

Avoiding danger from underground services

Avoiding danger from underground services

Health and Safety series booklet HS(G)47

Contents

Introduction 1

Application 1
Who should use the guidance 1
How to use the guidance 2
Definitions 2

The dangers 2

Electricity cables 2
Gas pipes 3
Water pipes and sewers 3
Telecommunications cables 3

Safe systems of work 3

Plans 5
Cable and pipe locating devices 9
Safe digging practice 10

Safe systems of work for trenchless methods 72

New housing developments 72

Installation of new services near existing services 72

Demolition sites 73

Appendices 13

Appendix 1 *Electricity cables* 74
Appendix 2 *Gas pipes* 76
Appendix 3 *Water pipes and sewers* 79
Appendix 4 *Telecommunications cables* 79
Appendix 5 *Legislation* 79
Appendix 6 *First aid* 27
Appendix 7 *Suggested text for workers information* 27

References 23

Further information 23

HSE BOOKS

© Crown copyright 7997

*Applications for reproduction should be made in writing to:
Copyright Unit, Her Majesty's Stationery Office,
St Clements House, 2- 76 Colegate, Norwich NR31BQ*

First published 7989

*Reprinted 7989, 7991, 7992, 7994, 1995, 1996,
7998 (twice)*

ISBN 0 7176 0435 7

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the prior written permission of the copyright owner.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

Introduction

1 Many accidents occur when underground services are damaged during excavation and other work involving ground penetration. Not all accidents occur immediately; some happen years after work has been carried out, perhaps when a pipeline is damaged and it corrodes over a long period of time. In addition to the risk of personal injury, damage can be very costly and can have knock-on effects. Consider, for example, the effect on a hospital or a home kidney-dialysis patient if services are lost.

2 This guidance incorporates and supersedes the guidance previously contained in Guidance Note GS33 *Avoiding danger from buried electricity cables*. It outlines the dangers which can arise from work near underground services and gives advice on how to reduce the risk. It deals only with risks to health and safety and is not concerned with damage which has no attendant risk. However, the precautions needed to reduce the risk of accidents will generally reduce the risk of damage.

Application

3 This guidance applies to all situations where underground services may be found and where work is undertaken which involves penetrating the ground at or below surface level. There is however one exception: work in a carriageway where the ground penetration is contained within the wearing and base courses (see Figure 1) where it is unlikely that services are present. An example of this would be road resurfacing. Even with shallow work of this type care will need to be taken not to damage surface boxes for valves, pressure points, siphons etc. All other work in roads will be covered by this guidance. All work in areas other than built-up roads, including work in footways and kerbing, is included regardless of depth, as underground services may be found very near the surface. Other matters relating to work near underground

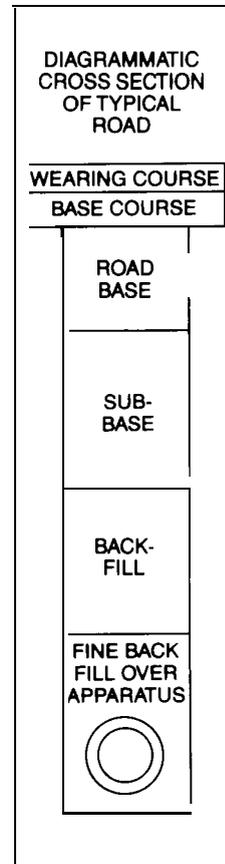


Fig 1 Carriageway work (See para 3)

services, such as the need to support excavations and the dangers of contaminated ground, are not covered.

Who should use the guidance

4 This guidance should be used by all those who have responsibilities under relevant legislation (see Appendix 5), including employers, employees, owners of underground services and those concerned with planning, organising and supervising work near such services. This includes work by or for the utilities and also roadworks, construction and demolition work. The guidance is aimed primarily at central and site management (including travelling supervisors) but it also contains a suggested text for workers' information which could be used by employees (see Appendix 7).

How to use the guidance

5 The guidance is divided into a main text and seven appendices. Many of the precautions to prevent damage apply equally to all types of buried service, and the main text sets out a general system of work. More specific precautions on each of the four types of buried services are given in Appendices 1 to 4, which need to be read in conjunction with the main text. The other appendices deal with legislation, first aid and a suggested text for workers' information.

6 The guidance was considered by a joint Health and Safety Executive (HSE) / industry working party which drew on a wide range of expertise. The working party concluded that, in many cases, there are no suitable alternatives to the precautions advocated in the guidance. People involved in this type of work who wish to carry it out in some other way than that advocated should ensure they achieve an equal or greater standard of safety.

Definitions

7 The term 'service(s)' means all underground electricity, gas, water (including piped sewage), and

telecommunications plant. It does not include underground structures such as brick sewers, railway tunnels, etc.

8 The term 'service connection' means a pipe and/or cable linking a distribution main with individual premises.

The dangers

9 The main dangers which may arise from work near underground services are summarised below:

Electricity cables

Injuries resulting from damage to live electricity cables are usually caused by the explosive effects of arcing current, and by any associated fire or flames which may follow when the sheath of a cable and the conductor insulation are penetrated by a sharp object such as the point of a tool (see Figure 2), or when a cable is crushed severely enough to cause internal contact between the conductors or between the sheathing and one or more of the conductors. This typically causes severe and potentially fatal burns to the hands, face and body. Direct electric shock is rare but not impossible. (See also Appendix 6(1));



Fig 2 Striking an underground electricity cable can cause serious burn injuries

Gas pipes

Damage to gas pipes can cause leaks which may lead to fires or explosions (see Figure 3).

There are two types:

- (i) damage which causes an immediate leak;
- (ii) damage which causes a leak some time later. The damage may occur at the time the work is carried out (for example damage to a pipe wrapping may eventually lead to corrosion) or subsequently, for instance poor reinstatement may leave a pipe inadequately supported or subjected to unequal forces.

In the former case the risk is to both the people carrying out the work and to others in the vicinity; in the latter, the risk is mainly to the public;

Water pipes and sewers

Damage to water pipes is less likely to cause injury, but a jet of water from a high pressure main could injure a person or damage adjacent services. In addition, a leak of water from an underground pipe

could wash away subsoil and reduce the support for adjacent services, highways and structures. Further dangers include the risk of flooding the trench or low-lying areas such as nearby basements. Sewers are generally gravity fed; however, some sewage is pumped at pressure. The main danger from damage to a sewer is the possibility of contamination.

Telecommunication cables

Although damage to telecommunication cables can be very expensive there is normally no direct risk of personal injury.

Safe systems of work

10 Buried services are widespread and it should be assumed that they are present until it is proved otherwise. This part of the guidance aims to help minimise the possibility of damaging them. It sets out a safe system of work which is based on obtaining, before work begins, as much information as possible about buried services in the area and then using that information to ensure safe digging.



Fig 3 Aftermath of a gas explosion

11 Our safe system of work has three basic elements:

(a) *Plans*

Wherever possible, plans or other suitable information about all buried services in the area should be obtained before excavation work starts, and the utilities should do everything reasonably practicable to ensure that such information is made available to enquirers. When this is not possible, as may be the case when emergency or other unforeseen work * has to be undertaken, the excavation should be carried out as though there are buried services in the vicinity. Account should be taken of any indications that buried services exist, such as the presence of lamp posts, illuminated traffic signs, valve pit covers, etc. However, the absence of such indications does not necessarily mean that there are no buried services. (See also paragraphs 16 to 20);

(b) *Cable and pipe locating devices*

Suitable cable and pipe locating devices should be used, in conjunction with any available plans, to determine as accurately as possible the position of metallic underground services in or near the proposed work area. These devices will not detect plastic pipes. (See also paragraphs 21 to 24); and

(c) *Safe digging practices*

Excavation work should be carried out carefully, and follow recognised safe digging practices. (See also paragraphs 25 to 34).

