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10 PIPELINE CLEANING AND INSPECTION SURVEY

10.1 GENERAL

10.1.1 Scope

- 1 This Part includes the specification for all work necessary to clean and carry out inspection surveys of sewerage pipelines. The specification applies equally to the cleaning and inspection survey of surface water and ground water pipelines.
- 2 Related Sections and Parts are as follows:

This Section

Part 1, General
Part 2, Earthworks
Part 4, Pipe Installation
Part 11, Sewer Rehabilitation

Section 1, General.

10.1.2 References

- 1 The following document is referred to in this Part:
Water Research Centre (WRC) Manual of Sewer Condition Classification
Water Research Centre (WRC) Sewer Rehabilitation Manual

10.1.3 Submittals

- 1 The Contractor shall submit complete data and details for pipelines cleaning and inspection survey for the Engineer's approval as follows:
 - (a) programme of work, detailed method statement, and schedule of equipment to be used on the project, general plant, and specialist equipment.
 - (b) proposed methods of flow diversion and overpumping
 - (c) specific data for the proposed specialist equipment before beginning any sewer cleaning and inspection as follows:
 - (i) original catalogues for all the proposed specialist equipment, which complying with the Specifications. These catalogues shall be considered as an integral part of the Contractor's method statement. All equipment to be provided for sewer cleaning and closed circuit television (CCTV) survey and sonar scanning shall be reliable and in good working condition
 - (ii) typical video recordings preferably on CD ROM of similar work carried out previously by CCTV camera and sonar scanner. Such recordings, if acceptable, will be retained by the Engineer as the standard for appraisal of subsequent recordings
 - (iii) video graphic printer
 - (iv) still pictures in digital format (Tiff, JPEG) for computer data storage and retrieving
 - (d) specific data to be submitted while carrying out and at the completion of the work:
 - (i) site coding sheets as designated under Clause 10.3.6 in this Part
 - (ii) the master and a copy of each video recording as designated in Clause 10.3.2 in this Part

- (iii) still colour pictures using video graphic printer of the inside of sewers, manholes, inspection chambers, and grease and oil interceptors, and the interior of pumping stations as required and as specified in Clause 10.3.5 of this Part.
- 2 The Contractor shall submit a method statement to the Engineer for approval four weeks in advance of commencing activity on site. The method statement shall comprise but not necessarily be limited to:
- (a) Equipment set-up and locations of proposed access points
 - (b) Anticipated cut off periods for services.
 - (c) Procedures for notifying affected residences and businesses.
 - (d) Procedures for verification of active services
 - (e) Procedures for complying with traffic control.
 - (f) Procedures for seeking permits to work.
 - (g) Safety procedures in particular working with scaffolding and entering confined spaces.

10.1.4 Specialist Subcontractor

- 1 The Contractor shall employ an approved specialist subcontractor designated in the contract document.
- 2 The Contractor shall provide the following information on sewer cleaning and inspection survey contracts carried out by the proposed subcontractor during the last five years:
- (a) project location
 - (b) name and address of client
 - (c) start and completion dates.
 - (d) cost of the works undertaken by the subcontractor
 - (e) length, diameter, and material of sewers
 - (f) reference letter from the client or engineer
 - (g) a sample document of the reports produced for at least two projects.
- 3 All operators employed by the subcontractor shall be fully skilled in the specified works.
- 4 The operator for interpreting the video recordings and preparing the site coding sheets shall be fully conversant with picture interpretation, defect coding and classification. A copy of the operator's current certificate of qualification for sewer surveys and fault classification issued by Water Training International of the U.K. or an equivalent body for the types of sewers to be inspected shall be submitted to the Engineer for approval before beginning the survey. If the Engineer determines that the Operator's qualifications and experience are not acceptable, the Contractor shall provide an acceptable replacement before beginning the survey.

10.1.5 Programme of Work

- 1 The sewage pipelines may be frequently surcharged and ready access to them may not be available. The Contractor shall make due allowance for such disruptions in his programming of operations. The Contractor shall cause minimum disruption to the utilisation of the pipelines and the period of overpumping shall be kept to the minimum necessary. Before starting the cleaning and inspection survey in any sewer length, the Contractor shall submit an application to CED Drainage Division O & M Section for a permit to work in the sewers.

10.1.6 Topographic Survey of Sewers

- 1 A topographic survey of the pipelines to be cleaned shall be carried out by the Contractor and a schedule provided to the Engineer. Some manhole covers may be buried under landscaping, debris, or the surface of roads, footpaths, or other pavements. These manholes shall be located by the Contractor on the basis of the Employer's record drawings using appropriate techniques and apparatus. The topographic survey of the sewer system shall include resurveying where affected by any rehabilitation works on completion of the sewer cleaning and inspection surveys as directed by the Engineer.
- 2 The survey shall include details of manholes, chambers, and oil and grease interceptors including topographic levels of covers and invert levels, locations and co-ordinates.
- 3 The Contractor shall locate accurately and survey all junctions and lateral connections into manholes, or directly into sewers, whether or not the existence or location of such junctions and lateral connections are shown on the Employer's record drawings.
- 4 The Contractor shall survey the original ground surface, taking levels at 50 m intervals or as directed by the Engineer along the route of the sewer, determine existing pipe diameters and invert levels, and the details shall be recorded in a schedule to the Engineer's approval. These details shall, when finally, and mutually agreed, be signed by the Contractor and authorized by Engineer as truly representing the configuration of the particular areas.

