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UK Water Industry

OPERATIONAL REQUIREMENTS: *IN SITU* POLYMERIC LINING OF SEWER PIPELINES

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This document has been prepared on behalf of the Water UK Standards Board. Technical queries should be addressed to the Standards Board c/o The Technical Secretary E-mail:mikeshpherd@thamesinternet.com . The latest version of this document can be downloaded from:
<http://www.wis-ign.org>.

OR SECTION 1: GENERAL

OR 1.1: Scope

1. These Operational Requirements cover material selection, pipeline cleaning, application, curing- and, inspection requirements needed to provide non-structural protective coatings, semi structural or fully structural *in situ* spray applied linings to pipelines and other non-circular assets constructed of iron, steel, asbestos cement, concrete, clay, plastic, pitch fibre or as limited by the material Instructions for Use (IFU) using polymeric lining materials for the *in situ* lining of sewer pipelines
2. These polymeric materials are placed *in situ* by spray application to pipelines of nominal 3" (75mm) diameter and above or as limited by the IFU.
3. Additional information and advice is presented in the Code of Practice: *In Situ* Polymeric Lining of Sewer Pipelines IGN 4-02-05⁽¹⁾
4. Material-specific information and advice including lining design information (if appropriate) is presented in the Instructions for Use (IFU) document provided by the material manufacturer.
5. It is the responsibility of the Sewerage Undertaker to ensure that all practices conducted on the sewerage network do not pose a risk to the operational capability of the system

OR 1.2: Implementation

1. These Operational Requirements shall apply from 1st May 2018.
2. Contractors shall be deemed '**Approved Contractors**' (as defined in OR 1.3 below), provided that they have:

- satisfactorily demonstrated to a **Nominated Certifying Body** (as defined in OR 1.3 below) that their Quality Systems and working procedures meet the requirements of this document.

- provided to all personnel performing lining roles defined in Appendix B a written guide to and awareness training of the Operational Requirements; and

3. Lining rigs shall be deemed '**Approved Lining Rigs**' (as defined in OR 1.3 below), provided that it has been successfully demonstrated to a **Nominated Certifying Body** (as defined in OR 1.3 below) that they comply fully with the requirements of this document.

Arrangements for training and certification of personnel are detailed in OR Sections 4 and 5 below.

OR 1.3: Definitions

For all aspects of *in situ* lining the following definitions apply:

Approved Contractor

A contracting company that possesses a valid certification or a contracting company, in seeking a new certification or renewing an existing certification, has demonstrated its ability to apply a specified polymeric sewer lining material correctly in supervised lining trials (as described in Appendix A), has been certified by a **Nominated Certifying Body**, and is employed by a Sewerage Undertaker to supply trained and appropriately certified personnel who are registered under an Energy and Utility Skills Register (EUSR) Scheme⁽³⁾ or equivalent and approved products and machinery to apply polymeric coatings in accordance with these Operational Requirements.

The **Approved Contractor** is approved in respect of a stated polymeric sewer lining material and rig combination. A Contractor may be approved several times over for various combinations of material and rig (see OR 3.2) and such rig/material combination approval notified to and entered on the nominated database.

The **Approved Contractor** is responsible for ensuring that all aspects of the rehabilitation process can be monitored and inspected by the **Undertaker's Representative**. This includes all components of the cleaning and lining process. An **Approved Contractor** working as a sub-contractor on behalf of an unapproved Contractor as part of a rehabilitation contract is acceptable with the full permission of the appointed person responsible for the Sewerage Undertaker contract.

Polymeric Sewer Lining Material

A polymeric material supplied for use in the *in situ* lining of sewer pipelines

As yet there are no harmonised international standards concerning fitness for use of *in situ* polymeric lining systems for use in sewer pipelines, or equivalent national standards for these products. In the absence of such national specifications, lining products shall be approved by the Authorities under any appropriate national regulation.

Polymeric sewer lining materials shall be used in accordance with the lining design information provided within the appropriate IFU.

Approved Lining Rig

A lining rig of a design that has been type tested in accordance with Appendix C and subsequently certified by a **Nominated Certifying Body** for the storage, heating, dispensing, mixing, and application of a specified polymeric sewer lining material.

New Contractor

A contracting company that wishes to undertake the supervised lining trials outlined in Appendix A so as to become an **Approved Contractor**

and is required by the **Nominated Certifying Body** to undertake a full (at least three linings) assessment procedure.

New Contractors either hold no approvals for application of polymeric sewer lining materials or the approvals they hold are for polymeric materials with significantly different properties or with different sewer rehabilitation outcomes, as detailed in A.4, Appendix A of this document.

Nominated Certifying Body

Water UK nominates Certifying Bodies.

A **Nominated Certifying Body** must be accredited by **UKAS** or other equivalent European Union accreditation service as a Conformity Assessment Body complying with these Operational Requirements (WIS 4--02-04) and with IGN 4--02-05⁽¹⁾ "Code of Practice: *In-situ* polymeric lining of sewer pipelines.

Nominated Training Certifier

Water UK nominates Training Certifiers.

A **Nominated Training Certifier** that is not already a **Nominated Certifying Body** shall be accredited by **UKAS** or other equivalent accreditation service as a Conformity Assessment Body complying with these Operational Requirements (WIS 4--02-04) and with IGN 4-02-05⁽¹⁾ "Code of Practice: *In-situ* polymeric lining of sewer pipelines.

UKAS (The United Kingdom Accreditation Service)

The sole national accreditation body in the UK recognised by the Department of Trade and Industry, on behalf of Government as a whole, by means of a Memorandum of Understanding dated 1 August 1995.

Responsibility	OR
General duty to inspect all materials and work undertaken	OR 1.5
Review material manufacturer's Instruction For Use (IFU) documents	OR 2.1
Require the Approved Contractor to demonstrate on a weekly basis that monitoring and alarm systems are operating in accordance with the Operational Requirements <u>and</u> rig type test conditions	OR 3.2
Inspect maintenance and calibration records of rig and components	OR 3.3
Be present at rig performance audits	OR 3.3
Monitor the Approved Contractor and take responsibility on behalf of the Sewerage Undertaker for the quality of all linings	OR 4.1
Where emergency circumstances require, consider return of the sewer to service prior to lining and specify in writing any appropriate actions required to be carried out by the Approved Contractor	OR 6.1
Be present at spin-up determination tests	OR 6.6
Consider need for spray-up test as a result of weather conditions	OR 6.6
Assess any rectification works linked to aborted linings prior to return to service	OR 6.8
Review mix-ratios and thickness recorded by the monitoring system	OR 6.8 and 6.9
Examine CCTV inspection and the lining print out and ensure that linings meet the Operational Requirements.	OR 6.11
Assess rectification of lining defects	OR 6.12
Assess suitability for return of sewer to service, having regard to risk of service failure and where necessary consider appropriate action	OR 6.13
Inspect any pipe samples for lining quality and coating thickness	OR 6.14
Sign all documentation and retain copies	OR 7

Responsibilities of the Undertaker's Representative

Undertaker's Representative

A person certified by a **Nominated Certifying Body** or a **Nominated Training Certifier** and registered under a EUSR or equivalent scheme appointed by the Sewerage Undertaker as their representative.

The **Undertaker's Representative** may or may not be a direct employee of the Sewerage Undertaker but shall not be an employee of the **Approved Contractor** or any organisation associated with the **Approved Contractor** (whether parent company, subsidiary company, joint venture or affiliated company).

The **Undertaker's Representative** is responsible for ensuring all linings and work undertaken by the **Approved Contractor** are carried out in compliance with and to the quality outlined in the Operational Requirements. For

reference, the responsibilities of the **Undertaker's Representative** are tabulated above together with the relevant section of these Operational Requirements

Recognised Fitter

A person formally trained by rig suppliers or rig manufacturers and who has provided acceptable evidence of their competence, training, and experience to a **Nominated Certifying Body** and has successfully completed Part 1 & 2 assessment in accordance with Appendix B

As noted in Appendix B, the **Recognised Fitter** is responsible for ensuring that lining rigs are set up in accordance with the conditions (alarm conditions, set-points, etc.) used when rig approvals were granted, and that rigs can perform in accordance with the Operational Requirements.

OR 1.4: Reference Documents

1. The following documents or any revisions thereof referred to in this document form an integral part of the specification.
 - BS EN ISO 9001⁽²⁾

OR 1.5: Inspection

1. The **Undertaker's Representative** shall, at all times, have access to all parts of the site during the entire course of the cleaning and lining process.
2. The **Approved Contractor** shall provide reasonable assistance to the **Undertaker's Representative** for the inspection of materials, workmanship, and quality.

OR 1.6: Workmanship

1. All work shall be performed in a thorough and workmanlike manner by trained and, where required by this document, appropriately certified personnel.

OR SECTION 2: MATERIALS

OR 2.1: General

1. The polymeric material used for *in situ* lining of sewer pipelines shall be:
 - supplied with a copy of the material manufacturer's Instructions for Use (IFU) documents, which shall be made available in all instances to the **Undertaker's Representative** and shall specify how the material is to be applied and used within sewer pipelines for specific design outcomes.

