INSTALLATION SPECIFICATION ACROLINE™ SYSTEMS

1. SCOPE

1.1 This specification is meant to provide general guidelines for good practice when installing Acroline Systems thermoplastic sheet liner. This method involves first prefabricating the virgin sheet into the appropriate size and configuration and then embedding the sheet into the concrete. Consult Armor product data sheet CE-270 for additional Acroline Systems information.

1.2 The key to a successful Acroline project is dependent on 2 specialized trades:

a) a certified and trained plastic welder fully trained, certified and familiar with the welding techniques and best practices when handling and installing anchored thermoplastic sheet.

b) a civil contractor involved in setting formwork and executing the concrete or grout pours to attach/anchor the lugs on the backside of the Acroline sheet into the substrate. The plastic fabricator rarely, if ever places concrete or grout, but they have knowledge and experience as to good practices based on their experience.

1.3 Coordination between the two parties is vital to the success of an Acroline project and cannot be over emphasized.

1.4 It is not the intent of this specification to fully detail either of these areas of expertise as it would be too voluminous. The level of knowledge to prepare Acroline sheet and the welding of the sheet is a very expansive topic requiring extensive training, and only those contractors with a certified welder team fully versed trained and certified in the intricacies of this art and science should ever attempt to fabricate Acroline sheet. The construction methods used to place concrete or grout are similarly expansive and many variables such as the project size, timeline, job access and numerous other factors may determine the approach chosen.

2. ACROLINE FABRICATION

2.1 Acroline Systems projects generally fall into 2 categories: new construction and retrofit projects.

2.2 Retrofit projects are often smaller assemblies such as trenches and smaller sumps, although retrofitting onto existing larger tanks have also been carried out. The prefabricated assemblies are set and braced, paying particular attention to both correct elevations and to anchoring the assembly to the adjoining concrete floor to prevent it from floating up when being grouted into place.

2.3 New construction typically involves attaching the Acroline sheet onto the concrete formwork and then the sheet is locked into the concrete when concrete is poured.

2.4 This specification makes note of practices to review in the coordination meetings between the fabricator and the civil contractor.

3. ACROLINE FABRICATION - RETROFIT PROJECTS

3.1 If the size of the fabricated assembly is smaller, it is advantageous to complete as much welding and fabrication as possible in the welding fabricators shop. This allows the control of environmental issues and avoids space limitations for layouts on the jobsite. It also offers the fabricator access to bending and butt-welding equipment which is not otherwise available on a jobsite. It allows the fabricator the opportunity to minimize the number of joints and often allows the fabricator to fabricate the floor and wall of the assembly simultaneously. Details such as trench grate lips are also handled far easier in a shop setting.

3.2 After shop fabricating, the fabricator typically prepares the assembly for shipping to the jobsite. This offers the opportunity to incorporate internal concrete formwork into the fabricated assembly to resist the grout or concrete pressures. One cannot rely on the fabricated shape by itself to resist concrete head pressure. Many fabricators have found using expanded polystyrene of a suitable density inside the fabricated assembly (such as a sump or trench) to be ideal as it completely fills the cavity yet is light in weight in comparison to a wooden bracing assembly. This also saves the cost of bracing the assembly at the jobsite by others.

3.3 Small retrofit projects such as a trench assembly can be of virtually an unlimited length. The fabricator will determine how to best fabricate the pieces to an optimized each piece's length, and will take into consideration the stock sheet size, the turns of the trenching, access at the jobsite, and consideration of how to execute the field welding of the sections once placed. This can only be done on a case-by-case basis.

3.4 Larger retrofit projects where Acroline sheet is fitted into an existing tank are not as common as smaller retrofit jobs such as trenches and sumps and often follow the techniques and requirements of new construction. The benefits of shop fabrication of the pieces is still a consideration though, and generally as much shop fabrication as possible is desirable. These project details and a coordinated plan of approach need to be reviewed between the parties.

4. ACROLINE FABRICATION NEW CONSTRUCION PROJECTS - WALLS

4.1 With new construction, Acroline panels are secured to the outside concrete formwork. In most cases this is done at the point of the concrete pour, although sometimes the panels are prepared off site and raised into place. The points outlined below are not meant to be all encompassing but document some typical issues experience has shown from past jobs and can form the basis for full dialog before beginning work between the fabricator and civil contractor.

4.2 Experience has shown there can be conflicting objectives on the jobsite. The civil contractor has a primary concern of erecting strong durable formwork that does not deflect in as little time as possible. The plastic fabricator is concerned about the possible damage to the Acroline sheet during the sheet placement on the formwork and during the concrete pour. So, for example, the civil contractor may simply nail a wave or bulge in the plastic sheet, so it lays flat. This, however, makes more work for the fabricator who must ensure the final Acroline liner is completely liquid tight.

4.3 Experience has shown these conflicting goals come down to a few things. The fabricator wants to minimize the attachment points of the fabricated sheet to the formwork, and the civil contractor wants the fabricated sheet to lay as flat against the form as possible.