* 'Unforeseen work' is work that occurs at such short notice that it cannot be planned in advance. The term does not cover emergencies in which people are at risk, but does include situations where it is considered necessary to start or continue work despite problems that would normally require further information from service owners etc. However, there may be many situations where it would be prudent to delay unforeseen work in order to obtain more information. In particular, a client may plan a job well in advance but only pass it to the contractor at the last minute. Clients should either pass on buried service information to the contractor in good time or allow the contractor time to obtain it from the service owners.



Fig 4 Using a cable locator

12 These key elements - plans, locators and safe digging - complement each other, and all three should be used when working near buried services. Using only one may not be enough: for example, a cable may be shown on a plan as a straight line, with measurements taken from fixed objects at the time of installation, whereas in practice the cable may snake or may have been moved out of position. Reliance on the plan alone would give a false position, but this could be alleviated by the correct use of a cable locator. If several cables are close together a locator may show them as a single cable, whereas the plan would help give a more accurate picture.

13 Anyone responsible for excavation work where buried services may be

present should liaise with the service owners (normally the utilities but sometimes other statutory bodies or private companies) when planning and carrying out the work. It is important that owners accept the need for close co-operation with those who have to excavate in the vicinity of their plant. They should be prepared to help locate and identify the plant when asked to do so, perhaps by sending a representative to the site. They should also consider further ways of improving and extending cooperation, particularly with other utilities, local authorities and contractors who have to perform a considerable amount of highway excavation.

14 The organisation and arrangements necessary for avoiding danger should be written into, or form part of, employers' statutory safety policies.

15 Employees should receive adequate instruction and training in the above procedures. The suggested text for workers' information at Appendix 7 and the information in leaflet IND(G)30(L) *Buried Cables - Beware* can be used as a basis for training programmes. The Construction Industry Training Board (CITB)² can give advice on available training. It is particularly important that anyone who uses a locator should have received thorough training in the use and limitations of that particular type or model. Most manufacturers can provide such training; employers should ensure that it is adequate for their employees' needs.

Plans

16 The owners of underground services should be approached for information and plans well before excavation is due to start. Where consultants and clients (which in some circumstances will include utilities and local authorities) obtain the information they should pass it on to the main contractor, who should in turn pass it on to those involved in excavation and groundwork. It may be possible to amend some projects at the planning stage to avoid existing buried services routes or

areas of particular service congestion. For major projects early approach to services owners is recommended as it may be possible to divert some services from the excavation area.

17 Most buried services belong to one of the utilities. Others may be found on or near commercial, industrial, military or other sites, and where known the owners should be consulted. Electricity cables under the highway may not be owned by the local electricity board (see paragraph 1 of Appendix 1).

18 Owners should provide either plans, which show the recorded line and depth (where known) of all their known plant buried in the proposed work area, or other suitable information. They are likely to receive many routine applications for information and should consider how best to make information available at short notice. Where reasonably practicable, arrangements should also be made to deal with emergencies outside office hours so that gangs can be given plans of underground services positions when they receive their work instructions. Some owners may have reservations, for reasons of security, about supplying copies of their underground services plans for such areas as those around important civil and military establishments. In such cases an alternative method should be used; for example a representative could be sent to the site to give information to legitimate contractors/utilities etc.

19 Plans are not normally drawn to scale but even if they claim to be, they should not be relied upon to obtain distances; the draughtsman may have made a mistake or reproduction may have changed the scale, especially if the plan was obtained from a microfiche slide or digital map. However, they can give a good indication of the location, configuration and number of underground services at a particular site, and will help subsequent tracing by locators. Those in charge of site work, and operators of locators, should be aware that plans may show spare ducts, and that the accuracy

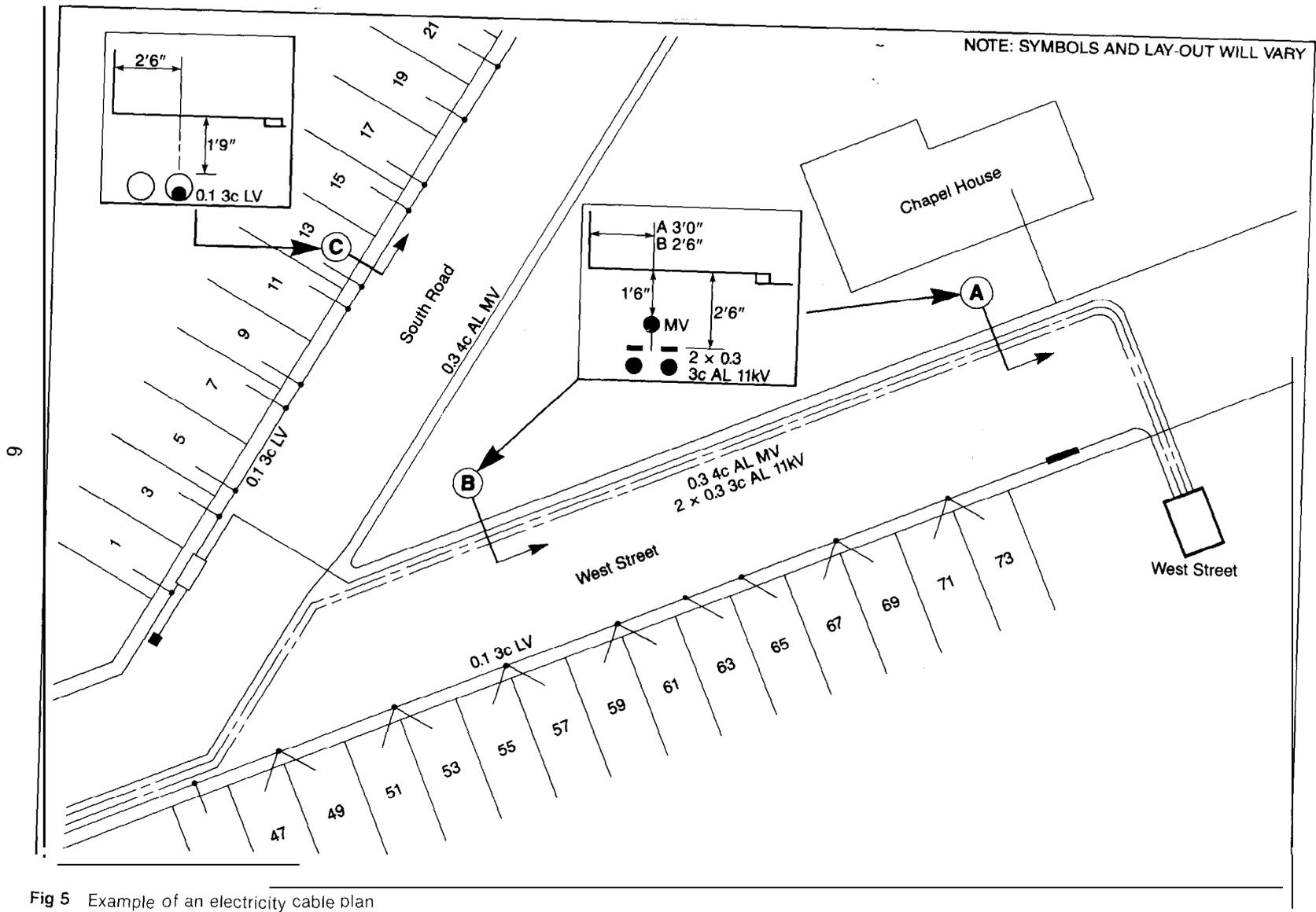
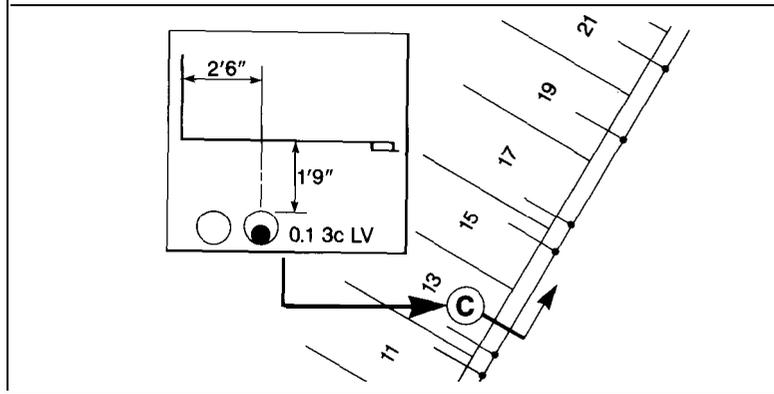
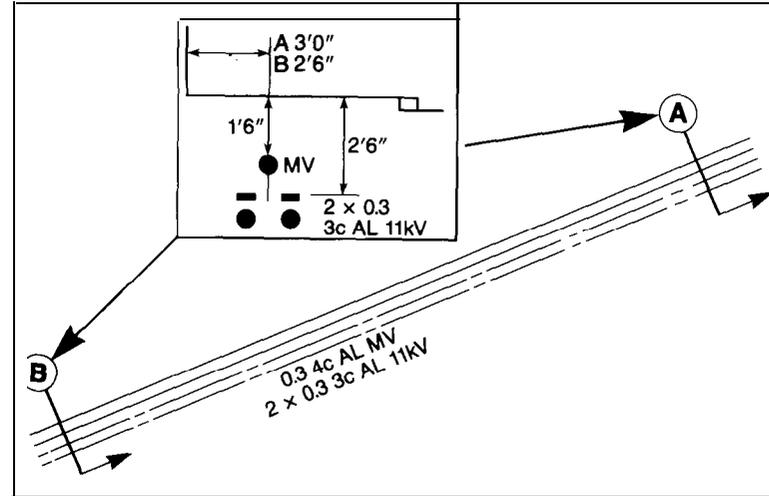