The IFU shall contain all additional information required to allow the **Approved Contractor** to apply the polymeric sewer lining material in accordance with these Operational Requirements, including:

- Temperature parameters, including any specific material application temperatures,

for resin components, for resin components and rig heating system (OR 3.2);

- A site test methodology to enable mix efficiency and cure to be evaluated where the mixed colour of the material does not allow a visual evaluation of mix efficiency to be undertaken.
- Whether a heated umbilical is required (OR 3.4);
- Details of types and lengths of approved in-line mixers suitable for use with the relevant material (OR 3.5);
- The correct solvent for cleaning the in-line mixer and spinner or spray head (see OR 3.5 and OR 3.6);
- Any procedures to be followed when pre-conditioning and transferring polymeric components to the tanks of a rig (see OR 6.3);
- The minimum air-cure time from completion of application before CCTV inspection can commence (see OR 6.10);
- The minimum air-cure period before the sewer can be considered for return to service. (see OR 6.11); and
- Over coating - over coating for the reinforcement or renovation of a historically applied spray lining shall only be carried out if the manufacturer has conducted tests to confirm compatibility between specific linings which are listed in the IFU document.
- Any necessity to overcoat a lining with the same material within a specific time period shall be specified if bonding between subsequent linings is required to achieve semi or structural lining performance.
- Mix ratios by weight and by volume.
- Details and types of spray head for normal application.
- Any necessity for provision of nitrogen or dry gas blanket in rig storage tanks.

- Material shelf life and storage temperature.
- Typical SG and viscosity of material components.

All of the above shall be provided as a Technical Schedule in an Appendix to the IFU

Polymeric lining products shall be supplied with the material manufacturer's certificate of conformity stating: Material type, batch code, date of manufacture, specific gravity (SG) and viscosity (see also OR 6.12.2).

OR SECTION 3: LINING EQUIPMENT

OR 3.1: General

1. The equipment used to apply polymeric materials shall be suitable for storage, heating, dispensing, mixing and application in accordance with the material manufacturer's Instructions for Use (IFU) and these Operational Requirements.
2. Suitable safety equipment to allow high-pressure working and minimise material discharges shall be incorporated into any design. A competent risk assessment shall be used to determine if manual and/or mechanical handling/ emptying of material component containers is acceptable.

OR 3.2: Lining Rigs

1. The rig used to line sewer pipelines with polymeric materials shall be certified by a **Nominated Certifying Body**.
2. The rig used to line sewer pipelines shall be a designated item of equipment. Rigs previously used for lining of potable water mains may be used for the lining of sewer pipelines but cannot be returned to potable water mains use without the written permission of the Water Undertaker.
3. The **Approved Contractor** shall obtain separate approvals for each generic lining rig/polymeric sewer lining material combination that is to be used.

Note: Appendix C details the test procedure and pass criteria for the approval of lining rigs.

4. Documentary evidence of these approvals shall be available from the **Approved Contractor**.
5. The equipment shall be designed to permit the operatives to obtain results described in these Operational Requirements and the associated Code of Practice.
6. The **Approved Contractor** shall notify the **Nominated Certifying Body** one month prior to the modification of any proposed lining rig modifications relating to the following key functions:
 - Monitoring system (and associated components);
 - Pumping system;
 - Alarms (and associated set points);
 - In-line mixers; and
 - Umbilical (hose diameter/configuration).

The **Nominated Certifying Body** shall then consider the need for further formal assessment. Modified lining rigs shall not be used without prior consent of the **Nominated Certifying Body**.

Failure to comply with the requirement to inform the **Nominated Certifying Body** of rig modifications or use of alternative rig designs shall result in the suspension of the contractor's certification until such approvals are obtained.

7. Except where separate provisions have been made for alternative monitoring technologies assessed according to the process detailed in Appendix F, all lining rigs shall conform to the following requirements:
 - i) use a positive displacement pump to dispense base and activator separately at the resin manufacturer's specified mix-ratio $\pm 5\%$;
 - ii) be fitted with in-line flow monitoring equipment with

- ancillary pressure monitoring, calibrated at prescribed maintenance periods. Calibration records (or copies thereof as long as the copies are certified and controlled in accordance with the requirements of the contractor's quality system) shall be retained on the rig for inspection at any time;
- iii) give appropriate audible-alarm and abort responses if the mix-ratio is out of specification (as detailed in Appendix C);
 - iv) store the base and activator separately and maintain material component temperatures in accordance with the material manufacturer's Instructions for Use (IFU) document throughout the rig;
 - v) have mechanical mixing where required as a necessity of the material viscosity, which shall be stated in the IFU and re-circulation facilities from the storage reservoirs through the hoses and return to storage;
 - vi) be fitted with a facility to continuously record the volume of polymeric materials passing through flow meters between calibrations; and
 - vii) provide continuous numerical visual display, a minimum of 2 copies of a printout and a telemetric link enabling remote monitoring of lining rig data providing the following information:-
 - spray-up data (duration* and mix ratio by volume);
 - flow rate;
 - mix-ratio by volume;
 - base output pressure;
 - activator output pressure;
 - lining speed in metres per minute;
 - coating thickness in mm (with a resolution of 0.01mm);
 - mix-ratio alarms;
 - elapsed time from start of lining;
 - date and real time;
 - percentage of acceptable mix-ratios measured by the monitoring system;
 - percentage of acceptable coating thickness measured by the monitoring system; and
 - lining rig identification number,
 - metreage.
- * *The spray-up duration is defined as the period of time from when pumping of the polymeric material commences on the rig to when the winching-in mechanism of the hoses is activated.*
8. Lining variables (flow rate, mix-ratio, output pressures, lining speed, thickness, metreage and elapsed time) shall be printed at a maximum interval of 30 seconds.
 9. Monitoring systems shall meet the alarm response time criteria specified in Appendix C.
 10. The **Approved Contractor** shall demonstrate to the **Undertaker's Representative** on a weekly basis using documentary evidence that monitoring and alarm systems are operating in accordance with the Operational Requirements and rig type test conditions. (This can be demonstrated either by explicit testing of the response times in accordance with Appendix C, or through review of the monitoring system parameters.)
 11. Durable paper and printing shall be used in the printing device such that the printout is still legible after the required retention period of the paperwork (see OR Section 7).
 12. The monitoring system shall have the capability of electronic transfer of all lining data over Wi-Fi link and storing the data to memory stick, SD card or other storage device along with the capability of printing

data from the last lining carried out at a later time, if required.

OR 3.3: Calibration and Rig Audits

1. All lining rigs shall be calibrated in accordance with the rig/equipment manufacturer's instructions after a specified volume of polymeric material components has been pumped (as specified in the **Approved Contractor's** Quality System), at a maximum interval of 12 months, or following replacement of any component that affects its calibration.
2. Flow monitoring systems and metering pumps shall be calibrated after a specified volume of polymeric material components has been pumped (as specified in the **Approved Contractor's** Quality System), at a maximum interval of 6 months, or following replacement or repair of any component that could affect mix-ratio or monitoring thereof.
3. The rig manufacturer/supplier or **Recognised Fitter** shall undertake the calibration of rigs and flow meters.
4. Documentary evidence (original or copies thereof as long as the copies are certified and controlled in accordance with the requirements of the contractor's quality system) of maintenance and calibration shall be kept with the lining rig and be available for inspection by the **Undertaker's Representative** and/or any authorised auditor. This documentation shall include serial numbers or identifiers to ensure correct identification of components. The lining rig shall not be operated if this documentation is not in place.
5. Each rig shall be shown to be operating in accordance with these Operational Requirements before being used on linings within an individual Sewerage Undertaker's region. To demonstrate this, the rig shall be subjected to a performance audit undertaken by a **Nominated Certifying Body** and/or the **Undertaker's Representative** and **Recognised Fitter** requiring the application of a coating to pipes laid above ground. A minimum pipe length of 20 metres shall be

lined of minimum internal diameter of 100mm.. The performance audit shall be undertaken by a **Nominated Certifying Body** if no lining has been undertaken within the previous 12 month period.

OR 3.4: Lining Hoses

1. Suitable rated pressure hoses for the lining rig/material combination shall be mounted on a drum with a precise winching system that can ensure smooth withdrawal.
2. When specified by the material manufacturer in the Instructions for Use (IFU) document, heated umbilical hoses shall be used.
3. The umbilical and hoses shall be maintained in clean condition and in good repair.
4. All heated umbilicals shall be used only with food grade oil or water containing a food grade anti-freezing agent. The **Utility Representative** shall ensure that any release of heating fluid does not affect the lining.
5. Hoses shall be distinctly marked or coloured to clearly distinguish them from hoses used on potable water contracts in order to ensure that no potential exists for cross use and contamination of drinking water pipelines. Hoses previously used on drinking water pipe lining may be used for lining of sewers but cannot be subsequently returned to use on drinking water mains without the written permission of the Water Undertaker.

OR 3.5: In-Line Mixer

1. In-line mixers for use with the polymeric sewer lining material shall be specified by the material manufacturer. Documentary evidence of suitable construction and satisfactory mixing in the in line mixer shall be available from the **Approved Contractor**
2. Documentary evidence of the approval shall be available.
3. Approved in-line mixers shall be clearly and indelibly marked with a unique reference that provides an audit trail to this approval.

4. Facilities for cleaning the in-line mixer shall be provided. These shall include the correct solvent as specified by the material manufacturer in the Instructions for Use (IFU) document. Health and safety precautions shall be implemented. Mixers used for application of high build semi structural or structural lining materials may need to be discarded after each lining as instructed in the IFU. If permitted in the IFU, a one use only disposable in-line mixer can be used to minimise operator contact with any solvent.

OR 3.6: Lining Application Heads

1. Lining application heads shall incorporate rear-venting exhausts and shall allow a coating of the required thickness to be applied without causing significant pin-holing or ridging.
2. Prior to each lining, the lining application head shall be operated by the **Approved Contractor** to ensure the head spins without malfunction.
3. Lining application heads shall be cleaned and inspected after every lining operation by a suitably trained lining operative. Any faults observed shall be rectified or the lining head replaced.
4. Facilities for cleaning the lining application head shall be provided. These shall include the correct solvent as specified by the material manufacturer in the Instructions for Use (IFU) document. Health and safety precautions shall be implemented. If permitted in the IFU, a one use only disposable lining application head can be used to minimise operator contact with any solvent.
5. The material manufacturer shall also specify in the Instructions for Use (IFU) if the polymeric lining material may be applied using a hand held spray gun and any modifications required to the lining equipment to enable this.

