WATER INDUSTRY INFORMATION & GUIDANCE NOTE

UK Water Industry

CODE OF PRACTICE: *IN SITU* POLYMERIC LINING OF SEWER PIPELINES

Contents

1. INTRODUCTION

The purpose of this Code of Practice is to supplement the Operational Requirements for *In Situ* Polymeric Lining of Sewer Pipelines(1). It is essentially a guidance document containing background information and recommendations for polymeric lining schemes.

Not all Operational Requirements are referenced in this Code but are fully set out in 'Operational Requirements: *In Situ* Polymeric Lining of Sewer Pipelines(1), hereafter referred to as the 'OR'

The Operational Requirements (including all Appendices referenced from the Operational Requirements) have been produced to provide Best Practice information and ensure that the highest standards of quality of workmanship and finished product are maintained.

It is recommended that the Code of Practice forms the basis of the contractual requirements for *in situ* polymeric lining works, though clauses may be amended to suit individual client circumstances. However, tender documents should clearly indicate if any amendments have been made to the standard specification and what those amendments are.

1.1 Scope

This Code of Practice covers the requirements needed to provide non-structural protective coatings, semi structural or fully structural *in situ* spray applied linings for sewer pipelines or other non- circular assets constructed of:-

- iron
- steel
- asbestos cement
- concrete
- clay
- plastic
- pitch fibre

or as limited by the material manufacturer's Instructions for Use (IFU) using polymeric lining materials for *in situ* lining of sewer pipelines. This currently includes two part epoxy resin and two part rapid setting polyurea /polyurethane materials.

Issues considered include:

- Polymeric lining materials;
- approvals required;
- scheme preparation;
- pipeline cleaning;
- application of coating;

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- curing;
- quality control procedures; and
- rectification of lining defects.

Definitions (highlighted in ***bold italics***) are given in the Operational Requirements (OR 1.3).

2. PROCESS SUMMARY

2.1 Scope

For engineers and contractors who are not familiar with the cleaning and lining processes, this section provides a brief introduction and schematic summary of the methods.

In situ polymeric lining provides another technique for the renovation of sewers and rising mains that has potential cost advantages over other techniques, such as CIPP, where such applications are appropriate and provides an alternative tool to maintain customer service standards. Linings can be undertaken to provide:-

- **Non-structural protective coatings:-**

Such applications would include the:-

1) lining of metallic pipelines where original factory applied coatings are/ have deteriorated thereby allowing the onset of internal pipe wall corrosion.

2) lining of concrete pipes where spalling has exposed reinforcement bars.

3) protection of assets from exposure to industrial waste and consequent accelerated deterioration.

4) restoration of original flow and head loss characteristics reducing pumping costs in rising mains and reducing risk of surcharge/blockage

- **Semi structural linings:-**

Semi structural linings work in concert with the original host pipeline to enhance the structural integrity of the combined asset.

Such applications could include the:-

1) bridging of cracks in pipe walls resulting from bursts, bending or shear failure of the host pipe

2) sealing of pin holes or other corrosion defects

3) reduction of risk of sewage contamination and flooding resulting from pipeline failure/burst

- **Structural linings:-**

Dependant on the physical properties of the material and, subject to compliance with the material manufacturer's IFU and design information, linings may be deemed fully structural replacements

For a lining to be deemed a fully structural replacement, it must be able to withstand all internal and external loadings without any support from the host pipe.

All linings may potentially serve as a barrier to corrosion, abrasion and tuberculation or scaling of host pipes along with reducing surface roughness for improved flow capacity and, depending on physical properties, may prevent assets from impact damage.

It is stressed that linings must be applied in full compliance with the material manufacturer's IFU and design information for the specified renovation outcome to be achieved.

Poorly or incorrectly applied linings will result in reduction of working life and risk of premature failure.

Material manufacturers may specify excluded substances that are not suitable for contact with applied linings within their IFU documents. Sewerage Undertakers should check that effluent or industrial discharges do not or are not likely contain such excluded substances.

2.2 Cleaning

A number of cleaning techniques are suitable for the removal of debris and encrustation so as to prepare the main for lining. These include:

- De-silting
- Jetting
- Vortex of Air

- Winching of Drag Scrapers and/or Plungers)
- Power Boring
- Sand blasting
- Or other appropriate techniques

