

ACS1420 Cured in place polyester lining

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ACS1420.1 Scope

This section covers the material requirements, design, supply, handling, installation, and testing of Cured in Place Polyester (CIPP) resin liners in pipelines. It includes pipeline preparation and cleaning, flow management, liner installation by inversion, pre- and post-installation inspection, and overall quality control requirements.

ACS1420.2 Geotechnical information

Use and interpretation of the geotechnical information provided to the Contractor by the Principal is entirely the Contractor’s responsibility. If additional geotechnical information is deemed to be necessary to confirm ground conditions, the Contractor shall allow in the Tender price for additional investigations. The Tender shall also specifically identify the risks pertaining to the installation and the proposed methods of addressing the risks.

ACS1420.3 General

Prior to commencement of the work, the Contractor shall satisfy the Engineer that the design, methodology, equipment, and labour proposed at the time of tender remains unchanged. Where required by the Engineer, the Contractor shall submit a detailed Methodology Statement and detailed Construction Programme which together demonstrate exactly how the Works will be undertaken. Where amendments are required to the methodology, equipment or labour, such amendments shall be discussed with the Engineer in advance of the implementation thereof and the Engineer’s acceptance of these amendments obtained.

ACS1420.4 Ventilation and lighting

The Contractor shall provide adequate ventilation and lighting in the pipeline, entry and exit points to ensure that a safe working environment is maintained at all times. The Contractor shall provide, maintain, and operate gas monitoring in the confined spaces.

ACS1420.5 Confirmation of information shown on construction drawings

Construction drawings are generally prepared from the Council's GIS and the information shown is indicative only and may not be accurate.

The Contractor shall be responsible for confirming all dimensions and the location of all features before undertaking any work or purchasing any materials.

The host pipe shall be inspected to confirm the extent of all pre-installation works required to be undertaken in accordance with *ACS1420.9 (CCTV inspections)*. The Engineer shall be notified immediately of any differences between the construction drawings and site observations and any required actions shall be agreed before proceeding.

ACS1420.6 Liner design

ACS1420.6.1 Structural design

The lining shall be designed in accordance with *AS/NZS 2566.1 (Buried flexible pipelines – structural design)* or other relevant standard, to satisfy the critical performance criteria of deflection, strength and buckling.

The Contractor shall supply full details of their design calculations with the tender. These calculations shall be specific to the size, loadings, and other conditions relating to each section of lining. The calculations shall verify that the proposed nominal wall thickness of each lining section given by the Contractor in the schedule of design information is greater than, or equal to, the required design thickness.

Design calculations shall be in sufficient detail to allow for the calculation to be checked and independently verified. Each calculation is to be complete, showing the following details:

- a) Definition of terms used in the calculation
- b) All input data values
- c) References to test results to justify material properties
- d) All units of measurement and conversion factors, where applicable

- e) Calculation formulae, with references to the equation numbers or relevant clauses given in the standard
- f) Details of any proposed deviation from the design standard.

For the purpose of structural design, it shall be assumed that in the long term there will be no bond between the existing pipe and the lining.

The lining shall be designed and fabricated in a manner that, when installed, it will fit the internal wall and length of the pipe being lined, within the tolerances nominated by the Contractor in the Schedule of Design information. Where lining technology requires, suitable allowance shall be provided for longitudinal and circumferential stretching or shrinkage of the lining during installation.

Design calculations shall include all the assumptions and material properties incorporated into the process, and any relevant formulae or other information utilised to determine the lining thickness required.

Review of the Contractor's design calculations shall not be construed as acceptance of the calculations. Responsibility of the design shall remain with the Contractor.

All work on the preparation of the design calculations, including proof checking and review, shall be incorporated in the Contractor's quality assurance system.

Unless specific deviations from the design submitted with the tender are agreed with the Engineer, the resins and liner supplied, and the liner installation shall faithfully reproduce the parameters set out in the liner design supplied with the tender.