10.1.7 Safety Requirements

- 1 The Contractor's attention is drawn to the hazards involved in working in confined spaces including sewers, sewer manholes, inspection chambers, wet wells, pumping stations and ancillary structures. The Contractor shall be responsible for ensuring that adequate precautions are taken to ensure safe working conditions.
- 2 The Contractor shall give evidence of having carried out training in avoiding the following risks associated with working in confined spaces in sewerage pipelines:
 - (a) presence of toxic, flammable and explosive gases
 - (b) persons falling
 - (c) falling objects
 - (d) drowning
 - (e) infection.
- 3 Training shall include the following:
 - (a) definition of confined spaces
 - (b) atmospheric hazards
 - (c) purpose and practical use of gas monitoring equipment
 - (d) practical use and maintenance of safety equipment such as breathing apparatus, safety harnesses, life lines and lifting frames
 - (e) personal protective equipment such as hard hats, gloves and safety boots
 - (f) health hazards
 - (g) hygiene procedures
 - (h) basic first aid procedures
 - (i) pre-entry procedure
 - (j) entry procedure
 - (k) exit procedure.
 - (l) rescue procedure.

All training courses shall involve both class room instruction and hands-on practical training which should include both entry and rescue drills.

- 4 Safety and Protective Equipment. The Contractor shall safeguard his work force against physical injury caused by falling or being struck by falling objects. Precautions shall include, but are not limited to, the provision of the following equipment for each person working in confined spaces:
 - (a) safety helmet with chin guard
 - (b) safety boots
 - (c) safety harness
 - (d) PVC gloves/gauntlets
 - (e) overalls
 - (f) rubber boots
 - (g) ear, eye, and face protection, where applicable.
- 5 In addition to the above, each gang working in a confined space shall have with them:
 - (a) four sets of 15 m life lines with spring shackle one end, eye at other
 - (b) portable ladder
 - (c) lifting frame complete with ropes and shackles for hand operation.
 - (d) powerful hand lamp, explosion proof (intrinsically safe)
 - (e) ventilation blower together with portable generator and flexible ducting
 - (f) positive pressure respiration face masks with associated portable compressor or air line system supplying air via compressed cylinders
 - (g) gas detectors capable of detecting both high and low oxygen, hydrogen sulphide and methane gas explosion proof (intrinsically safe).
- 6 All safety and protection equipment shall be regularly maintained and inspected by a competent person. Gas monitors shall be calibrated in accordance with the manufacturer's recommendations and a certificate issued with the date of calibration.
- 7 Each group of workers engaged in working in sewers, manholes, pumping stations and ancillary structures shall be provided with, and shall be familiar with the operation of gas testing equipment suitable for checking hydrogen sulphide, combustible gases, and lack of oxygen. Before entering confined spaces the atmosphere within such spaces shall be tested and certified as safe for entry by the responsible person to ensure that there is no build up of hydrogen sulphide or combustible gases, nor lack of oxygen. When working in sewers where accumulation of sludge or silt exists, the Contractor's attention is drawn to the fact that, when disturbed, sludge may release toxic gases. Adequate ventilation facilities shall be provided and continuous monitoring shall be made while work is in progress in live sewers or structures containing sludge or silt.
- 8 Should anyone working in a confined space complain of nausea or dizziness, all personnel shall be removed from that location immediately. Work may resume only when it is certified safe to do so, using breathing apparatus if necessary.
- 9 The Contractor shall safeguard his work force against health hazards while working in sewers and inform his work force of the dangers of bacterial infection while working in a sewage contaminated environment and shall impress upon them the importance of personal hygiene. All members of the work force shall be fit, and everyone who will be expected to work in sewers shall not suffer from:

- (a) Any heart defect.
- (b) Any history of fits or blackouts.
- (c) Deafness or loss of balance.
- (d) Claustrophobia.
- (e) Recurrent back ailments.
- (f) Shortage of breath on light exertion.

- 10 All members of the work force shall be vaccinated against tetanus, typhoid, paratyphoid, hepatitis A and B and cholera, and shall each carry an up-to-date medical record on their person. The Contractor shall provide a medical certificate of fitness for all his personnel.
- 11 The Contractor shall keep personal hygiene and emergency equipment within easy access of each working group. Emergency equipment which shall include but not be limited to:
- (a) Barrier cream.
 - (b) Disinfectant.
 - (c) First-aid kit with eye bath.
 - (d) Stretcher.
 - (e) Life lines 15 m long with spring shackle one end, eye at other.
 - (f) Lifting harnesses.
 - (g) Two sets of breathing apparatus with air bottle.
- 12 The address and telephone number of the nearest hospital with emergency facilities shall be posted in each working location.
- 13 The Contractor shall be solely responsible for liability for any claim or legal action arising as a result of an accident and shall not be absolved of any liability under the Contract for his having conformed to the above requirements.
- 14 The Contractor shall provide and erect approved safety barriers around all unattended open manholes and cover them with suitable temporary steel sheets. Advance warning notice road signs shall be erected at least 50 m in front and behind the area being worked in one day. At the end of each day works all manhole covers shall be replaced.

10.2 SEWER CLEANING

10.2.1 Scope

- 1 The cleaning of sewer pipelines and appurtenances includes but is not limited to the following elements:
- (a) location of manholes and chambers using suitable detection techniques and removal of overburden where necessary
 - (b) cleaning of manholes and chambers with either or both water jetting or wire brushing or other means approved by the Engineer.
 - (c) removal of any grit and debris from manhole bases and benching
 - (d) providing cutoff walls and overpumping where necessary
 - (e) water jetting including vacuum suction of debris.
 - (f) bucket and winch dredging, balling, kiting, pipeline internal gauging, or any other cleaning process as approved by the Engineer.
 - (g) flushing with water

- (h) removal of all sand, grit and debris jetted or dredged from the sewers and disposal of same to a disposal site required by the Engineer.
- (i) controlling of odour and nuisance arising out of rehabilitation works, flow diversion or overpumping.

