



**Corrosion
Engineering™**

AN ERGONARMOR COMPANY

TECHNICAL INFORMATION

CES-347

04/00 SUPERSEDES 03/99

CORROSION ENGINEERING SPECIFICATION FOR INSTALLATION

ACROLINE® SYSTEMS

I. GENERAL

1.1 Description

This specification describes the requirements for the fabrication and installation of prefabricated ACROLINE thermoplastic Concrete Protection Liners (CPL).

1.2 Reference Documents

ACROLINE Systems Design and Installation Handbook

1.3 Quality Assurance

1.3.1 All thermoplastic materials to be joined shall be manufactured from the same resin from the same supplier with the same Melt Flow Index (MFI).

1.3.2 All work shall be performed in strict accordance with these specifications and the manufacturer's current printed instructions.

1.3.3 Material production quality certificates for sheet goods shall be made available to Owner or Buyer upon request.

1.3.4 Corrosion Engineering strongly recommends that the Owner or its agent, the installer or general contractor, the approved ACROLINE System fabricator, and an agent of Corrosion Engineering participate in a preconstruction meeting for the purpose of communicating the construction methods and procedures which should be employed to ensure a successful installation.

1.4 Delivery, Storage, and Handling

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- 1.4.1 Prefabricated components shall be appropriately crated and protected during shipment. Packaging shall bear the manufacturer's label including the type and color of the materials.
- 1.4.2 All material shall be kept out of direct sunlight while in storage. Flat sheets and fabricated shapes shall be fully supported. The temperature shall not be less than 50°F (10°C) and not more than 90°F (32°C).
- 1.4.3 Material and prefabricated components shall be handled so as to prevent gouging, puncturing, or deformation.

1.5 Submittal

- 1.5.1 Fabrication Drawings shall be prepared by the Fabricator clarifying the type of plastic, method of joining each seam, designation of seams as field seams or shop seams, type of connection profiles and dimensions, method of nondestructive testing, type and design of crating, and requirements for transit and placement.

1.6 Safety

- 1.6.1 All work shall be performed in a safe and well maintained environment in compliance with all plant safety procedures and State, Local and Federal Regulations.

2. MATERIALS

2.1 Thermoplastic Liner Components

- 2.1.1 The chemical-resistant thermoplastic lining system shall be ACROLINE Concrete Protection Liners (CPL), welding rod, and joining profiles as supplied by Corrosion Engineering, Philadelphia, PA.
- 2.1.2 The ACROLINE sheets shall be manufactured from one of the following resins: High Density Polyethylene (HDPE), Polypropylene - random copolymer (PP-R), Polyvinylidene Fluoride (PVDF) or Ethylene and Chlorotrifluoroethylene copolymer (ECTFE).
- 2.1.3 CPL sheets shall be 2.5 mm to 12 mm (100 mils - 470 mils) thick.
- 2.1.4 ACROLINE CPL shall be non-skid, smooth, embedded aluminum barrier, polyester fabric embedded, co-extruded black-and-white, or

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double wall.

2.1.5 The ACROLINE thermoplastic lining system, as depicted, shall consist of ACROLINE CPL sheets with integrally molded anchor studs on one side.

2.1.6 All ACROLINE CPL sheets are manufactured by means of a unique and patented continuous extrusion process. This process extrudes the anchoring studs as an integral part of the sheet. Anchoring studs are located on 2.25" x 1.5" (57 x 38mm) centers, 39 per ft². or 420 per m². Each anchor shall consist of two branches 13mm or 18mm tall and at least 5mm thick in a V-formation with a 4mm tie. The angle of the V anchor shall be 60° on one side and 70° on the other. Welded or mechanically attached anchors, which may fail in shear, shall not be permitted.