ACS1420.6.2 Design loading

The finished lined pipe for each section shall be designed to carry the full ground loads arising from the maximum depth of fill over that section of pipeline. Vertical earth pressures shall comprise the full height of soil and construction materials above the pipe without reductions for trench effects.

The liner shall be designed to withstand groundwater pressure, such as may be applied through joints or cracks in the surrounding pipe wall, without separating or bulging away from the pipe wall.

The superimposed live load under roadways, industrial access ways, yards, and commercial storage areas shall be the NZTA HN HO 72 loading or in accordance with the NZTA Bridge Manual. In other areas such as parks, residential sections, or the like, the heaviest load likely to be encountered shall be considered. These loads shall be distributed in accordance with Clause 4.7.2 and Figure 4.2 of *AS/NZS 2566.1:1998 (Buried flexible pipelines – structural design)*.

Railway loads under main traffic lines or railway reserve shall be as advised by KiwiRail.

The design loading for any one length of lining shall be the maximum load produced from the combination of soil loadings, groundwater level, and live surcharge permanent loadings over that length.

ACS1420.6.3 Lining size

In determining the lining diameter, allowance is to be made for the difference in actual diameter between the pipes originally specified for the pipeline and the most severely corroded pipes in each section of the sewer. Where the lining technology requires, suitable allowance shall be provided for longitudinal and circumferential stretching of the liner during installation.

The pipe sizes given in the tender documents shall be used only as a basis for pricing. The Contractor shall be responsible for measuring the existing pipe prior to liner fabrication to ensure that a neat fit is achieved. The lining shall be considered to neatly fit if the gap between the inside of the host pipe and the outside of the lining is less than the maximum gap for the pipe diameter as nominated by the Tenderer in the product information.

ACS1420.6.4 Hydraulic requirements

The lining system shall not reduce the diameter of the existing pipe by more than 10% in pipes with 500 mm internal diameter and smaller at any location, including lateral connection locations, unless otherwise indicated on the drawings.

The lining system shall not reduce the diameter of the existing pipe by more than 5% in pipes greater than 500 mm internal diameter at any location including lateral connection locations, unless otherwise indicated on the drawings.

For laterals, installation of the liner into a lateral is not to reduce the internal diameter of the pipe by more than 15%. This permitted reduction is inclusive of wrinkles, protrusions, and deformations. In addition, following installation of the liner there must be no significant obstruction to flow through the pipe or any obstruction to the passage of cleaning or inspection equipment.

The lining material shall be such that the reduction in the cross-section area of the host pipe is compensated by the reduction in flow resistance of the lining (improved surface smoothness).

Account shall be taken of the build-up of slime and any defects which may affect hydraulic performance.

ACS1420.6.5 Material properties and service life

The minimum service life of the installed lining system shall be at 50 years.

Where material properties under load vary with time, material properties of the lining at the end of the 50-year service life shall be used in design calculations. The exception to this is design of the lining for loads applied only during installation, which may be based on short-term material properties.

The two-year values for ring-bending stiffness of the lining measured by testing may be used in calculations as representative values for the 50-year buried pipe stiffness.

The material properties used in the design shall be consistent with the composition of the lining material utilised in the rehabilitation. These properties shall have the same values as those nominated by the Contractor in the product information.

ACS1420.6.6 Chemical, temperature, and abrasion resistance

Except where specific requirements are stated in the tender documents, the lining system shall consist of materials that are chemically and biologically resistant to internal exposure to sewage, sewage related gases and mild concentrations of industrial effluent, for the service life of the lining.

Chemical resistance shall include satisfactory performance in the presence of small quantities of carbon monoxide, carbon dioxide, methane, hydrogen sulphide, sewer gas saturated with moisture, traces of mercaptans, hydrocarbons, detergent, soap, and dilute concentrations of acids. The lining system shall also be resistant to external exposure to soil bacteria and any chemical attack that may be due to residues remaining on the pipe wall, products from degradation of the existing pipe, or materials in the surrounding ground. The repair method and materials shall protect the concrete and reinforcing steel of the existing pipes, to prevent further or on-going attack and further loss of strength.