OR 3.7: CCTV Equipment

1. Colour CCTV equipment shall be used for internal pipeline inspection purposes. Such equipment and its operation shall be specified as follows:
 - i) provide suitable digital (DVD) or memory stick recording and storage in sewer.dat file format or other format specified by the Sewerage Undertaker with freeze frame facility and frame-by-frame advance; The Sewerage Undertaker may additionally specify the use of a laser light ring facility in order to check for ovality of the lined sewer.
 - ii) be properly maintained to ensure reliability and with suitable illumination to provide a clear, focused image;
 - iii) provide the following on-screen details at the start of the recording:
 - unique identifier;
 - date cleaned/lined as appropriate;
 - date CCTV surveyed;
 - location – street and town, grid reference, GPS;
 - excavation or manhole numbers;
 - pipe diameter; and
 - pipe material.
 - iv) provide the following on-screen details during the inspection:
 - excavation or manhole reference numbers;
 - metres travelled from launch; and
 - date.
 - v) digital media shall be correctly formatted and suitably stored to avoid damage to the recording such that it can be viewed subsequently by the **Undertaker's Representative** or any auditor required to do so.
 - vi) provide temporary or permanent storage to allow direct transfer or download of survey data to correctly formatted digital media in such a manner that survey data can be reviewed and assessed using standard equipment readily available for the playback of such media.
2. Site hygiene is important at this stage for Health and Safety purposes. CCTV

equipment including cables shall therefore be clean on insertion.

3. The speed of travel of the camera through the main shall be at a rate that ensures the entire pipe bore can be properly inspected and shall not exceed a maximum speed of 7 metres per minute.
4. The camera shall be halted for detailed inspection at on-line fittings, branches and any faults
5. CCTV cables, crawlers and cameras shall be distinctly marked or coloured to clearly distinguish them from equipment used on potable water contracts in order to ensure that no potential exists for cross use and contamination of drinking water pipelines. CCTV equipment previously used on drinking water pipe lining may be used for lining of sewers but cannot be subsequently returned to use on drinking water mains without the written permission of the Water Undertaker.

OR 3.8: Compressed Air

1. The air filter unit shall produce filtered air which does not impart oil or water vapour into the sewer pipeline. The filter sizes shall be matched to the compressor size and pressure.
2. Filtration units recommended for *in situ* polymeric lining of sewer pipelines consist of three filters, either separate or as a combined filter.
3. The first filter is often a coarse filter with a pore size of 25µm, or it may be a coalescing filter. It shall remove the large dust particles and some of the oil and water and therefore protect the other two filters.
4. The second filter shall be a coalescing filter which shall cause the droplets of oil and water to coalesce and collect in the bowl before the filter. Usually the filter should have an automatic drain to dispose of the collected oil and water. The highest efficiency filters shall be installed.

5. The third filter shall be a carbon filter which contains granulated or powdered activated carbon and is designed to remove oil vapour which has not been removed by the first and second filters. It is essential that filter elements are replaced at regular intervals. Filter manufacturers should advise on the frequency of replacement.

OR SECTION 4: UNDERTAKER'S REPRESENTATIVE

OR 4.1: Requirements

1. The **Undertaker's Representative** is required to monitor the **Approved Contractor** and take responsibility on behalf of the Sewerage Undertaker for the quality of all linings.
2. Such quality control shall only be carried out by personnel who meet the following criteria:
 - i) have achieved formal certification from a **Nominated Certifying Body** or a **Nominated Training Certifier** in the theory and site practice elements of the process as set out in Appendix B;
 - ii) resubmit for certification at three yearly intervals; and
 - iii) comply with all other requirements specified by the Sewerage Undertaker.

OR 4.2: Implementation Arrangements

1. Certification in full accordance with clause OR 4.1 shall be required.
2. **Undertaker's Representatives** who gain formal certification in the theory and site practice elements in accordance with Appendix B shall be deemed to be certificated.

OR SECTION 5: CONTRACTOR

OR 5.1: Requirements

1. Polymeric linings shall only be applied by **Approved Contractors** who comply with the following:
 - i) possesses a valid certification which has been, or is in the process of being notified to and entered on the nominated database;
 - ii) have gained certification in a supervised trial as outlined in Appendix A (separate approvals are required for each **Approved Coating Product/ Approved Lining Rig** combination);
 - iii) operate a current BS EN ISO 9001⁽²⁾ Quality System that explicitly includes polymeric lining of sewer pipeline methods and is certified by a third party certification body accredited to ISO/IEC 17021-1 (2015) by UKAS (United Kingdom Accreditation Service) or other equivalent accreditation service, Contractors currently accredited by a third party certification body not recognised by UKAS may continue to use that certification body provided they submit to an annual BS EN ISO 9001⁽²⁾ audit conducted by a Nominated Certifying Body employing a suitably qualified ISO 9000:2000 Lead Auditor. Such Approved Contractors shall be encouraged to become third party certified by an accreditation service recognised by UKAS or other equivalent accreditation service. New Contractors shall only be approved if their third party certification body is recognised by UKAS or other equivalent accreditation service;
 - iv) The scope of the Quality System shall cover each *in situ* lining system for which approval is held. Hence, the scope shall cover 'epoxy', 'rapid set', 'semi-structural', 'structural' etc. as appropriate (not each polymeric sewer lining material/**Approved Lining Rig** combination);
 - v) resubmit for contractor certification and lining rig assessments and a BS EN ISO 9001⁽²⁾ audit at five-yearly intervals;
 - vi) ensure any personnel involved with the actual lining process are direct employees of the certified contracting company or if self-employed can verify continuous employment with the contractor; and
 - vii) ensure sufficient personnel have achieved formal certification from a **Nominated Certifying Body** or a **Nominated Training Certifier** in the theory and site practice elements of the process as set out in Appendix B with renewal every three years.

OR 5.2: Implementation Arrangements

1. Full certification in full accordance with clause OR 5.1 shall be required.
2. Contractor personnel who gain formal certification in the theory and site practice elements in accordance with Appendix B shall be deemed to be certified with details notified to and entered on the nominated database.

OR 5.3: New Contractors

- A **New Contractor** who operates an appropriate BS EN ISO 9001 Quality System shall submit their draft quality manual, as it pertains to lining with the polymeric sewer lining material for which contractor approval is being sought, to the **Nominated Certifying Body** for assessment before the supervised lining trial.
- Following this assessment and any necessary modification to the quality manual, and after successful completion of the supervised lining trial, the **New Contractor** shall apply to a certification body with UKAS accreditation or other equivalent accreditation service accreditation for an extension to the scope of the contractor's BS EN ISO 9001 Quality System.
- An interim approval shall then be granted conditional to the requirement that within 3 months the *in situ* polymeric lining system for which approval is sought is explicitly

included within the scope of the contractor's BS EN ISO 9001⁽²⁾ Quality System. Failure to meet this timetable shall result in the withdrawal of the interim approval.

- **New Contractors** that do not operate an appropriate BS EN ISO 9001⁽²⁾ Quality System may still gain certification in supervised trials outlined in Appendix A. Following successful completion of the supervised lining trial, an interim approval shall be granted conditional to the requirement that within 18 months the **New Contractor** shall achieve full certification of their Quality System. Failure to meet this timetable shall result in the withdrawal of the interim approval.

OR SECTION 6: APPLICATION PROCESS

OR 6.1: Cleaning

1. The pipes shall be cleaned in full accordance with the material manufacturer's IFU requirements and specification. The process shall remove all internal deposits and loose or adhered material resulting from corrosion and pipe deterioration processes. In ferrous pipes, graphitisation may or may not remain depending on the cleaning process employed.
2. After cleaning, the pipe bore shall be smooth, clean, and free of dust, standing water and particulate matter. Where the dew point of the air in the pipe for lining is specified by the material manufacturer in the product IFU, the substrate temperature of the pipe must comply with any temperature differential specified in respect of the dew point of the atmosphere within the pipe.
3. Cleaned mains shall only be returned to service prior to lining in emergency circumstances. Approval shall be obtained from the **Undertaker's Representative** who shall specify in writing any appropriate actions that the **Approved Contractor** shall carry out.

The material manufacturer shall specifically state within the IFU if the pipe wall must be dry

and/or display any anchor pattern necessary for adhesion of the applied lining to the pipe wall as an inherent part of any lining design for structural or semi structural lining purposes

OR 6.2: Pre-Lining Inspection

1. A 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 that would result in poor lining quality or reduction of lining performance.
2. The **Approved Contractor** or/and the **Undertaker's Representative** shall carry out this inspection. The results of this survey shall be recorded on the CCTV Record and Sewer Pipe Lining Record (see OR Section 7).

OR 6.3: Lining Rig Preparation

1. The lining hoses shall not be inserted into the pipeline until the base and activator have been circulating through the hoses for sufficient time to attain a uniform temperature that is within the material manufacturer's specified temperature range.
2. Where possible, there shall be sufficient base and activator in the reservoirs to complete the lining. Should the addition of lining material components be required during a lining, it shall be pre-conditioned to within the material manufacturer's specified temperature range, so that it is the same temperature as the material components in the reservoirs, to within approximately $\pm 3^{\circ}\text{C}$, and transferred to the reservoirs in accordance with the Instructions for Use (IFU) document.

OR 6.4: Weight Checks

1. Weight checks of the base and activator shall be carried out prior to every lining to ensure the rig performance and material output is within the material manufacturer's specification.