10.2.2 Cleaning of Sewer Pipelines

- 1 Cleaning of sewers and manholes before inspection surveys shall include one or more of the above operations. The Contractor should note that pipelines, manholes, may have structural defects cracks etc., and may have been completely filled with sand, grit, sediment and other debris and the requirement to accurately measure the vertical inside diameter of the sewer necessitates that the invert of the sewer to be free of all sediment. The Contractor shall allow for the removal of all such material and disposal of same to a disposal site approved by the Engineer. Cleaning of sewers shall progress downstream.
- 2 Sewer cleaning shall be thorough and shall only be carried out by methods approved by the Engineer to remove all deposits, foreign matter, solid or semi-solid and hard intruding material and all other debris including sand, silt, slime, sludge, sediment, grease, roots, loose flaky or soft pipe wall materials, loose concrete from walls and underside of cover slabs and benching of manholes from within sewers and manholes. The liquid biological element of the sludge may be returned to the sewer system after suitable filtering methods to be agreed with the Engineer.
- 3 Where cast iron junction pieces have been used, the Contractor shall ream out or grind off the corrosion products to produce a pipe of diameter equal to the adjacent pipes. Care shall be taken to grind off all burrs which may otherwise puncture in-situ lining tubes during subsequent renovation works.
- 4 Pump station wells shall be cleaned where necessary to permit pipeline cleaning.
- 5 The designated sewer/manhole sections shall be cleaned using hydraulically propelled, high-velocity jet, or mechanically powered equipment. The equipment and methods selected shall be satisfactory to the Engineer. The equipment shall be capable of removing dirt, grease, rocks, sand, and other materials and obstructions from the sewer lines and manholes. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning again attempted. If, again, successful cleaning cannot be performed or the equipment fails to traverse the entire manhole section, it will be assumed that a major blockage exists and the cleaning effort shall be temporarily abandoned until further notification by the Engineer.
- 6 If the Contractor's cleaning equipment becomes lodged in a sewer it shall be removed by the Contractor at his own expense. This shall include excavation, repair of sewer, backfill and surface restoration.
- 7 All sludge, dirt, sand, rocks, grease, and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from manhole section to manhole section, which could cause line stoppages, accumulations of sand in wet wells, or damage pumping equipment, shall not be permitted.
- 8 Roots shall be removed in the designated sections where root intrusion is a problem. Special attention should be used during the cleaning operation to assure almost complete removal of roots from the joints. Procedures may include the use of mechanical equipment such as rodding machines, bucket machines and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners.

- 9 All solids or semi-solids resulting from the cleaning operations shall be removed from the site and disposed of at an approved off-site disposal facility. All materials shall be removed from the site no less often than at the end of each workday. Under no circumstances will the Contractor be allowed to accumulate debris, etc., on the site of work beyond the stated time, except in totally enclosed containers and as approved by the Engineer.
- 10 Acceptance of sewer line cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the Engineer. If CCTV inspection shows the cleaning to be unsatisfactory, the Contractor shall be required to reclean and reinspect the sewer line until the cleaning is shown to be satisfactory.

10.2.3 Jetting

- 1 Jetting shall be carried out using motorised jetting vehicles specially designed for the work involved and complete with an integral water tank. Jetting shall be carried out at an appropriate water pressure such that no damage to pipes occurs. The jetting pump shall have the capability to vary the water pressure at the jetting nozzle and be equipped with a sufficient length of suitable armoured bore hose and jetting heads to accommodate all possible working conditions and pipe size in the sewer system. Jetting pressure to be approved by the Engineer.
- 2 Brackish water shall not be used for cleaning. Treated sewage effluent may be used subject to the approval of the Engineer.
- 3 The hose shall be mounted on a power operated drum reel having variable speed and direction controls and a meterage indicator. The hose shall be equipped with a variety of nozzles totalling 15 to 30 including rear jets only, rear plus forward jets, rear plus side jets, and other such configurations necessary to ensure adequate cleaning of the pipeline. Manhole jacks and hose guide rollers shall be used to prevent damage to the hose.
- 4 During all jetting operations the channel of the downstream sewer manhole shall be provided with a cut off wall and all decumulated grit and debris shall be removed.
- 5 Hydraulically propelled equipment shall be of a movable dam type and be constructed in such a way that a portion of the dam may be collapsed at any time during the cleaning operation to protect against flooding of the sewer. The movable dam shall be the same diameter as the pipe being cleaned and shall provide a flexible scraper around the outer periphery to ensure removal of grease. Sewer cleaning balls or other equipment which cannot be collapsed shall not be used.
- 6 Mechanically powered rodding machines shall be either a sectional or continuous rod type capable of holding a minimum of 200 m of rod. The rod shall be specifically heat-treated steel. To ensure safe operation, the machine shall be fully enclosed and have an automatic safety clutch or relief valve. Buckets, scrapers, scooters, porcupines, brushes, and other mechanical equipment may also be utilised.
- 7 All equipment and devices shall be operated by experienced personnel so that sewer lines are not damaged in the process of cleaning. When hydraulically propelled tools (which depend upon water pressure to provide their cleaning force), or tools which retard the flow in the sewer line are used, all necessary precautions shall be taken to ensure that the water pressure created does not damage or cause flooding of property being served by the sewer. When possible, the flow of sewage in the sewer shall be utilised to provide the necessary pressure for hydraulic cleaning devices. When additional water from water mains is necessary to avoid delay in normal work procedures, the water shall be conserved and not used unnecessarily.

