Guide to Utility Management

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FOREWORD

After the disastrous landslip of 1994 occurred in Kwun Lung Lau on Hong Kong Island, the Government has paid more attention on utility maintenance with particular emphasis on leakage detection of buried water carrying services on both slopes and roads. The Government has increased resources and imposed additional legislation on the detection of underground utilities. As a direct result, the utility profession has been developing rapidly, and over the last decade, the number of "Utility Specialists" (管綫專業監理師) has grown as the Government's requirements for Competent Persons to carry out the investigations has been implemented, in addition, Recognized Professional Utility Specialist (RPUS) (管綫專業監察師) has been recognized in recent years. However, lack of standard surveying methods, centralized monitoring systems and organized management, have lead to unsatisfactory investigation results.

In order to address these issues, Hong Kong Institute of Utility Specialists (HKIUS) (香港管綫專業學會), targeting the promotion of knowledge and good practice in the utility profession, collaborated with Hong Kong Utility Research Centre (HKURC) and supported by the funding from the Professional Services Development Assistance Scheme (PSDAS) of HKSAR, published a series of guide books and pamphlets in 12 disciplines of the utility profession in order to set standards for the practitioners to follow. As part of HKIUS continual effort to enhance the professionalism of the utility profession, it is the intention of the series that the quality of the survey can be raised and that utility related incidents can be avoided by performing high quality utility practices. Hopefully, the resulting benefits can extend to the general public.

This issue provides good practice of Utility Management (UM) (管綫管理). It states the ways to manage the underground utilities so that the system can be properly maintained. This document is intended to be used by all personnel involved in the works.

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April, 2011

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1. INTRODUCTION

The underground utility systems in Hong Kong are rather complex but extremely important in support the growth of our society. Construction, maintenance and repair can be extremely difficult due to every utility system is laid according to their own requirement and there is no general system governs all the individual system and how they shall be laid under a systematical manner for the ease of future maintenance, upgrade, and installation new utilities within the system. As-build location of the utilities shall also be accurately recorded for the ease of future reference.

Utility system came from various utility undertakers, public or private. Each of which has their own standard and requirement on lying of their own underground utilities and provide different type of service to the community. General types of underground utility systems in Hong Kong include drainage service, fresh and salt water supply, electricity power, gas, communication, street lighting and government signaling system.

As the city develops, the demand for utility services is also growing. The number of utility services buried underground is enormous. Interruption of services may occur frequently due to deterioration of services or accidental destruction by reckless excavation works. Therefore, utility management is necessary and shall be part of the responsibility of all utility practitioners. A well-managed utility system can reduce the cost of maintenance and risk of utility related accidents. Utility Training Institute (UTI), aimed at maintaining a healthy underground drainage system and safe working environment, prepared guidelines to provide ways to manage the underground utilities so that the system can be properly maintained.

2. OBJECTIVE AND SCOPE

Utility management is to build a systematic utility system. A systematic system makes the installation of new utilities, maintenance of existing utilities and repair of deteriorated utilities easier. The purpose of this guide is to provide recommendations on the ways of utility management to enhance the quality of the utility system.

A comprehensive plan for new installations, good construction practice, careful maintenance and excavation, close monitor to the system and rehabilitation plan gives a sufficient and stable provision of services. Planning for new installation includes the consideration of demand of the services and the geological circumstance of the region. Design consideration of the pipe includes its materials, alignment and level that fit the function of the pipe. Good construction practice avoids long term damage to the pipe that endures its life. Monitoring the system such as periodical checking prevents pipe burst or other accidents and ensures a stable supply of services. Rehabilitation is necessary when the pipes cannot serve its purpose. This document provides practices to manage the utility system. It aims at providing guidelines for the practitioners to follow and facilitating the running of the whole system.

This guide provides information on the practices of utility management. Nevertheless, users of this guide shall refer to relevant documents for further information on safety that are not covered in details. It must be stressed that the guidelines given in this guide are in no way exhaustive, and professional judgment must be employed in all cases.

This guide is intended to be used by all personnel who are involved in utility management, including contractors, utility companies, consultants, government departments and other parties concerned.

3. TYPES OF UTILITIES

Hong Kong's utility system is in high density and very complicated. There are different types of utilities buried underground. They include:

Utilities	Description
Power cable	Power cable for electricity supply, the highest voltage cable of China Light and Power (CLP) and Hongkong Electric Company (HEC) are 400 kV and 275 kV respectively.
Water mains	Fresh water referred to treated drinking water for supply to residential and commercial. There is also raw water, untreated water for transportation between reservoirs. Service water mains operate at a pressure range from 7 to 10 bars and over 20 bars for transportation mains between service reservoirs.
Storm drains and foul sewerage	Transport surface water and used water. Separate into the normal gravity flow pipe and pumping main for increase of water head.
Gas pipes	Transportation of towngas and/or natural gas for residential and/or commercial use.
Telecommunication lines	commercial telephone lines, military communication lines in some areas of Hong Kong
Cable TV lines	Transfer TV signals for residential and/or commercial use.
Other services	Trains, trams, signal control and other abandoned services

The utilities buried underground are usually in the following manner: telecommunication lines are closest to the ground surface with around 0.5 meters depth. The gas pipes buried deeper at 1-2 meters below the ground. Then the high voltage cable that shall be at least 1 meter deep and the deepest shall be storm drains and sewerage drains.

The utility are either owned by government departments, public utility companies and private owners. The owner of the utilities are supposed to possess the information of their utilities, therefore, any person who want to carry out utility works can obtain record plan of the vicinity to have a better picture of the underground utility system.

