

ACS1440 Spiral wound liners

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ACS1440.1 Scope

This section covers the material requirements, design, supply, handling, installation, and testing of spiral wound PVC liners in pipelines. It includes pipeline preparation and cleaning, flow management, liner installation and overall quality control requirements.

ACS1440.2 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.

ACS1440.3 General

Prior to commencement of the work, the Contractor shall satisfy the Contract Administrator 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 Work Method Statement and detailed Construction Programme which together demonstrate exactly how the Works will be undertaken. Where amendments are required to the Work Method Statement, equipment or labour, such amendments shall be discussed with the Contract Administrator in advance of the implementation thereof and the Engineer's acceptance of these amendments obtained.

Personnel are not to enter pipes smaller than DN900.

ACS1440.4 Ventilation and lighting

The Contractor shall provide adequate ventilation and lighting in the tunnel, 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.

ACS1440.5 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 ACS1440.10 (*Pipeline preparation after cleaning*). The Contract Administrator shall be notified immediately of any differences between the construction drawings and site observations and any required actions shall be agreed before proceeding.

ACS1440.6 Liner design

ACS1440.6.1 Structural design

The lining shall be designed in accordance with AS/NZS 2566.1 (*Buried flexible pipelines. Structural design*), 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 liner profile of each lining section given by the Contractor in the schedule of design information is greater than, or equal to, that required.

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.

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 liner supplied, and the liner installation shall faithfully reproduce the parameters set out in the liner design supplied with the Tender.

ACS1440.6.2 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, ground water level, and live surcharge permanent loadings over that length.

ACS1440.6.3 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 pipeline, as verified by the Contractor through site measurements.

ACS1440.6.4 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%. 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

ACS1440.6.5 Material properties and service life

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

ACS1440.6.6 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 ongoing attack and further loss of strength.

Test procedures for determining the chemical-resistance properties of the liner and minimum chemical-resistance standards are defined in Section X2 of ASTM F1216-09.

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 rehabilitation system is to be sufficiently robust to withstand a minimum of twelve (12) pipeline cleaning operations a year using water jetting nozzles operating at up to 170 Bar, as may be required to remove 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 material properties of the rehabilitation system are to remain stable within a range of temperatures from 0°C to +40°C.

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

ACS1440.6.7 Quality assurance

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.

ACS1440.7 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.

ACS1440.8 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 accepted by the Contract Administrator.

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.

ACS1440.9 Pre-Installation 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 Contract Administrator is satisfied with the level of cleaning.

ACS1440.10 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 Contract Administrator 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.

ACS1440.11 Flow management

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

ACS1440.11.1 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 acceptance to the Contract Administrator and shall be accepted by them before each flow diversion commences. The Contract Administrator 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.

ACS1440.11.2 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.

ACS1440.11.3 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.

ACS1440.11.4 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.

ACS1440.11.5 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.

ACS1440.11.6 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.

ACS1440.12 Liner installation process

The liner is to fit neatly inside the host pipe, with the liner generally being in contact with the host pipe.

ACS1440.13 Annulus grouting

Grouting of the annulus may be required, either where specified in the drawings or particular specifications; or to satisfy structural design requirements.

For liners which require grouting, the Contractor shall produce a Grout Plan for each line segment, detailing the materials and application methodology for the grouting process, to ensure that the grout fills the annular space around the liner completely, without creating excessive external pressure on the liner which might cause it to buckle. The grout compressive strengths shall be at least 5 MPa at 28 days. Performance tests shall be carried out in compliance with NZS 3112: *Part 4: 1986 Methods of Test for Concrete – Tests Related to Grout*.

For installations where the grouting operation might create gradient and level errors due to flotation of the liner pipe during the grouting operation, it may be necessary to grout in stages, or to provide restraints, such as chains or partial filling of the liner pipe, to prevent flotation.

The annular void between the liner pipe and the host pipe is to be completely filled with cementitious grout. The grout material shall provide continuous contact between the host pipe and the liner, enabling the liner to achieve its design structural performance and preventing tracking of water or fines along the length of the lined pipe.

The grouting material and methodology shall be supplied with the tender and accepted by the Contract Administrator before any grouting of the liner commences.