10.2.4 Winching

- 1 The jetting machine shall incorporate a power-driven cable drum having not less than 200 m of 13 mm steel cable. The cable drum shall be mounted on an A-frame, fixed to the vehicle or trailer high enough off the ground to allow the bucket to be lifted above ground level. The backpull machine shall incorporate a power-driven cable drum with not less than 200 m of nylon rope or light steel cable. The working machine shall have a swinging arm fixed to the top of the A-frame. The swinging arm shall be capable of lifting the bucket clear of the ground and rotating it away from the manhole for emptying. A chute with rollers and a shaker bar may be used subject to the approval of the Engineer.

10.2.5 Bucketing

- 1 A range of bucket sizes shall be provided to suit the various pipe diameters. The buckets shall be cylindrical in cross-section with bails at each end having centre eye lugs and shall be of the clam shell type with the bottom made of two hinged halves such that when the bucket is pulled in the reverse direction, bottom first, the jaws open permitting debris to pass through. When the bucket is pulled forward the jaws shall close, thereby retaining any material in the bucket or which subsequently enters. Both ends of the bucket shall be able to dig into and scrape sediments and debris from the sewer invert.

10.2.6 Balling or Kiting and Pipeline Internal Gauging

- 1 Balls shall be of inflatable rubber or other material approved by the Engineer having an outside spiral thread and a swivel connection. With a hydraulic head differential of approximately 0.6 m, the ball shall rotate rapidly and produce a scouring jet on its periphery.
- 2 Suitable cable or rope shall be attached to the swivel connection fed from a cable drum mounted on an A-frame complete with braking facilities. A manhole jack and cable guide roller shall be used to feed the cable into the sewer. If the flow in the sewer is insufficient to produce adequate scouring velocity, the Contractor shall provide the additional supply of water to overcome the deficiency.
- 3 Kites may be used as an alternative to balls for sewers 600 mm diameter and above.
- 4 Pipeline internal gauges shall not be used unless attached to lines in both upstream and downstream manholes.
- 5 During all balling, kiting or gauging operations, the channel of the downstream manhole shall be provided with a cut off wall and accumulated debris removed.
- 6 Sewer cleaning balls or other equipment which cannot be collapsed shall not be used.

10.2.7 General Cleanliness of Areas during Sewer Cleaning

- 1 The Contractor shall take all necessary precautions to ensure that during the sewer cleaning operations there is no spillage of sewage and debris onto the streets and other areas. When spillage occurs, the Contractor shall immediately remove all spillage and clean all surfaces to their original condition.

10.3 SEWER INSPECTION - CCTV SURVEY AND SONAR SCANNING

10.3.1 Scope of Work

- 1 CCTV survey and sonar scanning shall be carried out only after satisfactory cleaning of the pipeline as specified in Clause 10.2 of this Part. The CCTV survey and sonar scanning shall include but not be limited to:
 - (a) Production of colour video tape recording on compact disc (CD) and coding.
 - (b) Accurate profiling of the cross-section of sewers and measurement of deflections.

- (c) Still colour pictures from a video graphic printer of the inside of sewers and manholes, inspection chambers and grease and oil interceptors, as directed by the Engineer.
- (d) Recording the complete survey on a computer database in accordance with WRC Manual of Sewer Condition Classification.
- (e) Pictures to be printed in a digital format (Tiff) for computer data storage and retrieval.

10.3.2 Survey Requirements

- 1 The rate of travel of the camera shall be such as to enable all details to be extracted from the video tape recording.
- 2 The axis of the camera shall be arranged to coincide with the centreline of the pipe.
- 3 The picture transmitted by the CCTV scanning camera (a scanning camera which can view lateral connections to sewers) and sonar scanner shall be free from interference and loss of vertical and horizontal hold. The picture shall be in focus, properly illuminated, of good contrast and without distortion. If vision is obscured at any time by the fouling of the lens, or lighting system, or if travel is impeded by obstructions, the camera shall be withdrawn and the defect rectified immediately.
- 4 The Contractor shall record the complete survey on a video tape format conforming with the recording equipment manufacturer's specification. The recording shall provide a continuous display of data on the monitor screen comprising the following information:
 - (a) automatic update of camera meterage
 - (b) date, day, month and year
 - (c) direction of survey - upstream or downstream
 - (d) gradient of sewer
 - (e) nominal diameter of sewer and the actual measured horizontal, vertical and diagonal diameters at close intervals as directed by the Engineer
 - (f) manhole/pipe type length reference number
 - (g) sewer use
 - (h) time of start of survey
 - (i) location reference.
- 5 The video recording shall be stopped whenever the camera is stationary for more than 5 seconds and shall have manual override capability.
- 6 The completeness of the video tapes shall be an accurate record of the sewer system which identifies and locates sewer defects, provides information that permits accurate analysis of the cause, extent, nature and severity of sewer deterioration and the measurement of horizontal, vertical and diagonal diameters of sewer and their locations.
- 7 Portions of video tape marred by interference, or otherwise unacceptable shall be erased and the relevant portion of sewer shall be resurveyed and rerecorded. The Engineer's decision as to the acceptability of any video recording shall be final.
- 8 Still colour photographs as designated under Clause 10.3.5.
- 9 The photographic negatives, the master video tapes, and a copy of the video tapes shall be handed over to the Engineer and shall become the property of the Employer.
- 10 If a self-propelled camera is used, it shall incorporate features to enable it to be winch drawn without affecting the quality of the video recording.