2.1.7 The plastic from which the ACROLINE sheet and components are made meet the following ASTM and/or DIN Specifications:

TYPE OF THERMOPLASTIC	RESIN	ASTM	DIN
High Density Polyethylene	Vestolen A3512 R Black	ASTM D 1248	16776, Part 1
Polypropylene	Vestolen P9422	ASTM D 4101	N/A

2.1.8 TYPICAL PHYSICAL PROPERTIES:

PROPERTY	TESTING METHOD	UNIT	TYPICAL VALUES			
			HDPE	PP	PVDF	ECTFE
Density	ASTM D 792	g/cm ³	0.94	0.90	1.78	1.68
Melt Flow Rate	ASTM D 1238	g/10 min	190/5	190/5	230/5	275/2.16
Heat Reversion (Dimensional Stability)	ASTM D 1637	%	120/2h	150/1h	150/2h	150/2h
Yield Stress	ASTM D 638	N/mm ² psi	≥15 ≥2175	≥20 ≥2900	≥28 ≥4050	≥25 ≥3625
Elongation at Yield	DIN 53 455	%	≥17	≥16	≥16	≥6
Elongation at Break	DIN 53 455	%	≥450	≥200	≥150	≥150
E-Modulus (tensile test, short term)	ASTM D 1708	N/mm ² psi	600 87025	750 108750	1050 152250	1675 242950
Fire Classification	UL 94		94-HB	94-HB	V-0	V-0

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Surface Resistivity	ASTM D 257	Ohm	>10 ¹³	>10 ¹³	>10 ¹⁴	>10 ¹⁷
Resistance to Pull-Out	SKZ test directives	t/m ² lbs/ft ²	≥30 ≥6000	≥30 ≥6000	≥30 ≥6000	≥30 ≥6000
Recommended Maximum Working Temperature		°C °F	60 140	90 194	120 248	120 248

2.2 Concrete and Cementitious Grout

- 2.2.1 All concrete or grout shall be minimum 4800 psi compressive strength and non-shrink.
- 2.2.2 Aggregate shall be properly sized, and mix design shall provide for adequate flow for the clearance space between the liner anchors, rebar, and excavation or outside form.
- 2.2.3 Portland Cement Concrete and grout substrates into which the ACROLINE CPL system will be cast shall be described in other documents.

2.3 Alternatives and Substitutions

- 2.3.1 No substitutions of materials or components are permitted for those specified unless substitutions have been approved in writing by the project engineer.

3. WELDING

3.1 Equipment

Welding and other fusion equipment shall be operated and maintained in accordance with the equipment manufacturer's specification.

3.2 Welders

Welders shall be certified according to ASTM C 1147-95 for the materials and welding equipment to be used and shall be employed by a fabricator, approved by Corrosion Engineering to fabricate ACROLINE Systems. Certification by Corrosion Engineering shall not be construed as an endorsement of the fabricator and/or the welder. Certification indicates that the fabricator and/or welder has the capability to perform this specific task.

3.3 Applicable Standards

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Welds shall be made in accordance with German DVS/DIN standards and AWS standards, where applicable. Standards pertaining to metal welding may not be substituted for standards pertaining to thermoplastic welding.

3.4 Surface Preparation

3.4.1 ACROLINE surfaces shall be washed, using water, wiping cloths and sponges to remove soil. Hoses shall not be used to wash or rinse surfaces unless welding is completed and tested.

3.4.2 All thermoplastic sheets shall be inspected prior to any fabrication or installation; all voids, defects or improper installation should be marked for repair.

3.4.3 Before being used, all weld rod shall be scraped to remove oxide layer when hot air welding equipment is used.

3.4.4 All surfaces to be welded including sheets and profiles shall be scraped prior to welding to remove oxide layer on plastic.

3.4.5 Recommended welding temperatures:

PARAMETER	HDPE	PP-R	PVDF
Melting Temperature of ACROLINE sheet	135°C	170°C	175°C
Temperature for Extrusion welding equipment	250-300°C	250-300°C	280-330°C
Temperature for Hot Air (hand) welding equipment	340-360°C	300-350°C	350-400°C

3.4.6 Air Volume

At least 40 liters/minute of air flow is required to sufficiently preheat the sheet. Excessive temperatures will burn the sheet, and the resulting carbon layer will be detrimental to weld quality.

3.5 Environmental Conditions

3.5.1 No welding shall be carried out directly over Portland Cement Concrete or grout, regardless of the age or moisture content of the concrete and/or grout.

3.5.2 Air temperature during fabrication and installation of ACROLINE liners shall be above freezing. In addition, the air temperature during

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fabrication and welding of ACROLINE liners shall be at least 40°F but not more than 100°F. Consult Corrosion Engineering for additional information when welding ACROLINE Concrete Protective Liner Sheets.