2. Such checks shall conform to the weight check procedure given in the Code of Practice and be reported on the Sewer Pipe Lining Record.
3. Before lining can commence, 3 consecutive weight checks shall be within $\pm 5\%$ (by weight of activator) of the material manufacturer's specified mix-ratio, calculated as
 $100: ((\text{weight of activator}/\text{weight of base}) \times 100)$; The lining machine pumps must stop after the third weight check has been taken.
4. 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 lining materials recirculated and the weight checks repeated.

OR 6.5: Lining Hose Insertion

1. Lining hoses shall be inserted into the sewer at a safe speed by means of a clean winch cable. Pipe end rollers shall be used as required to avoid damage to the pipe, hoses and winch cable and ensure no snagging occurs during the pulling-in operation.
2. Lining hoses shall not be allowed to come into contact with the excavation or manhole edges.
3. Lubricants shall not be used to aid the travel of the hoses through the main.

OR 6.6: Spray-up Procedure

1. The minimum spray-up time for each combination of **Approved Lining Rig** and polymeric sewer lining material shall be determined at the start of any lining contract, at least quarterly thereafter for the first year of operation (to build up a year-long record of spray-up times versus weather conditions), or at the request of the

Undertaker's Representative when weather conditions vary significantly from that for which spray-up determination records are available.

2. The procedure for the determination of minimum spray-up time is given in Appendix D. All spray-up determination tests shall be carried out in the presence of an **Undertaker's Representative**.
3. To check the lining application head, or spray gun, and any in-line mixer are working correctly and to ensure material stabilisation, a spray-up shall be conducted before each lining into a suitable container, which shall be kept well clear of the pipe ends.
4. All operatives involved in the spray-up procedure shall wear appropriate safety equipment.
5. For the lining to commence the **Approved Contractor** or/and **Undertaker's Representative** shall be satisfied that the following have been achieved:

- i) minimum spray-up time has elapsed.
- ii) material consistency is visually acceptable;
- iii) mix-ratio is within the required $\pm 5\%$ tolerance band; and
- iv) a record of the material consistency and mix colour has been taken by inserting a dip card into the material spray or other suitable sample taken where colour is not a determinant of mix ratio at the end of the spray-up period.

OR 6.7: Application Temperatures

1. Polymeric linings shall not be applied when the pipe wall temperature is below that specified in the material manufacturer's IFU,; the procedure for assessing the pipe wall temperature is given in Section CP 4.14.1 of the Code of Practice ⁽¹⁾

OR 6.8: Application of Lining

1. The **Approved Contractor** shall monitor the entire lining paying specific attention to the following:
 - pump performance;
 - mix-ratio;
 - lining speed;
 - lining thickness;
 - application head operation; and
 - smooth hose withdrawal.
2. Should a fault occur, the **Approved Contractor** can decide to abort the lining at any time as long as acceptable rectification works are carried out to the satisfaction of the **Undertaker's Representative** prior to return to service
3. Upon exit of the lining application head from the pipe and whilst still functioning, an exit dip card or other appropriate sample shall be taken.
4. Immediately after application of the lining, the **Approved Contractor** or/and **Undertaker's Representative** shall review the mix-ratios recorded by the monitoring system.
5. For a lining to be considered acceptable, 95% of mix-ratios measured by the monitoring system shall be within $\pm 5\%$ of the material manufacturer's specified mix-ratio and 100% shall be within $\pm 10\%$. If these criteria are not met, a non-conformity record shall be filled out and actions undertaken as deemed necessary by the **Undertaker's Representative** (see Section CP 4.13.1 of the Code of Practice⁽¹⁾ for guidance {for review}).

OR 6.9: Lining Thickness

1. The minimum lining thickness shall not be less than the design thickness specified or calculated in accordance with the material manufacturer's IFU requirements.

2. For a lining to be considered acceptable 95% of the coating thicknesses measured by the monitoring system and recorded on the print out shall not be less than the target design thickness and 100% shall not be less than 90% of the target design thickness. If these criteria are not met, a non-conformity record shall be filled out and actions undertaken as deemed necessary by the **Undertaker's Representative** (see Section CP 4.13.2 of the Code of Practice for guidance).

OR 6.10: Cure Period: End of Application to Post Cure Inspection

- From completion of application and before CCTV inspection can commence, the whole lining shall be air-cured for a minimum period in accordance with the material manufacturer's Instruction For Use (IFU) document.
- When unattended, if possible, open pipe ends shall be capped or stopped off using secure end caps that prevent water ingress

OR 6.11: Post Cure Inspection

1. Upon completion of the minimum cure period required before CCTV inspection (as specified in the IFU) the **Approved Contractor** shall carry out the following inspections and record the details:
 - i) inspect the pipe for uniformity of application and cure by visual examination (using suitable lighting) and, where possible, touching of all pipe ends;
 - ii) CCTV survey the entire length of lined pipe with digital recording.
2. The pipe shall not be considered for return to service until:
 - i) the full air-cure period specified in the IFU has elapsed (if different to the period required before CCTV inspection).
 - ii) post cure inspections are complete;

3. The CCTV inspection (recording or actual survey) and the lining rig printout shall be reviewed and signed off by the **Undertaker's Representative** within 24 hours of the completion of the lining.

OR 6.12: Lining Defects

1. Any lining defects shall be rectified by the **Approved Contractor** to the satisfaction of the **Undertaker's Representative** within the following timescales:
 - i) defects that could impact on flow or potentially result in uncontrolled sewage or waste water escape or other environmental contamination (such as severe water damage, the presence of unmixed resin components, faulty mix ratio or physical defects that may result in blockages) shall be rectified before the pipe is returned to service; and
 - ii) linings that show only physical defects that will not adversely affect water flow or structural integrity can be returned to service but shall be rectified within a timeframe determined by the **Undertaker's Representative**.
2. Certain lining defects may be rectified by over coating the lining after the minimum cure period has elapsed. Over coating shall only be carried out using the same polymeric material and provided that the manufacturer has conducted tests to confirm that this can be done with no detriment to the performance of the finished lining and shall include a statement to this effect in the IFU document. Where any maximum or minimum time period is specified in the IFU, within which over coating must take place, this shall be adhered to.
3. Any pipe lengths contaminated with unmixed material or mix ratio >10% of the material manufacturer's recommended mix ratio shall be re-laid or remediated as specified within the material manufacturer's IFU.

OR 6.13: Return to Service

1. Pipelines shall not be returned to service until the material manufacturer's

minimum cure period as specified within the IFU has elapsed. It is noted that surge and vacuum conditions may occur in return to service. The **Approved Contractor** shall ensure that linings have attained sufficient physical strength and properties to withstand anticipated return to service conditions.

OR 6.14: Pipe Samples

1. The requirement for taking pipe samples shall be at the request of the Sewerage Undertaker.
2. Before disposal, pipe samples shall be inspected by the **Approved Contractor** and **Undertaker's Representative** for lining quality and thickness and the details recorded on the relevant Pipe Sample Quality Record (see OR Section 7)

OR SECTION 7: Quality Control DOCUMENTATION

1. The form of documentation used in lining contracts shall conform to the minimum content specification given in Appendix E and be as specified by the Sewerage Undertaker.

Note: Example standard documents are contained in Appendix B of the Code of Practice: *In Situ* Polymeric Lining of Sewer Pipelines⁽¹⁾. No copyright attaches to these forms and they may be freely reproduced.

2. The following data/information shall be provided for every lining either in hard copy or electronic format:
 - i) Sewer Pipe Lining Record (SPLR) to include a copy of the numerical rig printout; together with dip cards, and
 - ii) CCTV Record (CCTVR) and recording.
3. The following sheets shall be provided when circumstances dictate:

- i) Non Conformance Record (NCR) – to report any defect experienced during lining;
 - ii) Pipe Sample Quality Record (PSQR) – for each pipe sample exhumed;
 - iii) Spray-Up Determination Record (SUDR).
4. The **Approved Contractor** shall supply all documentation used in the lining contract and identified in Appendix E as the minimum content specification for each lining to the **Undertaker's Representative** within 24 hours of completion of the lining, or return to service whichever is the sooner
 5. Record data may be supplied separately in paper (SPLR, CCTVR, NCR, PSQR, SUDR and printout) and hard copy (CCTV survey) or in electronic format incorporating all the designated record data which may be transmitted electronically directly to the **Undertaker's Representative** or to a remote location designated by the Sewerage Undertaker such that checking and signing etc may be achieved at the earliest time. Such transmitted data must be of legible or viewable quality, as applicable, and there shall be no significant deterioration in quality from the original.
 6. All sheets shall be cross-referenced, signed, and dated by the **Approved Contractor** and the **Undertaker's Representative** as being a true and accurate record of each lining and each shall retain a copy.
 7. If pipe lined in tests carried out above ground is to be used subsequently as pipe-make up pieces, the requirements of this Section apply. Pipe from test linings shall not be used if appropriate documentation is not available for the test lining.
- The **Undertaker's Representative** shall be informed of the locations where such pipe-make up pieces are installed into the network.
8. The Sewerage Undertaker shall retain all paper or electronic lining record data (including printouts) for a minimum of two years from the date of lining or for the period of the lining contract, whichever is the longer.
 9. Dip cards or other material samples shall be retained for a minimum period of six months from the date of lining or as specified by the Sewerage Undertaker.
 10. The Sewerage Undertaker shall retain all CCTV recordings for a minimum of two years or for the period of the lining contract, whichever is the longer.
 11. All paper, hard copy or electronic record data shall be treated and stored under conditions that will ensure legibility for a minimum of two years from the date of lining or for the period of the lining contract, whichever is the longer.

