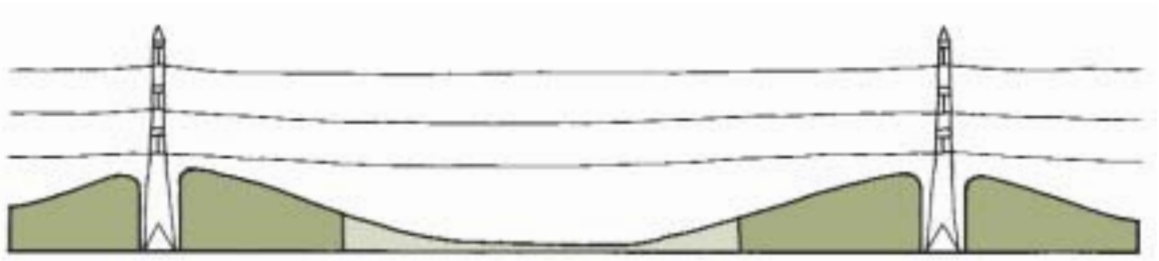
National Grid cannot prevent trees and vegetation being planted beneath its overhead power lines since it does not own the land. To ensure that future safety problems will not occur and to reduce the need for significant ongoing tree management works, National Grid recommends that only low height and slow growing species are utilised in areas beneath overhead line conductors. Similarly, when planting is proposed very near pylons consideration should be given to the need to maintain access to the pylon base and allow overhead line maintenance activities to take place safely and without causing damage to existing habitats and landscapes.

The diagrams opposite illustrate planting zones beneath and adjacent to a high voltage overhead line where the height of trees and woody vegetation must be restricted to ensure electrical safety clearances can be maintained. In considering the type of planting that may be appropriate, reference may be made to the mature height of trees as set out in NHBC Technical Standards, chapter 4.2 ‘Building near trees’, Appendix 4.2 – B ‘Water demand and mature height of trees’.

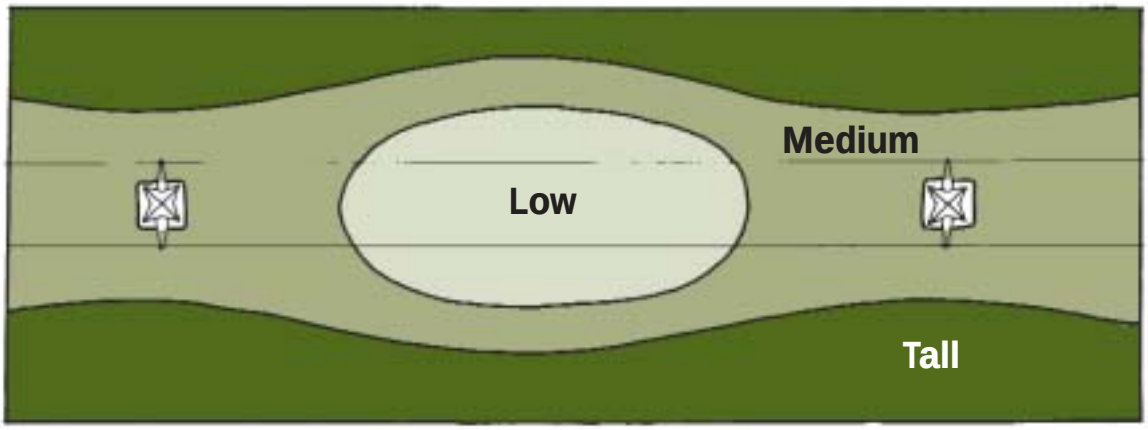
These diagrams are for illustrative purposes only. The specific clearance available at a particular location and therefore the precise extent of any planting zone will be dependent on the following factors:

- the design of the overhead line and type of pylon
- its operating voltage
- the spacing between pylons
- local topography
- proposals to alter ground levels.

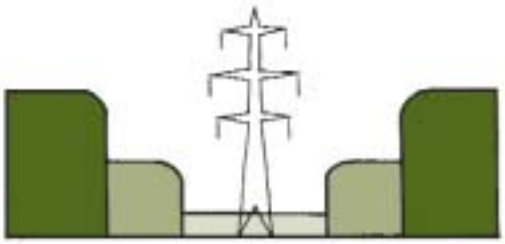
Detailed technical advice together with profile drawings of a specific high voltage overhead line span should be obtained from National Grid prior to any landscaping scheme being finalised.



Typical vegetation form along transmission route.



Typical form of planting zones.



Typical vegetation form crossing transmission route at mid-point.

Zone Characteristics

Tall - Forest Scale Trees
Eg: Ash, Beech, Horse Chestnut, Lime, Oak

Medium - Garden and Orchard Scale Trees
Eg: Apple, Cherry, Hawthorn, Mountain Ash, Pear, Plum

Low
Eg: Hedgerows, Allotments, Arable Crops, Reed Beds, Meadows/Wild Flowers, Grassland

4. Active recreation

General recreational use of land beneath and alongside high voltage overhead lines is possible where appropriate safeguards are implemented. There are many examples around the country of where recreational uses sit very well with an overhead line route. For example, golf courses and country parks.

From a safety point of view, two specific recreational activities are problematic in spaces around overhead lines: kite flying and fishing. In both these cases the situation may occur whereby the kite string or the fishing tackle may come into contact with the overhead line and potentially cause fatalities. National Grid is keen to reduce the opportunities for these activities to take place near to overhead power lines.