Fig 5 Example of an electricity cable plan

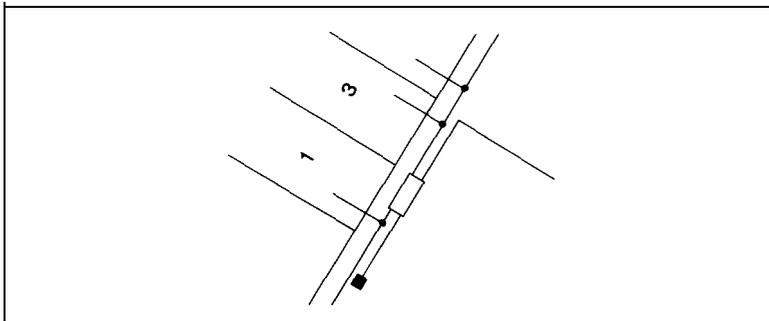


a) This section indicates a low voltage cable, running in a duct, with an empty duct alongside. The recorded depth and distance from the property boundary are also given. Note the service spurs into the properties; these will not always be shown.



b) The dashed lines indicate the path of the two 11 kV cables. The section indicates the configuration of the cables, with the two 11 kV below the medium voltage one, and covered by concrete slabs. The recorded dimensions from the property refer to the sections at A and B respectively.

7



c) This shows a junction box, which will be visible on the pavement. One of the cables is pot-ended.

d) The box indicates a transformer chamber or sub-station. The thickening of one of the cables shows the position of a cable joint, perhaps a previous repair.

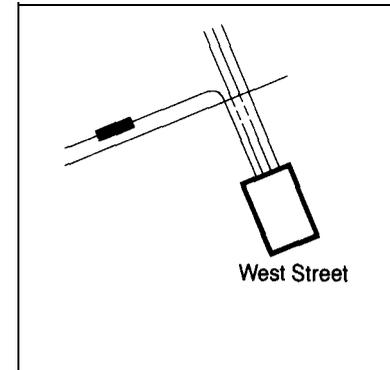


Fig 5 Example of an electricity cable plan

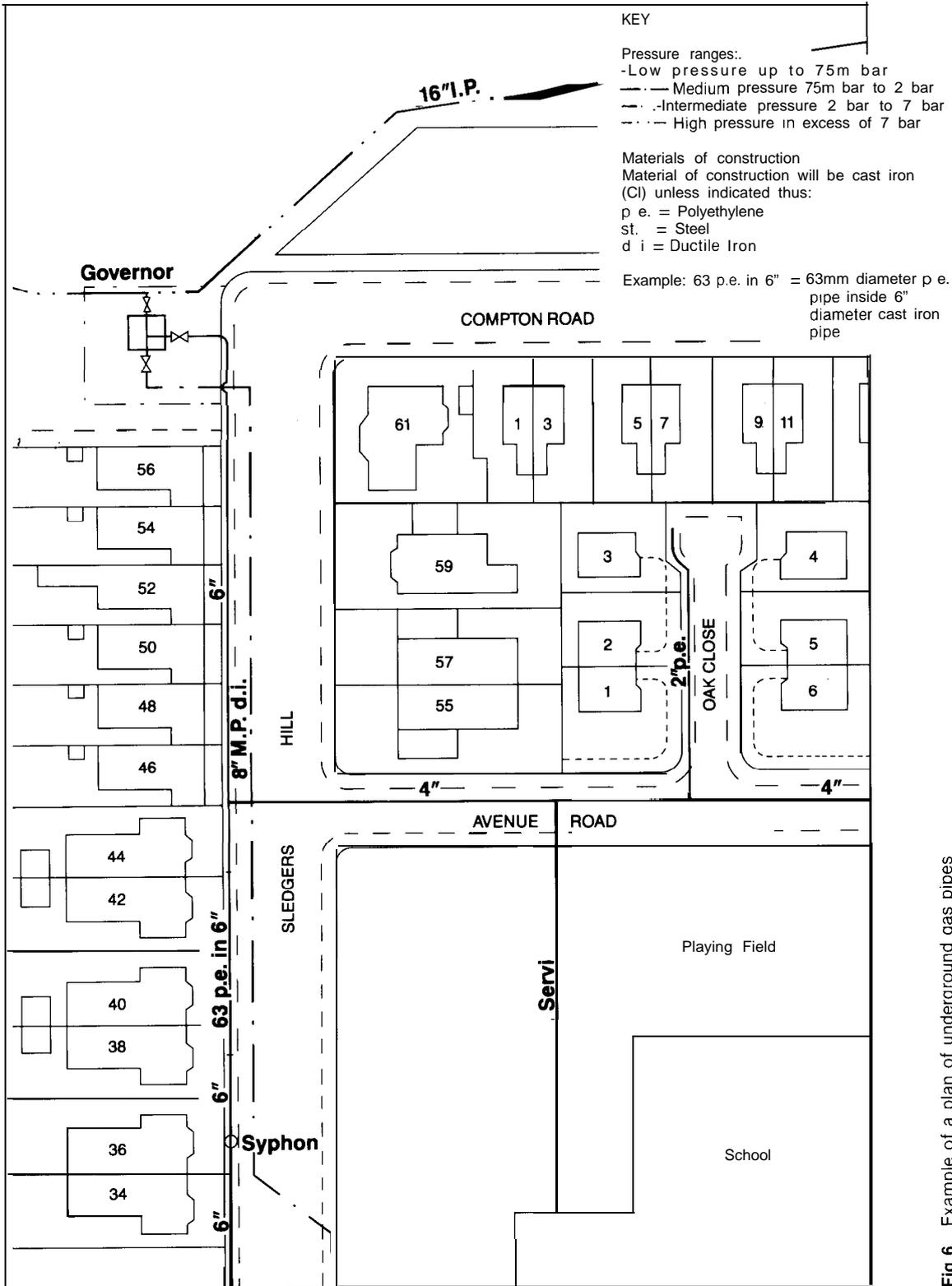


Fig 6 Example of a plan of underground gas pipes

of plans is limited because:

- (a) the position of reference points (eg the kerb line) may have changed since the plans were drawn;
- (b) regrading of the surface may mean that the depths shown are now incorrect;
- (c) services, particularly cables, may have been moved without the authority or knowledge of their owners;
- (d) in many cases service connections are not marked; and
- (e) services, marked as straight lines may, in practice, 'snake'. Excessively long cables may have been laid in 'horizontal loops outside substations, switchrooms, etc.