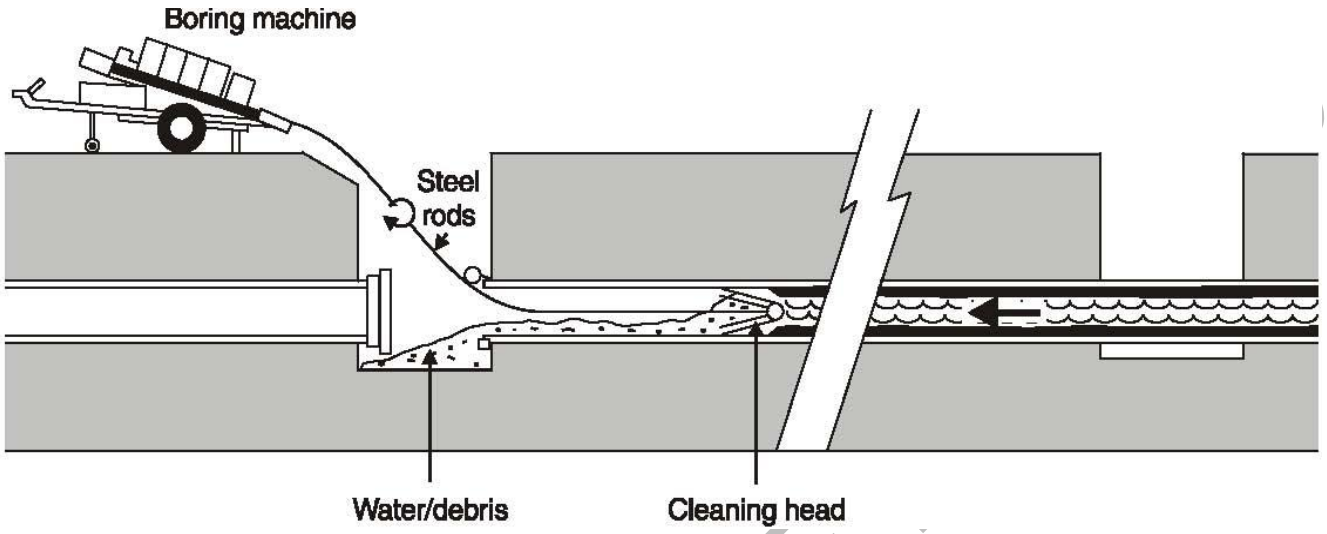

Figure 1 - Power Boring

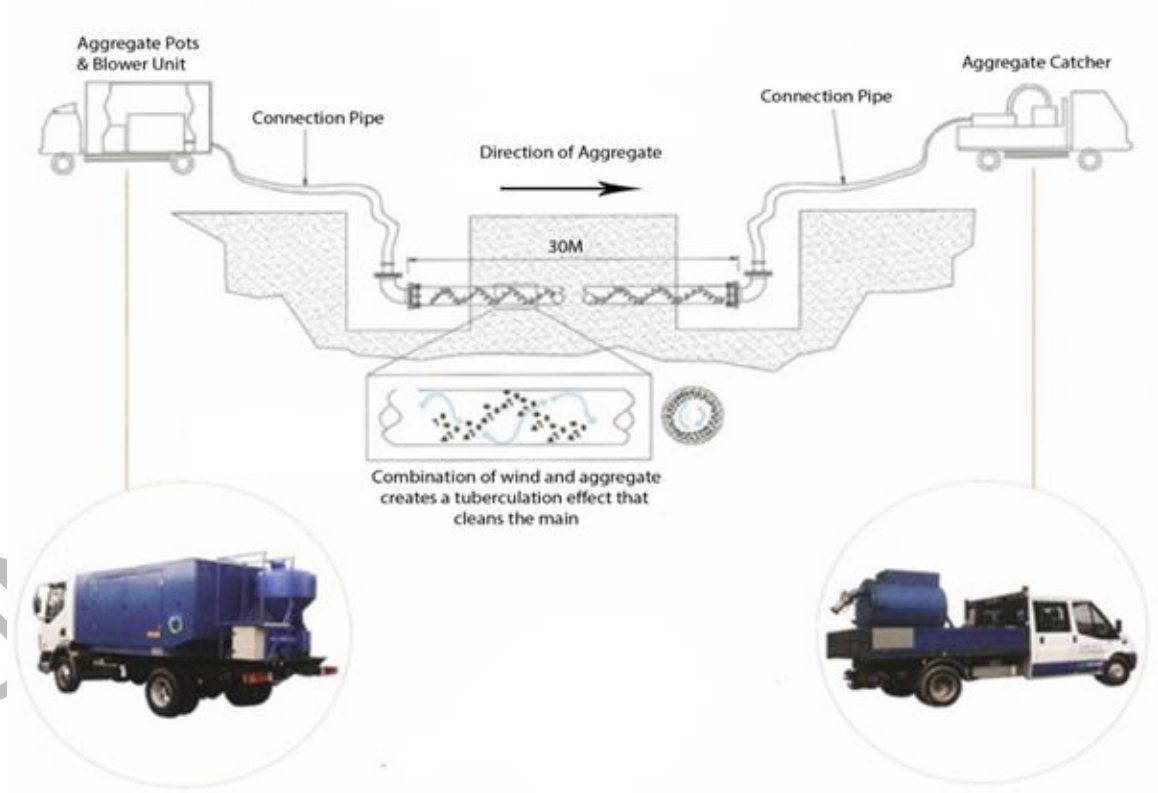

Figure 2 - Vortex of air

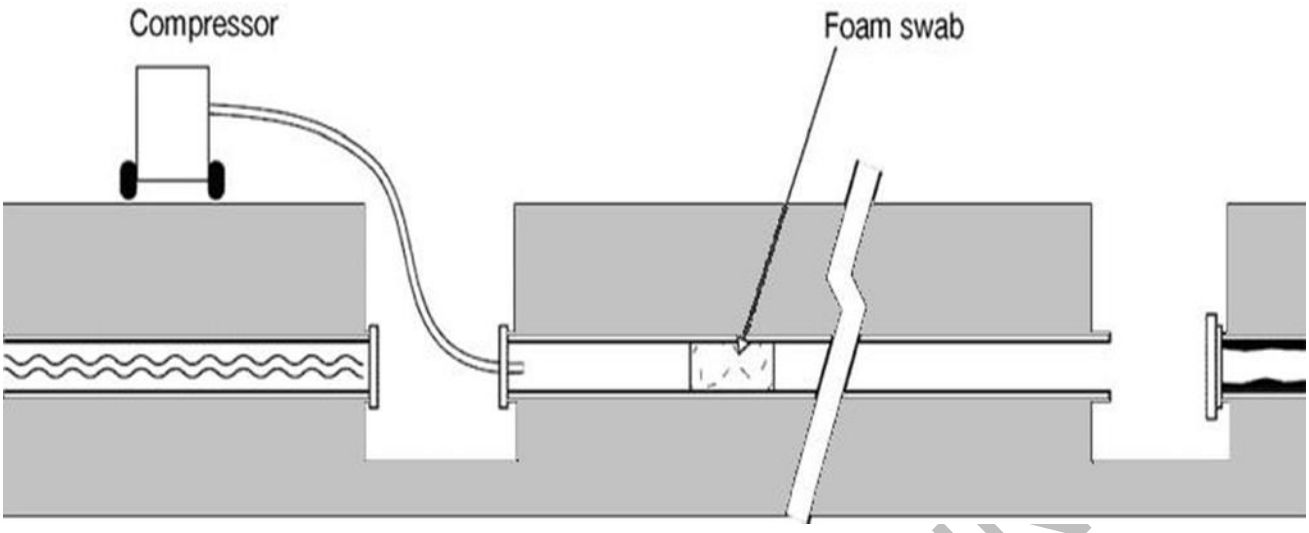

Figure 3 - Foam Swabbing

Plunging can be used to remove residual corrosion debris and water from the pipe. Alternative cleaning methods are acceptable if they meet the requirements of OR 6.1 which specifies the quality of cleaning.

2.3 Preparation of Cleaned Pipelines

Prior to spray application of any polymeric material, the pipeline substrate shall be prepared to the specification required by the material manufacturer as specified in the IFU document and free from any standing water.

After cleaning, and where included in the IFU or contract specification, the Sewerage Undertaker may require the pipe to be force-dried to a prescribed level. If so, forced air drying (using warm dry air) may be employed to dry the pipe. The dew point setting of the air in the pipe shall be in accordance with the material manufacturers approved lining Instructions for Use (IFU) and any temperature differential required for the pipe wall temperature complied with. The dew point shall be measured using appropriate measuring equipment inserted into the pipe and the result recorded on the Sewer Pipe Lining Record Sheet.

2.4 Pre Lining CCTV Inspection/Post Cure CCTV Inspection

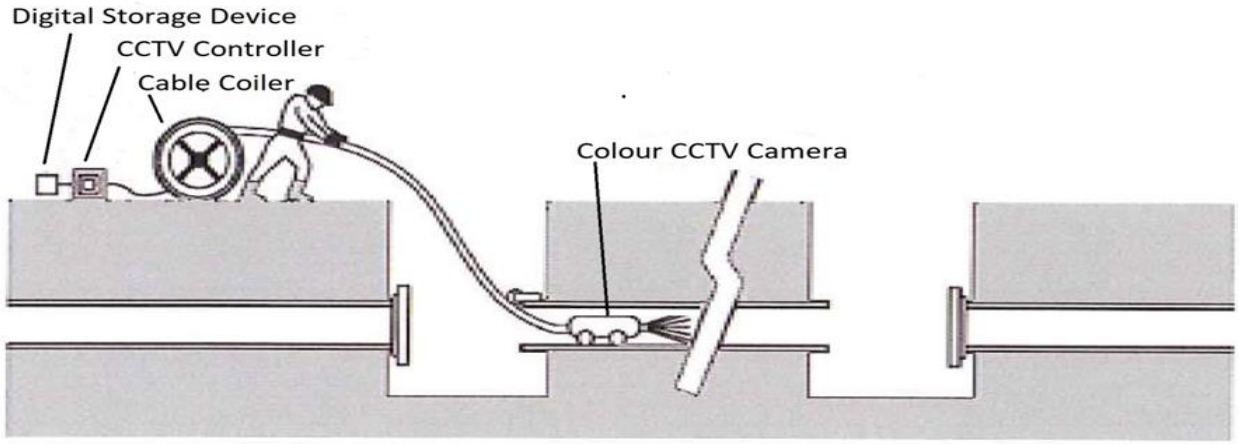

Figure 4 - CCTV inspection

2.5 Pre Lining laser profiling/Post Cure laser profiling

Where included in the contract specification, after cleaning and drying, and after the lining has cured sufficiently to support the passage of the profiling equipment without damage to the fresh lining, the Sewer Undertaker may require the pipe to be Laser profiled either in combination with or separate to CCTV Inspection. Equipment and software used for Laser profiling shall be tested and approved by a recognized independent testing group and include a tested certified accuracy of 0.5% or better and a repeatability of 0.12% or better.

2.6 Spray lining

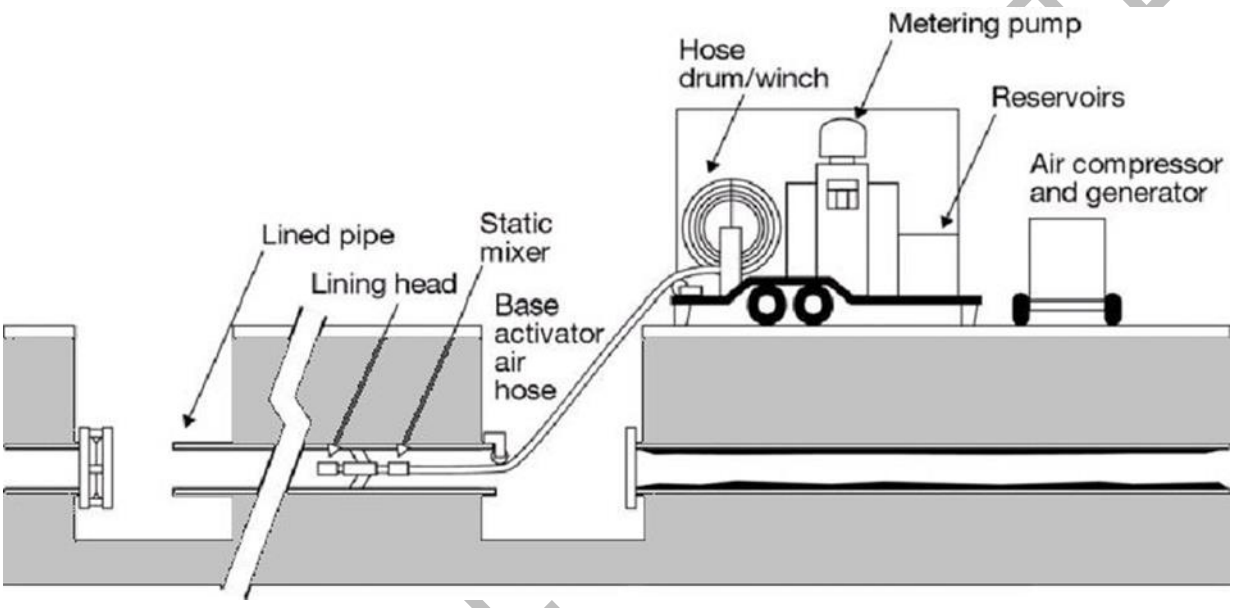

Figure 5 - Spray lining

The spray lining process is undertaken using a lining rig. The lining rig comprises of material reservoirs or tanks holding the requisite base and activator components which are fed into a metering pump.

This pump dispenses the components at the material manufacturer's specified mix ratio through flow meters which continuously monitor the mix ratio and the two separate components are then pumped through the lining rig hoses. Once the material components are within a specified temperature, the lining hoses or umbilical hose are pulled through to the far end of the cleaned and prepared sewer pipeline under renovation. A static mixer and lining head are then attached to the lining hoses and pumping of the base and activator components is then commenced.

The base and activator components are then intimately mixed though the static mixer and sprayed centrifugally onto the pipe wall by the lining head. By knowledge of the internal pipe diameter, the flow rate of the mixed components and the speed of withdrawal of the lining hoses and lining head, the thickness of the applied lining is controlled.

The lining rig continuously measures and records parameters such as time, distance, component pressures, mix ratio and applied lining thickness during the lining process for quality control purposes.

2.7 Health and Safety of Employees

The Approved Contractor is responsible for Health and Safety and the compliance with all applicable legislation relating to works.