- 3.5.3 Relative humidity above 80% can be deleterious to welds. Slight condensation of moisture on the sheet, rod or in the air supply can critically reduce weld strength.

The CPL sheet, welding rod, and profiles shall be 5°F (3°C) above the moisture dew point during fabrication and welding. This can be determined by psychometric measurements. Psychometric measurements involve the measuring of the air, moisture, dew point and material temperature.

Moisture may be in the form of groundwater infiltration, rain, dew, perspiration, condensation caused by faulty ventilation, or caused by heating of the concrete backing. In whatever form, moisture will not be tolerated. The heat from the welding gun will turn moisture into steam, which can result in a porous weld that will be weak and may leak.

- 3.5.4 If fabricating or installing ACROLINE CPL sheet in confined space, low velocity ventilation shall be provided in order to remove fumes from cleaning agents that may be required. Drafts directly on the welding surfaces will extract heat too quickly from the welded area and adversely affect weld integrity. Tenting the area in cold or drafty environments is highly recommended. Welds can be covered with a thin insulating blanket material to protect them from drafts during the first ½ hour of cooling.
- 3.5.5 Sufficient illumination, as recommended by the welding supervisor, shall be made available at all times during the preparation welding and inspection of all welds.
- 3.5.6 Protect all work during welding from water, precipitation, drafts, wind, extreme temperatures, and direct sunlight. The work area must be as clean and dry as possible prior to installation and welding.

3.6 Quality Control

All welds must be nondestructively tested by high voltage spark testing or vacuum box testing to ensure a leak-tight barrier.

3.7 Fabrication Design

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- 3.7.1 ACROLINE CPL sheets can be used to line trenches, sumps, basins, tanks, manholes, floors, lift stations, and other containment areas for the purpose of conveyance and/or containment of chemicals and corrosives. We recommend that before such vessels be constructed that the fabricator and/or designers review carefully DVS Standard 2205 Parts 1 and Part 5. Part 1 encompasses the design calculations for containers and apparatus made from thermoplastics; Part 5 of DVS 2205 encompasses the design calculations for rectangular tanks made out of various thermoplastics.
- 3.7.2 ACROLINE CPL sheet shall be fabricated in the minimum number of sub-assemblies of maximum size, dictated by transportation, installation, and access constraints, in order to minimize field welding.
- a. ACROLINE sheets shall be trimmed at the edges to ensure anchor spacing across adjacent sheets is minimized.
- 3.7.3 Connection Profiles
- Connection profiles are recommended when fabricating ACROLINE liners for vessels and other structures. You will find a series of sketches which outline the specific configurations of these connection profiles in the Design Guide (all measurements are in mm).
- 3.7.4 Pull Strip profiles - can be used to connect flat sheets. A Pull Strip profile requires one extrusion weld.
- 3.7.5 Termination Profiles - provide a continuous anchor between the ACROLINE liner and the concrete at terminations of the liner. The use of an end profile enhances greatly the ability for long-term fixing and prevents the penetration of corrosive liquids behind the liner.
- 3.7.6 Inside and Outside Corner Profiles - are used to connect sheets to make 90° corners and changes in direction.
- 3.7.7 All connection profiles have an electroconductive insert which allows for spark testing of connected joints.
- 3.7.8 Where fabricators chose not to use manufactured profiles, plate connections of their own design and fabrication may be substituted if approved by Corrosion Engineering. For example, thermoformed corners may be substituted for Corner Profiles. Thermoformed angles shall be of the same thickness as the CPL sheet and be smooth.

4. INSTALLATION

4.1 Excavation

Excavation of the area where the fabricated piece is to be installed must accommodate the structure. A minimum 2" clearance from the backside of the liner to the excavation or existing structure must be allowed for grouting/concrete placement.

4.2 Formwork

4.2.1 Wooden formwork shall be erected according to industry standards and must be of the proper size and strength to maintain the stability of the plastic during the placing and curing of grouting materials.

4.2.2 Outer formwork, when needed, shall be installed after the concrete protection liners have been attached to the interior formwork as described in Section III. C. 3. of this specification. Project scheduling shall also provide for steel reinforcing to be installed after attachment of ACROLINE sheeting to inner formwork.