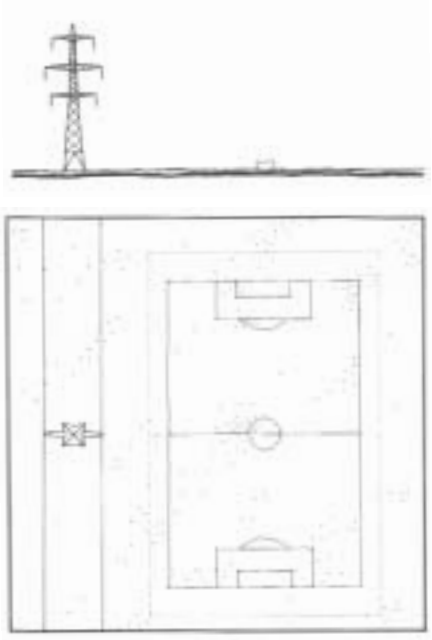


Diagram 1: example of a closed/supervised sports area.

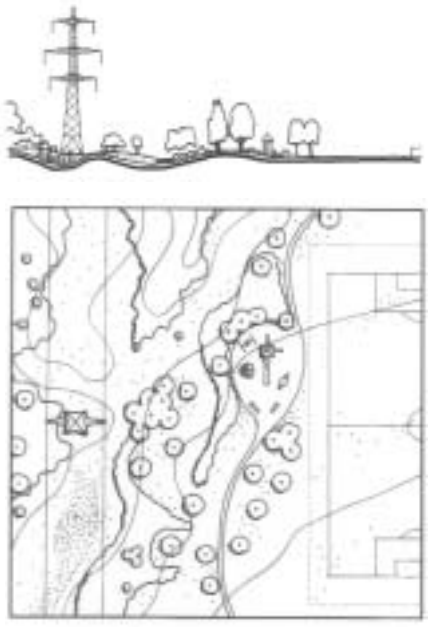


Diagram 2: Example of an unsupervised/open access sports area.

There are two distinct types of recreational space, closed and supervised sites and unsupervised open access sites. The ways of dealing with activities within these spaces vary according to the level of site supervision and security. For example, a sports pitch crossed by an overhead power line on land belonging to a sole use club, which can only be accessed by its members is unlikely to raise concerns about the potential for that site to be used for kite flying. It is likely to be sufficient to inform members of the dangers from the overhead power line and to erect appropriate signage around the site. See diagram 1 left which gives an example of a closed/supervised sports area.

However, if that same area were to be open to the general public and not subject to strict supervision, the effectiveness of using signage (pictograms are always advised) may be limited and it is likely that other tools would need to be used to discourage activities such as kite flying. Such tools may include the creation of buffer zones such as the planting of trees (see appendix 3), ground modelling, introducing shallow water areas or planting low growing plants that make it difficult to walk through in the vicinity of the overhead power line. Such physical measures would make an area unsuitable for kite flying. See diagram 2 left which gives an example of an unsupervised/open access sports area.

As a general rule, where it is intended to create open space areas near to overhead power lines which are unsupervised/open access areas, a buffer zone where access is restricted should extend 30m from the outer conductor of the overhead line route so that kite flying is discouraged. See diagram 3 below. However, with the appropriate treatment, such as those mentioned above, to deter the flying of kites, the extent of that buffer zone can be reduced so that the area around the overhead power line can positively contribute, both to the open space provision and to the development as a whole.

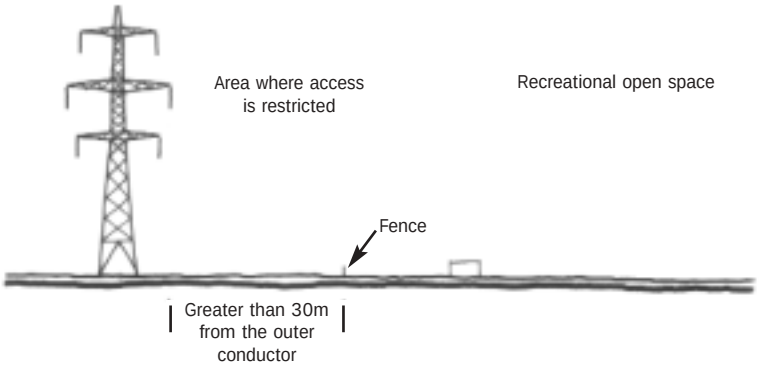


Diagram 3: Example of an unsupervised/open access area where no treatment of the land is intended between the overhead power line and the recreational open space.

It is possible to locate sports pitches and other formal recreational uses directly beneath overhead power lines as high voltage overhead lines are sufficiently high above the ground to allow such activities to take place. However it is preferable to site sports pitches alongside the overhead power lines, or using the overhead power line as the outfield to minimise disturbance to any activity. This will also reduce the potential conflict between overhead power lines and sports equipment such as rugby football goal posts and lighting columns.

The long term use and possible expansion of the recreational facility should also be considered at the initial planning stage. It may be a longer-term aspiration to include floodlighting, or stands/raised seating areas around formal sports facilities and these may have implications for the statutory safety clearances that must be maintained around all overhead power lines.

It should be noted that although spaces may be planned for a specific use, it is likely that children will use that space in ways adults had never thought of. Therefore, where it is proposed to locate focal points for children's activities such as children's play equipment and/or open spaces where kite flying may be possible, buffer/exclusion zones always need to be incorporated, or the facilities modified to exclude children or ensure that appropriate supervision measures are in place.