As an essential part of compliance in this, attention is drawn to the fact that workers whose

activities bring them into contact with sewage and sewage products are at risk of contracting a work related illness.

The majority of illnesses are relatively mild cases of gastroenteritis but, potentially fatal diseases, such as leptospirosis (Weil's disease) and Hepatitis can also be contracted.

Employee training should, amongst other items, provide information on understanding the risks to health and the ways in which infections can be picked up.

Contractor's employees should:-

- Use safe systems of work and wear the protective equipment that is provided
- Report damaged equipment and get it replaced
- Avoid becoming contaminated with sewage
- Avoid breathing in sewage dust or spray
- Not touch their face or smoke, eat or drink unless they have washed their face and hands thoroughly with soap and water
- Cleanse all exposed wounds, however small, with a sterile waterproof dressing
- Change out of contaminated clothing before eating, drinking or smoking
- Seek medical advice if suffering from a skin problem before working with sewage
- Clean contaminated equipment on site. Employees should not take contaminated clothing home for washing.

2.8 Working in Confined Spaces

In situ polymeric lining of sewer pipes will, by its inherent nature, involve working in confined spaces.

For this reason, it is a pre-requisite that employees undertaking Part 1 and Part 2 Lining Certification in accordance with Appendix B of WIS 4-02-04[(1)] possess Confined Spaces training (Water) and registered with Energy and Utility Skills Register (EUSR)[(2)] or equivalent.

A confined space can be any space of an enclosed nature where there is a risk of death or serious injury from hazardous substances or dangerous conditions (e.g. lack of oxygen)

Confined spaces can include storage tanks, wet wells, manholes, pumping chambers, excavations, enclosed drains, sewers unvented or poorly ventilated rooms amongst others.

Some places may become confined spaces when work is carried out, or during their construction, fabrication or subsequent modification or works.

Dangers arise in confined spaces from the following issues:-

- Lack of oxygen
- Poisonous gas, fumes or vapour
- Liquids or solids suddenly filling the space or releasing gases into it
- Fire and explosion risks
- Residues left in or on remaining surfaces giving off dust, fumes or vapour
- High dust concentrations
- Hot conditions leading to dangerous rise in body temperature

Increased dangers may exist if access to the space is through a restricted entrance such as a manhole which would make escape or rescue in an emergency more difficult

The Approved Contractor shall undertake a suitable and sufficient assessment of the risks for all work activities to decide what measures are necessary for safety (under the Management of Health and Safety at Work Regulations 1999 regulation 3)

In most cases, the assessment will include consideration of:-

- The task
- The working environment
- Working materials and tools
- The suitability of those undertaking the task
- Arrangements for emergency rescue

The Confined Spaces Regulations 1997 may also apply and contain the following key duties:-

- Avoid entering confined spaces if possible

- Implement safe systems of work
- Appointment of a Supervisor
- Ensure suitable and experienced employees are available
- Isolation of mechanical and electrical equipment
- Cleaning before entry
- Check the size of the entrance
- Provision of ventilation
- Testing the atmosphere
- Provision of special tools and equipment
- Provision of breathing equipment
- Preparation of emergency arrangements
- Provision of rescue harness
- Communications
- Check how alarm is raised
- "Permit to work" procedures

The points and items listed above are indicative of the requirements for working in confined spaces but is not intended as a definitive list of Health and Safety requirements to be addressed by the Approved Contractor.

3. APPROVALS

3.1 Polymeric Lining Materials (OR Section 2)

The materials used for *in situ* spray-applied polymeric lining of sewer pipelines are required to be solvent free systems. (OR 2.1)

Product specific information is provided in the manufacturer's Instructions for Use (IFU) document.

Where base and activator components are manufactured in two clearly distinguishable colours, when correctly mixed, this may provide a third distinctive colour allowing for a visual evaluation of mix efficiency to be conducted.

Where the mixed colour of the material does not allow a visual evaluation of mix efficiency to be undertaken, the material manufacturer's IFU document shall specify a test methodology to enable mix efficiency and cure to be evaluated. Methodologies such as Shore hardness testing may be specified for this purpose.

Polymeric material manufacturers are required to possess (and provide on request) current documentary evidence that the materials have been tested in accordance with the requirements for 'site applied materials'. This testing shall have been conducted using a curing regime that reflects typical site practice.

Manufacturers will also provide design information and installation guidelines to enable Sewerage Undertakers and Approved Contractors to ensure that linings applied are suitable for the exposure conditions likely to be encountered within the sewer pipeline and also for any other storm or impact conditions that may affect the lining design selected and anticipated working life.

3.2 Lining Equipment (OR Section 3)

The use of polymeric lining materials is based on the material formulation, the method of application as defined by the OR(1) and IFU documentation, and the equipment used in its application.

It is therefore essential that polymeric lining materials are applied using suitable pumping and monitoring equipment and that all ancillary equipment such as lining hoses, in-line mixers, and lining application heads are compatible with the polymeric material being applied.

3.2.1 Lining rig (OR 3.1 & 3.2)

The lining rig consists of separate storage containers for the components of the polymeric material, a heating system to correctly condition the polymeric material components, a pumping system to supply the polymeric materials to the hoses and maintain the mix-ratio, a monitoring system, and a winch/drum upon which are mounted the hoses that convey the components to the application head.

Optimum pumping and mixing efficiency is obtained by careful regulation of the temperature of the polymeric components and any mechanical mixing requirement specified in the IFU. Heating of these materials shall be in accordance with the manufacturer's instructions.

The lining rig shall therefore incorporate a heating system with controls to prevent overheating. Facilities to recirculate the polymeric components in the reservoirs

through the lining hoses prior to lining are also required.

Dependent upon the polymeric material formulation, the storage reservoirs may require a dry gas or dry air blanket to prevent atmospheric moisture pre-reacting with certain components in the material.

The output of the pump and the winch speed determine the coating thickness and the lining rig shall be designed to give control over these parameters. It is recommended that the operation of the rig monitoring system be sequential so that lining cannot commence until key information has been collated by the operating system, including data input by the Rig Operator. Such a sequence should include warm up, short and long recirculation modes, weight check, with the input to the controller of three consecutive sets of data meeting the tolerance requirements, at intervals of a minimum of 3 minutes**;** and spray-up, with countdown of the spray up time between starting of the metering pump (in spray up mode) and starting of the winch to commence lining, prior to the actual lining.

In addition to the specified requirements for the monitoring system (and print out) supplying the following information is considered good practice:

- umbilical temperature (base and activator polymeric products);
- mix ratio during spray-up.

Appendix C of the OR[(1)] details the standard assessment procedure for determining whether a spray-applied polymeric lining rig complies with the design and performance criteria required to meet the conditions of approval. This schedule may not be applicable to rigs that incorporate alternative monitoring technologies, assessed in accordance with the terms of Appendix F of the Operational Requirements.

Separate approvals are required for each combination of rig design and polymeric material.

Lining rigs shall be calibrated and audited according to the schedule and requirements set down in OR 3.3.

3.2.2 Lining hoses (OR 3.4)

Hoses shall have a suitable pressure rating for conveyance of the polymeric materials, and shall not be susceptible to any significant chemical attack from the materials.

Umbilical hoses shall contain separate lining hoses that have a suitable pressure rating for the conveyance of polymeric materials and are resistant to chemical attack from the polymeric material components.

The umbilical shall contain a fully pressure-rated heating line that helps maintain the temperature of the polymeric components through the umbilical if this is required by the material manufacturers approved lining Instructions for Use (IFU). The umbilical should also contain reinforcement to reduce stretching and the whole hose bundle, including the airline, should be suitably sleeved.

Minor scuffs to the outer sheath of the umbilical can be repaired locally. In certain circumstances, seriously damaged heated umbilical hoses may be successfully shortened provided there has been no damage to the base, activator or heating water lines.

Hose bundles or umbilicals should be clearly marked at both ends of the hose to distinguish them from hoses used on potable water contracts and ensure hoses cannot be subsequently returned to use on potable water mains without the written permission of the Water Undertaker.

3.2.3 In-line mixer (OR 3.5)

The satisfactory mixing of the polymeric components is fundamental to the application of a coating that has optimum performance and durability. The polymeric components are pumped separately through the lining hoses and are mixed immediately prior to the application head by an in-line mixer.

The polymeric lining material manufacturer shall specify the types of in-line mixer that are suitable and have been approved for use with their material and include details of these in the IFU.

In-line mixers shall be marked indelibly so as to provide an audit trail that allows the ***Undertakers Representative*** or independent Auditor to confirm that the in-line mixer being used has been approved for use with the polymeric lining material being applied.

In all cases mixers shall be constructed from pressure rated hoses suitable for the conveyance of the polymeric materials and shall not be susceptible to any significant attack from the materials being mixed or any solvent used to clean the mixer if the mixer is designated as re-useable.

3.2.4 Lining application head (OR 3.6)

The use of *in situ* spray-applied polymeric materials requires an application (spinner) head design that minimises the risk of blockage.

The design of the head will depend on the viscosity and setting properties of the material being applied. The contractor must ensure that the application head employed is designed for rapid material transfer and with a self 'cleaning' cone that applies a coating of specified thickness with minimal ridging and pin holing.

Irrespective of the setting properties of the polymeric material being used, the application head shall be designed to centralise the head in circular pipes and shall not have protruding attachments that could catch on dropped joints or other pipe intrusions thereby causing lining misses (see Section CP 4.19.3).