Government Departments include:

- Water Supplies Department
- Housing Department (for housing area)
- Fire Services Department
- Architectural Services Department (for government residential area)
- Building Department (for
- Drainage Services Department
- Highways Department
- Electrical and Mechanical Services Department
-

Public utility companies include:

- China Light and Power Company Limited
- Hong Kong and China Gas Company Limited
- Hongkong Electric Company Limited
- Hong Kong Tramway Limited
- Hutchison Communications Limited
- Mass Transit Railway Corporation
- New T & T Hong Kong Limited
- Wharf Cable Limited
- New World Telecommunications Limited
- Rediffusion (HK) Limited

3.1 Statutory requirement

Both employers and employees shall comply with relevant occupational health and safety legislations and obligations to ensure a safe working environment and minimize disturbance to the public caused by the work. Every project has its own particular and distinctive features. It is necessary for the project designer to identify the risk arisen from the works and design the works in such a way to remove and reduce the identified hazards present during the progress of the works.

The Workplace Health and Safety Regulations of Hong Kong specify several requirements for personnel involved in works, some of the requirements are stated in relevant ordinance or regulations such as working in a confined space, road traffic control, excavation safety, dangerous substance, noise at work, etc. It is important to follow relevant ordinances stated on the Occupational Safety and Health Council (http://www.oshc.org.hk) before commencement of work.

Also, operators shall use Personal Protective Equipment (PPE) and shall have sufficient knowledge in both usage and maintenance of the equipment. PPE shall include:

Steel toe cap, rubber safety boots
Safety helmet
Safety vest (reflective at night)
Safety goggles/Anti-glare glasses
Breathing apparatus/Disposable respirator
Harness and Fall arrester
Gloves
Ear muffs / ear plugs
Handy gas detector
Audio-visual alarm
Resuscitator

In works for the Water Supplies, the Drainage Services or other government departments, appropriate steps shall be taken to minimize or even eliminate any potential risks for injuring the public. In case where excavations is required, the access around the work area has to be properly supervised by a Competent Person (CP) (合資格人士), under Cap. 406H, the Electricity Supply Lines (Protection) Regulation, at all times. The access for "essential services", e.g., police, fire service and ambulance, has to be retained. Access to other public services, such as bus stops, footpaths, etc, shall also be maintained and supervised.

If excavations are required, no dirt, excess spoil or any other materials shall be left in the water channel to avoid polluting the drainage system. Sediment control procedures can refer to the Environmental Protection Department (http://www.epd.gov.hk).

Additional requirements shall be complied for some utility works. Extra safety precautions shall be taken when working in confined space, near electricity lines and gas mains. Working near MTR facilities requires the permission of the MTR Corporation.

4.2 Personnel Requirement

All utility works shall be performed by properly trained and accredited personnel. Accredited personnel shall hold a certified qualification issued by a Registered Training Organisation (RTO), such as Utility Training Institute or The Hong Kong Polytechnic University or equivalent.

Type of Personnel	Role	Minimum Training Requirement	Minimum Years of Experience
Project Leader (M/ FHKIUS + RPUS)	Contractual arrangement, check and certify reports.	Training courses for utility survey/detection methods and data management.	10 years in contract administration, preferably in utility survey.
Team Leader (M/FHKIUS)	Works arrangement, check data quality and consistency.	Training courses for utility survey/detection methods and data management.	10 years in works of utility survey.
Crew Leader (O/MHKIUS)	Supervision of field works and site safety.	Training course and valid training certificate for utility survey.	5 years in works of utility survey.
Operator (AMHKIUS)	On-site inspection and operation of equipment.	Training course and valid training certificate for utility survey.	3 years in works of utility survey.

Table 3.3.1 Training and Experience Requirements for Personnel Carrying Out Utility Survey using PCL. (Reference to the Code of Practice on Monitoring and Maintenance of Water-carrying Services, Work Branch, 2006 and HKIUS constitution, 2010)

All works within sewers, manholes or other confined spaces shall be carried out by Certified Workers of confined space and shall be performed in accordance with the requirements for works in the vicinity of Confined Space and Occupational Health & Safety Legislations, as well as any additional precautions that may be specified by the asset owner.

5. DESIGN AND CONSTRUCTION

Good design of the utility system and construction practices endure the lives of the pipelines. Many factors shall be put into consideration when designing the pipelines. The choice of materials, alignments and the surrounding environment etc. can affect the lives of the pipelines. Construction practices such as whether the pipe is laid on a leveled ground, whether the joint is well fitted, etc., contribute to the endurance of the pipe. The government has set out rules for pipe design. When the pipe is being laid, details of the installed pipe such as size, material, alignment and depth shall be recorded properly. Such records are useful in the future for the purpose of installing new pipes in the nearby vicinity, maintenance and rehabilitation.

5.1 Electricity Supply System

The Hong Kong and China Light Power and The Hongkong Electric are the two electricity suppliers of Hong Kong. Power cables are usually buried in a shallow depth. The following shall be considered when designing the electricity supply system.

Main Supply and Distinction
Load assessment

- Locations and types of loads expected (voltage, frequency, and phase).
- Load estimation shall base on floor area or consumer units.
- Major load centres and electrical equipment (identify and focus on them).
- Allow for diversity or future expansion.

Design of distribution substation (transformer Tx room)

- Electricity supply provided by establishing a substation at the building or by direct.
- Cables from existing low voltage network.
- Location of transformer room(s).
- Design requirements of HEC or CLP have to be satisfied.

Essential (Emergency) Power Supply

- Assessment of essential loads to be supplied to (e.g. fire services pumps, fireman's lift, emergency lighting).
- Design of standby emergency generator.
- Location, capacity required operation.
- To comply with Fire Services Department's requirements.

Lighting System

- Design criteria
- Lighting (illuminance) level in lux (unit of illuminance and luminous emittance) for each area of the building.