The Grout Plan must include checklists and log sheets to record the following details of the grouting process, which will be submitted by the Contractor with the as-built data for the liner installation:

Pipeline information			
Contract ID		Installation site identifier	
Pipeline asset ID		Address	
Liner ID			
Host pipe ID		Void volume (litres)	
Grout mix			
Date		Time	
Batch number		Volume	
Mix composition (including water content)		Mix strength	1d, 7d and 28d
Pot life		Viscosity (state units)	
Shrink ratio		Cure time	
Mixed by (name)		Signed	

Grouting shall be sampled and tested in accordance with ASTM F1741-08. Tests shall be undertaken to confirm that the grout has filled the annular space around the liner. In the case of pipes DN900 and larger, this should include undertaking hammer tests around the full circumference of the pipes at 1 m internals along the entire length. For smaller pipes, hammer tests are to be undertaken along first 2 m from each manhole.

ACS1440.14 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 annulus is not to be fully grouted, the annulus between the line and the host pipe at manholes and chambers as follows:

- For pipes DN375 and smaller, the length of annulus is to be sealed for a minimum of 200 mm from the manhole internal wall
- For larger pipes, the length of annulus sealed with epoxy is to be a minimum of 500 mm from the manhole internal wall.

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.

ACS1440.15 Reinstatement

Following the completion of the pipe rehabilitation works and the return of the sewers 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.

ACS1440.16 Quality assurance

The Contractor shall be responsible for the quality of the works. They shall demonstrate that all products, processes and services comply with the requirements of the Contract.

The Contractor shall prepare and implement a project specific Contract Quality Plan for the duration of the Contract. The Contractor shall submit the Contract Quality Plan to the Client for review before starting lining operations.

The Contract Quality Plan shall be maintained as a live document and new procedures shall be added when the work changes or new works begin.

All Sub-contractors shall comply with the Contract Quality Plan.

The Contract Quality Plan shall demonstrate that material properties used in the design are consistently achieved during preparatory works and during the liner installation. The values listed in the Contract Quality Plan must be consistent with the values provided by the Contractor in the Product Work Statement.

The Contract Quality Plan shall record the Contractor's implementation and recording of the Lining Process Plans and the results of the processes where applicable. These must include sufficient detail to provide evidence that the installed liner properties are consistent with the property values specified in the Contractor's design submissions.

They may include:

- a) Identification and timing information, including the date and time at which critical elements of the lining process variables were recorded 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 specialist Sub-contractors employed to perform works
- 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 Contract Quality Plan shall also include copies of checklists, log sheets which will be used to record contract data, and specimen copies of other record formats which will be used to record as-built details for the project, such as photos, video records, electronic files, etc.

ACS1440.17 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 International Accreditation New Zealand (IANZ).

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), specifications, and quality assurance procedures for 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.

The Contractor shall submit to the Client original copies of documents as evidence that the work has complied with the specified quality requirements, including all pertinent Subcontractor or secondary consultant records.

The Contractor is to advise the Client as soon as practicable in the case of any significant non-conformance.

ACS1440.18 Quality process audits

Upon request, the Contract Administrator 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 Contract Administrator shall be entitled to carry out the second or third party audits of the Contractor's and Subcontractors' quality systems 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.

The Contract Administrator 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.

Should the Contract Administrator identify any examples of non-compliance with accepted quality processes, a non-conformance notice may be issued in respect of that non-compliance.

The Contractor shall make suitable arrangements to notify the Client when a hold point will be reached so that the Client can review and/or witness if required any work process or test being undertaken by the Contractor.

The Client shall have the right to carry out at hold points, inspections, or tests to verify that the Contractor is implementing and maintaining the quality system in accordance with the Contract Quality Plan Documents.

ACS1440.19 Quality records

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

ACS1440.20 Inspection

The Contract Administrator 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 Contract Administrator when a Hold, Witness, or Verification Point will be reached so that the Contract Administrator can review and/or witness, if required, any work process or test being undertaken by the Contractor.

The Contract Administrator 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.

ACS1440.20.1 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 Contract Administrator 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.

ACS1440.21 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.

g) Certificate of completed work.