In addition, the application head shall incorporate rear venting air exhaust ports to minimise the occurrence of linings contaminated with blown dust and debris (see Section CP 4.19.10).

3.3 Approved Lining Contractors (OR Section 5)

Polymeric linings shall only be applied by ***Approved Contractors***. Direct employees of the ***Approved Contractor*** shall undertake the following quality-critical operations:

- lining rig operation, including warm up and safety checks;
- storage and handling of resin materials and cleaning fluids;
- quality checks on cleaning efficiency;
- weight checks;
- temperature checks on base and activator prior to lining;
- spray-up procedures;
- lining procedures;
- pre cure/post cure inspections;
- rectification of lining faults;
- recording of all quality critical data.

Sub-contract labour may only be used for ancillary site work, and not for any aspect of the lining that may affect the quality of the applied coating.

Subcontracting by an ***Approved Contractor*** to unapproved contractors (including subsidiary companies or franchises etc) is not permitted.

4. IN SITU SPRAY-APPLIED POLYMERIC LINING PROCESS

4.1 General

This section of the document considers the procedures necessary for the successful spray application of polymeric materials to sewer pipelines.

All the procedures included in this section shall be included (explicitly or by reference) in the ***Approved Contractor's*** Quality Management System and the contract documentation of the Sewerage Undertaker.

Approved Contractors shall implement schemes to required standards and as the situation demands, for:

i) customer care (e.g. notification, site information boards);

ii) street works;

iii) provision of over-pumping or tankering arrangements if required;

iv) site cleanliness;

v) risk management associated with the sewerage system (e.g. upstream contamination prevention, storm or surcharge conditions, adherence to any valve operations requirements, site contamination, CDM and health and safety issues, temporary pipe work, etc.).

Site practice shall not compromise the quality and cleanliness of the lining process.

4.2 Preparatory Work

In common with other renovation techniques, satisfactory and suitable preparatory work is essential for the successful completion of an improvement scheme. A range of activities shall be addressed, and the following list is provided for guidance (it is however, not exhaustive).

- Contract document preparation.
- Detailed investigation for improvement justification and generic technique selection.
- Detailed investigation of exposure or other environmental conditions anticipated within the pipeline
- Detailed lining design for intended rehabilitation outcome (i.e. non, semi or fully structural outcome)
- System preparation including site investigation and enabling works including tankering or over-pumping.
- Customer care planning.
- Consideration of waste/effluent disposal arising from cleaning process.
- Availability of water if required.
- Risk assessments.
- CDM/Health and Safety requirements.
- Arrangements for connected properties
- Discussions with other Utilities, Highways Authorities and Local Councils.
- Environmental assessments.
- Site access.
- Sewer isolation.

4.3 Fittings

Within pumped or gravity sewerage systems there is a wide range of fittings whose performance may be adversely affected if cleaned and lined incorrectly. Generally therefore all bends with an angle of greater than 22½°, tapers, valves, tee pieces and legged-off fittings should be replaced as part of the contract.

Air valves and other mains fittings should be removed and replaced after lining. It is recommended not to line through valves *in situ* and these should be removed as part of the remedial process.

4.4 Make-Up Pieces

Cut-outs for access may be replaced by ductile iron pipe previously lined with spray-applied polymeric material or with new ductile iron or polyvinyl chloride (PVC-O, PVC-A or PVC–U) pipes and fittings, as specified by the Sewerage Undertaker. Polyethylene may be used as long as specifically designed couplings are utilised (the pipe can creep and subsequently leak if standard couplings are used).

4.5 Polymeric Material Handling

The storage, handling and temperature requirements of polymeric materials are important and the material manufacturer's instructions shall always be followed. Incorrect storage and the uncontrolled use of ancillary heating devices present the greatest risk to overheating stored product. Storage conditions shall therefore be closely monitored.

Any polymeric material stored outside the material manufacturer's specified temperature range shall be quarantined and disposed of appropriately.

The ***Approved Contractor*** should therefore ensure that the polymeric components are stored in a suitable, temperature-controlled, secure environment and are used in date order. In addition, material batch numbers shall be recorded on the quality control documentation so that material production can be related to applied coatings.

4.6 Site checks

The ***Undertaker's Representative*** shall conduct site checks on the lining equipment and the materials supplied (including polymeric material storage facilities).

At the start of the contract, the ***Undertaker's Representative*** shall confirm with the ***Approved Contractor*** the suitability of the materials and lining equipment. This shall be reconfirmed regularly and the ***Undertaker's Representative*** shall be made aware of any changes to lining equipment or materials.

4.7 Access

After pre-lining works have been properly completed the pipeline shall be suitably isolated.

If excavations are required, these shall be of a suitable size to gain safe access to the sewer pipeline and shall meet the following criteria:

i) be located to allow clear access for all cleaning and lining operations to take place;

ii) the depth excavated beneath the pipe invert shall be a minimum of 150mm and sufficient to allow secure end caps to be fitted and prevent contamination of the pipe with excavation and other spoil;

iii) a suitably sized sump shall be excavated to aid removal of any remaining water from the excavation and subsequently prevent any further water from entering the pipe; and

iv) suitably sized pumps and/or tankers shall be used to remove water from the excavation and keep the water level below the pipe invert at all times.

The ***Approved Contractor*** shall comply with the current provisions for signing and protection of excavations.

Once excavated, a section of pipe of sufficient length to allow the renovation equipment to be inserted and removed should be cut from the pipe.

The pipe shall be cut such that a secure end cap or other fitting can be properly used. The pipe cutting equipment shall be suitable for the material and diameter of the pipe to be cut. Suitable safe working procedures shall be adopted.

4.8 Cleaning

A number of cleaning techniques are considered suitable for the preparation of sewer pipelines for *in situ* spray-applied polymeric linings. These include de-silting, pressure jetting, power boring, winching vortex of air, sand blasting or equivalent techniques as described in Appendix A. Other methods can be used provided they comply with the performance requirements of OR 6.1.

The choice of cleaning method is at the discretion of the Sewerage Undertaker and/or the ***Approved Contractor*** as defined in the Contract Specification

The quality of cleaning is paramount if linings are to be applied successfully. Pipes shall be cleaned in full accordance with the material manufacturer's IFU and shall leave the bore of the pipe free of internal deposits and loose or deteriorated remains of original coatings. In ferrous pipes, graphitisation may or may not remain depending on the cleaning process used.

All water and debris arising shall be suitable disposed of in compliance with the requirements of the Sewerage Undertaker or Environment Agency.

Any cables, rods or wires used during the cleaning process shall not be allowed to come in direct contact with the excavation or access point edge or cur pipe edge.

As noted above, residual water and debris shall be removed prior to lining. The continuing presence of substantial amounts of debris and/or water suggests inadequate cleaning and/or leaks in pipework and these faults shall be investigated and remedied.

Removal of water to provide a dry pipe to a dew point specified by the material manufacturer may be achieved by the use of forced ventilation using dry warm air.

It is to be noted that the degree of surface preparation for larger pipe diameters is of

greater importance due to reduced hoop strength of the cured lining.

4.8.1 Return to service after cleaning

Cleaned pipelines may be returned to service without lining However, as cleaning, drying and surface preparation in full accordance with the requirements of the material manufacturer's IFU will be required to be undertaken again prior to lining, this is generally only expected to occur in emergency circumstances and only with the written permission of the ***Undertaker's Representative***.

4.9 CCTV Inspection (OR 6.2)

A colour CCTV inspection of the whole pipeline with digital recording shall be carried out to check the quality of the cleaning and highlight any potential problems such as:

- passing or leaking valves or connections
- dropped joints;
- lead fish or other restrictions;
- protruding connections;
- structural failures
- standing water or moisture presence
- remaining debris or hard scale and.
- ground water ingress

Any locations where problems might be expected (e.g. connections, valves etc) should be inspected with particular care.

The Sewerage Undertaker may also specify that laser profiling be undertaken to check for ovality of the pipeline,

All CCTV equipment shall comply with the minimum specification given in the Operational Requirements (OR 3.7).

The speed of travel of the camera through the sewer pipeline shall be at a rate that ensures the entire pipe bore can be properly inspected and should not exceed a maximum speed of 7m per minute, but may have to be slower than this if there is ringing or any other fault in the lining which requires a slower speed to allow the fault to be properly inspected.

The recording of the CCTV inspection shall show the condition of the pipeline ready for lining and not an intermediate stage of cleaning. Hence, if cleaning faults are observed during the pre-lining CCTV inspection, the fault shall be rectified and the pipeline then re-inspected. It is important when digital recordings are made that the ***Approved Contractor*** ensures that any disks used are formatted correctly and stored in suitable containers to protect against subsequent damage.

Where the ***Undertaker's Representative*** is unavailable, the decision to line the pipeline may be made by the ***Approved Contractor*** but any cleaning defects that are subsequently identified by the ***Undertaker's Representative*** should be rectified by the ***Approved Contractor***.

4.10 Proving

It is important to ensure that there is free passage for the lining application head, which can be accomplished by passing a suitably sized 'prover' through the cleaned pipe length.

CCTV inspection often allows gross restrictions in the pipe to be identified, so explicit proving of the main may not be considered necessary. However, it should be noted that small changes in diameter associated with some repairs might not be identified during CCTV inspection, and these can result in lining problems. Use of a prover is therefore considered 'best practice'.