NATIONAL PLAYING FIELDS

5. Relocating overhead power lines

A frequently asked question is 'why can't National Grid remove or relocate its overhead line?' In order to answer this question it is important to explain some key issues.

Background

The National Grid is an integrated system and power is not necessarily generated in the area it serves. Most generation occurs in the north of England, and the main centres of demand are in the south, which means transmitting electricity over long distances. This is done most efficiently at high voltage.

National Grid's overhead lines were predominantly routed in the 1950s and 60s when the overriding concern was to bring electricity to those areas in need. Consequently, National Grid's overhead lines tend to run through the open countryside and to skirt cities and built-up areas.

However, they also cross the old industrial areas where the major electricity users, such as car manufacturers and chemical plants would have derived their electricity directly from the National Grid at high voltages.

Current planning policy means that the main areas currently planned for development tend to be sustainable urban extensions to existing settlements or the redevelopment of these old industrial sites - both areas that are now likely to have high voltage overhead lines nearby.

Typical constraints to moving lines

All requests for the removal or relocation of high voltage overhead lines are considered on their own merits. Where it is possible to move an overhead line, the cost for this and for dismantling the existing line would be borne by the developer/landowner. It is not acceptable to pass the cost of the relocation on to electricity consumers generally. However, as a general rule is it very unlikely that high voltage overhead lines will be moved.

First, there are significant legal, technical and topographical constraints to moving lines.

All of National Grid's overhead lines have been given consent under the Electricity Act by the Secretary of State for Trade and Industry and have agreement from the landowners. Any re-routeing of the overhead line would invariably require new consents and new landowner agreements. Where the re-routed line would be on an adjoining landowner's land, the new agreements would be required from a different landowner. New consents for overhead line routes are not easily obtained. Where local authority and public objections are made, a DTI Inspector is appointed and a public inquiry would be held.

In addition, where alterations are made to the electricity network, this requires an 'outage' on the network. This means that the electricity has to be routed through the network in a different way to make sure that power is provided to all parts of the country at all times. It is not possible to store large quantities of electricity. As the high voltage network is relatively limited in the UK, the opportunities to have regular outages on the system are also limited, mostly to very carefully pre-planned periods when National Grid can maintain and renew essential equipment, connect new customers and refurbish existing lines.

In terms of land use planning and environmental impact, in most instances the existing overhead line route has been routed to take account of all appropriate local factors. In seeking to amend that route, it might resolve the issue for the developer/local authority interested in one site, but it may have unacceptable knock-on consequences. For example, National Grid would not want to re-route an existing overhead line closer to existing properties in order to allow for new development to take place. Nor would National Grid want to re-route a line in such a way so as to make it more prominent in the landscape(which would also be the case if additional pylons and/or angle towers are required for a diversion).

Closely linked to this is the issue of sustainability. National Grid's equipment is built to have a lifespan of about 40-60 years. It is not easily portable or replaceable; and relocating and reconstructing sections of an overhead line is not something that can be done repeatedly at the request of various third parties. Relocation of a line is also unlikely to solve the problem long term anyway - once the overhead lines had been moved to allow some development to take place, in 20 years' time National Grid may be asked to move the relocated line once again to accommodate additional growth. Clearly, this is not a sustainable way either to manage the planning of our communities or to run an efficient electricity business.

It is accepted that high voltage electricity equipment is big and bulky, and it is for this very reason that it is difficult and costly to move around. Like motorways or railway lines, the electricity system is part of our national infrastructure and is not ordinarily something that a developer would look to relocate.

However, unlike a motorway or a railway line, the equipment only touches the ground at the pylon location, so it does not present a significant physical barrier on the ground to development; it is possible to cross under and around the overhead line. Obviously there is a visual impact associated with the equipment, but this work demonstrates how that impact can be mitigated.

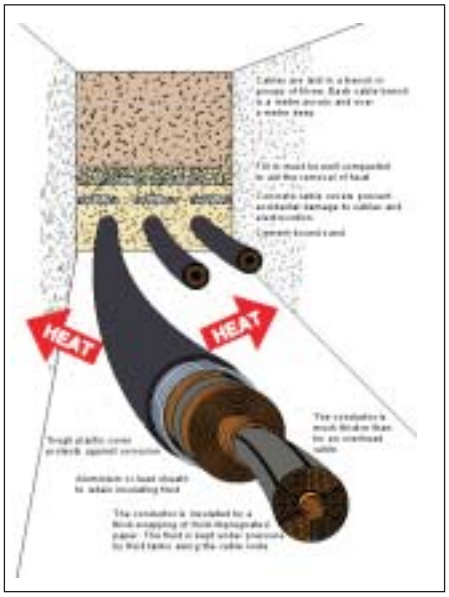
6. Undergrounding

Another frequently asked question is 'why can't National Grid underground its overhead power lines in order to enable development to take place and to remove the visual impact of the lines?' In order to answer this question it is important to get an understanding of the issues surrounding the undergrounding of high voltage overhead lines.

Background

Conductors transmitting electricity need to be insulated from the ground. The main difference between overhead lines and underground cables arises from the different ways in which they are insulated. Overhead lines use air whereas underground cable conductors are wrapped in layers of insulating material. Air is the simplest and cheapest insulation because it removes the heat produced by the electricity flowing through the bare overhead conductors naturally and efficiently.