OR SECTION 8: ADJUDICATION

- If there is any dispute between the **Contractor and the Nominated Certifying Body** concerning a failure to comply with this WIS, such dispute shall be referred to adjudication; either party may give a notice in writing to the other at any time of his intention to do so. The adjudication shall be carried out under the 'The Institution of Civil Engineers Adjudication Procedures (1997)' or any amendment or modification thereof being in force at the time of the notice.
- The adjudicator will be the Chairman of the In-Situ Resin Lining Expert Group as designated by Water UK in force at the time of the notice.
- The adjudicator shall reach his decision within 28 days of referral or such longer period as is agreed by the parties after the dispute has been referred. The adjudicator may extend the period of 28 days by up to 14 days with the consent of the party by whom the dispute was referred.
- The adjudicator shall act impartially.
- The adjudicator may take the initiative in ascertaining the facts and the law

- The decision of the adjudicator shall be binding until the dispute is finally determined by legal proceedings or by arbitration or by agreement.
- The adjudicator shall not be liable for anything done or omitted in the discharge or purported discharge of his functions as an adjudicator unless the act or omission is in bad faith and any employee or agent of the adjudicator is similarly not liable.

REFERENCES

This document makes reference to the latest edition of the following publications (except where otherwise stated) including all addenda and revisions which should also be consulted.

1. IGN 4-02-05 Code of Practice: *In Situ* Polymeric Lining of Sewer Pipelines. Water UK v1(date)
2. BS EN 9001 Quality Management Systems. Requirements. BSI, 2015.
3. Energy and Utility Skills Register (EUSR). Further information on the scheme is available at <https://www.eusr.co.uk>

WIS 4-02-04

APPENDICES

UNCONTROLLED IF PRINTED

Appendix A – CONTRACTOR CERTIFICATION

PROTOCOL TO BE USED FOR LINING TRIALS REQUIRED FOR CERTIFICATION AND RE-CERTIFICATION OF CONTRACTORS USING *IN SITU* SPRAY-APPLIED POLYMERIC MATERIALS

A.1 Introduction

This protocol has been developed on behalf of Water UK. It relates to the lining trials that contractors are expected to undertake and perform satisfactorily to gain certification to allow them to operate within the UK as **Approved Contractors** for *in situ* lining of sewer pipelines.

The physical application of the lining and a Lining Rig Assessment (Appendix C) shall need to be repeated at 5-year intervals to ensure that **Approved Contractors** are maintaining their standards, are using spray- applied lining rigs that comply with the design performance criteria and can continue operating.

In order to ensure that high standards of quality are maintained, it is essential that **Approved Contractors** operate a BS EN ISO 9001⁽²⁾ quality assurance scheme certified by a third party certification body with UKAS accreditation or other equivalent accreditation service accreditation and this will be audited by a **Nominated Certifying Body** at the initial Contractor Certification and at each 5 year renewal assessment. **Approved Contractors** historically accredited by a third party certification body not recognised by UKAS or other equivalent accreditation service will have their quality scheme assessed on an annual basis by a **Nominated Certifying Body** employing a suitably qualified ISO 9000:2000 Lead Auditor.

New Contractors not operating an ISO 9001⁽²⁾ quality assurance scheme shall be allowed an 18-month transition period after successful completion of a lining trial to become so certified.

A.2 Assessment Procedures

Each Contractor shall clean and line three separate lengths of pipeline, one 100m length of 100mm diameter pipe, one 50m length of 150mm diameter pipe and one 50m length of 200mm diameter pipe. (other diameters can be used at the discretion of the **Nominated Certifying Body**). The whole lining process shall be witnessed and assessed by the **Nominated Certifying Body**.

For **New Contractors** these pipes shall ideally be abandoned pipes or a system specifically constructed for the purpose of such trials. Live parts of the sewerage system may be used at the discretion of the Sewerage Undertaker providing suitable precautions are taken to isolate the pipes from service during the course of the trials and that any problems encountered with the linings on the test sections are remedied in accordance with OR 6.12 before return to service.

The decision to return a lined section to service will rest with both the **Nominated Certifying Body** and the Sewerage Undertaker; if either party has any doubts as to the suitability of the lining, the pipeline shall be replaced. Once the lining is applied, the **New/Approved Contractor** shall be expected to assess lining thickness and undertake CCTV inspections.

Where live pipelines have been used, the **New/Approved Contractor** shall provide fully completed paperwork as specified in the Operational Requirements for each lined length including copies of rig printouts. In other circumstances the Contractor shall demonstrate a thorough understanding of the principles of re-commissioning through a simulated return to service.

The **Nominated Certifying Body** carrying out the assessment can request as many re-inspections or re-linings as deemed necessary to ensure the **New/Approved Contractor** is suitably proficient in the lining process.

Should any section or complete lining prove to be defective, rectification works shall be carried out that ensures the durability of such a lining is not compromised and there is no adverse impact on operation of the network. As long as any defects are properly rectified to the satisfaction of the assessing **Nominated Certifying Body**, this shall not necessarily hinder certification.

A. 3 Certification

All contractors approved by a **Nominated Certifying Body** on behalf of Water UK to apply *in situ* spray-applied polymeric linings shall be given a 5-year certificate to that effect. They will be able to describe themselves as 'certified' for application of *in situ* spray-applied polymeric lining of sewer pipelines and shall appear in a list of **Approved Contractors** maintained by the Energy and Utility Skills Register (EUSR)⁽³⁾ on behalf of Water UK or other equivalent nominated scheme.

Approved Contractors wishing to have full registration or specific certification removed from the listing shall make a formal written application to a **Nominated Certifying Body** who will arrange removal and notify all sewerage undertakers via the Water UK Resin Lining Expert Group.

Approved Contractors who do not undertake any spray-applied resin lining within any 12 month period shall be required to conduct a Rig Performance Assessment (See C.4 Rig Performance Assessment Procedure) to the satisfaction of a **Nominated Certifying Body** when the **Approved Contractor** begins a new contract.

Approved Contractors who do not undertake any spray-applied resin lining in the UK within a consecutive three year period will have their certification revoked and shall be required to conduct a Contractor Certification, as described in this document, to the satisfaction of a **Nominated Certifying Body** before the **Approved Contractor** shall be allowed to begin a new contract.

Any **Approved Contractor** who undergoes a merger with another company or changes the name of their company shall inform the **Nominated Certifying Body** who originally approved their certification of the change. The **Nominated Certifying Body** would then consider if further certification is required.

A. 4 Certification for Further Materials and/or Rigs

Approved Contractors are limited by each approval to the lining rig design and the material used for the certification. Should such an **Approved Contractor** wish to use an alternative or modified design of rig or a different material, the **Nominated Certifying Body** shall be consulted and further certification trials undertaken.

Re-certification of an **Approved Contractor** for use of a different material and/or lining rig will in most cases require the auditing of only one lining. However, a full assessment procedure shall be followed where the **Approved Contractor** has only previously undertaken non- structural lining and is now seeking certification to apply semi-structural or structural lining materials

In this case, the full assessment procedure is required so that the **Nominated Certifying Body** can confirm that the **Approved Contractor** has taken into account the difference in the polymeric material and application process, as specified in the IFU.

A.5 Updates to Specifications

It should be noted that specifications and performance requirements for *in situ* spray-applied polymeric lining systems are under constant review and that when requirements change, existing and new contractors shall have to demonstrate compliance. An appropriate transition period shall be negotiated to enable such new requirements to be met.

Appendix B - TRAINING REGIME

PERSONNEL EMPLOYED IN THE *IN SITU* SPRAY APPLICATION OF POLYMERIC LINING OF SEWER PIPELINES

B.1 Introduction

The training regime for *in situ* spray-applied polymeric lining is designed to ensure that application of such linings is only undertaken and monitored by personnel who have proven competence and possess an understanding of the entire process. Personnel shall also be confined space trained and registered under the EUSR scheme or equivalent.

A rigorous schedule is set in order to fulfil all the requirements of these Operational Requirements and the Code of Practice IGN 4-02-05⁽¹⁾, which requires stringent certification criteria that are subject to formal renewal at intervals not exceeding 3 years.

Such training can only be carried out by **Nominated Certifying Bodies** or **Nominated Training Certifiers**, as appointed by Water UK, and shall be subject to regular audit by **UKAS** or other equivalent accreditation service to ensure that the high standards specified are maintained.

The content of the training courses given here is the minimum that is acceptable. Completion of such training does not preclude either the **Approved Contractor** or Sewerage Undertaker from carrying out further training on the subject.

The key personnel working for an **Approved Contractor** that require training and certification are defined as:

Site Agent	The person responsible for the management of a number of lining gangs, providing all lining records to the Sewerage Undertaker and ensuring all work undertaken is in compliance with the Operational Requirements. The Site Agent shall understand all aspects of the lining process, the requirements of the Operational Requirements, health and safety implications and the significance of quality assurance.
Foreman/Ganger	The person responsible for all activities of the lining gang and, whilst he may not regularly operate the lining equipment, he is expected to demonstrate a detailed understanding of rig operation and all aspects of the process and the requirements of the Operational Requirements.
Rig Operator	The person responsible for the operation of the lining rig and providing key information for quality assurance records. The Rig Operator shall demonstrate a detailed understanding of rig operation and maintenance, and all aspects of the process and the requirements of the Operational Requirements.
Application Head Operator	The person responsible for the operation and maintenance of the applicator head and in-line mixer. The Application Head Operator is expected to understand rig operation, undertake pre- and post-lining inspections and be aware of all aspects of the process and the requirements of the Operational Requirements.
Recognised Fitter	The person responsible for ensuring that lining rigs are set up in accordance with the conditions (alarm conditions, set-points, etc.) used when rig approvals were granted, and that rigs can perform in accordance with the Operational Requirements.