4.11 Weight Checks (OR 6.4)

Weight checks of the polymeric material components shall be carried out to ensure the material output is within the material manufacturer's specification. Such checks shall be reported on the Sewer Pipe Lining Record (SPLR) and shall conform to the following:

i) be conducted prior to every lining with the rig fully operational in long circulation mode; that is, circulating through the entire length of the hoses;

ii) polymeric material shall be collected at the anticipated flow rate for the lining in appropriately sized containers;

iii) a minimum of 200g of base component shall be collected for each weight check;

iv) a minimum of 3 minutes shall elapse between each weight check;

v) before lining can commence, 3

consecutive weight checks shall be within ±5% (by weight of activator) of the material manufacturer's specified mix-ratio, calculated as 100:(weight of activator/weight of base x 100);

vi) the third weight check shall be carried out immediately before the hoses are inserted into the main to be lined; the time of this weight check shall be recorded on the Sewer Pipe Lining Record; and

vii) scales used to weigh the samples shall record to ±1 gram, shall be calibrated at a maximum of 6 monthly intervals, and shall be accurate to ± 1% full scale deflection.

viii) if unheated lining hoses are used, the time between the final weight check and the start of lining application shall not exceed 30 minutes. If heated umbilical lining hoses are used, the time between the final weight check and the start of lining application shall not exceed one hour. If these times are exceeded, the hoses shall be withdrawn, the polymeric materials recirculated and the weight checks repeated.

4.12 Application of Coating (OR 6.5 to OR 6.10)

Storage reservoirs shall be filled prior to operation and the polymeric material batch numbers recorded on the site paperwork. A competent risk assessment must be used to determine if manual and/or mechanical handling/ emptying of material component containers is acceptable. Where material is delivered in oversized containers then mechanical handling equipment should be utilised.

The base and activator components shall be heated in the rig to within the range specified within the material manufacturer's IFU document.

Prior to lining, the ***Approved Contractor*** shall demonstrate to the ***Undertaker's Representative*** the functioning of the pumping and monitoring systems by:

- demonstrating that the flow metering and pressure monitoring units are functioning, including checking that warning devices and alarm systems are operable;
- demonstrating that the pumping and flow metering units are functioning correctly by conducting defined weight checks on the proportion of base and activator delivered.

Once the lining rig is fully prepared and correctly heated, the temperature of the base and activator shall be recorded on the Sewer Pipe Lining Record.

The hoses can then be winched into the main using a suitable clean cable. The hoses are drawn to and clear of the furthest access hole at which point the application head and in-line mixer unit are attached (OR 6.5).

Before lining commences and material components are pumped to the application head, the ***Approved Contractor*** shall check the head for malfunction. If functioning satisfactorily, the pumps are activated and mixed material is thereby delivered to the application head.

Since the base and activator are generally of different viscosities, polymeric material shall be pumped through the application head to waste until correct stabilisation of the lining rig and satisfactory proportioning of the material has been achieved at the spinner head. The spray-up time varies according to the polymeric material used, the design of the lining machinery, and ambient temperatures (OR 6.6).

Under no circumstances can lining commence if any faults are identified during pre-lining checks or any doubt remains as to the correct material proportioning at the spinner head.

If the time between the final weight check and the start of lining exceeds 1 hour for a heated umbilical and 30 minutes for an unheated umbilical, the hoses shall be withdrawn and the polymeric materials re-circulated.

The actual spray-up time shall be recorded on the Sewer Pipe Lining Record or on the lining rig print out.

Once the ***Approved Contractor*** or/and ***Undertaker's Representative*** are satisfied that the minimum spray-up time has elapsed, polymeric material consistency at the application head is acceptable, and the mix-ratio is within the required ±5% tolerance band, the lining can

commence by withdrawing the hoses at a controlled rate.

The winch speed shall be controlled so that a lining of the specified minimum thickness is achieved at the material flow rates delivered by the rig pumping system.

4.12.1 Addition of polymeric material during lining (OR 6.3)

Approved Contractors shall ensure that wherever possible the reservoirs contain sufficient polymeric material for the lining.

Should it be necessary to add material while lining is proceeding, it shall be pre-conditioned to within the material manufacturer's specified temperature range, so that it is the same temperature as the polymeric material components in the reservoirs, to within approximately ±3°C.

4.12.2 Monitoring of lining (OR 6.8)

The ***Approved Contractor*** shall monitor the performance of the lining rig throughout the lining. It is also considered good practice to monitor the sound of the application head; change in its sound can give an early indication of problems.

If the ***Undertaker's Representative*** or the ***Approved Contractor*** suspects a fault with the equipment or the coating, the process shall be aborted and all lining equipment removed from the pipeline.

After curing a suspected faulty lining for the period specified by the material manufacturer in the IFU, the lining shall be rectified in accordance with OR 6.12 and with CP 4.19

4.12.3 Dip cards

Under normal lining conditions, at least one dip card or other material sample is taken after the spray-up time has elapsed and immediately before commencement of lining and a further dip card or sample taken on completion.

The dip cards or samples should be cured and can be retained as a permanent record, for a minimum period of six months, or as specified by the Sewerage Undertaker.

4.13 Assessment of Lining Printout

Immediately after completion of the lining, the ***Approved Contractor*** shall review the lining printout to ensure compliance with WIS 4-02-04.

The ***Undertaker's Representative*** shall review the lining printout within 24 hours of the completion of lining.

4.13.1 Assessment of mix-ratio criterion (OR 6.8)

For a lining to be considered acceptable 95% of the mix-ratios shall be within ±5% of the material manufacturer's specified mix-ratio and 100% shall be within ±10%.

Immediately following the lining, the lining printout shall be reviewed by the ***Approved Contractor*** (or/and ***Undertaker's Representative*** if he/she is immediately available) to determine if this criterion has been met. If this criterion is not met a non-conformance record shall be filled out. The lining rig should be put into re-circulation mode and weight checked. These results shall be recorded on the Sewer Pipe Lining Record. If the weight checks demonstrate a mix-ratio fault, the lining shall not be returned to service until rectification in accordance with OR 6.12 and CP 4.19 has been conducted.

If the weight checks are satisfactory, however, and given that mix-ratio faults can be indicative of flow meter and/or signal processing problems, rather than mix-ratio errors, the response should be in proportion to the risk.

If there is <u>any</u> additional evidence of mix-ratio fault (from CCTV inspection and/or pipe samples) then appropriate measures shall be taken (i.e. rectify contaminated pipe lengths in accordance with OR 6.12). However, if the non-conformity is only marginal (for example, the printout shows that the lining is only just outside the 95% criterion) and there is no evidence of poor

cure/mixing, rectification may not be necessary.

The ***Undertaker's Representative*** is the final arbiter of whether there is a potential risk to lining quality and whether rectification is required.

4.13.2 Assessment of coating thickness criterion (OR 6.9)

The minimum lining thickness is specified in or calculated in accordance with the material manufacturer's IFU requirements throughout the lining. However, there are signal-processing issues associated with the encoders used to infer coating thickness, as well as process variations that affect coating thickness estimates. To reflect these issues, unless otherwise specified in the procurement contract, a lining is deemed acceptable if 95% of the coating thicknesses recorded on the printout are not less than the specified thickness and 100% are not less than 90% of the thickness specified by the Sewerage Undertaker.

If this criterion has not been met, a non-conformance record shall be filled out and appropriate actions taken.

If the printout indicates a thin coating, a sample may be taken and over-lining will be required if the coating is considered too thin. However, the response should again be in proportion to the risk. If the non-conformity is only marginal (for example, the printout shows that the coating is only just outside the 95% criterion), rectification may not always be necessary.

The ***Undertaker's Representative*** is the final arbiter of whether there is a potential risk to longevity of the coating and whether rectification is required.

4.14 Curing (OR 6.10)

The cure period shall commence only when the lining head is removed.

The cure period specified in the individual manufacturer's IFU document will have been used as the basis of the suitability of the polymeric material and under no circumstances can this period be reduced before return to service.

The use of end caps or stoppers during curing is essential for polymeric materials that cure over night to prevent any damage to the lining from the ingress of water.

For materials that set more rapidly, the use of end caps during curing is not absolutely necessary as long as lining operatives remain at each open pipe-end throughout the curing period. However, open pipe-ends shall be capped off if this is not the case.

4.14.1 Application temperature (OR 6.7)

Polymeric lining materials shall not be applied when the pipe wall temperature is below that specified in the material manufacturer's IFU since this may result in a delay in cure and risk damage to linings on premature return to service.

The pipe wall temperature is taken as the temperature of the water flow sampled through the nearest upstream access point on the sewer pipeline to be renovated. This should be conducted immediately before the pipeline is isolated for cleaning and lining. Lining shall not be undertaken if this temperature is below the material manufacturer's specified minimum temperature.

This assessment shall be conducted if the ambient air temperature is (or is likely to be) below 5°C.

The ***Approved Contractor*** shall record the temperature of the water sample on the Sewer Pipe Lining Record sheet.

4.15 Post-Cure Inspections (OR 6.11)

After completion of the cure period, a preliminary inspection of the pipe ends shall be undertaken to determine the coating hardness (degree of cure).

The ***Approved Contractor*** or/and the ***Undertaker's Representative*** shall inspect and record the quality of the lining at both pipe ends. During the inspection, the lining shall be

checked physically; if the application were correct in terms of mix-ratio, all pipe ends would appear identical in terms of cure and hardness.

Once sufficiently hard to withstand the passage of a camera and in accordance with the manufacturer's IFU, the quality of the applied lining along its entire length shall be determined by colour CCTV inspection. Inspections of this nature allow for the evaluation of cure, proportioning and mixing, and for the assessment of any lining faults.