Further notes on the use and limitations of plans for electricity cables and gas pipes are given in Appendices 1 and 2 and examples are shown in Figures 5 and 6. In certain cases, such as construction site work and large-scale excavation work on the highway, it would be useful to transfer the information onto the working plans for the guidance of those carrying out the work; particular care should be taken where topographical changes have occurred since services were laid. Adequate instruction and training in how to read and interpret the plans should be given to anyone who needs to use them.

20 Even when work has to start without plans, as may be the case for emergency and unforeseen work, every effort should be made to locate buried services and possible owners should be consulted. Telephone requests for information should be presented so that names, locations, references, dimensions and instructions are recorded in a consistent way to avoid errors or misunderstandings; any information provided should be read back to confirm accuracy. In the meantime it should be assumed that buried services are present and digging should proceed with extreme caution, and only after a locator has been used to detect metallic cables and pipes. It is particularly

important that anyone carrying out excavations in such circumstances should be adequately trained and supervised.

Cable and pipe locating devices

21 The position of any services in or near the proposed work area should be pinpointed as accurately as possible by means of a locating device, in conjunction with any available cable plans or other suitable information (see Figure 4). Plans will help the operative using the locator to interpret the signal, and so give the maximum information to those involved with the work before digging starts.

22 Various locators are available, and guidance on their selection and use is given in *Cable Locating Devices*³ and *Performance Guide for the Assessment of Metallic Pipe and Cable Locators*⁴. The main types of locator available can be classed as follows:

- (a) *Hum detectors* These are receiving instruments which detect the magnetic field radiated by live electricity cables *which have a current flowing through them*. They will not detect, for example, service connection cables to unoccupied premises or street lighting cables in the daytime, because little or no current is flowing;
- (b) *Radio frequency detectors* Receiving instruments which respond to low frequency radio signals, which may be picked up and re-emitted by cables and long metallic pipes. If radio frequency detection is used, other metallic objects may re-radiate the signal and results may vary appreciably according to locality, length of the buried cable or pipe and distance from the termination, and geographical orientation;
- (c) *Transmitter-receiver instruments* A small portable transmitter or signal generator can be connected to a cable or pipe, or placed very close to it so that the signal is induced into it. The receiver can then detect this

signal. Usually some part of the cable or pipe needs to be already known so that the transmitter can be properly positioned, and these locators generally require more skill to operate than other types. They can, however, provide useful information in difficult situations where the techniques in (a) and (b) have not been successful; and

- (d) Metal detectors Conventional metal detectors will usually locate flat metal covers, joint boxes, etc but may well miss round cables or pipes. They can be a useful tool for finding inspection points which may provide connection points for a transmitter.

Some commercially available instruments use more than one of these techniques and may include a depth measuring facility.

23 The degree of confidence with which buried services can be detected depends on a number of factors such as the characteristics of the device being used, the type and depth of the service, the magnitude of the current carried by the cable, effects of other cables and metal pipes close by, and the training, skill, hearing and experience of the operator. **In particular, a locator may not be able to distinguish between cables or pipes running close together and may represent them as a single signal.** If two are sited one above the other it may not detect the lower one. Having dug and found one cable or pipe does not mean that there is not another close by. **Frequent and repeated use should be made of locators during the course of the work.** Locators will not detect plastic pipes or other non-metallic ducts and services unless either:

- (a) a metallic tracer wire has been laid with the pipe. This enables a signal transmitter/receiver to be used. Plastic gas and water pipes are the non-metallic services most likely to be encountered and few have been laid with metallic tracer wires in the past. The exception is plastic pipes on Liquefied Petroleum Gas (LPG) metered estates, which do have an

indicator tape incorporating a metallic tracer wire installed with them; or

- (b) a small signal transmitter is inserted into and pushed along the pipe. This is a sophisticated technique which is not likely to be appropriate for most jobs.

24 Locating devices should always be used in accordance with the manufacturer's instructions and should be regularly checked and maintained in good working order. The line of any identified services should be noted and marked with waterproof crayon, chalk or paint on paved surfaces (any residual markings being erased after excavation as far as possible) or with wooden pegs in grassed or unsurfaced areas. Steel pins, spikes or long pegs, which could damage services laid at shallow depth, should not be used.

Safe digging practice

25 Once a location device has been used, excavation may proceed, with trial holes dug using hand tools as necessary to confirm the position of any buried services. Special care should be taken when digging above or close to the assumed line of such a service. **Hand held power tools and mechanical excavators are the main causes of danger and they should not be used too close to underground services.** Advice on appropriate safety margins from electricity cables and gas pipes is given in Appendices 1 and 2.

26 Incorrectly used hand tools are a common source of accidents but when carefully used they can normally provide a satisfactory way of exposing buried services, once the approximate positions have been determined using plans and locators. Every effort should be made to excavate alongside the service rather than directly above it. Final exposure of the service by horizontal digging is recommended as the force applied to hand tools can be controlled more effectively. In particular:

- (a) spades and shovels should be used rather than other tools. They should

not be thrown or spiked into the ground, but eased in with gentle foot pressure;

- (b) picks, pins or forks may be used with care to free lumps of stone etc and to break up hard layers of chalk or sandstone; and
- (c) picks should not be used in soft clay or other soft soils near to buried services.

A proprietary air-knife operated by compressed air is now available and can be used to expose buried services safely.

27 Particular care is necessary when gas leak search techniques such as barholing are used. Refer to British Gas guidance material⁵ for advice.

28 Once underground services have been uncovered, failure to identify them correctly is another common cause of accidents. A wide variety of materials and colours has been used by the utilities over the years.

29 Water pipes, electricity cables and telecommunication cables may be of black plastic and if any black plastic service is found, it should be assumed to be a live electricity cable until proved otherwise. Similarly, cast iron and steel water pipes may look very like gas pipes, and if any such pipe is uncovered, it should be treated as a gas pipe. In some coal mining areas British Coal cables are yellow and may be mistaken for gas pipes. Some services run in ducts, making them difficult to identify. **Where there is any doubt about the identity of an exposed service it should be treated as an electricity cable or gas pipe until proved otherwise.** All services should be assumed to be live until disconnected and proved safe at the point of work. Obtain written confirmation of disconnection from the owner before removing a redundant service.

30 The utilities⁶ have now agreed on a national colour coding system for buried services up to 75 mm in diameter. Remember, however, that old or privately owned services may not conform. The

system is as follows:

<i>Colour</i>	<i>Service</i>
Black	Electricity
Red	Electricity - some 11 KV cables
Blue	Water
Yellow	Gas
Grey/White	Telecommunications
Green	Cable television

Do not confuse this colour coding system with the one contained in BS 1710⁷, which generally applies to **above ground** building and process services.

31 It is important to remember that colours may look different under poor or artificial lighting and that ducts may well contain any one of the services, irrespective of the type or colour of the duct.