The minimum requirement is for three fully trained personnel for each operating lining gang excluding the Site Agent throughout the entire rehabilitation process. Failure to maintain this level

of qualified staff shall result in suspension of lining operations until such time as sufficient qualified personnel are available.

The key personnel working for a Sewerage Undertaker that require training and certification are defined as:

Undertaker's Representative	The person engaged by the Sewerage Undertaker shall understand all aspects of the process to ensure that all lining work fully complies with the Operational Requirements. The Undertaker's Representative is ultimately responsible for monitoring the quality of application and validation of all records in accordance with the Operational Requirements.
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B.2 Training Requirements for Lining Operatives

Part 1: Theory and Understanding

Lining operatives shall attend a course that provides a broad understanding of all aspects of *in situ* spray-applied polymeric lining. The Lining Operatives shall be trained and registered under the Energy and Utility Skills Register (EUSR)⁽³⁾ scheme or equivalent. The minimum contents shall include:

- regulatory aspects of sewer pipeline rehabilitation;
- background of *in situ* spray-applied polymeric lining;
- material formulation and details;
- material, machinery and personnel accreditation criteria;
- details of Operational Requirements and the Code of Practice ⁽¹⁾;
- cleaning and lining machinery;
- cleaning and lining process;
- inspection criteria;
- CCTV inspection;
- recognition and rectification of lining defects;
- return to service
- Quality Assurance paperwork;
- health and safety and environmental protection;
- requirements of ISO 9001.

A written assessment shall be successfully carried out to gain Part 1 Certification. Part 2 can only be awarded upon successful completion of Part 1.

Note: The Part 1 certification is transferable when personnel change employment between the various **Approved Contractors**.

Training can only be considered transferable to another rig type and material type following consultation with a nominated certifying body who will make an assessment based on the relevant training requirements. If the nominated body considers that training is not transferable then appropriate training as determined by the nominated body must be completed

Part 2: Practical

Prior to undertaking this Assessment, the **Approved Contractor** shall ensure that formal training of all personnel has been undertaken in the operation and maintenance of all relevant plant and machinery associated with the sewer pipeline lining process.

During the practical assessment, personnel shall display a practical understanding of the following:

- lining rig operation, maintenance, cleaning and calibration;

- application head operation, cleaning and maintenance;
- weight checks;
- determination of spray-up times;
- cleaning and lining process;
- pre- and post-lining inspections;
- CCTV operation and interpretation;
- return to service procedures
- rectification of lining defects;
- completion of Quality Assurance paperwork;
- health and safety and environmental protection.

Failure to successfully complete Part 2 Certification shall require further training before resubmission.

Note: The Part 2 Certification is transferable when personnel change employment between the various **Approved Contractors** but is limited to the material/rig for which the certification was awarded.

Upon transfer of a lining operative to a different **Approved Contractor**, it is the explicit responsibility of that **Approved Contractor** to ensure that formal training is given in the operation and maintenance of all relevant plant and machinery with which the lining operative is not familiar.

B.3 Training Requirements for Undertaker's Representatives

Part 1: Theory and Understanding

The **Undertaker's Representative** shall attend a course that gives a broad understanding of all aspects of *in situ* spray-applied polymeric lining. He/she shall be confined space trained and registered under the EUSR scheme or equivalent.

The course content is identical to the Contractor course with the addition of the following items:

- site monitoring procedures;
- client (Sewerage Undertaker) responsibilities;
- understanding Quality Assurance paperwork;
- good working practice;
- range of cleaning and lining machinery.

A written assessment shall be successfully carried out to gain Part 1 Certification. Part 2 Certification can only be awarded upon successful completion of Part 1.

Note: The Part 1 certification is transferable when personnel change employment between the various Utilities.

Part 2: Process Appreciation and Site Supervision

During this assessment, personnel shall display a practical understanding of the following:

- material details;
- machinery details and operation;
- understanding of monitoring system;
- weight checks;
- determination of spray-up times;
- cleaning and lining process;

- pre- and post-lining inspections;
- understanding and interpretation of printout;
- CCTV operation and interpretation;
- return to service;
- rectification of lining defects;
- completion of Quality Assurance paperwork;
- health and safety and environmental protection.

Participants shall also be expected to demonstrate an understanding of alternative machinery and materials.

Note: The Part 2 certification is transferable when personnel change employment between the various Utilities.

B.4 Certification

Successful participants in these training schemes shall be issued with a registered identity card, which shall give the following information:

- ID photograph;
- Name;
- Role (Undertaker's Representative., Recognised Fitter, Lining Operative);
- Reference number;
- Material;
- Lining Rig (Rig manufacturer; controller/monitoring system);
- Date of certification;
- Date of expiry;
- Name of certification agent.

The maintenance of the training records and the issue of registered identity cards is conducted by the register of the EUSR_scheme.

Appendix C - LINING RIG ASSESSMENT SCHEDULE

C.1 Introduction

This schedule 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. Note: This schedule may not be applicable to rigs that incorporate alternative monitoring technologies, assessed in accordance with the terms of Appendix F.

The standard assessment consists of three stages:

- i) A review of the rig design;
- ii) A yard-based assessment of rig performance;
- iii) An assessment of lining capability;

The assessment procedure shall be carried out for each rig-polymeric material and/or monitoring system-polymeric material combination, as deemed appropriate by the **Nominated Certifying Body** undertaking the assessment.

Notwithstanding this consideration, the assessment shall be undertaken as a type test; that is, initially a one – off test of rig design but shall be re-assessed at 5-year intervals during Contractor re-certification.

In addition to the type test detailed herein, **Approved Contractors** shall monitor the on-going performance of every lining rig so as to facilitate the early identification of trends that indicate the need for maintenance and/or calibration.

Note: Rig re-assessment shall include this test.

C.2 Output

Upon successful completion of the assessment, the **Nominated Certifying Body** shall issue a certificate as proof that the rig and monitoring system meet the design and performance requirements for the *in situ* application of the specified polymeric material.

C.3 Review of Lining Rig Design

Objective

To review the design of the lining rig and ensure that it incorporates all required design features.

Method

If deemed necessary by the **Nominated Certifying Body**, a summary of the rig design and a schematic showing key components and hydraulic/pneumatic and base and activator circuits shall be submitted to the **Nominated Certifying Body**, at least one week prior to the assessment. The relevant key components are as follows:

- Transfer and metering pumps;
- Monitoring system including control panel(s);
- Flow meters;

- Temperature sensors;
- Speed encoder(s);
- Pressure sensors;
- Heating system(s);
- Storage reservoirs;
- Winch;
- Valving;
- Hose including heating system and pressure rating;
- Air filtration devices; Roller arrangements and launch/retrieve systems (if used) and
- Suitable safety systems for high pressure working.

This list is not exhaustive and further information may be required upon examination of the rig.

The rig manufacturer shall submit a copy of the rig operating manual and their indicative calibration regime to the **Nominated Certifying Body**, at least one week prior to the assessment.

The **Nominated Certifying Body** shall then inspect a lining rig to ensure it incorporates accepted design features and components.

It should be appreciated that whilst the rig specification given in the Operational Requirements defines key requirements, this should not limit any further development or inhibit innovation of new types of systems.

Should the rig manufacturer propose to include any developments that are potentially outside of the specification, full details of such equipment shall be submitted at least one month prior to the rig assessment for consideration of suitability

The rig owner should be aware that retrospective fitting of unapproved equipment to any approved rig design shall contravene the Operational Requirements and will lead to suspension of their certifications.

C.4 Rig Performance Assessment Procedure

The procedure for the rig performance assessment is as follows:

- i) The rig shall not be preconditioned; i.e. it shall not have been operated on the day of the assessment;
- ii) The rig shall be started and conditioned as if in use on a lining site under standard operating conditions;
- iii) When the materials are at suitable temperatures (as defined in the manufacturer's IFU), the rig shall commence short and, subsequently, long cycle recirculation;
- iv) Whilst on recirculation, the rig shall be set to run at a suitable flow rate (this will be determined per rig depending on individual rig performance);
- v) During the course of these activities the basic performance and operation of the rig shall be monitored.

When the rig is performing suitably a number of procedures shall be carried out to confirm monitoring system compliance, as detailed in C.5 to C.7 and C.9.

C.5 Response to Fault Conditions

Objective

To ensure that appropriate alarms are given when there is an operational fault and that spurious alarms do not occur.

Method

The performance of the alarm system shall be monitored throughout the assessment process. In addition, the following fault conditions shall be simulated in the presence of the **Nominated Certifying Body**.

The following tests shall be carried out with the rig operating as if lining except that the hoses do not have to be reeled in.

Condition	Pass Criteria
<p>1. Simulated Hose Burst:</p> <p>A hose burst shall be simulated by rapidly opening a dump valve installed downstream of delivery pumps and upstream of the hoses and flow monitoring devices.</p> <p>This test shall be repeated at least twice for valves operated on both the base and activator supply lines at a range of flow rates as requested by the Assessor.</p>	<p>A low-pressure alarm that would be obvious to the Approved Contractor shall be given within 10 seconds of the simulated hose burst on both the base and activator supply lines.</p>
<p>2. Simulated Increase in Material Pressure:</p> <p>An increase in material pressure shall be simulated by closing a valve installed in an appropriate location, as determined by the Assessor.</p> <p>This test shall be repeated at least twice for valves operated on both the base and activator supply lines at a range of flow rates as requested by the Assessor.</p> <p>Should this test be deemed detrimental to the rig, it can be curtailed (at the discretion of the Assessor). However, confirmation of the alarm operation shall still be provided.—</p>	<p>An alarm that would be obvious to the Approved Contractor shall be given within 10 seconds of the simulated pressure increase on both base and activator supply lines.</p> <p>(Note – the only way the rig can be made to alarm in 10 secs is for these valves to be positioned pre- umbilical. This is not generally where a blockage would occur)</p>
<p>3. Loss of Power to the Monitoring System:</p> <p>This fault condition shall be simulated by interrupting the power supply to the monitoring system.</p>	<p>It shall not be possible to inadvertently line with the monitoring system switched off.</p>

General Pass Criteria

During the assessment the rig alarms shall function appropriately and there shall be no spurious alarms triggered by normal operation.

