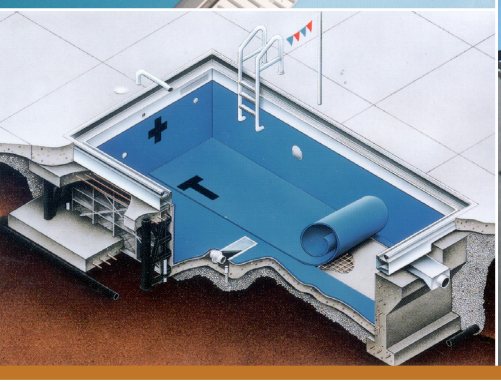
Natatec® Pool Lining Systems

Information and Technical Data



Colorful, durable, watertight swimming pool lining systems.

Natare Corporation

Swimming Pools, Aquatic Facilities and Water Features

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Natare Corporation is one of the most respected suppliers of equipment, systems and services for commercial and public swimming pools, water features and aquatic recreation in the United States and around the world.

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Natare offers a comprehensive selection of equipment and systems, in combination with consulting, engineering and technical services. Whether it's design, construction, renovation or operation, Natare is part of state-of-the-art aquatic facilities around the globe.

The following information is a collection of topics pertaining to Natare® Perimeter Recirculation Systems. These documents include product support information as well as typical specifications and drawings.

We invite all inquiries concerning aquatic or water feature development, planning, construction or renovation. Additional information can be found on-line at www.natare.com or you may contact us at (800) 336-8828.

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Natatec® PVC Pool Lining Systems

Natatec PVC pool lining systems are an ideal way to contain water. Our revolutionary lining system allows a fast and economical installation of a continuous reinforced PVC blanket in a swimming pool or aquatic facility. Pioneered in Germany, pool membranes are highly durable, waterproof and low maintenance. Over 70,000 installations and 30 years of field experience demonstrate that PVC pool lining systems can dramatically reduce construction or renovation cost, limit maintenance and extend the life of a swimming pool facility.

Think of our pool lining system as a PVC pool shell that covers, protects and waterproofs almost any type of pool or aquatic structure. For renovation or new construction, this may mean savings up to 50 percent, when compared to conventional techniques.

This combination of Natare products presents the most cost-effective and functional way to construct any public, institutional, municipal pool.

Our system is effective for gunite, concrete or plaster pools and works especially well on block wall, steel, stainless steel, aluminum or any surface that forms the structure of a pool. In fact, Natatec PVC pool linings are perfect for surfaces that would be unacceptable for conventional pool coating or lining products.

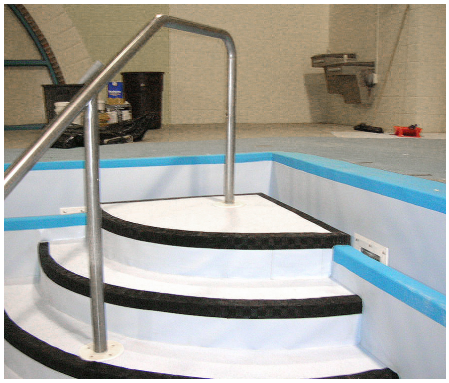
Natatec provides a tough, waterproof, yet flexible liner that ensures top quality for in-ground, above-ground, or elevated construction. It provides a line of defense as it eliminates leakage and problems caused by shrinkage cracks, construction joints, and imperfections in concrete construction.

Our renovation system can turn abandoned or unusable pool structures, into operating facilities by permanently waterproofing the entire pool shell and providing an attractive surface.

For new construction, our pool lining system can be used to quickly and cost effectively construct swimming pools or water features.

Before and After





Above: An indoor waterpark's cement gutter system was leaking large amounts of water each day. Our Natatec PVC lining system was the solution by wrapping the deteriorated gutter. Now the pool is free from crumbling dangerous cement with a great new look.



Above: An outdoor pool's plaster bottom is popping and cracking, creating leaks and an unsafe swimming pool. Natatec was used to cover the floor and walls once all of the loose plaster was removed. Now this pool will be water tight for years and always have a safe rock free bottom. Other improvements to this pool were; adding a Uniwall perimeter recirculating gutter system to increase water efficiency with cleaner and clearer water, as well as a Uniwall Bulkhead system to separate the diving well from the rest of the pool which added six more 25 yard lanes.