32 Services uncovered in an excavation may need to be supported (see Appendices 1, 2 and 3). Backfilling of any excavation should be done carefully and, where possible, any warning tiles, tape etc above the services should be put back in their original position unless the excavation showed this to be incorrect, in which case they should be replaced above the service to which they refer. Warning tape should not be used for any other purpose, eg guarding an excavation, and should not be discarded in an excavation when it is backfilled. Any fill containing items likely to damage the services, such as large pieces of rock and hardcore, should not be used. For specific advice on backfilling in the vicinity of gas pipes (where long-term damage is a particular hazard) see Appendix 2. Other utilities can give advice on how to backfill trenches in which their services have been exposed.

33 If buried services have been found to be too shallow, or if the plans or other information have proved to be inaccurate, the owners should be informed, preferably before the excavation is backfilled, and

they should amend their records accordingly.

34 If a buried service suffers damage, however slight, the owner should be informed immediately and, in the case of electricity cables, gas pipes or high pressure water mains, arrangements made to keep people well clear of the area until it has been repaired or otherwise made safe by the owner.

Safe systems of work for trenchless methods

35 Trenchless methods are increasingly being used for laying and renovating buried pipes and cables, particularly where there is a need to avoid surface disruption⁸. The most widely used techniques are impact moling, pipe bursting and auger boring. Care should be taken when using trenchless methods to avoid colliding with, and thereby damaging, other services. With moling and pipe bursting it is also important not to come too close to adjacent services, as displaced soil may damage or enter nearby pipes or ducts.

36 Plans, locators and trial excavations should be used to locate existing services in the same way as for traditional excavation methods. The path of the device being used should then be planned accordingly. As a general guide, the minimum clearance between adjacent services should be either one and a half times the diameter of the pipe being laid or 150 mm, whichever is the greater. However, these clearances may need to be varied taking into account such factors as the construction of adjacent plant, ground conditions, bore diameter, the accuracy and reliability of the technique/equipment being used, and whether the other plant is parallel or crossing the proposed line. Moles are prone to deflection from their original course and if there are existing services in the vicinity a mole tracking device should be used.

New housing developments

37 Underground services within the confines of partly completed housing developments are especially prone to damage from the numerous site operations that have to be carried out. Each utility should keep to its agreed position as in NJUG publication Number 7⁹. A common trench may help to control the position and separation of underground services. Where buried services are laid on partly developed sites, special arrangements may be necessary for their temporary protection at vehicle and mobile plant crossing points. Advice on the installation and protection of buried electricity cables feeding plant used for construction work (eg cranes, hoists etc) is given in HSE Guidance Note GS24¹⁰.

38 Close liaison should be maintained between the developers, their contractors, and the utilities. A marked-up plan of the estate showing the up-to-date position of buried services (including any variations from planned routes) should be kept on site by the builder/developer for the information of those involved in excavation and groundwork.

Installation of new services near existing services

39 New underground services often have to be laid in ground which contains existing services. Where it is reasonably practicable to do so, the utility planning the new installation should aim to site it so that it is separated from all existing buried services by the distances specified in NJUG publication Number 7⁹.

40 Where, because of buried services congestion, this standard cannot be attained, there should be as great a separation as is reasonably practicable.

41 Where the utility which is laying the new buried service has to reduce the separation, it should inform the utility whose service has been affected. This will enable them to amend their records for future reference.

Demolition sites

42 Special problems can arise in the case of service terminations in derelict property or on demolition sites. Anyone concerned with demolition work has a duty to give adequate notice to the relevant gas, electricity and water authorities of intention to demolish any premises. Work should not start until either those authorities have confirmed in writing that the supply has been disconnected, or other appropriate safeguarding action has been taken. For further advice read BS 6187¹¹ and HSE Guidance Note GS29 Parts 1 to 4¹².

43 Buried services on industrial or

commercial sites may be owned by the site occupier. A contractor who is to demolish buildings or plant on such a site should contact the services owner, whether this is the site occupier or the site owner, to ensure that all relevant services are isolated before work starts.

Appendices

Appendices 1 to 4 give advice on matters which relate particularly to each of the four main types of underground service. **It is additional information and should be read and used in conjunction with the advice contained in the main text.**

Appendix 1 Electricity cables

Plans

1 Most electricity cables to buildings belong to a local electricity board (look under Electricity in the telephone directory for area and regional offices). It is possible however that cables under the highway belong to other bodies such as the highway authority, the street lighting authority, the Central Electricity Generating Board, Ministry of Defence, a railway or a private company. Such owners should be traced and consulted wherever possible.

2 Figure 5 shows an example of an electricity cable plan. Note however that symbols vary between electricity boards, and advice should be sought from the issuing office. Remember that low/medium and high voltage cables may be shown on separate plans.

Cable locating devices

3 Hum detectors are simple to use, but they do not respond to unloaded or direct current cables and they may fail to detect lightly loaded low voltage cables (such as those used for street lighting) or well-balanced high voltage cables. A locator with a radio frequency detection mode may detect these cables and should be used as a back-up check.

4 Even where the locator gives no indication, there may still be cables present, and any cable uncovered may still be live.

5 If a cable recorded on an electricity board plan cannot be located, appropriate assistance or advice should be sought. If digging has to start before such assistance or advice has been obtained, extreme care should be taken.

Safe digging practice

6 In most cases there will be no permanent surface marker posts or other visible indication of the presence of a buried cable. Even if no cables are shown on plans or detected by a locator, a close

watch should be kept for any signs which could indicate their presence.

7 Underground cables are normally laid in trenches between 450 mm and 1 m deep, but they can often be found just below the surface. This should always be borne in mind, particularly if the ground has been disturbed or if there are cellars or structures such as bridges in the area which may have prevented cables being laid at standard depths. Even shallow excavations (eg for post holing and fencing work) may be a source of danger.

8 Cables may have been laid directly in the ground with a bed or surround of fine soil or sand, or in cement-bound sand, or in earthenware or plastic pipes or ducts, or they may have a layer of tiles, slabs or coloured plastic marker tape laid above them. However, such protection may have been disturbed and moved and should not be relied upon to give an accurate indication of a cable position. Although high voltage (HV) cables normally have tiles or marker tapes laid over them, low voltage (LV) cables may be laid without separate protective cover. This emphasises the importance of safe digging practice.

9 Occasionally, cables are terminated in the ground by means of a seal, sometimes with external mechanical protection. These 'pot-ended' cables should be treated as live and should not be assumed to be abandoned or disused.

10 Using hand-held power tools to break up paved surfaces often leads to accidents. Where practicable, such power tools should not be used within 0.5 m of the indicated line of a cable buried in or below a paved surface. When power tools have been used to break the surface away from the indicated line of the cable, it should then be positively located by careful hand digging under the paved surface. The paved surface should be gradually removed until the cable is exposed. If the cable is not so exposed then it must be assumed to be embedded within the paved surface. Where possible a cable locator should be used as a

depth guide down the side of the excavation. The 0.5 m safety margin may be reduced:

- (a) where congestion of buried cables renders it impracticable; or
- (b) where surface obstructions limit the space available;

but **only** if the line of the cable has been positively identified by plans and confirmed by a locator. Because of the difficulty in confirming depth, hand-held power tools should never be used over the cable unless either:

- (a) the cable has already been exposed , by digging under the surface to be broken out and it is at a safe depth, (at least 300 mm) below the bottom of the hard surface material; or
- (b) physical precautions have been taken to prevent the tool striking the cable. Advice on the safe use of hand tools is given in paragraph 26 of the main text.