The lining shall have sufficient abrasion resistance to accommodate the migration of silt, sand, and debris along the pipe. It shall be sufficiently robust not to be damaged by pipe cleaning equipment that may be required to remove future blockages or debris accumulation in the pipeline.

The installed lining shall not be subject to shrinkage, thermal contraction, recovery, or reversion that adversely affects its strength, water tightness, fixings at the ends and openings, or hydraulic performance.

The lining material and configuration shall have satisfactory structural and bonding properties to meet the design criteria used.

ACS1420.7 Pipe cleaning

In addition to the requirements of Stormwater Standard Specification *ACS1410 Pipe Cleaning*, the existing pipelines are to be cleaned of any sediment and any loose or damaged concrete and reinforcement before the liner is installed. Any protrusions or materials likely to have a deleterious effect on any component of the lining system are to be removed. A CCTV inspection in accordance with Stormwater Standard Specification *ACS1510 Internal Inspection of Pipelines* shall be carried out to confirm that the standard of cleaning has been satisfactory.

Protrusions into the pipe that exceed the values in Table 1 Maximum values for protrusions and deformations, shall be removed.

Table 1 Maximum values for protrusions and deformation

Host pipe original diameter	Maximum reduction in diameter
≤ 500 mm	10%
500 mm and above	5%

Protrusions that extend for more than 50% around the circumference shall be expressed as a total reduction in the diameter.

All roots, fat and loose debris shall be removed prior to lining.

No stormwater or other fouling material shall be allowed to flow down the pipe from the time it has been cleaned and inspected until the lining is completely installed, cured, and is ready for service. If there is any contamination in this period, the pipe shall be cleaned and re-inspected before further lining work proceeds.

ACS1420.8 Disposal of excavated material and pipe cleaning debris

Material excavated in the process of establishing temporary works or liner insertion is to be stockpiled in an area secure from public access or removed from the site to a disposal site approved by the Engineer.

Contaminated solid material and groundwater (if any) produced from cleaning the pipe or any of the manholes, or from any other activity on the site shall be removed from the site in suitable leak-proof vehicles or containers, so as to avoid contamination of any private or public property. Contaminated material shall be disposed of to a suitably licensed landfill and shall not be stockpiled on the site.

ACS1420.9 CCTV inspections

The CCTV inspections and laser profiling shall be carried out in compliance with the Stormwater Standard Specification *ACS1510 Internal Inspection of Pipelines*.

The Contractor shall carry out a CCTV inspection of each section of the cleaned pipe immediately prior to commencing the liner insertion process. Inspection records are to be reviewed with the Engineer, and no other lining preparatory work shall proceed until the Engineer is satisfied with the level of cleaning.

ACS1420.10 Pipeline preparation after cleaning

Where preparatory cleaning and inspection reveals a substantial hole or holes in the pipe wall, which are likely to cause excessive deformation or other damage to the permanent lining, preliminary patching of the hole(s) or other appropriate repair will be required. The form and method of carrying out any such preliminary repair is to be agreed by the Engineer before installation of the liner proceeds.

Where there are abrupt discontinuities in the cleaned pipeline, and these may adversely affect the installation or performance of the lining, the discontinuities shall be infilled with an approved mortar. The mortar shall be resistant to external exposure to soil bacteria and any chemical attack that may be due to residues remaining on the pipe wall, products from degradation of the existing pipe, components of the lining system, or materials in the surrounding ground. In its fully cured state, the mortar shall be permanently resistant to softening in the installed location.

The infilling mortar or preliminary patch repair mortar shall be adequately cured before installation of the main liner so that it is not displaced or compressed by the lining process.

Where the pipe is too small to enable discontinuities to be infilled with mortar, alternative methods of remediation including excavation and realignment will be required.

A similar approach may be required where a pipe joint is significantly misaligned.