Site cleanliness is important at this stage to avoid contamination of the pipe interior. CCTV equipment including cables shall therefore be clean on insertion. The speed of travel of the camera shall allow the survey to be carried out effectively and the whole pipe diameter to be inspected. When surveying pipes the camera shall be well focused, properly illuminated and the speed of survey controlled such that at all times the picture is not distorted by excessive speed of travel. The detail of the lining shall be clearly discernible and there should not be any need to reduce the natural speed at which the survey is carried out, using the viewing software, in order to make the survey details more discernible or assessable. The speed of survey shall not, in any case, exceed 7 m/min. The presence of ridging/ringing in a lining can cause 'bouncing' of the camera distorting the picture, or causing disturbance to create electrical interference and affect picture quality. In such circumstances the speed of survey shall be reduced such that the detail of the lining can be more easily seen and assessed properly without distortion of the survey picture. The speed reduction shall be such that the impact of ridging/ringing is minimised so that the detail of the lining between the rings can be clearly seen and assessed.

In the event that survey is not carried out to a standard deemed to be acceptable the ***Approved Contractor*** shall be required to resurvey the pipe at a later date to meet the above requirements and this additional work, if necessary, shall be carried out at the ***Approved Contractor's*** expense.

To avoid a potential need for re-inspection due to faulty recordings, it is good practice for the CCTV lining record to be checked before the CCTV mobile unit leaves the site.

Under no circumstances shall a main exhibiting lack of cure, mixing, or proportioning be returned to service until it has been rectified to the *Undertaker's Representative's* satisfaction.

Any apparent water damage faults shall be immediately brought to the attention of the *Undertaker's Representative*.

4.16 Pipe Sampling (OR 6.14)

The lining print out gives the nominal lining thickness, calculated from the pipe diameter and lining variables (pumping rate and winch speed). However, lining thickness may not be uniform around the circumference of the sewer if the lining head has not been properly centralised or is offset within the pipeline. The actual thickness applied to the pipe can be determined through pipe sampling.

When requested, ***Approved Contractors*** shall take pipe samples at an agreed point in the lined section of main but generally avoiding pipe ends at lining entry and exit points.

Pipe sampling is undertaken at the request of the Sewerage Undertaker.

Pipe samples shall be removed by a method suitable to the pipe materials in order to avoid damage to the adjacent remaining lining. The material manufacturer may specify an end sealing system to be used at pipe cut locations and this should be utilised to prevent subsequent damage or deterioration of the remaining lining. Disc cutters should be avoided as they can cause damage to the coating by heat transfer and are not recommended for use in excavations.

Coating thickness shall be measured on both cut faces of the sample at the four clock positions of 3, 6, 9 and 12.

These coating thickness measurements can be made with a micrometer or more simply with a proprietary thickness gauge, which is capable of unambiguous cured coating thickness assessment. All measurements shall be recorded on the Pipe Sample Quality Record sheet.

In addition to thickness measurements, the pipe samples shall be examined for other lining faults with rectification in accordance with Section CP 4.19.

4.17 Return to Service (OR 6.13)

The IFU may state a return to service procedure, including avoidance of any surge or vacuum conditions that may occur. If these are stated, they must be followed.

The pipes shall be pieced-up using suitable couplings which shall be protected both externally, using for example protective mastic and tape or proprietary coatings, and internally by the use of a suitable coating if required.

4.18 Hand Spraying

4.18.1. As part of the overall sewer asset rehabilitation contract, the Sewer Undertaker may specify that manholes, chambers, wet wells or other associated assets are to be similarly protected or enhanced by application of polymeric materials used for sewer pipeline rehabilitation. Dependant on the physical dimensions and shape/form of the asset, the polymeric material may be applied by hand spray gun.

4.18.2 The material manufacturer's IFU will include information on cleaning and preparation of substrates, any surface drying requirement and application of the polymeric material to the asset surface including information on hand spraying application equipment specified for this purpose.

4.18.3 Linings applied by hand spray techniques should be carefully inspected for uniformity of application and cure by visual examination using suitable lighting and by touching sprayed surfaces to check for hardness and freedom from surface tack

4.19 Rectification of Lining Faults (OR 6.12)

This section describes the more common faults and provides basic instructions for rectification.

A pipe length exhibiting any fault that is related to the application of faulty mix-ratio, severe water damage, unmixed material or single component application shall not be returned to service before rectification as described below.

Lining faults where the ***Undertaker's Representative*** is satisfied that the lining is correctly proportioned and cured (that is, physical lining faults) may be rectified after the cure period and CCTV inspection as specified in the IFU. Such linings may also be returned to service but shall be rectified within a reasonable timeframe at the discretion of the ***Undertaker's Representative***. Where rectification requires overcoating this shall only be carried out using the same material and where possible should be conducted before the pipeline is returned to service. When this is not possible the original coating shall be cleaned to ensure that the surface is free of debris and organic films, etc. that may limit adhesion and long term durability.

If a proportion of the lining is acceptable and the remainder is faulty, the pipeline can be split and the acceptable section returned to service. The faulty lining shall be rectified or replaced before return to service and details of all works carried out on each section shall be recorded on the relevant quality assurance record sheets.

When over-coating is required this shall be carried out within any timeframe specified by the material manufacturer in the IFU and if this is not possible the subsequent action detailed in the IFU must be adopted.

4.19.1 Lining over debris

Inadequate pipe cleaning that has not been identified by CCTV inspection after cleaning may leave deposits and/or loose debris in the pipe that can be incorporated into the lining or lined over. It is possible that this may cause premature failure of the lining and decrease the expected hydraulic performance of the lined pipe.

If the fault is localised it may be rectified by excavation and removal of the faulty pipe which can be replaced with a suitable make-up piece. However, if the faulty section is extensive, it shall be re-laid**,** if not

able to be adequately cleaned and over-lined.

Figure 6 - Debris trapped in applied lining

4.19.2 Ridged lining

Ridged linings (ringing) may be caused by persistent jerking of the lining head in the pipe as a result of snagging of the umbilical/hoses on bends, fittings or lining hose exit points. It can also be caused by winch gear malfunction. Provided the mix-ratio is correct, the troughs are at least minimum design lining thickness and the ***Undertaker's Representative*** considers the ridge peaks acceptable, no remedial action is required.

A ridged lining with any part below the minimum specified thickness will generally require remedial action and in any case will require a non-conformance record to be completed. Ridging considered excessive and unacceptable to the ***Undertaker's Representative*** will similarly require remedial action and a non-conformance record to be completed. Short sections can again be cut out and replaced with a make-up section. Larger sections will need to be relined or, where ridging is considered excessive and unacceptable and cannot be removed, re-laid. If the peaks are thick and/or ragged then driving power boring rods and cutters or similar through the pipeline is recommended. This action will not remove the lining but could remove any obstructions to the subsequent free flow within the pipeline. Care should be taken to prove small bore pipelines before any relining is attempted.

Any stalactites forming within the crown of the pipeline must be completely removed to the satisfaction of the ***Undertaker's Representative*** since these could otherwise act as rag traps and affect the subsequent hydraulic performance of the pipeline. Following relining, the curing, inspection and return to service procedures are as described previously.

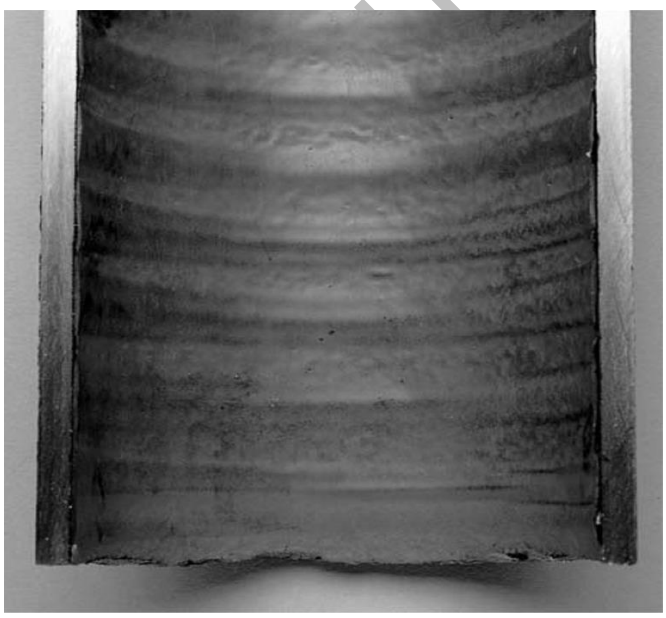

Figure 7 - Ridged lining

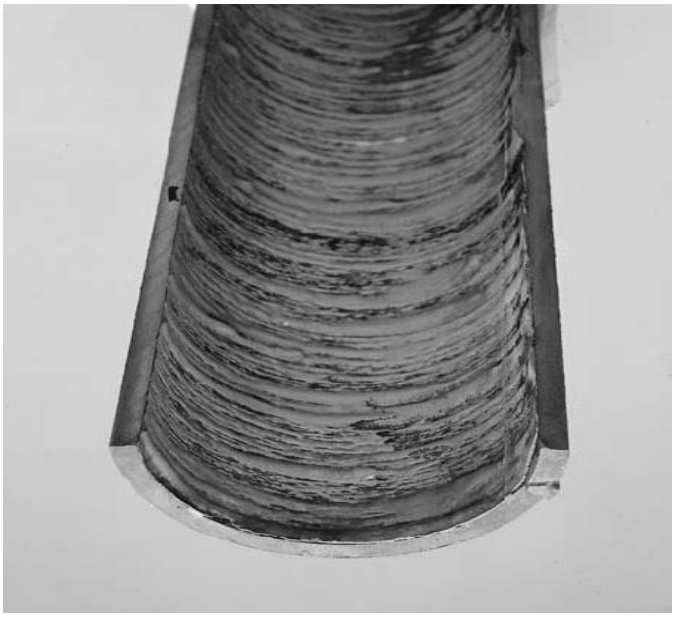

Figure 8 - Severely ridged lining

4.19.3 Incomplete lining

An intermittent fault on the lining machine or a severe jerking action of the lining head caused by poor adjustment of the skids or winch action, unsatisfactory design of the application head, or protruding obstacles in the main may result in sections of pipeline with no lining.