4.4 With respect to waves and bulges when attaching the sheet to the formwork, liners commonly experience several expansion and contraction cycles throughout the day especially if the outside formwork is in the direct sunlight and black sheet is used. Gray polypropylene Acroline liners may be used to minimize this expansion and contraction, minimizing (but not eliminating) fit up problems due to excessive liner expansion and contraction. The selection of the gray polypropylene option is dependent on cost and the chemical environment however and is not always a feasible answer. Consult with the fabricator on site to review this in more detail.

4.5 The fabricator must trim the sheet to fit from the standard 2 m (6.5') by 4 m (13') sheet sizes. Besides adjusting for height, the fabricator must also give consideration on how the sheets are joined side by side or end to end, and how they will be spark tested once the concrete is poured to later test and verify the seams

are fully sealed. Various joining techniques are available for the fabricator, and care must be taken to ensure they are properly incorporated. These details can be time-consuming and there may be conflict as to whose scope of work the attachment of anything to the formwork may fall. Again, communication and pre-job planning are critical at this stage.

4.6 When joining adjacent panels between forms it is difficult to install joiner profiles after the liners are hung on the forms. Alternative means of securing the edges of the sheets may be necessary. If nails are used to secure the edges of the sheets, they should be driven between adjacent sheets and bent over to clip the sheets to the forms. Alternatively, nails may be driven through the liner as close to the edge of the sheets as possible to ensure that the nail holes will be sealed when the seams are extrusion welded later. Seams not using pull-strip profiles should be sealed with copper tape. The tape will prevent concrete from getting into the seam area during the pour and will act as a counter-electrode when the extrusion-welded seam is spark tested later for quality assurance. However, awareness that something as simple as nail spacing can double up on the amount of welding per seam (2 welded seams needed instead of 1) and disputes over justified extra charges can arise.

4.7 Experience has shown when attaching the plastic sheet to formwork it is also good practice to use the snap tie penetrations as an attachment point and nail the sheet above and below the snap tie hole. The holes from the snap ties must be repaired anyway, and keeping the small nails close to the snap tie holes allows them to be easily identified and found and repaired together. The worst-case scenario for the fabricator is the random nailing of the plastic against the form as small nail holes are leak points and can be difficult to find, especially if using finishing nails with small heads.

4.8 The most reliable way for the fabricator to check for a free pinhole weld is to use electric conductivity testing whereby an electric charge passes through the welded seam. The voltage will make an electrical connection to an underlying conductive point if there is a pinhole. The conductive back layer is typically a self-adhesive copper tape that is installed behind the plastic sheet at all weld points such as between wall panels, floor/wall corners, grate lips etc. The tape must be installed while there is full access to the sheet backside – i.e. before the concrete is poured. Schedule work sequencing accordingly.

4.9 All extraneous penetrations must be repaired after the forms are stripped. It is most economical to extrusion weld butted liner sheets in the field with a single pass. To do so, the gap between adjacent sheets should not exceed ¼" (6 mm). Seams with a larger gap between the sheets must be bridged with a cover strip. Cover strips are typically 2 – 3" (50-75 mm) wide and are extrusion welded on both sides, doubling the number of lineal feet of weld required to join the two sheets.

4.10 Removing formwork is done after the concrete has reached a suitable strength to allow formwork to be removed. If tools such as crowbars are used to remove the formwork, take care to prevent damage to the liners.

4.11 After the walls are poured and the forms are stripped, penetrations for wall braces or bulges in the liner may be filled with grout. Protruding nails are trimmed with side cutters. The part of the nail that remains in the wall acts as a counter-electrode for spark testing the welds used to repair these liner penetrations. Care must be taken to mark all nail holes and other small penetrations with a grease pencil at this time to clearly identify them for repair. Not doing so can lead to significant time wasted hunting for sources of leaks.

5. ACROLINE FABRICATION NEW CONSTRUCION PROJECTS - FLOORS

5.1 Vertical walls must always be installed first. Establish the finished floor elevation and snap a chalk line along the wall 3/16" (5mm) below the elevation.

5.2 The typical thickness of the grout bed under the floor sheeting is recommended to be 3" (75 mm). Start by tack welding a 1 ½" x 1 ½" (38 mm x 38 mm) wall screed strip to the wall. Proper location of screeds will facilitate the subsequent placement of sheet.

5.3 The screed strip is best installed as follows, assuming the full sheet size of 6.5' x13' (2 m x 4 m):

5.4 String a line parallel to one of the long walls at the elevation of the wall screed guide.

5.5 Find the location where the distance from the string to the wall is the greatest.

5.6 Using the above location snap a line the width of a sheet away from the wall. This provides the centerline of the first-floor screed strip or form board.

5.7 From this point measure along both short walls in intervals of the sheet width plus 1/8" (3 mm) to determine the centerline of each subsequent screed strip.