C.6 Suitability and Accuracy of Monitoring Equipment

Objective

To determine if the monitoring system is suitable and if recorded/displayed mix-ratios are representative of the actual mix-ratio output by the rig.

Method

Monitoring system suitability and accuracy shall be assessed in four stages in the presence of the **Nominated Certifying Body**.

1. Review of Meter Constants:

All multipliers and/or functions used to convert meter/transducer/encoder readings for display/recording purposes shall be documented and submitted to the **Nominated Certifying Body** for review.

2. Response Time of Mix-Ratio Monitoring System:

The monitor response time shall be assessed by running the rig under normal operating conditions, at the maximum delivery rate (base plus activator) attainable for the rig under test. A change in the mix-ratio shall then be imparted by opening a valve positioned downstream of the pumps and upstream of the flow meters (these can be the same dump valves used to simulate hose burst, as described above).

For rigs where monitoring system updates are linked to the metering pump cycle, rather than an explicit time base, the leak shall be initiated at the start of the pumping cycle. (Discounting the effect of leak size, this is the worst-case scenario, as the monitoring system would not update again until the end of the pumping stroke or cycle.) Note: In some cases, the response time of monitoring systems can be assessed by reviewing the alarm conditions and timing the pump stroke/cycle. Such an approach can be used at the discretion of the **Nominated Certifying Body**.

The time taken for the monitoring system to register a change in mix-ratio (by volume) in the interval $>5\%/<10\%$ and $>10\%$ shall be measured.

This test shall be repeated at least twice for valves operated on both the base and activator supply lines

This test shall be carried out with the rig operating as if lining, except that the hoses do not have to be reeled in.

3. Suitability of the Monitoring System:

The suitability of the monitoring system shall be tested by review of the alarm conditions and/or by simulating faults on the rig so as to generate out of tolerance mix-ratios directly (for example, by operating a valve so as to induce a mix-ratio error), as required by the **Nominated Certifying Body**.

This test shall be carried out with the rig operating as if lining, except that the hoses do not have to be reeled in.

4. Accuracy of Monitoring Equipment:

The accuracy of the monitoring system shall be assessed by comparing weight check data to the mix-ratios output by the monitoring system. 10 weight checks carried out in accordance with the standard weight check protocol given below, shall be made under each of the following conditions:

- Total flow rate: maximum attainable for the rig;
- Total flow rate: 2/3 the maximum attainable ($\pm 10\%$);
- Total flow rate: 1/3 the maximum attainable ($\pm 10\%$).

Weight checks shall be taken at intervals of at least 1-minute using the following standard weight check protocol.

- i) Cups of at least 0.5-litre capacity shall be used.
- ii) At least 250 grams of the smaller volume component in the product mix ratio shall be collected for each weight check.
- iii) The checks shall be carried out whilst re-circulating and taken at the end of the hoses using the provided weight check facilities (usually on the rig tanks).
- iv) Balances shall be calibrated at a maximum interval of 6 months and be accurate to $\pm 1\%$. The balance shall record to the nearest gram.
- v) The weight check data shall be recorded on a form showing:
 - date;
 - rig identification number;
 - operator;
 - time of the weight check;
 - flow of the base and activator;
 - component pressures;
 - component temperatures;
 - weight of the base;
 - weight of the activator;
 - calculated mix-ratio (by weight of activator);
 - monitor mix-ratio.

At the discretion of the **Nominated Certifying Body**, process parameters that change gradually through the type test (such as pressure and temperature) need only be recorded intermittently (rather than for each weight check).

The mix-ratios calculated from the weight checks shall be compared with the mix-ratios recorded by the monitoring system at the time of the weight check. The mix-ratio output by the monitoring system may be obtained from either the screen display (recorded manually) or the printout, but the **Nominated Certifying Body** shall be satisfied that the screen display and printout are consistent.

Pass Criteria

The pass criteria for the above tests are given below. It should be noted that where monitoring systems are not capable of explicitly implementing the requirements given in 2 and 3 below, alternative criteria shall be considered if they are, in the opinion of the *Nominated Certifying Body*, at least as onerous as those stated.

1. Review of Meter Constants:

The **Nominated Certifying Body** shall be satisfied that all functions (including any averaging or smoothing functions) and/or constants used to convert meter/transducer/encoder readings for display/recording purposes (including those determined during calibration) are required and do not distort the output of the monitoring system.

The **Nominated Certifying Body** shall also be satisfied that all functions and/or constants used are consistent with the mix-ratio response time requirement outlined below.

It shall be demonstrated that on-site personnel cannot change the meter constants.

2. Response Time of Mix-Ratio Monitoring System:

The time taken for the monitoring system to register a change in mix-ratio (by volume) in the interval 5% to 20% shall meet the following criteria:

$$\text{response time} \leq \left\lfloor \frac{1}{R} \times 50 \right\rfloor \text{ seconds}$$

Where R is the total pumping rate in l/min (for example, if R = 5 l/min, then the monitoring system shall register the change in less than 10 seconds).

It shall also be demonstrated that on-site personnel cannot change the time over which meter signals are averaged or the monitoring system is updated.

3. Suitability of the Monitoring System

A steady measure of mix-ratio shall be given and displayed clearly on the monitoring system. Mix-ratio shall be permanently recorded on the printout; mix-ratio faults shall also be registered on the printout.

Any two consecutive mix-ratio readings that exceed the $\pm 5\%$ allowable tolerance band shall produce an audible alarm that would be obvious to the **Approved Contractor**.

Any reading that exceeds the $\pm 10\%$ tolerance shall produce an audible alarm that would be obvious to the **Approved Contractor** and shall cause the lining to be automatically aborted. Linings must be automatically aborted by shutting the rig down immediately.

Within an acceptable lining, 95% of mix-ratios measured (not recorded) during the entire length of main by the monitoring system shall be within $\pm 5\%$ of the required mix-ratio and 100% shall be within $\pm 10\%$. It is desirable that appropriate alarms that would be obvious to the **Approved Contractor** be given if the 95% criterion is not being met.

The printout for a lining shall give a summary that clearly indicates whether the mix-ratio specification (95% of mix-ratios within $\pm 5\%$ and 100% within $\pm 10\%$) has been met.

A similar summary shall be given for the number of acceptable/unacceptable coating thicknesses.

4. Accuracy of Monitoring Equipment

When assessed against the mix-ratio given by a calibrated weight check, the monitoring system shall give a measure of mix-ratio that is accurate to within 5%. Hence, the monitor error shall be less than 5%, with monitor error defined as:

$$\text{Monitor error} = \text{absolute} \left(\frac{\text{Weight check mix ratio} - \text{Monitor output mix ratio}}{\text{Weight check mix ratio}} \right) \times 100$$

Note: This calculation requires the “as pumped” specific gravity of the resin components to be known.

C.7 Accuracy of Mix-Ratio Delivery

Object

To determine if the rig is compatible with the mix-ratio tolerance band of $\pm 5\%$ by weight of activator.

Method

Weight checks shall be taken using the standard weight check protocol given above. A minimum of 60 weight checks shall be taken over at least two days, with the rig being started from cold on each day of testing.

The rig operator shall follow normal rig start up procedures each day and start taking weight checks once the rig has reached operational temperatures and pressures at which lining could normally commence.

A minimum of 30 of the weight checks shall be audited; that is, carried out in the presence of the **Nominated Certifying Body** (these weight checks can be the same as those used to check the accuracy of the monitoring system).

At the discretion of the **Nominated Certifying Body**, this test may be carried out in long-circulation (warm-up) mode.

Pass Criteria

Weight check data shall fall within the following tolerance bands:

- 95% of audited weight checks within $\pm 5\%$.
- 100% of audited weight checks within $\pm 10\%$.
- 95% of total weight checks within $\pm 5\%$.
- 100% of total weight checks within $\pm 10\%$.

Where these pass criteria are not met, the test may be repeated at the discretion of the **Nominated Certifying Body**.

C.8 Suitability of Calibration and Maintenance Schedules

Upon completion of the rig assessment, the rig manufacturer or owner/operator shall conduct a complete rig calibration exercise. Such a procedure shall be conducted in the presence of the **Nominated Certifying Body**.

A suitable maintenance and calibration schedule, expressed as volume of polymeric components pumped (or equivalent measure) shall be determined and incorporated into the **Approved Contractor's** Quality System.

In this context, it is considered good practice that the performance of each lining rig is assessed on an on-going basis by analysing weight checks and the mix-ratio data output by the monitoring system. The maintenance/calibration schedule can be derived from the results of such ongoing performance.

It is recognised that the data required may, in the first instance, be sparse. This shall not be considered a barrier to the operational use of a rig providing the rig design is otherwise shown to meet the requirements of the assessment. However, an appropriately cautious provisional volumetric maintenance and calibration schedule shall be adopted until the wear characteristics of rigs have been fully evaluated.

C.9 Lining Trial

For routine Rig Performance Assessments at least one lining shall be assessed so as to determine compliance with the Industry and Regulatory requirements under operational conditions. For Performance Assessments conducted as a result of an **Approved Contractor** not having lined for a period of 12 months a single lining shall be assessed by the **Nominated Certifying Body**. Key emphasis shall be placed on the coating application in terms of:

- i) compatibility of the lining equipment, including the lining application head;
- ii) overall ability of the rig to apply a lining of the correct specification;
- iii) compliance of the rig with the Operational Requirements for the *in situ* application of spray-applied polymeric materials to sewer pipelines

At the discretion of the **Nominated Certifying Body**, these requirements can be assessed by lining of pipes laid above ground. In such trials, a minimum pipe length of 20 metres shall be lined as part of a normal assessment procedure and as a result of an Approved Contractor not having lined for a period of more than twelve months but less than three years.