Selection of luminaries for different usage and applications.

- Simple lighting calculations (lumen method).
- Lighting (switching) control and lighting circuit.
- Emergency lighting (separate circuitry may be required).
- Outdoor lighting (e.g. floodlighting and neon lights).
- Coordination with architectural and interior design.

Design Considerations

- Relationships with and implications from other Building Services systems.
- Electrical design always comes after others because it has to obtain ratings and demand of equipment from other services systems.

1) Coordination of electrical services with other trades and with architectural design.
2) Space requirements: (estimate the space required and make adjustments later on).
   For Tx room and emergency generator.
   (i) For rising main, meter room.
   (ii) For distribution boards (in cupboards, in corridor or on walls).
   Accessibility of equipment (e.g. access to Tx room by HEC/CLP personnel).
   Estimated costs for electrical services systems and other B.S. systems.

Materials and structures of electrical conduits

Electrical conduits and fittings

Electrical conduits and fittings shall comply with BS 4568: Parts 1and 2 and shall have Class 4 heavy protection inside and outside. Conduits shall be heavy gauge with screw-end construction in steel and shall have an external diameter of at least 20 mm. Conduits shall be longitudinally welded.

Metal boxes for enclosing electrical accessories shall comply with BS 4662 and shall have heavy protection inside and outside. The boxes shall be of preferred sizes and shall be 35 mm or 47 mm deep as appropriate. Circular ceiling boxes of deep pattern shall comply with BS 4568: Part 2 and shall have Class 4 heavy protection inside and outside. The boxes shall be at least 60 mm deep internally.

Cable ducts and fittings

uPVC and steel are common materials used for the cable ducts and fittings. uPVC cable ducts for installation above ground or for casting into concrete shall be Class 0 uPVC pipes complying with BS 3506. Cable ducts for installation below ground shall be Class B uPVC pipes complying with BS 3506.

Joints and fittings for use with uPVC cable ducts shall comply with BS 4346: Part 1 and BS 4346: Part 2. Solvent cement for uPVC pipes and fittings shall comply with BS 4346: Part 3.

Steel cable ducts shall be steel tubes complying with BS 1387, medium series, screwed and socketted tubes and shall have screwed sockets suitable for screwing to BS 21, Table 2 pipe threads. The tubes, sockets, clamps and saddles for ducts shall be hot dip galvanized in accordance with BS EN ISO 1461:1999.

Alignment

Concealed electrical conduit systems shall be arranged and installed in accordance with best trade practice and in such a manner that all cables can be drawn with ease and without damage.

Bends in concealed electrical conduit systems shall be formed by using proprietary bending equipment of a type agreed by the Engineer. Connections and other work shall be carried out using purpose made equipment. Conduits shall not be bent by more than 90° and the internal radius at bends shall be at least 2.5 times to the external diameter of the conduit. Conduits shall not be flattened at bends. Burrs and sharp edges shall be removed from the ends of conduits before installation. Concealed electrical conduit systems that are to be cast into concrete shall be fastened to the reinforcement with tying wire of the same type used for the reinforcement. The conduit systems shall not be positioned between the reinforcement and the outside face of the concrete unless permitted by the Engineer.

Conduit boxes shall be of compatible size and shall have a single extension ring of the required depth if the plaster finish exceeds 13 mm thick. Multiple extension rings shall not be used.

5.2 Gas Supply System

There are three types of common fuel gas being used in Hong Kong, town gas, natural gas and LPG. Gases are being conveyed in pressurized pipes of various pressures. As the gas pipes are highly explosive, extreme care shall be taken when carry out gas pipe works or work near the gas pipes. Protective measures can be taken to protect the pipes from damage and shall be on the list of design consideration.

Design considerations:

1) The following shall be considered in planning and installation of the gas pipes.

2) Pipe arrangement is similar to water supply.

3) Gas pipes must have fall and drain points.

4) Underground pipes shall be protected by bitumen or ‘denso’ tape to prevent leakage.

5) Naturally ventilate spaces is preferred.

6) Allow easy detection of leakage

7) Gas company shall be consulted before installation

8) Gas meter must be sited conveniently for access

Materials

Mild steel and Polyethylene pipes are two common materials used for gas pipes.

Material Type	Material Standard	Size Range (mm)	Max. Operating Pressure	Jointing Method
Ductile Iron (DI)	BS 4772 / EN 969	Ø100 - 400	240 kPa	Mechanical Flexible Jointing System
Galvanized Iron (GI)	BS 1387	1□50	7.5 kPa	Screw Joints
Steel (ST)	API 5L	Ø50 - 750	3500 kPa	Welded Joints & Flanged Joints
Polyethylene (PE)	GBE/PL2 EN1555 GB15558	Ø32 - 400	400 kPa	Butt Fusion Electrofusion Transition Fittings

**GI pipe of dia. 50mm or less can take up to 240kPa operating pressure

Precautions shall be taken during installation as gas is explosive.

- Do not fit inside chamber or pipe duct with electrical devices because sparks may cause fire or explosion.

- Spacing and insulation when in contact with other services to reduce the risk of excessive heat and leakage.

Sufficient free area for ventilation in gas pipe shafts, such as grille at the highest point.

5.3 Drainage

The drainage system is divided into two sub-systems, the sewage system and stormwater drainage system.

Sewage drains
In planning the sewerage system, the following documents shall be referred to ensure the compatibility with the overall strategy and master plans:

- The Sewage Strategic Study (SSS) for Hong Kong and the Strategic Sewage Disposal Scheme (SDSS);

- The appropriate Sewerage Master Plan (SMP) Study.