When conductors are buried underground, high quality insulation is needed to withstand the very high voltage, so layers of insulating material are used. Unfortunately this form of insulation retains heat produced in the conductor and, as the earth does not cool conductors as well as the air, the underground conductors tend to run much hotter than overhead ones.



Underground cable installation.

Impacts associated with Undergrounding

As underground conductors tend to be hotter than overhead ones, this results in the need for a larger conductor underground than would be necessary overhead. This could be up to four times larger and may result in as many as 12 separate cables for a 400kV cable circuit, all of which need to be well spaced. This can result in construction activity the width of a dual carriageway (approximately 60 metres).

This also requires around 30 times more excavation than is associated with an overhead line. This much larger scale of construction can have a greater impact in terms of disturbance to flora and fauna, land use and archaeological sites than the impact associated with overhead lines, where the main impacts are centred on the area where the pylon is constructed. It will also result in a more significant visual impact during construction.

Sealing end compound.

Land is also required for sealing end compounds, which is where underground cables are joined to overhead lines. These compounds contain a substantial terminal tower, a small building and other transmission equipment, and can have a considerable visual impact.

Cost issues

National Grid is required under the Electricity Act 1989 to develop and maintain an efficient, co-ordinated and economical system of electricity transmission. In order to fulfil these requirements, National Grid needs to take into account economic, operational and environmental factors to assess the issues of overhead lines and underground cables.

National Grid has a responsibility to operate the transmission system in an economic manner. There are significant cost differences between a length of 400kV underground cable compared to the same length of 400kV overhead line. It costs between 15 and 25 times as much to install underground cable as to build an overhead line route. The cost difference is not so significant at lower voltage levels (below 275kV), which is why a significant number of lower voltage lines are undergrounded in urban areas.

Where a third party (developer, local authority etc.) seeks the undergrounding of an existing overhead line, the costs associated with the undergrounding are borne by the third party, not by National Grid or electricity consumers generally.

Where underground cables are installed, National Grid requires an approximate width of 30 metres in perpetuity above the cables to be kept free from development or planting in order to allow ready access for maintenance and to ensure that the cables are not disturbed.

Maintenance

In addition to construction costs there are increased maintenance costs associated with underground cables, as they are more complex than overhead lines and it can be a long and costly process trying to locate faults and carry out repairs. There are also operational costs associated with the length of time that the circuit is not in use.

Underground cable tunnels

In recent years technology has allowed for the development of high voltage electricity cables to be placed in dedicated deep-bore tunnels. Though the installation of a deep-bore tunnel is extremely costly, it is an alternative to direct-burial undergrounding in highly constrained urban areas, or in circumstances where the restrictions resulting from a direct-burial cable are not acceptable, such as the swathe of land required, reliability of the cable etc.

Internal view of high voltage underground cable tunnel.

Key advantages and disadvantages

Overhead lines (or, more accurately, their pylons) have a visual impact on the landscape, where underground cables in themselves do not. Underground cables can be an appropriate solution to servicing electricity needs where overhead lines are impracticable, or the associated visual impact is considered unacceptable. However, where underground cables are constructed, the land cannot be built upon and trees cannot be planted immediately above or adjacent to the cables, so corridors of considerable width have to be left undeveloped, causing restrictions on land use. There can also be disturbance to flora and fauna and archaeological features associated with the construction of underground cables.

Swathe of land required for direct burial.

Generally underground cables are less reliable and as such more time is spent on the repair of faults and on maintenance of underground cables than comparative sections of overhead line. Work carried out on an underground cable is also more disruptive due to the need to dig around the cable.

Further information: 'Overhead or Underground: National Grid's Approach' booklet, available free from National Grid.

7. Tower design

National Grid uses a variety of steel lattice tower (pylon) designs for the support of overhead line conductors. The size, height and spacing of transmission towers are determined by topographical, operational and environmental considerations.

A typical National Grid overhead line route will involve the use of three main types of tower:

- Suspension Towers, which support the conductors on straight stretches of line
- Deviation Towers, at points where the route changes direction
- Terminal Towers, which are somewhat heavier in construction and are seen for example at substations or where lines are connected to underground cables.

National Grid engineers are regularly working on new designs which provide alternative choices to the familiar traditional lattice towers, and in 1999 National Grid initiated a research project to develop and evaluate novel transmission tower concepts. Such designs would be considered for use on any major new overhead line route. However, it is not likely that existing pylons would be replaced with any of these new designs.

Further information: http://www.nationalgrid.com/uk/social&environment/tower_design.asp

8. Noise

High voltage overhead lines can generate noise. The level of this noise depends on the voltage of the overhead power line. Sometimes a ‘crackling’ sound accompanied by a low frequency hum can be heard. Noise from an overhead power line is produced by a phenomenon known as ‘corona discharge’. Overhead power lines are constructed to minimise this, but surface irregularities caused by damage, insects, raindrops or pollution may locally enhance the electric field strength sufficient for corona discharges to occur.

The noise levels associated with an overhead power line are weather related, and higher noise levels are likely to occur during damp weather conditions. Overhead power lines are normally quiet during dry weather, except during long, dry spells when airborne debris adheres to the conductors. This noise will disappear when sufficient rain falls to wash the debris away.

9. Safety clearances

Contact by people or objects with high voltage equipment must be avoided. For overhead power lines a statutory minimum clearance must be maintained between conductors and the ground. The higher the voltage of the line, the greater the safety clearance that is required.