ACS1420.11 Flow management

Flow in the pipe to be lined and in any connecting pipes, shall be managed as part of the Contract.

ACS1420.11.1 Flow management plan

The Contractor shall provide a Flow Management Plan to accommodate pipe flow for any sections around which flow is to be diverted for the works. The Flow Management Plan shall include contingency provisions for failure of equipment, power supply, or other components of the flow management facilities. It shall also provide for the increased flows caused by rain in the bypass pumping period.

The Flow Management Plan and the Project Programme shall allow for each bypass operation to be in service for an agreed trial period before any of the works in the pipeline proceed.

Details of each flow diversion operation shall be submitted for approval to the Engineer and shall be approved by them before each flow diversion commences. The Engineer shall have the final decision as to when and whether a diversion operation shall commence. The Contractor shall make reasonable allowance for inability to work during periods of wet weather.

Approval of the Flow Management Plan shall not relieve the Contractor of their responsibilities to ensure that sufficient and adequate pumping or other flow arrangements are provided at all times for the flows.

ACS1420.11.2 Bypass capacity and pipe protection

When flow in the main and connecting pipes is plugged, blocked, or bypassed, sufficient precaution shall be taken to protect all upstream pipelines from surcharging and damage. Precautions shall be taken to ensure that control operations do not cause overflows, flooding, or other damage to public or private properties.

The Contractor shall ensure that surcharges or overflows of the pipe as a result of lack of capacity in the main diversion system do not occur. It will be the Contractor's responsibility to assess the flow in each line and to ensure that all plant and equipment used for the temporary diversion of flows is adequate for the required duties.

If the diversion capacity is exceeded by flow in the pipeline, the Contractor shall either:

- Cease work at the earliest possible time and reinstate flow to the main and connecting pipes

OR

- Continue to work by increasing the diversion system capacity to match the higher actual or anticipated flow.

The Contractor shall be responsible for clean-up and restoration of any area affected by surcharge, overflows, or spillage associated with these works, to the satisfaction of the Engineer.

An indication of the flows that will need to be pumped at various stages in the project may be shown in the Tender Documents. Where such flows are shown, the minimum installed capacity of bypass provisions should exceed these values with a satisfactory safety margin.

ACS1420.11.3 Bypass pumping

Where required, the Contractor shall set up pumps and hose or pipeline routes with the capacity to maintain the stormwater service to all the properties within the catchment.

Where hose or pipeline routes cross roads, access ways, etc, the Contractor shall make all necessary arrangements for continued vehicle access with property owners and occupiers and obtain all necessary permits from local authorities.

Where properties cannot readily be served by the bypass pumping arrangements, suitable provision shall be made to hold back flow or other suitable means to maintain stormwater service.

All costs of establishment of bypass pumping routes, traffic management, obtaining of permits, reinstatement of surfaces, and tidying up on completion shall be included for in the Schedule of Prices.

ACS1420.11.4 Flow management contingency plans

These and other flow contingencies need to be provided for:

- a) Full or partial blockage or failure of bypass pumping equipment (pump or hoses)
- b) Failure of a pipe plug
- c) Flow from any major source upstream increasing rapidly
- d) Any other likely cause of high flows or flow levels in the specific location.

The Contractor's Safety Management Plans shall recognise and make provision for these eventualities.

ACS1420.11.5 Standby pumps and equipment

At all times during the period of bypass pumping, the Contractor shall have standby pumps kept on site, sufficient to maintain the full bypass pumping requirement. Standby pumps shall be capable of full operation independent of primary pump power sources.

Additional pipelines, hoses, and fittings shall be available on site to provide for any pipeline failure during a bypass operation, and to meet all flow management contingency plans.

ACS1420.11.6 Work downstream from plugged pipelines

The Contractor shall take particular care to secure in place any pipe plugs that are required for bypass pumping or for flow retention. The Contractor shall be responsible for the repair of any damage caused to any liner by the dislodgement of any plug or leakage from any plugged pipeline.