The following factors shall be taken into consideration when there are new installations of storm drains:

Wastewater characteristics	Flow components and loads of the wastewater
Existing data	Existing data of domestic, commercial and industrial flow
Population and Employment forecasts	Planning data must be represented in a form compatible of unit sewage flows.
Flow estimation	For existing sewage development, it is preferable to take into account the field data, with the objective of identifying industrial and groundwater infiltration components. For new development, this can only based on global unit flow parameters.
Load estimation	Similar to that of flow estimation
Global flow and load parameter	This shall be considered in new development of the sewage system.

Design Criteria

Capacity (gravity pipelines)

A sewer is subjected to a wide range of flow conditions. It must have sufficient capacity to cater for the designed peak flow. On the other hand it must also minimize the deposition of solids under low flow conditions.

The maximum flow rate for a circular pipe at no surcharge occurs when the flow depth is about 0.8 pipe diameters. For design purposes, the full bore flow at no surcharge shall be taken as the design capacity of the sewer.

Levels

As the size of the sewer increases downstream, it is normal practice to align the soffits at the same level in manhole. This is to prevent the sewer from being surcharged by back water effect when the downstream sewer is flowing full. Similarly, when a lateral sewer joins a main sewer, the soffit of the lateral shall not be lower than that of the main sewer. If the situation allows, it is preferable to have the lateral at equal soffits to minimize the possible surcharge of the lateral.

Alignment

The designer shall check carefully whether the alignment of sewer will be obstructed by other utilities.

Material

The following factors shall be taken into account in selecting the type of pipe for a project:

Hydraulic design: gravity or pressure flows;

Structural design: crushing test strengths (and pressure ratings in the case of pressure pipelines) that are available;

Nature of the fluid to be conveyed;

Nature of ground water and external environment;

Cost considerations: capital and maintenance costs;

Pipe jointing system: ease of installation, past performance;

Durability: resistance to corrosion and abrasion

Ease of cutting and branch connections;

Availability of pipe size, fittings and lengths in the market for construction and subsequent maintenance;

Length and weight of individual pipes in relation to transportation and handling;

Future operating procedure and system development.

Corrosion Protection

In general, most of the pipes and fittings are susceptible to both internal and external attack by corrosion unless appropriate protective measures are adopted. The degree of attack depends on the nature of the soils, the characteristics of the fluid being conveyed and the type of pipe protection used.

5.2 Storm drains

Construction

Construction of storm drains shall be complied with the specifications set by the Government. The planning of the storm drainage system involves the assessment of the performance of the existing system within a catchment and the design of a new or upgraded system to allow for the impact of new development within the catchment and/or to assess the necessity and feasibility of bringing the flood protection standards up to the level set by the Government.

Rainfall analysis	Based on historic or synthetic rainstorms. For design purpose, synthetic rainstorms based on Gumbel distribution are recommended.
Sea level analysis	Sea level forms the downstream hydraulic boundary condition of stormwater drainage system.
Flood protection standards	Design standard for drainage system that is adequate to accommodate a T-year flood, where T is the design return period of the flood event. Appropriate flood protection standards shall be chosen to suit the type, category and design life of the drainage system.
Runoff estimation	Methods to estimate runoff from single storm event can be based on statistical or deterministic approaches.
Hydraulic analysis	Hydraulic analysis for drainage planning or design makes use of runoff results of the various subcatchement and the characteristics of the drainage system to determine flood levels throughout the system.
Erosion and sedimentation	Common applications in the drainage field including river bed and bank protection, velocity design in channels and pipes, scour around bridges piers and the quantification of sedimentation at the lower reaches of drainage systems.

Material

In general, concrete pipes have been used extensively for stormwater pipelines throughout the Territory and are normally available up to 2500mm diameter. Where the stormwater flow is severely polluted, consideration may be given to the use of vitrified clay pipes to provide better protection against corrosion. Other pipeline materials are available and may be considered in relation to their advantages and disadvantages for particular situations. If such alternative materials are proposed, full account shall be taken into their acceptability from the operation and maintenance point of view.

Levels

As the size of a stormwater drain increases downstream, it is preferable to maintain the soffits at the same levels at the manhole. This is to prevent the drain from being surcharged by backwater effect when the downstream pipe is flowing in full rate. Similarly when a lateral drain joins a main drain, the soffit of the lateral shall not be lower than that of the main drain. If the situation allows, it is preferable to have the lateral at a higher level to minimize possible surcharge of the lateral.

Designing for flush soffit requires adequate fall along the stormwater drain, and may not be achievable especially over reclaimed land. Under this circumstance, the inverts shall be kept at the same level to achieve a smooth flow when the stormwater drain is flowing partially full.

Depth of pipeline

Designers shall avoid burying deep underground pipelines. In general, the maximum depth of a pipeline shall not be more than 6 m, below such depth, maintenance and reconstruction of the pipeline will be very difficult. If the situation warrants such deep pipeline, one shall always consider other alternatives including the use of intermediate pumping station.

Normally, the minimum cover from the surface of the carriageway to the top of the pipeline shall be 900 mm. For footway, the minimum cover shall be 450 mm.

Pipe bedding, laying and jointing

The engineer-in-charge shall determine the suitable bedding and pipe materials to be used, and the appropriate depth of bedding.