Safety clearances must be maintained from buildings constructed under or adjacent to overhead power lines. For technical and amenity reasons National Grid does not encourage built development immediately beneath its lines. Access is required for the maintenance of the lines. The clearances must also be maintained for structures such as street lighting, objects on which a person may stand and new roads and new ground levels (where these will be altered by civil engineering operations) and where planting takes place.

The safety clearances are set out in the Electricity Safety, Quality and Continuity Regulations 2002. Clearances at specific locations will be dependent on several factors including the line's construction, design, and its operating voltages. This is why it is important to contact National Grid before making any changes to ground levels in the vicinity of overhead power lines.

Further information:

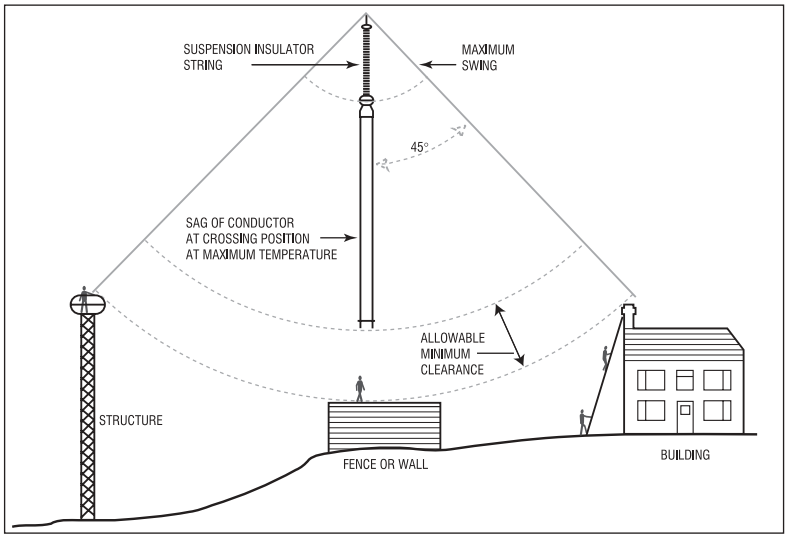
ESI Standard 43.8 which can be obtained from the Electricity Association, 30 Millbank, London SW1P 4RD (Tel 020 7963 5801)

Electricity Safety, Quality and Continuity Regulations 2002. Publication reference URN 02/1544. London, DTI.

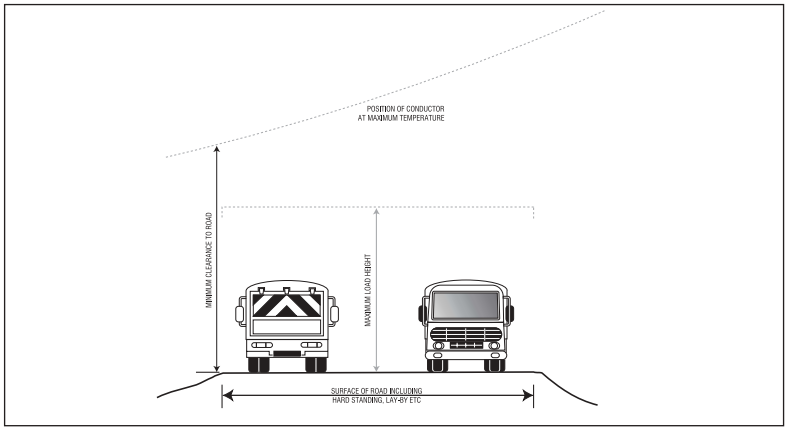
Electricity Association Technical Specification 43 – 8 Issue 2: 1988 – Overhead Line Clearances

Health & Safety Executive Guidance Note GS 6 – Avoidance of danger from overhead electric lines

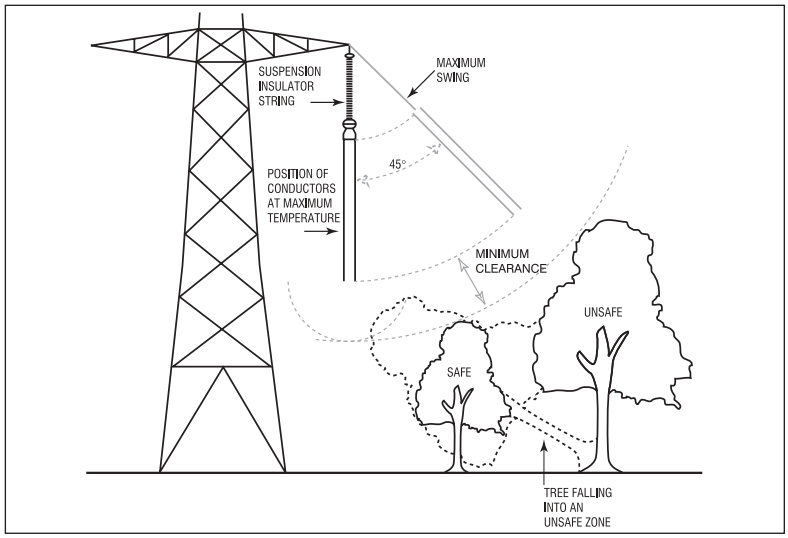
'Development Near Lines', brochure, available free from National Grid