11 Where mechanical excavators are used in the possible vicinity of underground cables, the work should be arranged so that damage to cables is avoided so far as is reasonably practicable, and so that everyone is kept well clear of the excavator bucket while it is digging. If a cable is struck, the driver should stay in the cab. If the driver has to leave the cab he should jump clear and not climb down, otherwise he may be electrocuted. A watch should be kept on the machine and no-one should go down into the excavation or touch the mechanical excavator or the cable until the cable owner has made the damaged cable safe.

12 During digging work a careful watch should be kept for evidence of cables, and repeat checks made with a locator to determine more precisely the position of

any cable as signals become clear. Remember that a cable is positively located only when it has been safely exposed, and even then, digging should still proceed with care: there may be other cables, particularly HV cables, adjacent or lower down.

13 Where it is necessary to break away or disturb concrete in which a cable is embedded, either the local electricity board should be asked to make the cable dead, or an alternative safe method of excavation agreed with the electricity board or other owner of the cable before work starts. When excavation can proceed safely only after a buried cable has been made dead, and where permits to work or other safety documents are used, liaison should be maintained between the parties involved to ensure that work covered by the permit is completed, and workmen are clear, before the circuit is re-energised.

14 Accidents sometimes occur after underground cables have been exposed. Cables should not be used as hand or foot holds by anyone climbing in or out of the trench. Where a cable exposed for more than 1 m crosses a trench, the owner should be asked to provide support. Any cables lying in the bottom of an excavation should be protected by nail-free wooden planks, troughing or other suitable means, but care should be taken not to use materials or equipment which could damage or penetrate the outer sheath of cables. Cables should not be moved aside unless the operation is supervised by the cable owners. Precautions should be taken to prevent access to exposed cables by children or other unauthorised people.

15 Hard or sharp materials such as pieces of rock, large stones, hard-core or surplus concrete, should not be tipped into open cable trenches. Advice on backfilling cable trenches can be obtained from electricity boards.

Appendix 2 Gas pipes

1 Most underground gas pipes belong to British Gas (look under 'Gas' in the telephone directory). One important exception is on private 'metered' estates which may be fed from the normal British Gas distribution system, or may have gas piped to users from a bulk liquefied petroleum gas (LPG) store. In the latter case, owners/managers should be able to provide information, but on certain estates (caravans or other rented accommodation) owners and managers may not be available round the clock. At sites made up of privately owned dwellings there will not normally be a site owner or manager. Further information may be obtained from the LPG supplier whose name and telephone number (manned 24 hours) should be displayed at the bulk storage vessel compound. The risk from leaking LPG is even greater than from a natural gas leak as it is heavier than air and does not disperse so readily. In addition it can travel great distances below ground level before accumulating at low level. Guidance Note CS11¹³ gives further advice.

Plans

2 On request, the local British Gas region or owner will give approximate locations of gas pipes, usually in the form of plans. Early contact, preferably at the planning stage, is beneficial and will allow full discussion of proposals to ensure the safety of plant and operators. An example of a plan of underground gas pipes is shown in Figure 6. Such plans do not normally show the position of service connections. Their existence should be assumed and it may be possible to estimate the probable line of the service connection pipe from the gas meter position, or from the point of entry into the premises. Where the presence of gas mains which operate at pressures of 2 bar (30 psig) and above is indicated, the

owner should be further consulted before work begins.

Pipe locators

3 Locators of the radio frequency detection or the transmitter/receiver types should be used to help locate metallic gas pipes before excavation. However, an increasing number of gas pipes are made of plastic, and these cannot be traced by such devices. This is why it is especially important to use plans and safe digging practices. Plastic pipes on private LPG metered estates will have an indicator tape incorporating a metallic tracer wire installed with them. The wire can be used to indicate the line of the pipe.

Safe digging practice and avoidance of long term damage

4 The depth of cover for gas mains laid in a roadway is normally 750 mm, and for those laid in a footway 600 mm. The depth of cover for gas service connections is normally 450 mm in both road and footways. However, at entry positions to buildings, the depth of cover for the service connection may be 375mm. Remember that these depths are only a guide and pipes may be found at shallower depths. The depth of cover may for example have been reduced since the pipe was installed, perhaps because other works (such as road alterations) have been carried out in the area. Pipes passing over cellars or in the vicinity of bridge structures may have to be laid at shallower depths.

5 Gas pipes are laid directly in the ground although in certain soils selective backfill may have been used as a bed and pipe surround. Ductile iron pipe will sometimes be found wrapped in loose fit polyethylene sleeving as protection against corrosion. Polyethylene mains may be inserted into redundant cast iron, spun iron or ductile iron gas mains and polyethylene service connection pipes

may be inserted into yellow convoluted ducting on new housing estates. Marker tiles may be used above gas pipes, eg when they have been laid at a shallow depth in bridge structures or above cellars. Polyethylene (plastic) mains may have a coloured plastic marker tape above them. The presence of gas plant may also be indicated by valve boxes and marker posts. Marker posts/plates are sometimes used to indicate the position and size of valves or siphons on gas mains. However, such markers may have been disturbed and should not be relied upon as an accurate indicator of position.

6 Plastic gas pipes should be located by hand digging before mechanical excavation begins. This may also be necessary for metallic pipes if they have not been successfully located by a pipe locating device. This is particularly important for service connection pipes, which will not be marked on plans. A suitable hand digging method is to dig a trial trench along the road near the kerb, or in the footpath, where the service connection pipes are likely to be at their

most shallow (see Figure 7). When the positions and depth of the pipes have been determined, work can proceed.

7 The danger created by damaging a gas pipe with an excavator is much greater than if the damage is done with a hand-held power tool (the opposite is true for work near electricity cables and this is reflected in the different safe digging practices). Gas pipes may have projections such as valve housings, siphons and stand pipes which are not shown on the plans and to allow for this mechanical excavators should not be used within 0.5 m of a gas pipe. Greater safety distances may be advised by the Gas region or owner depending on mains pressure.

8 Hand-held power tools can damage buried gas pipes and should be used with care until the exact position of a buried pipe has been determined. They may be used to break a paved or concrete surface above a gas pipe, unless there are any indications that the pipe is particularly shallow or close to the surface to be broken up.



Fig 7 Example of a trial trench dug to find the position of gas service connection pipes

9 Where heavy plant may have to cross the line of a gas pipe during construction work, the number of crossing points should be kept to a minimum. They should be clearly indicated, and crossings at other places along the line of the pipe should be prevented. Where the pipe is not adequately protected by an existing road, crossing points should be suitably reinforced with sleepers, steel plates or a specially constructed reinforced concrete raft as necessary. The owner of the pipe will advise on the type of reinforcement necessary.

10 Explosives should not be used within 30 m, and piling or vertical boring should not be carried out within 15 m of any gas pipe without prior consultation and agreement with the owner. The owner should be consulted before carrying out excavation work within 10 m of any above ground gas installation.

11 If welding or other hot work involving naked flames is to be carried out close to gas plant and the presence of gas is suspected, the owner should be asked to check the atmosphere before work begins. Even when a gas-free atmosphere exists, care should be taken to ensure that no damage occurs. Particular care should be taken to avoid damage by heat, sparks or naked flames to plastic gas pipes or to the protective coatings on other gas pipes.

12 If a gas leak is suspected, the following action should be taken immediately:

- (a) **remove all people from the immediate vicinity of the escape.** If the service connection to a building or the adjacent main has been damaged (see note below), warn the occupants to leave the building, and any adjoining building, until it is safe for them to return;
- (b) inform the local British Gas region (or other owner as appropriate) by telephone;
- (c) prohibit smoking, and extinguish all naked flames and other sources of

ignition, within at least 5 m of the leak; and

- (d) assist Gas Board staff, Police or Fire Services as requested.

It is important to note that a mechanical excavator may not only cause damage/leakage at the point of impact. For example, damage to a service connection outside the building may result in further, unseen damage to the connection inside the building. Gas leaking from the damage inside or gas travelling along the line of the service connection pipe from outside the building may cause a build-up of gas within the building.