ACS1420.12 Liner installation process

The liner shall fit neatly inside the host pipe and shall be installed with no twists, wrinkles, or bulges that could adversely affect the hydraulic performance or long-term life of the lining.

A lining shall be considered to neatly fit if the gap left between the inside of the host pipe and outside of the lining is less than maximum gap for the pipe diameter nominated by the Contractor in the design information submitted with the Tender.

Provision is required to remove from the sewer any water that is displaced ahead of the liner during insertion. Sufficient water head is to be applied during insertion to ensure that groundwater is not able to accumulate between the liner and the host pipe.

ACS1420.13 Water supply for liner installation

The Contractor shall make their own arrangements for water supply and payment for water to invert and cure the linings and for disposal of the water after installation.

ACS1420.14 Manholes and cut-outs

The ends of the liner and the cut-out around any of the connections are to be so secured so that for the design life of the liner, they will provide a smooth transition to the original pipe, and they will not become detached during high velocity flows from high pipe flows or pipe cleaning operations.

Where the lining terminates at the entry or exit from a manhole, the flow channel shall be shaped to match the ends of the lining, to provide for smooth flow with no abrupt discontinuities.

The finished surface in all flow channels and manhole benching is to be trowelled to the equivalent to a U3 finish as described and illustrated in NZS 3114. Other surfaces may have an "off the gun" finish, provided it is equivalent to U2 or better.

ACS1420.15 Reinstatement

Following the completion of the pipe rehabilitation works and the return of the pipe to normal operation, all affected areas of the site shall be reinstated to a condition at least equal to that existing prior to the commencement of work. The records of the pre-condition survey carried out prior to the commencement of site works shall be used in the event of any discussion regarding the extent of reinstatement.

Pipes, manholes, or any other facilities adversely affected by the work shall be reinstated to their pre-existing condition or better.

ACS1420.16 Monitoring of longitudinal shortening

Monitoring of longitudinal shortening shall be carried out and reported for each lining length installed. Monitoring shall comprise the measurement of the longitudinal movement of both ends of the initially installed lining relative a marked location on the adjacent manhole wall.

Three series of measurements shall be made by the Contractor as follows:

- a) At completion of cutouts
- b) 14 days
- c) 90 days.

ACS1420.17 Quality assurance

The Contractor shall submit test data to substantiate that the values for material properties nominated in design calculations and in the schedule of design information can be achieved by the materials supplied for installation and by the installed and cured liner. The Contractor shall nominate the tolerances that are to be allowable for test results for approval by the Engineer.

All imported materials, products and systems, shall be tested, appraised, and certified in New Zealand or Australia by an IANZ/NATA accredited laboratory to the requirements of the Auckland Codes of Practice, appropriate AS/NZ Standard and NZ Building Code (as applicable).

In addition, the Contractor shall provide evidence of the material's/product's manufacturing process (e.g. mill certificates). Any alternative testing regime, of an equivalent standard, shall be agreed by the Engineer.

Where testing is done outside of New Zealand and Australia, the Contractor shall be required to prove the chain of custody of materials to ensure that there has been no substitution of untested materials.

The Quality Assurance Plan (QAP) shall demonstrate that material properties used in the design are consistently achieved during preparatory works and during the liner installation. These shall be the values similar to those nominated by the Contractor in the schedule of design information.

The QAP shall record the Contractor's observance of the process plans and the results of the processes where applicable. They may include:

- a) Identification and timing information. Timing information is to include the date and time on which critical elements of the process were implemented. Where relevant, temperature information shall also be recorded
- b) Observations, measurements and tests, and all necessary Hold, Witness, and Verification Points
- c) All tasks carried out by Subcontractors employed to perform works under the contract
- d) Verification by the operator of all works performed, and acceptance of responsibility for the works performed, whether by Contractor or Subcontractor personnel. The verification shall include a statement that all of the works have been performed in accordance with the Contractor's process plans
- e) Procedures where test results do not conform with specified parameters.