5.8 It is also recommended that center line be scribed into the screed strip before placement.

5.9 Once the above has been determined, construct forms for placement of grout in panels by using 2x4 lumber.

6 FLOOR SHEET INSTALLATION

6.1 Installing the floor of an Acroline vessel requires grouting of the sheet and embedding the sheet into the wet grout. To prevent the sheet from pulling away from the grout it is weighed own using ballast while the grout cures hard. Sheets for floors are normally supplied with a shop installed overlap strip and conductive tape for subsequent void testing.

6.2. Sheets should be laid out and arranged in advance, trimmed as needed to fit properly on the screeds. Trimming should not result in removal of any anchors from the sheet.

6.3. Layout is best staggered so that a maximum of three sheets meet in any one place. Before placement of sheet ensure that conductive tape is on the anchor side of the sheet 1/16" to 1/8" (1.6-3.2 mm) from the edge of the sheet for use in spark testing of the finished lining.

6.4. The setting bed grout mix is prepared using a mixture of three (3) volumes of concrete sand to one (1) volume of Portland cement with an amount of water so that the mortar can be molded into a ball by hand and a slight side to side motion of the hand will cause the ball to slump. The mix must be sufficiently flowable to easily embed the Acroline sheet, while not losing strength because of too much water. A concrete grout mix using up to a 3/8" (9 mm) max dia. aggregate is acceptable although a finer grout mix is easier to work with. It is generally more practical to supply the setting bed mortar mix as a ready-mix load with certifications accompanying each truck. The ready mix should be delivered to the site with the minimum amount of water added (1"- 2" slump) and the mix adjusted at the site before placing at a 4"- 5" (100-125 mm) slump. Plasticizers to improve flow should be discussed with the ready-mix supplier where tight pour cavities exist. For larger projects, complex installations, or in very warm weather, it is advisable to have a retarder added to the mix. Do not retard more than 6 hours.

6.5. For smaller jobs the setting bed can be mixed in portable concrete mixers using a prebagged grout mix.

6.6 It is advisable to pre-moisten the concrete slab before placing the setting bed mortar to enhance the bond to the base slab. In instances where the base slab is more than three (3) months old, a concrete bonding agent is recommended.

6.7 The setting bed mortar is placed level with the top of the floor and wall screed strips. Screed, compact, and finish as is normally done for screed installations. Fill low spots immediately with fresh mix. Finish with a wood or magnesium float.

6.8 Carefully remove all setting bed grout and foreign substances from the surfaces of screed strips with a damp sponge to assure that the sheet will lie properly.

6.9 Place the grout in areas that will only be immediately covered with Acroline sheet. Avoid spraying water on setting bed grout.

610 Carefully place the pre-cut sheet onto the leveled and compacted setting bed. Gently press the sheet edges to firmly seat onto the screed strips. Next, cover the Acroline sheet with 5/8" or ¾" (16-19 mm) exterior grade particleboard or wafer board, sized to leave approximately 1/8" (3 mm) of the perimeter edge of the sheet exposed. This will allow laying of adjacent Acroline sheet without interference.

6.11 Place approximately ½ the required ballast evenly over the surface of the particleboard or wafer board**.** The recommendation for ballast is to use 20-25 lb (9-11 kg) sandbags prepared in advance of setting the sheet. The amount of ballast weight to be used is 18 lbs/sf. (88 kg/sm). A 6.5' x 13' sheet (2m x 4m), with a total area of 86 sf (8 sm) will require approximately 1500 lbs of ballast or 60 x 25 lb (11 kg) bags.

6.12 With ½ the required ballast placed evenly on the board, gently tamp the board between the ballast using a hand tamper. Tamping must not distort the sheet in any way. Tamp with just enough force and repetition to ensure that the setting bed grout encapsulates the anchors and the sheet edge seats firmly on the screeds.

6.13 As tamping is completed, apply remaining ballast. Leave ballast in place for a minimum of three days.

6.14 Clean screed strips of residual setting bed mortar.

6.15 Proceed with field welding of seams and testing for holidays.

6. CLEANUP

6.1 Consult specific product data sheets for suggested tool cleaning recommendations. Clean Acroline sheet and prepare using fabricator approved prep methods.

7. SAFETY PRECAUTIONS DISCLAIMER CONTACT INFORMATION

7.1 Consult current Safety Data Sheets (SDS's) before commencement of work.

7.2 Mixes and applications of this product present a number of hazards. Read and follow the hazard information, precautions and first aid directions on the individual product labels and safety data sheets before using. While all statements, technical information, and recommendations contained herein are based on information our company believes to be reliable, nothing contained herein shall constitute any warranty, express or implied, with respect to the products and/or services described herein and any such warranties are expressly disclaimed. We recommend that the prospective purchaser or user independently determine the suitability of our product(s) for their intended use. No statement, information or recommendation with respect to our products, whether contained herein or otherwise communicated, shall be legally binding upon us unless expressly set forth in a written agreement between us and the purchaser/user. For all Terms and Conditions of Sale see armor-inc.com.

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