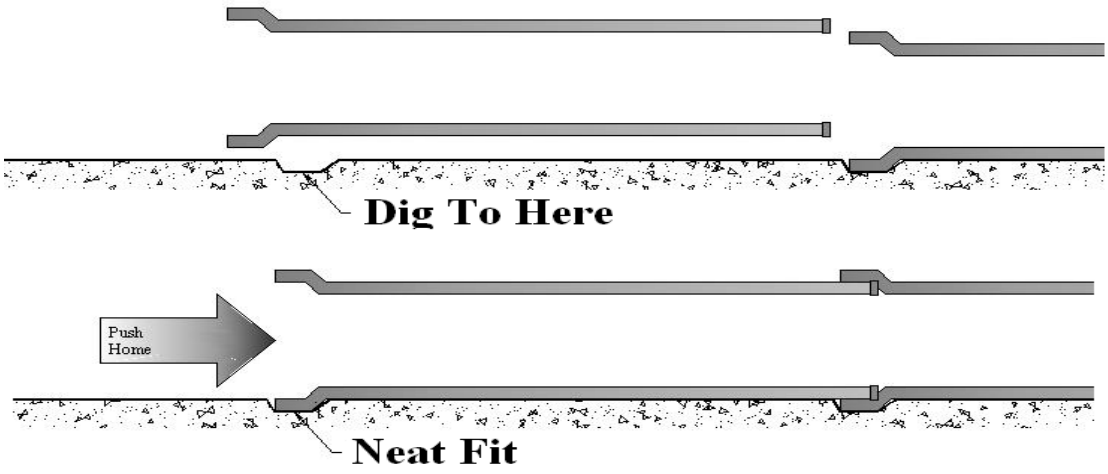

Fig. 5.1 General precautions for pipe laying

The bedding must be level, compacted and able to support the full length of the barrel of the pipe. Failing to meet such requirements can lead to defects such as cracks and fractures.

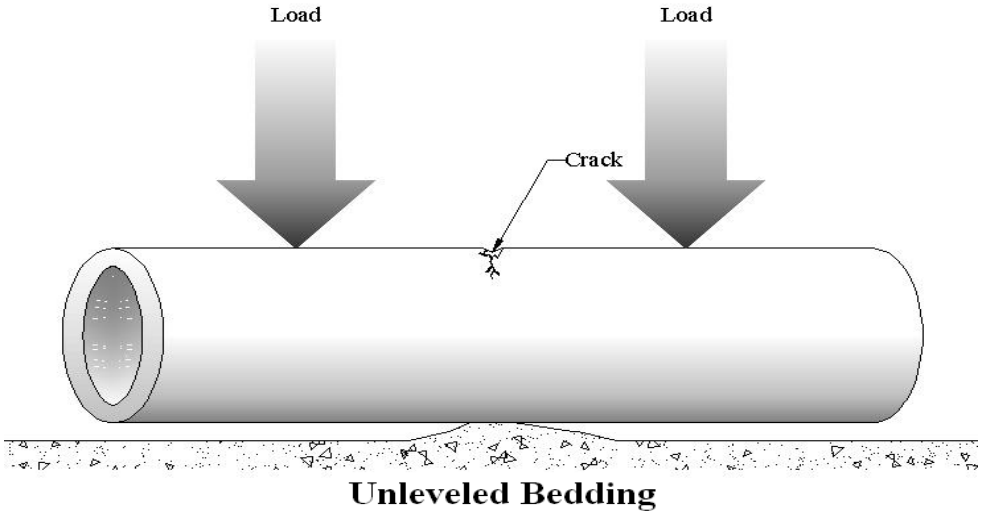

Fig. 5.2 Defect as a result of unleveled bedding

In laying the pipe, the operator shall ensure the pipe is bedded evenly along the full length of the barrel and dig rooms for the socket.

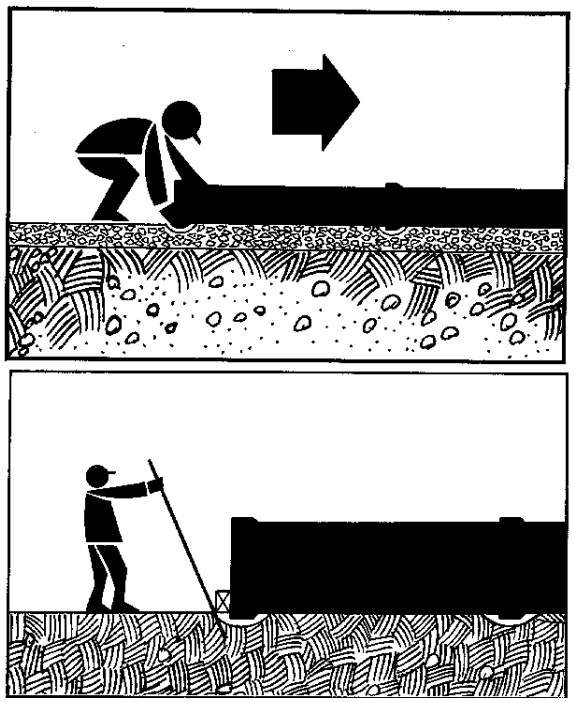

Fig. 5.3 Proper ways of pipe laying

Large diameter pipes require mechanical means to successful laying.

Fig. 5.4 Laying of large diameter pipes

Fig. 5.5 Set pipe in position by crane

Fig. 5.6 Pipe re-position by manual tool

Fig. 5.7 Setting of rubber ring

Fig. 5.8 Finished first layer backfill

Bedding Factors

The strength of a precast concrete or vitrified clay pipe is given by the standard crushing test. When the pipe is installed under fill and supported by bedding, the distribution of loads is different from that of the standard crushing test. The load required to produce failure of a pipe in the ground is higher than the load required to produce failure in the standard crushing test. The ratio of the maximum effective uniformly distributed load to the test load is known as the 'bedding factor', which varies with the types of bedding materials under the pipe and depends to a considerable extent on the efficiency of their construction and on the degree of compaction of the side fill.