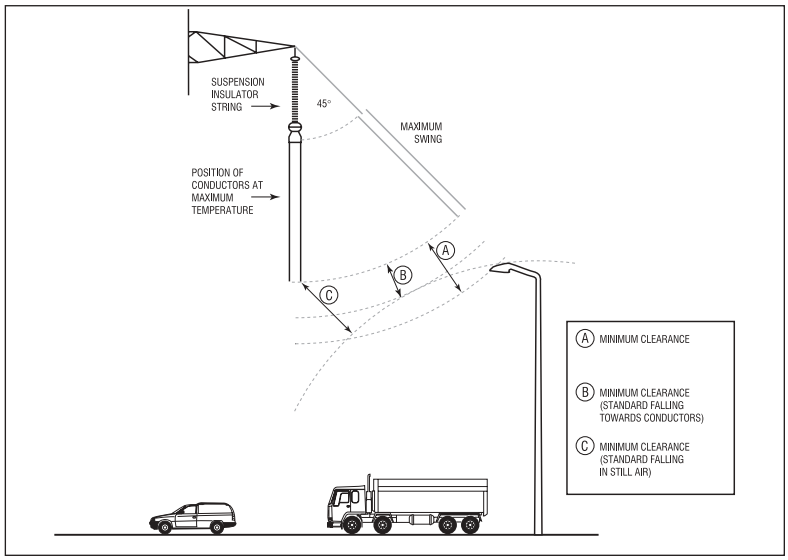
Clearance to objects (on which a person can stand). (Ref. Item 6 table 1).



Clearance to roads. (Ref. Item 2, 3, 4, 5 table 1).



Clearance to trees. (Ref. Item 8 table 1).



Clearance to lighting standards. (Ref. Item 11 table 1).

Item	Description of Clearance	Minimum Clearance (metres) at 400,000 volts	Minimum Clearance (metres) at 275,000 volts
1	To ground	7.6	7.0
2	To normal road surface	8.1	7.4
3	To road surface designated “6.1 metres high load” routes	9.2	8.5
4	To motorway or other road surface where “Skycradle” can be used	10.5	9.8
5	To motorway or road surface where scaffolding is to be used on:		
	(i) Normal 3 lane motorways	16.3	15.6
	(ii) Elevated 2 lane motorways	13.3	12.6
6	To any object on which a person may stand including ladders, access platform, etc	5.3	4.6
7	To any object to which access is not required AND on which a person cannot stand or lean a ladder	3.1	2.4
8	To trees under or adjacent to line and:		
	(i) Unable to support ladder/climber	3.1	2.4
	(ii) Capable of supporting ladder/climber	5.3	4.6
	(iii) Trees falling towards line with line conductors hanging vertically only	3.1	2.4
9	To trees in orchards and hop gardens	5.3	4.6
10	To irrigators, slurry guns and high pressure hoses	30.0	30.0
11	To street lighting standards with:		
	(i) Standard in normal upright position	4.0	3.3
	(ii) Standard falling towards line with line conductors hanging vertically only	4.0	3.3
	(iii) Standard falling towards line	1.9	1.4

Table 1: Overhead line conductor clearances.

10. Electromagnetic compatibility (EMC)

Some electronic and radio equipment may be susceptible to the electromagnetic fields and low level radio noise produced by high voltage equipment. Such issues are more likely to have an impact on commercial land uses in the vicinity of high voltage overhead lines rather than on residential developments. EMC issues can be minimised by considering the electromagnetic environment of an area when new electronic equipment is being specified.

11. Electric and magnetic fields (EMFs)

Electric and magnetic fields are all around us. EMFs are associated with all electrical apparatus, including power lines, underground cables and domestic appliances. They diminish rapidly with distance from the source. Electric fields are associated with voltage and magnetic fields vary with the current in the line or appliance.

There are continuing concerns about EMFs. Over the past 20 years, some scientists have linked exposure to everyday levels of EMFs with various health problems, ranging from headaches to Alzheimer's disease. The most persistent of these suggestions relates to childhood leukaemia. But the evidence is not straightforward.

A number of epidemiological studies, particularly in the US and in Scandinavia, have suggested an association between the incidence of childhood leukaemia and EMFs or the proximity of homes to power lines. Other studies, notably the world's largest ever study of its type conducted in the UK during the 1990s, have failed to confirm such associations.

No causal link has so far been established between cancer (or any other disease) and EMFs and there is no established mechanism by which these fields could cause or promote disease.

In the UK the Government relies on the scientific advice of the National Radiological Protection Board (NRPB), an independent body charged by Parliament with giving advice on EMFs, including advice on safe levels of exposure. Government has indicated that it expects industry to follow the present NRPB guidelines, and the electricity industry in the UK has committed itself to following the present guidance on safe levels of exposure given by the NRPB. If Government advised differently, National Grid would, of course, follow that advice.

Neither the UK Government nor the NRPB has recommended any special precautions for the development of homes near power lines on EMF grounds.

National Grid's EMF Helpline deals with enquiries from members of the public, including prospective homebuyers, sellers and their professional advisers who may be concerned about the health implications of nearby electricity facilities. The EMF unit provides relevant information to concerned individuals and will undertake field measurements as appropriate.