Figure 9 – Incomplete lining

These faults are usually only observed on post-lining CCTV inspection and the rectification procedure depends upon the magnitude of the fault.

Generally this type of lining fault manifests itself as a single short unlined section (1-2m) in a lining length and this is best dealt with by excavation and replacement with a suitable make-up piece or over-lining.

Provided the ***Undertaker's Representative*** is satisfied that the mix-ratio of the lined sections is correct, larger unlined sections or multiple sections will be more cheaply rectified by relining. Following relining, the curing, inspection and return to service procedures are as described previously.

4.19.4 Thin linings

Thin linings are usually identified during CCTV inspection where the host pipe substrate may show through the coating, or more reliably when pipe samples have been taken. Remedial action is as for CP 4.19.3 (Incomplete lining).

Figure 10 - Thin lining

4.19.5 Linings with invert slump

Except when considered unacceptable by the ***Undertaker's Representative***, an invert slump can be tolerated provided the thickness at the clock positions of 3, 9 and 12 is within the minimum specification requirement. However, where a coating is below the specification thickness at 3, 9 and 12 it shall be rectified following the recommendations in CP 4.19.3 (Incomplete linings).

Slumped linings considered excessive and unacceptable to the ***Undertaker's Representative*** will require remedial action.

Where the unacceptable slump is over short sections, this is best dealt with by excavation and replacement with a suitable make-up piece. Longer sections may need to be re-laid, since it is unlikely that the slumped lining will be removed by boring techniques. In any case, a non-conformance record shall be filled in.

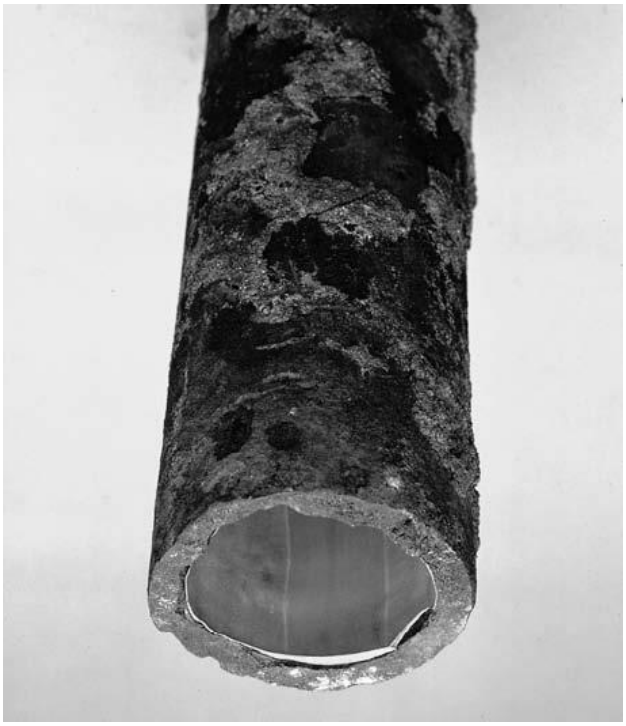

Figure 11 - Slumped lining

Figure 12 - Severe slumping

4.19.6 Lining through water

On occasions water may collect in a low point in the main as a result of water passing from a valve, branch connection or from ground water ingress after the pre lining CCTV inspection and before lining hose insertion. This type of fault is usually observed after the post-cure CCTV inspection.

Lining through standing water may result in severe water damage and the pipeline shall not be returned to service until the fault has been rectified to the satisfaction of the ***Undertaker's Representative***.

CCTV inspections shall be conducted in both directions to establish the precise position and extent of the problem. Care shall be taken when conducting CCTV surveys to ensure that potentially uncured polymeric material is not spread over the remaining lining by the camera.

Where the damage is over short sections, it may be dealt with by excavation and replacement with a suitable make-up piece. Longer sections may need to be re-laid unless the uncured material can be successfully removed by cleaning in order to permit over-lining.

Figure 13 - Effect of lining through water

4.19.7 Invert water damage

Invert water damage may take two forms. The first, illustrated in Figure 14, occurs where water has passed over the partially cured lining but does not cause severe damage. Provided the water-damaged area is intact and has a thickness above the minimum specified, no further action is required. Lining damage as shown in Figure 15 is caused by water flowing down the invert immediately after lining. Where the damage is over short sections, it may be dealt with by excavation and replacement with a suitable make-up piece. Longer sections may need to be re-laid unless the damaged or any uncured material can be removed by cleaning in order to permit over lining.

Figure 14 - Minor water damage

Figure 15 - Major water damage

4.19.8 Presence of unmixed base or activator

In the event of an unobserved fault occurring in the lining machine, or a burst base or activator hose resulting in the application of an unmixed component, or contamination of the inside of the pipe with an unmixed component, the pipeline shall remain isolated and not returned to service until rectified.

Short lengths of uncured component lining would only be witnessed on CCTV inspection and contamination of the CCTV equipment can be expected.

Figure 16 – Unmixed resin material

As required by OR 6.12, this lining fault shall be rectified by relaying or remediating the contaminated length by cleaning and removal of all unmixed material in order to permit over-lining

4.19.9 Blistered lining and blowholes

Blisters have been observed in linings of certain spray-applied materials. This may be observed during CCTV survey and pipe sampling as slightly raised hollow blisters, ranging from a few mm to 3 to 5 cm in size.

Figure 17 - Blistered lining

Figure 18 - Blowholes in lining

The decision to undertake rectification is a matter for engineering judgement. Localised blistering may be rectified using local repair procedures if specified within the material manufacturer's IFU. Linings that exhibit substantial quantities of blisters can be power bored, swabbed and over-lined.

Blowholes can occur occasionally. Some blowholes are in effect large pinholes with direct penetration to the substrate whereas others are blemishes that have sealed and are of no consequence.

The decision on whether or not to rectify this fault is at the ***Undertaker's Representative***'s discretion. If it is localised, the section of pipe may be cut out. However, if the problem is widespread and severe, rectification shall be carried out as described in previous sections.

Note: The exact reasons for both blowhole formation and blistering are not known, but they may well be formed due to an interaction between the pipe substrate (and/or previous coatings) and polymeric material. If blowhole and blistering is a significant problem on a particular scheme, it could be that *in situ* lining is not suitable and that other rehabilitation techniques should therefore be considered.

4.19.10 Speckled linings

Speckled linings can be observed during CCTV inspection and occasionally on pipe samples. Surface speckling of the lining may be caused by poor cleaning – loose friable corrosion deposits left in the main are disturbed by the passage of the application head resulting in a surface contamination of the lining by the dust.

Speckled linings can also be localised at joints where loose deposits often remain lodged in the joint cavity. When disturbed, this 'contaminates' a short section of lining either side of the joint. It is essentially an aesthetic problem and the lining may be returned to service at the ***Undertaker's Representative's*** discretion. Linings unacceptable to the ***Undertaker's Representative*** shall be over coated.

Simple localised joint contamination needs no rectification provided the lining is intact.

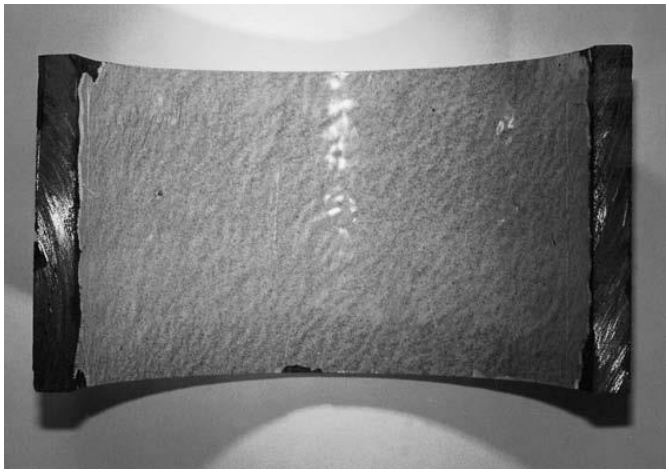

Figure 19 - speckled lining

4.20 Quality Control Documentation (OR Section 7)

The ***Approved Contractor*** is responsible for ensuring that all documentation is issued to the ***Undertaker's Representative*** within the prescribed timescales.

The form of Quality Control documentation used in lining contracts shall conform to the minimum content specification given in Appendix E of the OR[(1)].

Example standard documents are contained in Appendix B of this Code of Practice. No copyright attaches to these forms and they may be freely reproduced.

4.21 Return to Service

The Approved Contractor shall ensure linings are fully cured as specified in the material manufacturer's IFU in respect of any return to service procedures. The Contractor's Method Statement shall specifically include any actions required to avoid surge, vacuum scour or impact damage occurring to the newly applied lining.