The methods of bedding with precast concrete pipes are shown on the relevant DSD Standard Drawing. The values of the bedding factors below are average experimental values and are recommended for general purposes:

(a)	granular bedding	1.9
(b)	120_o plain concrete bedding	2.6
(c)	120_o reinforced concrete bedding with minimum transverse steel area equal to 0.4% of the area of concrete bedding	3.4
(d)	concrete surround	4.5

All new conduits/pipelines/manholes shall be surveyed prior to acceptance to confirm the construction is in accordance with design specifications and that they are:

- Clean, with no construction rubble/rubbish;
- Straight between the two manholes/nodes;
- Level, on grade with no ponding;
- Joints in accordance with manufacturers specifications for rebound;
- No structural defects e.g. cracks, fractures, broken;
- No infiltration.

6. MAINTENANCE

Instead of remedial actions taken after the damage to the pipes, preventive measure is a relative active approach.

Maintenance Objectives

The objectives for proper maintenance and operation include:

- To offer a quality of service that is acceptable, having regard to costs and the effects on the environment, and to remedy recognised deficiencies.
- To monitor the capacity of the system and to restore the flow capacity by removal of excessive accumulation of silt and grease, etc.
- To monitor and maintain the structural integrity of the system.
- To prevent excessive infiltration and inflow.
- To desilt for environmental reasons so as to mitigate nuisance to the public.
- To provide feedback when necessary on the need for improvement and upgrading works
- To achieve the above service objectives by making the best possible use of manpower and resources at the least cost and least disruption to the public.

Preventive measures include monitoring of the system and prevent damage to the pipe.

6.1 Monitoring of the system

Inspection of all existing utilities installations shall be carried out regularly to ensure that the systems operate properly. The frequency of inspection shall be determined principally based on the nature and importance of the installations, the likely consequence in the event of malfunctioning of the system, the frequency of drainage complaints received in the vicinity and the resources available. Priority shall be given to the system installations where the result of any failure would be serious or the remedial works particularly expensive.

Water and sewerage system
Special attention shall be paid to any sign of deterioration in the systems both hydraulically and structurally, since any structural defect, blockage, leakage or siltation detected at its early stage of formation would allow preventive remedial works to be carried out at lower cost.

Ways of inspection for water system:

1) Installation of permanent noise loggers

2) Inspection by leak noise correlation, electronic/ mechanical detection

Ways of inspection:

1) Closed Circuit Television Surveys
2) Desilting programme
3) Manual rodding and scooping
4) Water jetting

Some drains or water mains may need special treatment:

- Conduits within Red Routes, Pink Routes and Expressway

- Conduits behind slopes

Gas system
The service suppliers shall ensure the services provided are smooth and uninterrupted. Regular inspection shall be carried out by trained technicians on all types of pipes to check for any leakage or seepage from the pipe. Gas leakage can lead to serious consequences such as explosion and fire.

Electricity and telecommunication network
The service suppliers shall impose close supervision to the services. Control center can be established to obtain real-time information regarding the transmission of the services. Any damages and problems of the system can be notified immediately by the control center.

6.2 Prevent damage

Prevention of damage to pipes starts from good design and construction. Up to standard design and construction works maximize the function of the pipes and minimize long term damage to the pipes. Another common cause of damage to pipes is excavation. Pipes are vulnerable when they are exposed. The best way is to reduce the number and scale of excavation works to minimize the exposure of pipes. If excavation is necessary, attempt every measure and precaution to avoid damage to the pipes.

To minimize the number of excavation works, the works shall be well coordinated. Highways Department has established rules and systems to manage the request of excavation. An excavation permit by the Highways Department shall be issued before the commencement of any road opening works.

To apply the excavation permit, the utility undertakers shall register the road opening works to the Highways Department. In order to minimize the disturbance to the public, the Excavation Permit Management System implemented by the Highways Department has figured out conflicting works or repeated works and the applicants shall make correspondent coordination to reduce the number of road opening works. Once a series of works have been completed and the affected road section reinstated, excavation will normally not be allowed to take place in the same area for a period of three months.

To avoid occurrence of repeated opening at the location of the proposed work, the responsible inspector of works shall check whether:

1) Any other utility undertakers has carried out excavation at that location not more than 3 months before the intended commencement date of the proposed work;

2) Any other utility undertakers will carry out excavation at that location within 3 months after the intended completion date of the proposed work;

3) The applicant has ever carried out excavation at that location not more than 6 months before the intended commencement date of his proposed work (Note: Trial hole/trench excavations shall not be taken into account as repeated openings); and

4) The applicant will carry out excavation at that location again within 6 months after the intended completion date of his proposed work.

If repeated opening is identified, the inspector of works shall inform the applicant to adjust the proposed start date of his plan.

In order to avoid damage to other utilities and possible consequential accidents, the applicant shall collect information regarding the alignment of the underground utilities within the vicinity. A centralized database could greatly reduce the effort in collecting utility records from each utility undertaker. Utility Undertakers began to computerize utility records in early 1990s. In 2000, 8 utility undertakers and Government Departments committed to develop the Electronic Mark Plant Circulation (EMPC) System, a system to request / provide utility records electronically. The system can automatically compile and transmit electronic utility record drawings by email to the requesting organizations. This saves time and effort of both the requesting organizations and the replying organizations (i.e. utility undertakers).

The Police, Highways Department and Transport Department shall also be noticed if the opening area is significant. Details of the permit can refer to Excavation Permit Processing Manual (2010) issued by the Highways Department. The manual can be accessed via www.hyd.gov.hk.

If excavation work is necessary, suitable measures shall be strictly implemented to prevent damage to the utilities. Some general rules are listed below:

When digging the ground
Location of the utilities shall be ensured by cable detection devices. Mechanical excavators and hand-held power tools shall not be used too close to the utilities. Certain distance of clearance between the service and the point where the machines are used shall be maintained. Hand tools can be used to expose the lines. Hand tools shall be used alongside the service rather than directly above the service.