4.3 Attachment of Liners to Formwork

4.3.1 The liner may be fastened to the form with small flat head nails (to prevent the nails from pulling through the plastic liner) along the centerline of Pull Strip Profiles, or at the edges of other types of profiles.

4.3.2 Forms shall not be nailed through the ACROLINE liner except at Connection Profiles as described above.

4.3.3 At the joints in the liner, the sheets are joined together by means of a wire looped across anchor studs at every fourth stud, and are thereby held together inside the forms.

4.3.4 Liners shall be attached to formwork such that unwelded seams do not allow grouting material to leak through the seams or to cause significant irregularities in the weld area.

4.3.5 When liner sheets are fit to the wooden forms, ensure that no damage is done to the liners or the fabricated weld seams.

4.4 Installation of Reinforcement

4.4.1 Care should be taken to prevent the steel reinforcement from damaging the liner during installation of the reinforcement or after it is in place.

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- 4.5 Placement of Concrete or Grout
 - 4.5.1 Protect grouted/concrete area from water and weather until initial cure has occurred.
 - 4.5.2 The ACROLINE thermoplastic CPL sheet must be properly supported to ensure it will not deflect, float or move during concrete or grout installation.
 - 4.5.3 Proper concrete or grout placement and curing procedures should be followed per the ready mix supplier or grout manufacturer's instructions.
 - 4.5.4 Place concrete/grout continuously, pouring from one side or end only to prevent air pockets. Work concrete or grout under frame with push rods, strips, or vibrators. Be sure grout completely fills the space to be grouted/concreted, and that grout/concrete is compact and free of air pockets.
 - 4.5.5 Any resulting voids in grouting materials must be repaired prior to commissioning the system. Voids are detected by sounding and visual inspection. Repair shall be in accordance with the ACROLINE design guide method for repairing voids in grout.
- 4.6 Removal of formwork
 - 4.6.1 The formwork shall remain in place until cure of grout/concrete is acceptable to remove formwork in accordance with the grout manufacturers recommendation.
 - 4.6.2 The Concrete Contractor must remove (or incrementally move) all forms, snap off form-ties, when used, and remove all debris from the work area.
- 4.7 Field Welding
 - 4.7.1 All joints between panels must be aligned and tightly fitted, and free from concrete infiltration due to insufficiently rigid, poorly anchored, or ill-fitting form work.
 - 4.7.2 All seams, and areas adjacent to seams to be welded must be clean, dry, and free from concrete or other contamination.
 - 4.7.3 Cement, soil and other contaminants must be removed with water or appropriate cleaning agents approved by Corrosion Engineering.

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4.7.4 Welding shall be carried out in accordance with Section III. A. of this specification.

5. INSPECTION

- 5.1 All welds shall be inspected to assure proper joint construction and liquid tightness. All welds shall be tested using high voltage sparking or vacuum box testing by a Corrosion Engineering certified applicator. Spark testing will be performed after first welding pass, or the root pass.
- 5.2 When installation is completed, tested and cured, the system shall conform in physical properties to those as listed herein. From inception of design to completed installation, the project shall be supervised and quality controlled by Corrosion Engineering or by one of its certified fabricators/applicators.

6. PROTECTION

- 6.1 No other trades or traffic shall be permitted on or over the work during the period from completion of the welding to acceptance by the Owner.
- 6.2 In the event of damage, all repairs and replacements will be made immediately and to the satisfaction of the responsible party. Cost of repair or replacement shall be borne by the party responsible for the loss or damage.

7. DISCLAIMER

- 7.1 The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. Since the conditions and methods of use of the product and of the information referred to herein are beyond our control, Corrosion Engineering expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information; NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, IS MADE CONCERNING THE GOODS DESCRIBED OR THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be applicable when such product is used in combination with other materials or in any process. The user should thoroughly test any application before installation. Nothing contained herein should be taken as an inducement to infringe any patent and the user is advised to take appropriate steps to be assured that any proposed use of the product will not result in patent infringement.

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- 7.2 Please contact Corrosion Engineering for specific recommendations at +1-610-833-4000 or fax +1-610-833-3040.

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