13 No manhole, chamber or other structure should be built over, around or under a gas pipe and no work should be carried out which results in a reduction of cover or protection over a pipe, without first consulting the owner.

14 Where gas pipes cross or are parallel and close to excavations, changes in backfill etc may cause differential ground settlement and increased stress in the pipe. For pipes parallel and close to excavations, the degree of risk depends upon the depth of the excavation, the distance of the pipe from the excavation, and the type of soil. Wherever an excavation may affect support for a gas pipe the owner should be consulted. In some cases it may be necessary to divert the **gas** pipe before work begins. Further information is contained in the *Model Consultative Procedure for Pipeline Construction Involving Deep Excavation*¹⁴.

15 Where an excavation uncovers a gas pipe the backfill should be adequately compacted, particularly beneath the pipe, to prevent any settlement which would subsequently damage the pipe. Backfill material adjacent to gas plant should be selected fine material or sand, containing no stones, bricks or lumps of concrete etc, and should be suitably compacted to give comparable support and protection to that provided before excavation. No power compaction should take place until 200 mm cover of selected fine fill has

been suitably compacted.

16 If the road construction is close to the top of a gas pipe, the owner should be asked about necessary precautions. The road construction depth should not be reduced without permission from the local Highway Authority.

17 No concrete or other hard material should be placed or left under or adjacent to any gas pipe as this can cause pipe fracture at a later date. Concrete backfill should not be used within 300 mm of a gas pipe.

18 Where an excavation uncovers a gas pipe with a damaged wrapping, the owner should be told, so that repairs can be made to prevent future corrosion and leakage.

19 Pipe restraints or thrust blocks close to gas mains should never be removed.

20 Anyone who carries out work near underground gas plant should observe any specific requirements made by gas staff, and ensure that access to the plant by those staff is available at all times. No unauthorised repairs to gas pipes should be made. **If in doubt, seek advice from the local Gas region. The addresses and telephone numbers for all emergencies and enquiries can be found in the telephone directory under 'Gas'.**

Appendix 3 Water pipes and sewers

1 In general, work near underground water pipes is of low risk and most precautions are more concerned with reducing the cost of damage than with eliminating hazard. However there are some dangers and the following precautions should be taken:

- (a) where work is carried out near high pressure mains, plans should be obtained from the relevant Water Undertaking and, where possible, a pipe locator used. Safe digging practices should be followed, using hand tools as far as is practicable;

- (b) at bends in mains, concrete thrust blocks may be used. Under no circumstances should either thrust blocks or the ground supporting them be disturbed, as this can cause sudden failure of the main;
- (c) exposed water pipes should be supported as necessary and the correct method of backfilling used. For advice, contact the relevant Water Undertaking; and
- (d) if a water pipe or its wrapping is damaged the relevant Water Undertaking and the owners of any other underground services which may be affected should be informed immediately.

Appendix 4 Telecommunications cables

1 No special precautions are required to prevent danger. Owners of the cables should be consulted on precautions to avoid costly damage.

Appendix 5 Legislation

Relevant legislation enforced by the Health and Safety Executive

1 The Construction Regulations, made under the Factories Act 1961, apply to building operations and works of engineering construction as defined in Section 176(1) of the Act; they therefore cover most work in the vicinity of buried services. In particular, Regulation 44(1)* of the Construction (General Provisions) Regulations 1961 requires that:

Before any operations or works to which these Regulations apply are commenced, and also during the progress thereof, all

* The Electricity at Work Regulations were laid before Parliament in April 1989. These Regulations revoke Regulation 44(1) of the Construction (General Provisions) Regulations 1961 with effect from April 1990, but impose a similar requirement under Regulation 14 of the new Regulations.

practicable steps shall be taken to prevent danger to persons employed from any live electric cable or apparatus which is liable to be a source of such danger, either by rendering such cable or apparatus electrically dead or otherwise.

2 The Health and Safety at Work etc Act 1974 (HSW Act) applies to all work, whether or not the Construction Regulations apply. The duties placed on an employer by Section 2 of the Act include the provision and maintenance of systems of work that are, so far as is reasonably practicable, safe and without risks to health, and the provision of such information, instruction, training and supervision as are necessary to ensure, so far as reasonably practicable, the health and safety at work of employees.

3 Section 3 imposes a duty on employers to take precautions, so far as is reasonably practicable, to ensure the safety of people not in their employment: This duty could apply to any owner of underground services, to clients, local authorities or other utilities or main contractors who have the necessary records and other information required by contractors or subcontractors. Section 4 of the Act requires anyone who makes premises available as a work place to ensure, so far as is reasonably practicable, that access is safe, and plant and substances present are safe and without risk to health.

4 Section 7 imposes duties on each employee to take reasonable care for their own safety and for the safety of anyone else who may be affected by their acts or omissions at work, and to co-operate with their employer in meeting their own duties.

5 The Gas Safety Regulations 1972* apply to gas services owned by British Gas plc. Part II controls their installation, and Part VII deals with removal, disconnection, alteration, replacement and maintenance.

* The Gas Safety Regulations made under the Gas Act 1972 were made relevant statutory provisions of the Health and Safety at Work etc Act 1974 by provisions within the Gas Act 1986.

Other legislation

6 A supplier of electricity has a duty under Regulation 36 of the Electricity Supply Regulations 1988† to make and, so far as is reasonably practicable, keep up to date 'a map or series of maps indicating the position and depth below surface level of all his works'. The supplier must provide these maps free of charge to anyone who has good reason for requiring them. Regulation 10 of the 1988 Regulations imposes requirements for the protection of underground cables and Regulation 11 imposes requirements regarding the depth and manner of their installation.

7 Public utilities must give notice of their proposals for planned works under the Public Utilities Street Works Act (PUSWA) 1950‡ so that their work may be co-ordinated and their apparatus safeguarded. Emergency and 'excepted' works under PUSWA Section 26(2), such as service laying, can be started without advance notification. The terms 'emergency' and 'excepted' works however relate only to notifications between utilities for the purpose of PUSWA and do not affect the legal obligations under the HSW Act to give and obtain information needed to ensure safe working. This general duty on employers to obtain information is endorsed by the specific duty on electricity boards to make it available (see paragraph 6 above). The requirement applies to all work regardless of its PUSWA classification (ie 'excepted' or not) and includes work not covered by PUSWA. While the procedures for planned works under PUSWA may provide information needed under the HSW Act, owners of buried services will also need to make other arrangements for providing such information in the case of 'emergency' and 'excepted' works.

† Enforced by the Department of Energy

‡ Enforced by highway authorities. In January 1984 the Minister of State for Transport announced an independent review of PUSWA. The review was published in November 1985 and made a large number of recommendations, currently under consideration.

Appendix 6 First aid

1 Burns are the main injuries that result from damage to live buried cables or from fire or explosion following a gas leak. With electricity cable accidents in particular, they may be flash burns, spatter burns from molten metal and electrical burns. Direct electric shock is rare. In many cases the burns are made more severe by the fact that the injured person was working bare-chested*.

2 Workers should know how to give emergency aid until help arrives. Competence in cardio-pulmonary resuscitation and the immediate care of burns and unconsciousness would be an advantage. In remote locations it may be desirable to provide a means of communication, eg two-way radios, so that help can be quickly sought if there is an accident.

3 A casualty should not be moved unless in a position of danger. This is particularly important when the person has been thrown some distance and may have suffered injuries in addition to burns. People giving first aid should take care not to touch any exposed cables or tools that may be live.

4 Striking a live buried cable may cause unconsciousness, and the breathing and heart may stop; urgent action is then needed. It is essential to establish a clear airway and cardio-pulmonary resuscitation should be given as soon as possible by someone competent and trained to do so.