REFERENCES

1. WIS 4-02-04 "Operational Requirements: *In Situ* Polymeric Lining of Sewer Pipelines". Water UK Issue 1 (April 2018)

2. Energy and Utility Skills Register (EUSR). Further information on the scheme is available at https://www.eusr.co.uk

Code of Practice:

In Situ Resin Polymeric of Sewer Pipelines

Appendix A: Description of Vortex of Air or other equivalent pipe cleaning techniques

A.1 Prior to polymeric lining, pipelines may be cleaned by using Vortex of Air or equivalent pipe cleaning techniques as an alternative to more traditional techniques such as boring or scraping. This involves blowing dry, washed aggregate down the pipe at high speed until all water, tuberculation, loose deposits or deteriorated remains of a previous coating and other foreign materials from inside the pipe have been removed. The cleaning method used shall not remove areas of graphitisation and shall leave the bore of the pipe dry, smooth, intact and free from dust to ensure a secure bond for any spray lining to be applied, and not to provide any sharp promontories which may damage the lining.

A.2 The aggregate used should be dust free, dry granite or flint that meets the equipment manufacturer's specification. The aggregate and removed deposits will be collected in an enclosed receptacle at the end of the pipeline and upon completion of cleaning of the pipe the contents of the vessel will be disposed of in an environmentally safe manner which may involve them being buried in a suitable on-site operation

A3 An adaption of the Vortex of Air cleaning technique may be used to clean asbestos cement (AC), concrete or plastic pipes prior to in situ liningIn some techniques the aggregate is replaced with water alone. The process involves the injection of water into the air stream to provide a cleaning medium that will remove any remaining pipe coating or slime deposits from the wall of the pipe thereby providing a suitable sound substrate to which a lining may be applied.

A4 Any waste water from the process of cleaning whether filtered or unfiltered, shall be discharged into a designated manhole within a sewerage system or tankered to a suitable disposal point. Water must not be discharged into a surface water outlet whether to a piped system or to a watercourse. If a suitable sewerage outlet is not available then waste water shall be transported, within the receiver tank or separate container, to the nearest approved sewer outlet for disposal.

A5 Throughout the process due care and attention must be paid to the health and safety issues related to the handling of asbestos based or other hazardous materials including use of appropriate PPE; packaging and correct disposal of solid waste or other waste water, contaminated during the cleaning process. Care must be taken to employ appropriate safety measures in cutting of pipes and ensuring equipment entering the pipe is suitably cleaned on exit.

A.6 Suitable precautions must be taken to protect operatives and the public from injury during the use of all types of cleaning equipment.

Code of Practice:

In Situ Polymeric Lining of Sewer Pipelines

Appendix B: Example Quality Control Documentation

APPENDIX B: EXAMPLE QC DOCUMENTATION

Example standard documents are presented below. No copyright attaches to these forms and they may be freely reproduced. Example documents given are:

- SEWER PIPE LINING RECORD
- CCTV RECORD
- NON CONFORMANCE RECORD
- PIPE SAMPLE QUALITY RECORD
- SPRAY-UP DETERMINATION RECORD

INSERT YOUR COMPANY LOGO HERE **SERIAL NUMBER**

SEWER PIPE LINING RECORD (All items to be completed)

Scheme/ Location	

Contract		***Access Hole or M/H Refs.***	
Contractor		***Pipe Diameter***	
Supervisor		***Pipe Material***	
Gang Ref.		***Polymeric Material***	
		Lining Type	
		Design Thickness	
Date		***Length Lined***	

Lining rig number			
Application head number/type			
In-line mixer serial number			
Length of static mixer			
Base batch numbers		***Quantity***	
Activator batch numbers		***Quantity***	

Cleaned: visual checks OK?	YES	NO	**Method used**		
Cleaned: CCTV survey OK?	YES	NO			
Ambient temperature	°C		**Pipe wall temperature**	°C	
Base temperature	°C		**Activator temperature**	°C	
Lining: time start			**Spray-up time**	(Secs)	
Lining: time complete					

WEIGHT CHECK 1			
Test No.	**Weight of base (B)**	**Weight of activator (A)**	**Mix-ratio = (A/B)x100**
1			
2			
3			
Time of Test No. 3			

WEIGHT CHECK 2: PRE/POST LINING			
Test No.	**Weight of base (B)**	**Weight of activator (A)**	**Mix-ratio = (A/B)x100**
1			
2			
3			
(If required)			

Weight check 1 OK?	YES	NO	**Weight check 2 OK?**	YES	NO
Mix-ratio print out OK?	YES	NO	**Tab test OK?**	YES	NO

INSPECTION	**PRE-CURE**		**POST CURE**	
Uniformity OK?	YES	NO	YES	NO
Quality OK?	YES	NO	YES	NO
Thickness OK?	YES	NO	YES	NO
Hardness OK?			YES	NO

Curing time: start (exit of head from pipe)			**Curing time: finish (post cure inspection time)**		
Duration of cure			**Tack free**	YES	NO
CCTV survey OK?	YES	NO	**CCTV Record number**		
Reconnection date			**Reconnection time**		
Pipe sample record number			**Quality results OK?**	YES	NO
Non-conformance record no.					

Comments:

For Client		**For Contractor**	
Signature		**Signature**	
Print name		**Print name**	
Position		**Position**	
Date		**Date**	

INSERT YOUR COMPANY LOGO HERE **SERIAL NUMBER**

POLYMERIC LINING - CCTV RECORD

Scheme/ Location	

Contract		**Access or M/H Refs.**	
Contractor		**Length Surveyed**	
Supervisor		**SPLR Number**	
Gang Ref.		**Polymeric Material**	
Date	am/pm		

CCTV recording reference

Faults observed	Position	Comment 1	Comment 2
Incomplete lining			
Water damage			
Slump			
Ridging/ Ringing			
Stalactites or Rag Trap			
Mix-ratio error			
Single component			
Blisters / blowholes			
Hard scale / deposits			
Poor cleaning			
Other			

CCTV TO BE WITNESSED BY CLIENT

For Client		**For Contractor**	
Signature		**Signature**	
Print name		**Print name**	
Position		**Position**	
Date		**Date**	

Remedial action required? YES NO

Remedial action taken? YES NO

NCR number

Pipe sample taken? YES NO **PSQR number**

Contractor's Representative

Signature	
Print name	
Position	
Date	

INSERT YOUR COMPANY LOGO HERE **SERIAL NUMBER**

POLYMERIC LINING NON CONFORMANCE RECORD

Scheme/ Location			
Contract		**Access or M/H Refs.**	
Contractor		**Polymeric Material**	
Supervisor		**RLR Number**	
Gang ref.		**Length Lined**	
Date			
Nature of defect			
Reason for defect			
Action taken			
Date of action		**SPLR Number (if relined)**	
Action taken to prevent recurrence			
Comments			

For Client		**For Contractor**	
Signature		**Signature**	
Print name		**Print name**	
Position		**Position**	
Date		**Date**	

INSERT YOUR COMPANY LOGO HERE **SERIAL NUMBER**

POLYMERIC LINING PIPE SAMPLE QUALITY RECORD

Scheme/ Location			
Contract		**Access or M/H Hole Refs.**	
Contractor		**Polymeric Material**	
		Design Thickness	
Supervisor		**RLR Number**	
Gang Ref.		**Length Lined**	
Date			

END 1

(Position)	3 o'clock	6 o'clock	9 o'clock	12 o'clock
Thickness (mm)				

Mean **Max** **Min**

END 2

(Position)	3 o'clock	6 o'clock	9 o'clock	12 o'clock
Thickness (mm)				

Mean **Max** **Min** **Lining accepted?** YES NO

LINING FAULTS

Faults observed	(tick)	Comments
Incomplete lining		
Water damage		
Slump		
ridging/ Ringing		
Stalactites or Rag Trap		
Mix-ratio error		
Inadequate cure		
Blisters		
Poor cleaning		
Other		

PIPE CONDITION

	(tick)	Comments
Oval		
Undersize		
External light corrosion		
External medium corrosion		
External heavy corrosion		

Comments:

Photographs taken	YES	NO
NCR number issued (if any)		

Attach any photograph reference to record

Sample passed to client: Inspection Office **Date**

For Client

Signature	
Print name	
Position	
Date	

For Contractor

Signature	
Print name	
Position	
Date	

INSERT YOUR COMPANY LOGO HERE **SERIAL NUMBER**

POLYMERIC LINING SPRAY-UP DETERMINATION RECORD

For method see Operational Requirements Appendix D

Scheme/ Location	

Contract		**Polymeric Material**	
Supervisor		**Rig Type**	
Gang Number		**Rig Number**	
		Lining Head Type	
Date			

Total Flow Rate	(l/min)	**Ambient Temperature**	°C
		Umbilical Temperature	°C
		Base Temperature	°C
		Activator Temperature	°C

TEST RESULTS

Elapsed Time	Colour or Cure Correct		Assessment of Cure
10s	YES	NO	
20s	YES	NO	
30s	YES	NO	
40s	YES	NO	
50s	YES	NO	
60s	YES	NO	
70s	YES	NO	
80s	YES	NO	
90s	YES	NO	
100s	YES	NO	
110s	YES	NO	
120s	YES	NO	

Tab cure time		**Date tested**	
Min. acceptable spray up time	(secs)		

Test carried out by

Signature	
Print name	
Position	
Date	

Witness by client

Signature	
Print name	
Position	
Date	