Further information:

www.emfs.info

EMF Helpline: 0845 702 3270 or Emfhelpline@uk.ngrid.com

12. Glossary

AMENITY	Relates to the immediate environment around development. Safeguarding residential amenity means that existing levels of privacy degree of overlooking and quality of environment are not compromised by adjacent or surrounding development.
BOUNDARY TREATMENT	Refers to various methods of defining boundaries (e.g. front and back gardens, open spaces, car parks and service areas). Boundary treatments can include walls, railings, hedges and fences, tree and shrub planting. Of particular relevance to urban design is the use of robust boundary treatments defining the boundary between public and private space.
BUILDING LINE	The extent of the built component of a development (external walls/arcades). Usually refers to the front elevation of a building.
CIRCUIT	Term used to describe specific electrical paths on the transmission system. i.e. Overhead Line.
CONDUCTOR	A material through which an electric current can easily flow.
CONTINUITY OF FRONTAGE	Refers to the use of continuous or 'joined up' building frontages and built forms to reinforce the perceived degree of enclosure. This can be achieved by the use of buildings, boundary treatments (e.g. walls/ fences/railings) or landscaping.
CROSS SECTION	Scale drawing showing the horizontal and vertical dimensions of each building/street/open space element within a given distance.
CUL DE SAC	A street closed at one end.
DENSITY	A measure of the average number of persons, households or units of accommodation per area of land.
DESIGN PRINCIPLE	An expression of one of the basic design ideas at the heart of a master plan.
DEVELOPMENT BRIEF	A document which sets out requirements for development, in terms of quantum and location of land use, character of development and detailed design. Developers are usually expected to adhere to these requirements.
DEVELOPMENT FRAMEWORK	A document or plan which provides a broad 'framework' or 'structure', within which individual development proposals sit.
DEVELOPMENT PLAN	Statutory documents setting out policies and proposals for an area to guide the development of land in the public interest. Planning applications should normally be determined in accordance with the development plan. The development plan for a given area will include a range of documents including Structure Plans and Local Plans or Unitary Development Plans, Minerals Local Plans and Waste Local Plans.
DEVIATION TOWER	Pylon used where there is a change in the direction of the line.
EARTH WIRE	A conductor connected to earth at some or all supports, which is suspended usually but not necessarily above the line conductors to provide a degree of protection against lightning strikes.

ELECTRIC AND MAGNETIC FIELDS	Electric and magnetic fields are produced by any electrical apparatus, including domestic appliances and overhead power lines.
ELECTRO MAGNETIC COMPATIBILITY	The condition which exists when equipment neither adversely affects nor is adversely affected by its electromagnetic environment.
ELEVATION	Scale drawing showing the vertical projection of any one side of a building.
ENCLOSURE	The use of buildings to create a sense of defined space. Enclosure is achieved where the buildings form a strong continuous edge and where the ratio of the width of the space or street to the height of the buildings enclosing it is sufficient for the observer to feel that they are in an enclosed rather than an open space.
FAÇADE	The face of a building, especially its principal front.
FLASHOVER	A disruptive electrical discharge between equipment at phase voltage and earth, or between two phases, including breakdown across the surface of an insulator as well as sparkover through air.
FORM	The layout, density, scale, appearance and landscape of development.
FORMAL OPEN SPACE	Usually refers to areas of open space which are permanently laid out or enclosed for certain sports activities (e.g. sports pitches, courts, greens).
FRONTAGE	That part of a building/group of buildings which significantly contributes to the character of an area and defines the street.
GARAGE COURT	A courtyard area providing access to garaging for several dwellings. Usually positioned in the centre of a development block or in a courtyard setting. In design terms it is recommended that garage courts serve a maximum of around eight dwellings from a single point of access, and that the garage walls themselves define the court (see 'Parking Court').
GROSS DENSITY	The overall density of a neighbourhood or settlement, including all land uses such as parks, schools, commerce, roads and infrastructure. Residential gross density is calculated as the average number of dwellings within the given boundary, and usually expressed as dwellings per hectare/acre. Can also be expressed as habitable rooms per area (usually used in higher density/city centre calculations). Non-residential density is usually calculated on the basis of plot ratios (see below).
HARD LANDSCAPE	Refers to the use of building materials for landscape purposes. Usually incorporates the use of paving, street furniture, public art, and water features.
INFORMAL OPEN SPACE	Usually refers to areas of open space which are laid out for informal activity (e.g. parkland, village greens, lakeside areas, 'kickabout' areas).
KILOVOLT (kV)	1000 Volts.

LANDMARK	A memorable building or structure which stands out from its background by virtue of its height, size or some other aspect of design. Often significantly contributes to the character of an area. Landmarks are often used as orientation points within the local environment, and aid legibility (see below).
LAYOUT	The way buildings, routes and open spaces are placed in relation to each other.
LEGIBILITY	The degree to which a place (its structure, form and function) can be easily understood and communicated.
LOAD	Customer demand on the transmission system.
MASTER PLAN	A plan or illustration which sets out the overall structure or layout of new development. Often used to convey a development concept or image of the development rather than specify detailed design issues.
MIXED USE DEVELOPMENT	Development which encompasses a variety of different land uses within close proximity. Can refer to adjacent buildings which accommodate different land uses, or different land uses which are accommodated within a single building or group of buildings.
NATURAL SURVEILLANCE	The ability of people to be seen from surrounding built form, often as a means of discouraging crime. Also known as passive surveillance.
NET DENSITY	The defined area of housing (or commercial uses) alone within a neighbourhood or settlement, excluding all land uses such as parks, schools, roads and infrastructure but including incidental green space, internal streets and private drives. Calculated as the average number of dwellings within the given boundary, and expressed as dwellings per hectare/acre. Can also be expressed as habitable rooms per area (usually used in higher density/city centre calculations). Non-residential density is usually calculated on the basis of plot ratios (see below).
OVERHEAD LINE	An electricity line suspended from steel pylons.
PARKING COURT	An area within which vehicles may park, usually positioned in the centre of a development block or in a courtyard setting. May include garages (see 'Garage Court').
PERIMETER BLOCK	All buildings need two faces: a 'front' onto public space (for entrances and the most public activities) and a 'back' where the most private activities occur. Applied consistently, designing development with a 'front' facing outwards onto the public space (street, square or park) and a 'back' which faces inwards to the centre of the block (with private outdoor space), leads to the creation of 'perimeter block' development.