Appendix D - DETERMINATION OF MINIMUM SPRAY-UP TIME

D.1 Introduction

The spray-up time shall be established for the specific equipment and polymeric material being used.

Spray-up time is determined by spraying material into a suitable clean, empty container (e.g. a bucket) and taking a series of dip cards made of PVC, PE, PP or impermeable cardboard.

The dip cards are held in the stream of mixed polymeric material emitting from the application head. A sequence of dip cards is taken until the system stabilises and reaches the correct mix-ratio at the head. A stable colour is taken as an indication that the correct mix-ratio has been reached.

Note: this assumes the mix-ratio at the pumps is correct; alarms would be given if this were not the case.

Where the mixed colour of the material does not allow a visual evaluation of mix efficiency to be undertaken, the material manufacturer shall specify a spray up determination process within the IFU document.

The Application head may be either a spinner head or hand held spray gun depending on the methodologies incorporated in the material manufacturer's IFU

D.2 Procedure

The following procedure shall be adopted.

- i) Dip cards shall be taken at regular timed intervals of 10 seconds during spray-up for a minimum of 1 minute.
- ii) Dip cards shall cover the period prior to colour stabilisation and for several 10-second time intervals after stabilisation.
- iii) The cards shall be stored in chronological order at ambient temperature and allowed to cure for the material manufacturer's specified cure period.
- iv) The degree of cure of the material on the dip-cards after this time shall be tested:
 - For polymeric materials that are brittle when correctly proportioned, mixed and cured, a simple way of assessing cure is to snap the cards; a fully cured polymeric material will break cleanly.
 - Some polymeric materials, however, demonstrate a ductile failure mode when correctly proportioned, mixed and cured, which makes this method unsuitable. For these ductile materials the spray-up time can be assessed through colour consistency or material properties and a subjective assessment of the degree of cure (in terms of tackiness, etc.).

The snap test is therefore only a guide. In practice, the first dip card that has the correct colour or material properties and is fully cured represents the minimum spray-up time for the prevailing conditions.

- v) A safety margin of at least 30 seconds shall be added to the minimum spray-up time.
- vi) Under no circumstances shall the spray-up time used in lining operations be less than 30 seconds. Where material component hoses within the umbilical are pressurised before the in line valves are opened, and provision is made to open the valves simultaneously. In such

circumstances the minimum spray up time shall be in accordance with the approved IFU, or where a time is not stated a minimum of 30 seconds.

vii) The results of the test shall be recorded on a Spray-Up Determination Record.

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Appendix E – DOCUMENTATION

E.1 Minimum Specification

The form of documentation used in lining contracts shall conform to the minimum specification given below. All documentation for a lining shall be given unique reference numbers and be cross-referenced to allow an appropriate audit trail to be maintained, in accordance with the requirements of the Sewerage Undertaker and Contractor's quality system.

<p>Sewer Pipe Lining Record (SPLR)</p>	<p>General:</p> <ul style="list-style-type: none"> • Contractor • Contract/ Scheme/ Location • Supervisor • Gang Ref. • Date <p>Sewer details:</p> <ul style="list-style-type: none"> • Pipe Diameter/ Material • Lining length • Access Hole or M/H Refs. • Removal from service arrangements <p>Rig/Polymeric material details:</p> <ul style="list-style-type: none"> • Polymeric Material • Lining Rig No. • Head No. • Length of mixer • Base & Activator Batch Nos./Quantity <p>Cleaning:</p> <ul style="list-style-type: none"> • Method of cleaning • <p>Cleaning Survey Report:</p> <ul style="list-style-type: none"> • Summary of visual inspection • Summary of CCTV inspection <p>Weight check calculation record (pre/post):</p> <ul style="list-style-type: none"> • Weights of samples • Calculations of mix-ratio • Time of final weight check <p>Lining details:</p> <ul style="list-style-type: none"> • Target Lining Thickness • Lining Type (structural, semi structural etc) • Temperature(ambient/base/activator/ pipe wall) • Spray-up time • Start/end time of lining • Mix-ratio conformance • Cure start time (from exit of machine from pipe) / finish time (when post cure inspection is completed) / duration <p>Post cure observations:</p> <ul style="list-style-type: none"> • Uniformity (acceptability) • Quality (acceptability) • Thickness (acceptability) • Hardness (acceptability) <p>Post cure operations:</p> <ul style="list-style-type: none"> • • Return to service time
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	Form Verification/Sign-off
CCTV Record (CCTVR)	<p>General:</p> <ul style="list-style-type: none"> • Contractor • Contract/ Scheme/ Location • Supervisor • Gang Ref. • Date <p>Pipe details:</p> <ul style="list-style-type: none"> • Pipe material and diameter • Access or Man Hole Refs. • CCTV Recording Ref. • Length surveyed • Polymeric material • SPLR Number <p>Observations:</p> <ul style="list-style-type: none"> • Faults observed <p>Form Verification/Sign-off</p>
Non-Conformance Record (NCR)	<p>General:</p> <ul style="list-style-type: none"> • Contractor • Contract/ Scheme/ Location • Supervisor • Gang Ref. • Date <p>Pipe details:</p> <ul style="list-style-type: none"> • Pipe Diameter • Lining length • Access Hole or Manhole Refs. • SPLR Number <p>Polymeric Material :</p> <ul style="list-style-type: none"> • Polymeric Lining Material <p>Nature of defect</p> <p>Reason for defect</p> <p>Remedial Action taken/Date</p> <p>Action taken to prevent recurrence</p> <p>Form Verification/Sign-off</p>
Pipe Sample Quality record (PSQR)	<p>General:</p> <ul style="list-style-type: none"> • Contractor • Contract/ Scheme/ Location • Supervisor • Gang Ref. • Date <p>Pipe details:</p> <ul style="list-style-type: none"> • Pipe Material/ Diameter • Lining length (m) • Access or Manhole Refs. • SPLR number • Target lining thickness <p>Polymeric Material:</p> <ul style="list-style-type: none"> • Polymeric material <p>Measurement Record (both ends)</p> <p>Observations</p> <p>Form Verification and Sign-off</p>

Spray-Up Determination Record (SUDR)	General: <ul style="list-style-type: none"> • Contractor • Contract/ Scheme/ Location • Supervisor • Gang Ref. • Date • Polymeric material • Lining Rig Type • Lining Rig No. • Temperature (Base/Activator/umbilical/ambient) • Total Flow rate • Application Head Type (Spinner/Spray Gun) Spray-Up test results Minimum Spray-Up time Form Verification and Sign-off
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Example standard documents are contained in Appendix A of the Code of Practice: *In Situ* Polymeric Lining of Sewer Pipelines. No copyright attaches to those forms and they may be freely reproduced.

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Appendix F - ALTERNATIVE MONITORING TECHNOLOGIES

F.1 Introduction

Pre-lining weight checks provide confirmation that the lining rig has attained a stable output, at the correct mix-ratio. Furthermore, weight checks carried out over consecutive lining processes, in conjunction with rig calibration and maintenance schedules, show that this stability is being maintained. This level of protection and monitoring is improved by the use of in-line flow meters, which allow direct monitoring of the mix-ratio during the lining process, and can therefore detect transitory problems.

Water UK has determined that a flow meter based monitoring system provides the necessary level of monitoring and alarm functionality for *in situ* resin lining rigs and should, therefore, be adopted as the industry standard. This determination is not intended to preclude the use of innovative technologies that afford the same level of monitoring, alarm functionality, and/or protection against inadvertent application of an out-of-ratio lining. The following procedure outlines the arrangements for facilitating the introduction of alternative systems.

F.2 Formal Procedure

The equivalence of the alternative technology shall be demonstrated through the following formal procedure.

Stage 1: The rig manufacturer shall submit to a **Nominated Certifying Body** a review of the design and operating characteristics of the alternative technology.

Stage 2: The **Nominated Certifying Body** shall formulate a performance-based test schedule and carry out a suitable test program to assess the equivalence of the alternative technology.

Stage 3: Where the **Nominated Certifying Body** deems the alternative technology appropriate, the results of the assessment shall be reported to a review body designated by Water UK.

Stage 4: The review body will assess the results and stipulate any additional conditions of use, as appropriate.

Should it be shown that the alternative technology complies with both Regulatory and Industry requirements, an approval certificate, together with any conditions of use, will be issued by the **Nominated Certifying Body**.

F.3 Generic Technologies

For the purposes of this document, alternative monitoring technologies will fall into two generic types:

Type 1: Equivalent measure of mix-ratio: Alternative in-line monitors that provide a real time and in-line measure of mix-ratio based on a direct measurement of flow, which is not inferred from other operational parameters such as pressure.

For this type of alternative technology, the performance criteria outlined in the Rig Assessment Schedule given in Appendix C will be applied. The pass criteria will be that the same level of monitoring and alarm functionality is afforded by the alternative system.

Type 2: Other Systems: Where systems do not give a real time in-line measure of mix-ratio it shall be demonstrated that the design of the rig is such that inadvertent application of an out-of-ratio lining is not possible when the rig is used under specified operational conditions. Further, the

required operational conditions shall be set through appropriate design features (for example; appropriate control of operating pressure and temperature ranges).

For this type of alternative technology, it shall be demonstrated that the level of protection afforded by the system equals or exceeds that given by a flow meter based system.

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