When the services are exposed
It is essential to provide temporary support for the excavation (e.g. shoring, or timbering or sheet piling, as the case may be) to ensure the stability of the excavation during works. For excavation depth of less than 1.2 m, shoring support may not be required for ground that is found to be self-supporting. However, if external loads are likely to be present, or if there is doubt to the stability of the trench sides due to the presence of weak ground or high groundwater, especially in inclement weather, the trench sides shall be supported even if the excavation depth is less than 1.2 m.

Backfilling

All warning tapes, tiles, protection plates or other protection materials shall be reinstated in their original position by the working party. The service suppliers shall be approached to make up protection materials if they are found to be damaged or missing before the backfilling.

The same backfilling materials shall be used unless otherwise agreed with the electricity supplier. In general, cement bonded sand or sieved soil of suitable fineness shall be used as covering material for the backfilling. Unsuitable filling materials are likely to cause damage.

If doubt, the working party shall seek advice from the service suppliers on the specific backfilling requirements (thickness of the bedding layer, type of materials to be used and method of compaction, etc.).

The backfill shall be adequately compacted, particularly beneath the service, to prevent any settlement which would subsequently damage the service. No power compaction shall take place until cover of certain thickness of selected fine fill or sieved soil has been suitably compacted above the service.

Specific requirements are set up for different types of services. For water services, please refer to 'How to prevent damage to water mains' published by WSD. For electricity supply lines, Code of Practice on Working near Electricity Supply Lines by EMSD provided detail requirements on working near underground and overhead electricity supply lines. For gas mains, 'Avoid Danger from Gas Pipes' states good practice for working near gas pipes.

Trench excavation

Support of trench excavation shall be constructed strictly in accordance with the design and contract specifications. In no circumstances shall workers be permitted to work in an unsupported trench which is deeper than 1.2 m. Some general guidelines on the requirements of the support installation are given below.

In ground composed of moderately firm to firm soil, vertical trench sides may stand unsupported for a considerable period of time, and hence half timber board support or half sheet pile support may be adequate provided that the groundwater level is below the bottom of the trench. When the ground condition is poor and has little or no "free-standing" time, full timber board support or full sheet pile support shall be installed in such a way that the sides of the trench are supported at all times. That is, installation of sheeting, excavation and insertion of walings and struts proceed by stages until the full excavation depth is achieved.

Installation of support ahead of the excavation to the full depth is in advantage where the soil and sheeting sections allow this. Use of sheet piles rather than timber boards makes it possible to drive to full depth ahead of excavation in most ground and to greater depths. This is considered advantageous where the trench is constructed in poor ground and there are few crossing services. Where existing services crossing a trench line are encountered, timber board support shall be provided as far as possible to the exposed excavation face surrounding the services. If decking for traffic or pedestrians is not required, support frames shall ideally protrude above ground level.

Removal of struts may be required in order to give access during lowering of pipes or equipment, or compaction of backfill. Only the minimum practicable number of struts shall be removed. It is important that the ground is adequately supported at all times while workers are working in the trench.

7. REHABILITATION

7.1 Pipe Replacement

When pipes are found to be damaged, repair work shall be carried out as soon as possible. Replacement of damaged pipes by open excavation is a commonly used method.

To replace defective pipes by open excavation method, always pay attention to the following:

- maintenance of the existing flow
- road traffic conditions
- presence of underground utilities
- nuisance and inconvenience to the public
- excavation dewatering
- working area and shoring requirements

Close liaison with the utility undertakings and traffic authorities is required before the replacement work is carried out so that suitable construction method can be determined. The drawback of the open excavation method is that it may occupy substantial road space for a long period of time. In the urban area with heavy traffic, the economic loss due to traffic disruption as a result of open excavation is becoming hard to justify. At the same time, people's aspiration is rising and they are becoming less tolerant to traffic disruption. As a result, when drainage repair or improvement is required, trenchless methods for pipe rehabilitation shall be considered as alternatives to open excavation.

7.2 Trenchless Methods

For most trenchless methods, the scope to increase the flow capacity is rather limited. In general, the unit cost of trenchless renovation is higher than conventional open cut technique where the pipeline to be replaced is shallow and there is no obstruction due to underground utilities or other physical structures. However, when the need for increased flow capacity is not a deciding factor, trenchless renovation method can be employed with benefits of keeping social costs and economic losses to a minimum as well as avoiding physical obstruction problems that would otherwise arise if conventional method is used.

However, if the defective drains in the urbanized area have become under-capacity, opportunity shall be taken during the remedial works to replace them by larger pipes so that the overall capacity of the network can be increased to cope with any anticipated developments.

Some typical trenchless methods which can be used for the rehabilitation of defective pipes are described in the following paragraphs. It shall be noted that the list is not exhaustive and other methods may also be applicable.

7.3 Localised Repairs and Sealing

Joint Grouting. This method is applicable to drains in which leaking is through the joints but the drains are still structurally sound. Chemical grout is injected into the leaking joint, filling up the void surrounding it to stop further leakage. For small drains, the chemical grout is internally applied by an inflatable packer guided by a CCTV camera and the same packer is used to test for air tightness of the grouted joint. For large pipes, it may be more convenient to send people into the drains to carry out the grouting directly.

Mechanical Sealing. This method involves the installation of a metal band or clip faced with an elastomeric material at the damaged section of pipe, which forms a seal with the inner surface of the pipe. It has the advantage of not relying on in-situ chemical reaction, and can also be installed quickly.