- 11 The location of any conditions that may result in a limitation of rehabilitation techniques that could be used and/or prevent proper installation of designated rehabilitation materials in the pipelines shall be noted. The Contractor shall propose corrective measures and/or alternative methods of rehabilitation for the approval of the Engineer.

10.3.3 Survey Equipment

- 1 The CCTV survey and sonar scanning equipment shall be modern and of advanced design and shall be tested and calibrated immediately before beginning work. The equipment shall be tested as designated herein by the manufacturers or an approved independent test laboratory at intervals of not more than 6 months. Original certificates of compliance with the specifications of this Part shall be submitted to the Engineer before beginning work. The equipment shall include but not limited to the following:
- (a) CCTV camera and sonar scanner suitable for mounting on the same trolley as and when required
 - (b) colour TV camera with swivel, lift and radial device and able to focus on points of interest
 - (c) camera light head assembly with sufficient illumination for the diameter of sewer pipes
 - (d) camera wheeled/tracked crawler assembly, self-propelled/flexible-shaft driven and remotely operated with forward, reverse, left, right stop and load indication
 - (e) cable reel of minimum 200 m cable length with fully automatic and microprocessor controlled cable handling facility
 - (f) power winch with either lockable or ratcheted drums
 - (g) CCTV/Sonar central control units
 - (h) colour TV monitor
 - (i) high-resolution scanning device including high speed pipe profiler and software to interpret the signals
 - (j) video cassette recording system with audio video information system
 - (k) all standard and optional accessories recommended by the manufacturers.
- 2 The picture quality of the camera shall be tested using the Marconi Resolution Chart No. 1 or equivalent clearly defined with no tinting to show white, yellow, cyan, green, magenta, red, blue and black.
- 3 The quality of the CCTV electronics, camera and monitor shall be such that the following criteria are satisfied and if any of the criteria are not met during the survey the lengths of sewer so affected shall be resurveyed at the Contractor's expense:
- (a) Shades of Grey. The grey scale shall show equal changes in brightness ranging from black to white with a minimum of five stages
 - (b) Colour. With the monitor control adjusted for correct saturation, the six colours plus black and white shall be resolved with the primary and complementary colours in order of decreasing luminance. The grey scale shall appear in contrasting shades of grey with no tint
 - (c) Linearity. The background grid shall show squares of equal size, without convergence or divergence over the whole picture. The centre circle shall appear round and have the correct height/width ratio within $\pm 5\%$

- (d) Resolution. The live picture shall be clearly visible with no interference and capable of registering a minimum number of TV lines/picture height lines. The resolution shall be checked with the monitor colour control turned down. For tube type cameras this shall be 350 lines and for CCD type cameras it shall be 250 lines
- (e) Colour Consistency. The colour on the live picture and that on the video picture shall be consistent with that described for the Marconi Resolution Chart No. 1.
- 4 The camera shall be capable of taking clear pictures in any direction; i.e., 90 ° to the left and 90 ° to the right (total 180 ° in horizontal axis) and also 360 ° in the circumference of the pipe without using extra revolving mirror attachment.
- 5 The camera shall continuously transmit distance at each meter length, electronically matched to the movement of the camera with a maximum tolerance of ± 0.1 % on the control TV monitor and the resultant video tapes.
- 6 The camera shall indicate the degree of inclination of the sewer line with tolerance of 0.2 % on the TV monitor with a printout of the slope.
- 7 The camera crawler assembly shall be adjustable for deployment in sewers of varying diameters. When required, both sonar scanning and CCTV equipment shall be mounted on the same crawler assembly.
- 8 The video tape recording of the transmission for CCTV and Sonar scanning units shall be provided to accurately record on video tapes, of quality approved by the Engineer. In the central control unit, the operator shall have remote facilities to control the camera, the cable drum and power winch.
- 9 Each unit shall carry sufficient number of guides and rollers to ensure that, when surveying all bonds are supported away from pipe and manhole structures and all CCTV cables and lines used to measure the camera's location within the sewer are maintained in a taut manner and set at right angles, where possible, to run through or over the measuring equipment.
- 10 At the start of each and every working shift, the camera shall be positioned centrally and at right angles to the test card at a distance where the full test card just fills the monitor screen, ensuring that the edges of the test card castellation coincide with the edges of the horizontal and vertical scan (raster). The card shall be illuminated evenly and uniformly without any reflection. The illumination shall be to the same colour temperature as the colour temperature of the lighting that will be used on the CCTV survey equipment in the pipe. The test shall be recorded for subsequent use by the Engineer, the recording time to be at least 30 seconds. The type of camera used is to be identified on the test recording. The recording must show the camera being introduced into the test device and reaching its stop position. Other test devices may be used subject to approval by the Engineer.
- 11 The Contractor shall note that the Engineer may periodically check both the live and recorded picture colour consistency against the colour bar. Any differences will necessitate re-survey of the lengths affected at the Contractor's expense.
- 12 The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The adjustment of focus and iris shall provide a minimum focal range from 50mm in front of the camera's lens to infinity. The distance along the pipe in focus from the initial point of observation shall be a minimum of twice the vertical height of the pipe. The illumination must be such as to allow an even distribution of the light around the pipe perimeter without the loss of contrast, flare out of picture or shadowing.

- 13 Where the CCTV survey equipment is towed by winch and bond through the pipe, all winches shall be stable with either lockable or ratcheted drums. All bonds shall be steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV survey equipment. All winches shall be inherently stable under loaded conditions.