5 Electrical burns are deceptive, with underlying damage possibly far more serious than appears on the surface.

* Even ordinary work clothing can greatly reduce the severity of the burns and, of course, flame-retardant clothing is better. However, clothing made from man-made fibres such as nylon may melt and stick to the skin increasing the severity of the burns. This document offers no opinion on whether or when flame retardant clothing should be provided or used. Employers should consider the matter with respect to their own circumstances. **The wearing of flame retardant clothing is no substitute for a safe system of work.**

Sterile covering should be placed over the affected areas as soon as possible to reduce the risk of infection, and all burn cases should receive professional medical attention. Urgent help is essential for severe burns, which can prove fatal.

6 A first-aid container, or small travelling first-aid kit (for those working in dispersed locations with no fixed accommodation or storage on site) should be provided with the standard contents as laid down in paragraphs 5 to 8 of the Guidance Notes for the Health and Safety (First-Aid) Regulations 1981¹⁵. The quantities of equipment should be appropriate for the number of employees involved. Sterile triangular bandages and sterile dressings can be used to cover burns, and a sterile, individually-wrapped, paper disposable sheet or similar sterile covering may be used for burns involving an extensive area. Further advice is given in HS(R)11¹⁵.

7 All cases of injury resulting from an electrical accident should be referred for professional treatment.

8 Advice on appropriate sources of first-aid training can be obtained from local offices of the Employment Medical Advisory Service.

Appendix 7 Suggested text for workers' information

Anyone who works near underground services should be properly trained in safe procedures. Information issued to employees can usefully supplement this training and act as a reminder of the main points. A suggested text is given below. It could be usefully adapted to meet the needs of individual organisations by adding supervisors' names, contact points, etc. It could be produced as a pocket card or leaflet, or in some other appropriate form.

Advice to site personnel when working near underground services

Underground services, particularly electricity and gas, can be dangerous. Damage to electricity cables can cause a

flash, leading to severe burns or even death. Gas leaks can cause fire or explosion.

Damage can result from excavation or penetration of the ground, eg by a road pin.

Underground services may be found in roads, footpaths and on sites. Always assume that they are present. Treat any services found anywhere as LIVE.

Accidents have happened because people have mistaken one service for another, eg black plastic covered electricity cables look like black plastic water pipes and cast iron gas and water mains look alike. **Check before you act.**

Before starting work

- make sure you have **plans** of the underground services in the area. This may not always be possible for emergency or unforeseen works. **Remember that service connection cables and pipes from the main to a building or street light may not be shown;**
- use a cable and pipe locator to trace electricity cables and metal pipes. You should have been trained how to do this. **If in doubt, or if you have any difficulty, ask your supervisor for advice;**
- mark the positions of the cables and pipes using paint or other waterproof marking on the ground;
- look for signs of service connection cables or pipes, eg a gas meter or service connection entry into a house or a street light;
- hand dig trial holes (as many as necessary) to confirm the position of services in the area of your work. This is particularly important if there are plastic pipes, which cannot be found using a locator.

When you start work

- wherever possible, hand dig near

buried services. Spades and shovels are safer than picks, pins or forks;

- check that any cable which is embedded in concrete and has to be broken out has been made dead before work starts, or that another safe way of working has been agreed with the electricity board;
- watch out for signs of services as work continues;
- backfill around services with a fine material. **DO NOT** use flints, bricks, mass concrete or similar material;
- report any damage to a cable, pipe or pipe coating. Even if there is no immediate danger, damage could lead to danger at a later date;
- do not use hand-held power tools within 0.5 m of the marked position of an electricity cable (unless the number of services present makes it impossible or surface obstructions reduce the space available);
- do not use hand-held power tools directly over the marked line of a cable **unless;**
 - (a) you have already found the cable at that position by careful hand digging beneath the surface **and** it is at a safe depth (at least 300 mm) below the bottom of the surface to be broken; or
 - (b) physical means have been used to prevent the tool striking it;
- do not use a mechanical excavator within 0.5 m of a gas pipe. If an excavator is used near an electricity cable keep everyone clear of the bucket while it is digging;
- do not use exposed services as a convenient step or hand-hold;
- do not handle or attempt to alter the position of an exposed service;
- do not install plant close to an existing service. Ask your supervisor to tell you what the separation should be;
- do not build existing services into a manhole or other structure or encase them in concrete.

If you suspect a gas leak

- remove everyone from the immediate area of the escape. Remember that if a service connection to a building has been damaged it may cause a leak in the building. Warn the occupants of the building, and of the adjoining buildings to leave;
- telephone the local Gas region immediately;
- ban smoking and naked flames within 5 m of the leak;
- assist the Gas Board, Police or Fire Services as requested.

REMEMBER - IF IN DOUBT, ASK.

References

- 1 Construction Industry Training Board, Bircham Newton, Kings Lynn, Norfolk PE31 6RH Tel: 01553 776677
- 2 National Joint Utilities Group (NJUG) publication No 3 *Cable Locating Devices*. Available from National Joint Utilities Group, 30 Millbank, London SW1
- 3 NJUG publication No 8 *Performance Guide for the Assessment of Metallic Pipe and Cable Locators*. For availability see reference 2
- 4 *A Code of Practice for Barholing* prepared jointly by British Gas plc and the Society of British Gas Industries
- 5 NJUG publication No 4 *The Identification of Small Buried Mains and Services*. For availability see reference 2
- 6 BS 1710: 1984 *Specification for identification of pipelines and services*. Available from the British Standards Institution

7 Technical note 127 *Trenchless Methods of Construction* published by Construction Industry Research and Information Association (CIRIA), 6 Storeys Gate, London SW1

8 NJUG publication No 7 *Recommended Positioning of Utilities' Mains and Plant for New Works*. For availability see reference 2

9 BS 6187: 1982 *Code of Practice for Demolition*. Available from the British Standards Institution

10 *Health and safety in demolition work*. HSE Guidance Note GS29, Part 1 (rev) HSE Books 1988 ISBN 0 11 885405 4, Part 3 HSE Books 1984 ISBN 0 11 883609 9, Part 4 HSE Books 1985 ISBN 0 11 883604 8

11 *The storage and use of LPG at metered estates* HSE Guidance Note CS1 1, HSE Books 1987 ISBN 0 11 883946 2

12 *Model Consultative Procedure for Pipeline Construction Involving Deep Excavation* published by Water Authorities Association: British Gas

13 *First aid at work* COP42, HSE Books 1990 ISBN 0 7176 0426 8

Further information

The HSE film *Alive . . . or Dead?* covering the hazards from buried electricity cables is available from CFL Vision, PO Box 35, Wetherby, W Yorks, LS23 7EX
Tel: 01937 541010

The future availability and accuracy of the references listed in this publication cannot be guaranteed.



MAIL ORDER
HSE priced and free
publications are
available from:
HSE Books
PO Box 1999
sudbury
Suffolk CO10 6FS
Tel: 01787881165
Fax: 01787313995

RETAIL
HSE priced publications
are available from
good booksellers

HEALTH AND SAFETY ENQUIRIES
HSE InfoLine .
Tel: 0541 545500
or write to:
HSE Information Centre
Broad Lane
Sheffield S3 7HQ

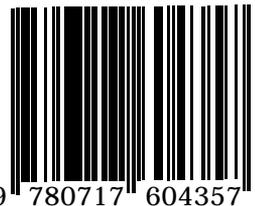
HSE home page on the World Wide Web:
<http://www.open.gov.uk/hse/hsehome.htm>

HSG47

£3.25 net

Formerly ISBN 0 11 885492 5

ISBN 0-7176-0435-7



9 780717 604357