7.4 Internal Lining

Internal Lining using Epoxy Impregnated Liner. This method uses a factory fabricated lining tube conforming to the internal dimension of the drain to be rehabilitated. The liner consists of one or more layers of polyester felt in contact with impervious polyurethane membrane, the thickness of which are chosen to suit individual requirements. The polyester lining is firstly impregnated with specially formulated resin in the factory. After delivery to site, the liner is inserted into the defective drain and properly expanded so that its external surface is in contact with the interior of the defective drain. A high temperature environment is introduced inside the liner to enable the resin impregnated polyester felt to cure, harden and form a continuous solid pipe inside the original pipe. Any branch connection to the relined drain can then be reopened with a remotely controlled hole cutting machine.

Internal Lining using Pre-deformed Polyethylene Liner. This method involves placing a factory made polyethylene liner inside the defective drain. The liner is firstly deformed, then wounded on a reel and delivered to site. It is pulled through the existing drain by winches. Water at high temperature and pressure is then used to cure and to restore the circular shape so that the liner fits snugly inside the old pipe.

Internal Lining using a Smaller Pipe. This method involves pulling/pushing a thin walled pipe such as steel pipe, GRP pipe, HDPE pipe and so on, through a defective drain. The external size of the new pipe is smaller than the internal size of the old pipe. The pipes are generally jointed by welding as the pipes are pushed. The annular space between the new and the old pipes is grouted by cement/concrete.

7.5 On-line Replacement

Pipe Bursting. This method, sometimes called the pipe eating system, employs powerful hydraulic expanders or bursters which progressively destroy and expand the old pipe as it advances itself through the pipe. The replacement pipe, generally of larger size, is pulled in behind the bursters. The method has been used overseas but its potential applicability in Hong Kong is rather limited as it may easily cause damage to other utilities in the close proximity. However, computer aided design checks are now available to assess whether this technique is safe. This method is normally employed only for small diameter pipes as huge bursting force is required for the burster. Specialist shall be consulted when considering employing this method.

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Appendix A: Abbreviations

Company/ Organization	
Code	Description
BD	Buildings Department, HKSARG
CEDD	Civil Engineering and Development, HKSARG
DSD	Drainage Services Department, HKSARG
EMSD	Electrical and Mechanical Services Department, HKSARG
EPD	Environmental Protection Department, HKSARG
HA	Hong Kong Housing Authority, HKSARG
HKIUS	Hong Kong Institute of Utility Specialists
HKURC	Hong Kong Utility Research Centre
HyD	Highways Department, HKSARG
LandsD	Lands Department, HKSARG
LD	Labour Department, HKSARG
PolyU	The Hong Kong Polytechnic University
UTI	Utility Training Institute
WRc	Water Research Centre
WSAA	Water Services Association Australia
WSD	Water Supplies Department, HKSARG
WTI	Water Training Institute
Others	
Code	Description
%	Percentage
BMP	Bitmap (Picture Format)
BWCS	Buried Water Carrying Service
CCE	Conduit Condition Evaluation
CCE(CCTV & ME)	Conduit Condition Evaluation(Closed Circuit Television & Man- Entry)

Company/ Organization	
CCES	Conduit Condition Evaluation Specialists
CCTV	Closed Circuit Television
CD	Compact Disc
CL	Cover Level
COP	Code of practice
CP	Competent Person
DN	Nominal Diameter
DP	Design Pressure
DVD	Digital Versatile Disc
e.g.	Exempli Gratia
GIS	Geo-Information System
EPR	Environmental Protection Requirements
etc.	et cetera
GL	Ground Level
H	Height
HKCCEC	Hong Kong Conduit Condition Evaluation Codes
HPWJ	High Pressure Water Jetting
hr	Hour
Hz	Hertz
ICG	Internal Condition Grade
ID	Internal Diameter
IDMS	Integrated Data Management System
IL	Invert Level
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group (Picture Format)
kHz	Kilo- Hertz
kPa	Kilopascal

Company/ Organization	
m	Meter(s)
ME	Man Entry
MHICS	Manhole Internal Condition Survey
mm	Millimetre(s)
Mpa	Megapascal
MPEG	Motion Picture Experts Group (Video Format)
MS	Method Statement
MSCC	Manual of Sewer Condition Classification, UK
OHSAS	Occupational Health and Safety Assessment Series
PPE	Personal Protective Equipment
ppm	Parts per million
PS	Particular Specification
PSI	Pound Per Square Inch
QA/ QC	Quality Assurance/ Quality Control
Ref.	Reference
RMSE	Root Mean Square Error
RPUS	Recognized Professional Utility Specialist
RTO	Recognized Training Organization
SCG	Service Condition Grades
SOPs	Safe Operator Procedures
SPF	Sun Protection Factor
SPG	Structural Performance Grade
SRM	Sewer Rehabilitation Manual
STP	System Test Pressure
TTA	Temporary Traffic Arrangement
US	Utility Specialist
VHS	Video High Speed

Company/ Organization	
W	Width
WLD	Water Leakage Detection
WO	Works Order
WP	Work Procedure

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Guideline Amendment Form

Please fill in the following form if any error or mistake is found in this manual. We thank for your support and appreciate your continuous help in improving this manual.

Discipline*	Page No.	Description of Existing Content	Suggested Amendment

* A. Conduit Condition Evaluation (CCTV and ME Survey)
B. Manhole Internal Condition Survey
C. Utility Survey (Pipe Cable Locator Survey, PCL)
D. Water Leakage Detection and Control
E. Advanced Leakage Detection of Buried Water Carrying Services Affecting Slopes
F. Pipe Rehabilitation by Trenchless Technology
G. GPR(Ground Penetrating Radar) Survey
H. Flow Study in Drainage Conduit (流量監控)
I. Pipe Condition Surveys by other non-destructive methods
J. Data Management for Utility Records
K. Utility Management
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