10.3.4 Survey Vehicle

- 1 The CCTV and sonar scanning vehicles shall be equipped with the following three separate compartments:
- (a) driver's cabin
 - (b) operator and viewer's compartment (seating for minimum three persons)
 - (c) Camera and sonar scanner equipment storage compartment.
- 2 The operator and viewer's compartment shall be insulated against noise and extremes in temperature and be provided with means of controlling external and internal sources of light in a manner capable of ensuring that the monitor screen display complies with the specified requirements.
- 3 The equipment storage compartment shall have adequate space for equipment, both operational and stored. Equipment used in sewers shall not be stored in compartment.
- 4 The vehicle shall be equipped with air-conditioner for the driver's cabin and the operator's room. A wireless communication system between the operator inside the vehicle and the helper outside the vehicle shall be provided.
- 5 The vehicle shall be complete with all equipment and apparatus necessary to carry out a complete sewer inspection survey. Colour monitors, a sonar processor unit, replay and on-board reporting, video recorders, video printers, computers and computer printers to generate survey reports and data base shall be provided. The operator/viewer's compartment shall be designed for optimum productivity.
- 6 The vehicle shall be equipped with the following road safety equipment:
- (a) a minimum of two amber regulation flashing beacons fixed at diagonal corners of the vehicle, which shall operate continuously while the vehicle is stationary on the highway in a working situation
 - (b) traffic signs and cones, which shall be displayed in accordance with the recommendations of the Traffic Police Section, with a minimum of:
 - (i) four reflective boards: Arrow
 - (ii) two reflective boards: Men Working (in English and Arabic)
 - (iii) two reflective boards: Road Narrows (in English and Arabic)
 - (iv) 20 reflective cones
 - (v) 12 battery operated flashing road lamps.
 - (c) a sufficient number of bright coloured overalls with fluorescent over-jackets or belts, which shall be worn by all operatives while working on roads.
- 7 Relevant safety equipment specified in Clause 10.1.7 shall be made available.

10.3.5 Photographs

- 1 After sewer cleaning and in parallel with the CCTV inspection, excellent quality still colour photographs 90 mm x 130 mm with the date and submitted in TIFF format an album with captions providing a detailed description, the precise location and reference numbers as designated shall be taken of:

- (a) the inside the sewer to show the typical conditions for each length of sewer. A minimum of three photographs per manhole length shall be taken at every junction piece, faulty joint, broken pipe, and other points of interest as directed by the Engineer
 - (b) the interior of each manhole, chamber and grease/oil trap. A minimum of three photographs shall be taken of each structure showing the general extent of corrosion to the structure's walls, bases, benching and the underside of cover slabs as directed by the Engineer
- 2 Photographs shall be taken of the internal condition of the pipes at the beginning of a defect, at service connections and such other places as the Engineer shall direct. Where defects exist at adjacent points, photographs should not be taken at intervals of less than 2m unless absolutely necessary to show the second defect. Where photographs are not otherwise required, a general condition photograph shall be taken at every 10m.
- 3 Photographs must clearly and accurately show what is displayed on the monitor which shall be in proper adjustment.
- 4 Photographs shall be clearly identified in relation to the location (minimum requirement manhole start and finish numbers or pipe length reference numbers) survey direction, chainage, photograph number, and date when the photograph was taken. The annotation shall be clearly visible and in contrast to its background, shall have a figure size no greater than 5mm, and be type printed. The annotation shall be so positioned as not to interfere with the subject of the photograph.
- 5 Hard copy of the photographs shall be supplied in suitable A4 sized plastic holders and bound in ring binders or lever arch files. The photographs shall be presented in chronological order and each file shall contain a contents page providing clear cross-referencing to the report. The minimum requirements of the contents page shall be locations (district, street name and road number), photograph numbers and dates when photographs were taken.

10.3.6 Site Coding Sheets

- 1 Site coding sheets detailing the condition of each pipe length and manhole shall be completed in the format of the WRC Manual of Sewer Condition Classification and as approved by the Engineer. These sheets shall be submitted to the Engineer with the video tape to which they refer. A draft copy of the coding sheets shall be submitted weekly to the Engineer for his approval. When requested by the Engineer, more frequent reports of selected parameters shall be submitted.
- 2 The site coding sheets shall be standardised to the approval of the Engineer to indicate the following minimum requirements:
- (a) location reference to sewer length concerned
 - (b) nominal diameter of sewer
 - (c) actual measured horizontal, vertical and diagonal diameters of sewer and their locations, as a continuous computer printout at close intervals and as directed by the Engineer
 - (d) date of survey
 - (e) direction of survey
 - (f) time of start of survey
 - (g) sewer gradient

- (h) trial hole records
- (i) coded reference to any defects encountered
- (j) location of defects
- (k) location of any junctions or laterals encountered
- (l) location of any still photographs taken.

- 3 In addition to the final report and any interim reports on a section of the pipe as defined above, the Contractor shall provide the Engineer with the following:
- (a) One copy of the completed survey report coding forms at the end of each working shift.
 - (b) One copy of sheets containing the pipe reference number, distance, orientation and deflection measurements of the pipes surveyed at the end of each working shift.
 - (c) One copy of photographs and recordings on a weekly basis as the work progresses or as previously agreed with the Engineer in writing.

10.3.7 Excavation

- 1 When directed by the Engineer, the Contractor shall excavate and expose sections of sewer for examination.
- 2 The Contractor shall carry out such excavations expeditiously and shall break or expose the sewer section upon removal from the trench for detailed physical examination and testing.
- 3 Excavations shall be carried out in accordance with Part 2 of this Section.
- 4 When directed by the Engineer, the Contractor shall reinstall the sewer section or replace the sewer section with new pipe of same size and material in a manner to completely conform to the original installation and shall backfill, compact and reinstate the excavation in accordance with Part 4 of this Section.