The QAP shall also include appropriate completed checklists, tests of samples of the installed liner, video records, photographs, approvals, computer printouts, electronic information, as-built details recorded, and the like.

ACS1420.18 Quality tests

The Contractor shall be responsible for the quality of all products, processes and services utilised or provided under the Contract, and shall provide all test facilities and perform demonstrative conformance of all products, processes, and services to the technical requirements of the Contract.

Unless otherwise agreed by the Contractor and the Engineer, all laboratory tests undertaken by the Contractor shall be performed by laboratories currently registered with an authority recognised by JAS-ANZ.

ACS1420.19 Quality process audits

Upon request, the Engineer shall be given access in conjunction with or through the Contractor, to carry out quality audits, quality monitoring, assessment, or reviews to ascertain the effectiveness of the quality system put in place by the Contractor and their Subcontractors.

The Engineer shall be entitled to carry out the second or third party audits of the Contractor's and Subcontractors' quality system by:

- a) A review of the Contractor's conformance to the Quality Plan
- b) A review and verification of the Contractor's quality procedures and work instructions and documentary evidence of compliance with the technical requirements of the Contract.

Should the Engineer identify any examples of non-compliance with approved quality processes, a non-conformance notice may be issued in respect of that non-compliance. In extreme cases, where it is considered by the Engineer that there may be a risk to health and safety, or that the quality of the completed works may be compromised, the Engineer may order suspension of work in accordance with *NZS 3910:1998*, Clause 6.7 until such time that the Contractor rectifies the cause of the non-compliance to the satisfaction of the Engineer.

ACS1420.20 Traceability

The Contractor shall establish and maintain documented procedures for unique identification of individual products or batches of work as appropriate. This traceability shall include, but not be limited to:

- a) The source(s) of material and equipment used
- b) Instructions, equipment (processing, inspection, measuring and testing equipment) and personnel utilised for performing activities essential in meeting the specified customer needs, throughout the design, production, installation, delivery and commissioning phase of the product
- c) The distribution and location of the product after delivery.

ACS1420.21 Quality records

The Contractor shall submit to the Engineer, original documents as evidence that the work has complied with the specified quality requirements, including all pertinent Subcontractor or secondary consultant records. These reports shall be submitted within 24 hours if unsatisfactory, and seven days if satisfactory.

ACS1420.22 Inspection

The Engineer shall be given access in conjunction with or through the Contractor to all laboratories and other facilities used for quality control tests to verify that specified requirements are being met.

The Contractor shall make suitable arrangements to notify the Engineer when a Hold, Witness, or Verification Point will be reached so that the Engineer can review and/or witness, if required, any work process or test being undertaken by the Contractor.

The Engineer shall have the right to carry out at Hold, Witness, or Verification Points, inspections or tests to verify that the Contractor is implementing and maintaining the quality system in accordance with the Contract documents.

ACS1420.22.1 Post installation CCTV inspections

A post-installation CCTV inspection shall be carried out in compliance with the Stormwater Standard Specification *ACS1510 Internal Inspection of Pipelines*.

An inspection is to be carried out on each newly installed section of pipe lining. Flow shall not be allowed through the pipeline until the Engineer is satisfied that the quality of the lining meets the requirements of the specification.

A final CCTV inspection is to be carried out at the end of the maintenance period.

ACS1420.23 Completion and handover procedure

On completion of the refurbishment of both the pipelines and the manholes (if included in the Contract), the following as-built information is to be provided by the Contractor:

- a) A description of the pipe preparation work
- b) A record of the condition of each section of the pipe after cleaning but before lining commenced
- c) A list of the materials utilised in the liner and in any associated repair work, with relevant test certificates for materials
- d) A description of lining handling, preparation, and installation procedures that were utilised
- e) A CCTV record of the completed works, clearly showing critical aspects of the lining and any associated manhole repairs
- f) The names of all parties to the design and installation contract.