PERMEABILITY	The degree to which an area has a variety of pleasant, convenient and safe routes through it.
PLANNING APPLICATION	Application under the Town and Country Planning Act 1990 (as amended) to carry out development on or to change the use of land. Applications are determined by a relevant planning authority as part of their statutory development control function.
PLANNING GAIN	See 'Planning Obligations'.
PLANNING OBLIGATIONS	A requirement attached to a planning permission to pay specified monies or to undertake specified works to mitigate some of the effects of an approved development when it is implemented. Unlike a planning condition, it is a separate legal agreement and is attached to the land rather than to the developer, and so may be enforced against either the original developer and/or anyone acquiring an interest in the land. A planning obligation may be negotiated during the processing of a planning application, or may be unilaterally declared by the applicant. Typical planning obligations could include the delivery of affordable housing, contributions to educational and community facilities, open space and play equipment, highways improvements. Planning obligations are also known as 'planning gain' or 'section 106 agreements' (see below).
PLOT RATIO	A measurement of density generally expressed as gross floor area divided by the net site area, expressed as a ratio of the square metres or square feet (e.g. a plot ratio of 0.5:1 indicates that the amount of built floorspace covers 0.5, or 50%, of the site).
PRIMARY STREET	A street which by its design can be identified as the most important and connected route through an area. Often accommodating public transport, street planting and higher levels of public activity; primary streets can define and contribute greatly to the character of an area.
PUBLIC REALM	Streets and spaces available for use by everyone without charge - shaped by buildings, landscaping, structures and activities alongside or within them.
RADIO INTERFERENCE	Interference generated by corona discharge from an overhead line at radio frequencies.
SAFETY CLEARANCE	Distance from nearest exposed conductor or from an insulator supporting a conductor which must be maintained to avoid danger.
SECTION 106 AGREEMENT	The legal document which sometimes forms part of a planning consent, and which specifies the obligations which a developer must enter into or satisfy as part of the development permitted (see 'Planning Obligations').
SHARED SURFACE	These are streets within which a single surface treatment is employed. Vehicular movement, parking and pedestrian areas are integrated with no segregation of movement/space.

STREET FURNITURE	Objects desired or required as part of the laying out of a street. Includes seating, lighting, bins, cycle storage, signage, boundary treatments and planters. Street furniture can also incorporate public art.
SUBSTATION	A location in the transmission system used to control the flow of load and often a location at which voltage is transformed.
SUPPLEMENTARY PLANNING GUIDANCE	Additional guidance covering detailed issues to supplement policies within the Development Plan. Supplementary Planning Guidance, or SPG, does not have the same status as an adopted development plan policy, but may be a material consideration in determining planning applications.
SUSPENSION TOWER	A pylon structure that is used to keep the overhead line conductors off the ground.
SUSTAINABLE DEVELOPMENT	Can be summarised as development that meets present needs without compromising the ability of future generations to achieve their own needs and aspirations (PPG1).
TERMINAL TOWER	A pylon used at a sub-station or cable sealing end to terminate a line which is bulkier and more substantial than a typical pylon.
TOPOGRAPHY	The configuration of a land surface, including its relief and the position of its natural and man-made features.
TOWER	In National Grid, a steel lattice structure for supporting the overhead conductors, usually carrying double circuits, more commonly know as a pylon.
TRANSFORMER	A device for changing one value of alternating voltage to another without altering the frequency.
TRANSMISSION	The means by which bulk electricity is taken from power stations to substations.
TRANSMISSION ROUTE	The land crossed by a high voltage overhead line.
URBAN DESIGN	The art of making places. Urban design involves the design of the built environment, spaces and landscapes and the establishment of frameworks and processes which facilitate successful development.
VIEW	The direct, prominent and unobstructed lines of sight within the public realm visible from a particular point and contributing to the legibility of the area.
VISTA	An enclosed/framed view.
VOLT (V)	Unit of electrical pressure.

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14. Contributors

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Bellway Homes

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Countryside Properties

The County Surveyors Society

Department of Trade and Industry

English Partnerships

Fairview New Homes

Heart of Thames Gateway Limited

House Builders Federation

The Landscape Institute

National Playing Fields Association

Office of the Deputy Prime Minister

The Planning Officers Society

Royal Town Planning Institute

Royal Institute of British Architects

Royal Institution of Chartered Surveyors

Thames Gateway London Partnership

Town and Country Planning Association

15. Contacting National Grid

A. For planning application consultations, developer enquiries and advice on safety clearances, please contact the following:

Land and Development Group
National Grid Transco
NGT House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA
Tel: 01926 653000

B. For development plan consultations, general town and country planning and amenity issues, please contact the following:

Land and Development Policy Manager
National Grid Transco
NGT House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA
Tel: 01926 653000

C. For questions on, or issues with, EMF please contact the following:

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National Grid Transco
NGT House
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