10.3.8 Survey Reporting

- 1 The Contractor shall complete the CCTV survey and sonar scanning in appropriate lengths as directed by the Engineer before handing over the records for that line. All records for a particular length shall be handed over at one time unless directed otherwise by the Engineer and all recordings on one tape shall be of the same length. The report shall include the following, all as designated herein:
 - (a) site coding sheets
 - (b) correctly labelled video tapes of approximately one hour duration
 - (c) pictures on compact discs in a digital format (Tiff)
- 2 The report shall be completed using a computer based database with software that shall be fully compatible with the Oracle database used by the Ministry of Municipality ARC INFO GIS system and approved by the Engineer. One copy on a 3.5 inch diskettes of all computer generated data shall be provided with the report. Four copies of draft report shall be submitted for Engineer's approval followed by final report incorporating appropriate responses to the Engineer's comments.
- 3 The Contractor shall enter the information obtained from the survey into a computer database in accordance with the WRC manual of sewer classification which shall allow for the storage, retrieval and analysis of this information. Furthermore the database shall link the survey information with an electronic drawing of the pipeline which shall allow the viewing of still images representative of the major problems identified by the survey.

- 4 The Contractor shall supply 2 copies of each recording in CD format.
- 5 The condition survey report shall include the following:
 - (a) Pipe condition classification in accordance with the WRC format.
 - (b) Manhole/pipe length reference numbers.
 - (c) Date of survey.
 - (d) Road name/location.
 - (e) Direction of survey.
 - (f) Time of start of survey.
 - (g) Weather conditions.
 - (h) Pipe dimensions.
 - (i) Materials of construction.
 - (j) Depth of flow.
 - (k) Profiling of pipe cross sections to give a complete circumferential profile and deflections within the pipe.
 - (l) Clock position of all connections including meterage from manhole.
 - (m) Whether or not connections are dry and running.
 - (n) Location and description of obstructions, structural defects, missing pieces of pipe, open and/or offset joints, ovality, leakage or evidence thereof, corrosion, erosion, break-in connections, protruding connections, mineral deposits, roots, previous repairs, sags and other abnormalities with respect to the pipeline's condition with counter distance in metres from the start manhole's centreline.
 - (o) Photographs as specified herein.
 - (p) Recommendations, including options and alternative methods to extend the service life by a further 50 years by lining, replacement or other refurbishment.
 - (q) Estimated cost and programme for carrying out the recommendations.
- 6 If the Engineer requires separate survey reports for any section of the survey or requires some or all of the section to be grouped together in a single survey report he shall notify the Contractor accordingly.

10.4 OVERPUMPING AND FLOW DIVERSION

10.4.1 Source of Flow

- 1 Manholes and sewers being worked on shall be completely isolated and by-passed such that they do not contain any sewage. This shall be achieved by plugging, pumping and bypassing or diverting the flow.
- 2 When flow in a sewer line is plugged, pumped and bypassed or diverted sufficient precautions must be taken to protect the sewer lines from damage that might result from sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.
- 3 The Contractor shall submit his proposed method of overpumping or flow diversion to the Engineer for approval.
- 4 The Contractor shall co-ordinate and agree all his activities on live facilities with the Drainage Affairs Maintenance Department staff responsible for upkeep of the drainage system. A signed Permit to Work shall be obtained from Maintenance Department prior to the commencing the work.

10.4.2 Pipe Stoppers

- 1 The flow shall be stopped off using pipe stoppers of a type approved by the Engineer. The stopper shall be of circumferential compressible rubber rings fully inserted inside the pipe before tightening. Inflatable type stoppers for sewers less than 300 mm diameter shall be of a type approved by the Engineer.
- 2 Stoppers shall be suitable for the sizes and classes of pipe in which they are used and must not cause damage to existing pipes. Stoppers must be able to withstand the maximum possible differential head at each location and shall be fully restrained in accordance with the manufacturer's recommendations.
- 3 The Contractor shall be solely responsible for maintaining such stoppers in good working condition and for the consequences of any failure thereof.
- 4 Where a section of the sewerage system is isolated for work involving man-entry to the isolated area, a minimum of two stoppers shall be used at each boundary location isolating the area from the main sewer and subsidiary sewers. At least one of these stoppers at each location should be of an approved pneumatic type.

10.4.3 Stopping Off Flow

- 1 For the length of sewer being surveyed, the Contractor shall plug off the outlet of the downstream manhole and the inlet to the upstream manhole. The next upstream manhole shall be used as a pumping sump with the outlet to that manhole also being plugged off.
- 2 All service connections discharging into the plugged off sewer shall be satisfactorily isolated the overpumping system shall be provided to the approval of the Engineer.
- 1 Interruption of service will not be permitted.

10.4.4 Pumping Plant

- 1 Overpumping shall be carried out using suitable mobile pump sets of adequate capacity and head to the approval of the Engineer.
- 2 The Contractor shall provide sufficient number of standby pumps of adequate capacity. Where required by the Engineer, a temporary sump shall be provided to prevent surcharging of upstream sewers.
- 3 The pumps shall be controlled by suitable level controls installed to operate at levels to be approved by the Engineer and shall be capable of dealing with the flow in the sewer and any material likely to be transported in it without being blocked.

10.4.5 Sewage Flooding

- 1 Full-time attendance with mobile phone facilities shall be provided by the Contractor at each pumping location such that in the event of mechanical breakdown, flooding or blockage, immediate assistance will be summoned.

10.4.6 Overpumping of Flow

- 1 Pumped sewage flows shall be discharged to a manhole downstream of the sewer length being cleaned or surveyed. The open end of the pump delivery pipe shall be laid in order to minimise turbulence of the pumped flow. No sewage shall be dumped onto any surfaces outside the sewer system.
- 2 The pump delivery pipe shall be of suitable armoured material which in all locations subject to traffic flow shall be suitably protected with preformed steel plates bridging the pipe or by other means approved by the Engineer. Such protection shall be adequate to allow passage of vehicular traffic over the pipe.

10.4.7 Temporary Diversion of Flow

- 1 Where temporary sewer diversion is required the Contractor shall notify the Engineer accordingly and submit his proposals for implementation of such diversion.
- 2 The Contractor shall obtain all other permissions and approvals from relevant authorities prior to commencement of such diversion. On completion of temporary diversionary works the temporary pipelines shall be removed or be adequately sealed and inlet and outlet manholes reinstated to their original condition.

10.4.8 Entrances to Private Properties

- 1 The Contractor shall not cause any obstruction to the access of private properties. If the obstructions are unavoidable, the Contractor shall provide and maintain in good order alternative access to the approval of the Engineer.

10.4.9 Odour and Noise Control During Flow Diversion and Overpumping

- 1 The Contractor shall take necessary precautions for controlling odour and noise with prescribed limits approved by the Engineer and for preventing nuisance and inconvenience to the local residents and the public during the flow diversion and overpumping operations.
- 2 The Contractor shall include in his method statement, the measures to be taken for noise and odour control.
- 3 The Contractor shall provide special measures to prevent the odour release to the approval of the Engineer.
- 4 The Contractor shall install temporary chemical dosing system to contain the odour release if other measures fail.
- 5 For odour control, the measurement of hydrogen sulphide shall not be more than 1 ppm measured at a distance of 1m from the point of discharge to the adjacent property.

10.5 CONTRACTOR'S QUALITY CONTROL PROCEDURE

- 1 The Contractor shall operate a quality control system, to be approved by the Engineer, which will effectively gauge the accuracy and consistency of the CCTV survey report produced by the operator from the monitor picture.
- 2 The system shall be such that the accuracy of reporting should be a function particularly of:
 - (a) The number of faults not recorded (omissions).
 - (b) The correctness of the coding and classification of each fault recorded.
- 3 The minimum levels of accuracy to be attained shall be as follows:
 - (a) Header accuracy 95%
 - (b) Detail accuracy 85%
 - (c) Lowest acceptable tolerance 75%
- 4 The Engineer shall be entitled in accordance with Section 1 Part 8 and this section to audit periodically the control system and be present when assessments are being computed.
- 5 When requested by the Engineer, the Contractor shall forward to the Engineer sufficient details and information for this audit assessment.

- 6 Should any report fail to achieve the specified percentages for a particular pipe length, the Engineer shall require the Contractor to re-code and re-submit the report. If the accuracy check fails, the Contractor shall repeat the full quality control check on 10 surveys, 5 surveys either side of the survey which has failed. If any further failures are found to be outside the tolerances laid down above within these additional checks, the process will be repeated until an acceptable standard is reached. Any reports that have failed will be re-coded by another qualified surveyor and submitted to the Engineer to replace those in his possession.
- 7 Quality selection is achieved by using two parameters:
 - (a) Population - the anticipated number of surveys carried out by one surveyor over a period of time (normally 1 year).
 - (b) Sample size - the number of surveys required to be checked to satisfy the quality control validity.
- 8 The sample surveys for quality control are to be selected by the use of computer generated random numbers (ERNI) or other such equivalent method and shall be 5% of the total population. Each surveyor shall have a different set of random numbers, which are sorted into chronological order, and are renewed once the population size has been reached. The random numbers shall not be disclosed to the surveyor until they have been used up.
- 9 On site the surveyor logs certain information on the surveys being carried out and in the order in which they are surveyed.
- 10 The “in-office” staff then count, through the surveys that have taken place and copy those reports that coincide with the random numbers.
- 11 Copy of the relevant section of the recording shall also be made available.
- 12 Information on the recording and its contents are entered on a survey selection log.
- 13 Header information - All header information shall be checked to ensure that left and right justified entries are correctly entered, alpha or numeric symbols are correctly used and all compulsory boxes filled in. The percentage of accurate entries shall be ascertained and any that fall below the value specified shall be rejected. All decimal percentage points shall be rounded down to the nearest whole number.
- 14 Detail information - Each error/omission is treated on an equal basis whether or not it is a minor or major error or omission. During the checking each error/omission is highlighted on the report from which the following totals are calculated for each survey report:
 - (a) The number of actual entries that should have been made.
 - (b) The number of actual errors/omissions made.
- 15 These totals are entered on the right of the survey report being checked. Individual column totals are also calculated and entered on to the survey accuracy log.
- 16 The accuracy of each survey is arrived at by taking the number of actual errors/omissions away from the number of actual entries that should have been made and dividing the result by the number of actual entries that should have been made and multiplying by 100 to create a percentage.
- 17 This percentage is entered on the survey detail rating form.
- 18 The ongoing accuracy of the surveyor (the “confidence level”) is calculated by taking the mean of 5 percentage results (each 5 representing one control unit).
- 19 Both the individual survey percentages and the mean results are entered onto the surveyor’s accuracy graph which has two boundaries:

- (a) Specified mean - the level of accuracy expected.
 - (b) Specified tolerance - the level to which the accuracy can fall before specific action is taken.
- 20 Any surveyor whose quality control results fall below the specified mean on more than 2 occasions or the specified tolerance at any time shall be deemed to have failed his quality control criteria and shall be invalidated from acting as a team leader on this Contract until he has attended and passed an approved course for pipe condition classification.

END OF PART

ARAB ENGINEERING BUREAU