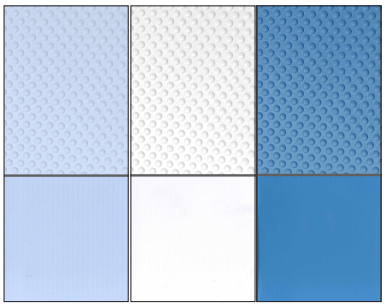
Above: An outdoor pool with ceramic tile was showing its age as the grout and tiles were coming loose. Our Natatec system was simply applied over the tiles to create a nice smooth surface with no annual expensive grouting and plastering cost again.

Design, Construction, Features and Benefits

The System

The Natatec System is an ideal way to keep an aquatic facility up-to-date without straining your budget. Natatec eliminates expensive and troublesome pool coating maintenance, while making your pool completely watertight. Costly facility downtime is dramatically reduced as Natatec does not require periodic maintenance, patching, sealing or recoating. Natare's complete, custom engineered pool construction and renovation programs solve old pool problems and make new pools a reality.

Colors Available



Natatec PVC is available in three colors: white, sky blue (light blue), and Caribbean blue (dark blue). Black is offered for use in racing lanes, targets and other pool details. Custom logos and other details may be permanently applied using an overlay of a contrasting color membrane.

Materials

- **Type ND** - The basic lining material, available in rolls 72 inches in width by 82 feet in length. This durable pool lining is 60 mils thick. Type ND is a strong, yet flexible combination of high quality polyester fabric sandwiched between two layers of PVC.

- **Type NDP** - A slip-resistant material .067 inches thick, similar to type ND, type NDP is specially designed with an embossed surface. The embossing provides a comfortable, yet easily cleaned and slip-resistant surface for high traffic areas.

- **Type NGT** - A jet-black, embossed material designed exclusively for pool details, such as targets and racing lanes. NGT is approximately .05 inches thick. It is available in widths to meet NCAA, FINA or USS marking requirements.

- **Fleece** - An 11 ounce, 150-mil geotextile fleece separator is installed beneath the lining. This separator fleece is an extremely high quality, certified, geotextile fabric. This engineered fabric is very resistant to the freeze/thaw cycle, soil, chemicals and ultraviolet light exposure. An excellent surface for separation or isolation, this fabric has been used extensively for roadways, rail-beds, pond liner protection and drainage systems. Natatec fleece is unique in that it is guaranteed to be free of all foreign materials such as needles, bits of wire, etc., which could be potentially damaging to the completed lining.

- **PVC Coated Steel** - The PVC steel or stainless steel is hard-laminated with a layer of PVC laminated to one side, providing a total thickness of approximately 1/16th inch (20 gauge). Coated steel offers excellent corrosion resistance. This PVC coated steel is used to form edges, angles, corners or other transitions where a firm surface is necessary to weld the membrane. PVC coated steel is available in full sheets as well as conveniently formed angles and flat pieces.

  Standard sizes include: 1" x 2"
  PVC steel angle 10'-0" long with
  PVC on the inside or outside surface,
  and 2" flat PVC pieces, 10' long.

Galvanized / Stainless Steel Sheet - A twenty gauge, heavily galvanized or stainless steel sheet is also provided in several standard configurations. This steel sheet is used to form or reinforce edges, to serve as a protective barrier between tar joints, over holes or crevices, or virtually any area where extra heavy duty reinforcement, shaping or separation is required. The PVC is not connected to this sheet.

Twenty gauge galvanized or stainless steel is available in 48" x 120"

Design, Construction, Features and Benefits (Continued)

rectangular sheets or cut-to-fit sections. Other standard sizes include: 2" x 2" by 10' twenty gauge galvanized or stainless steel angle, and 6" x 10' twenty gauge galvanized or stainless steel sections.

Special configurations of both galvanized or stainless steel and PVC coated steel are available.

Step 1: Clean Surface and walls

Step 4: Apply compression strip around the perimeter of the pool walls on top of liner.

- **Fleece Separator Adhesive** - A special non-water soluble glue is used to attach the fleece separator to the pool wall or bottom. Standard practice is to apply this adhesive with a roller. A standard five gallon container will cover approximately 1,000 square feet.

Step 2: Apply adhesive and fleece to walls.

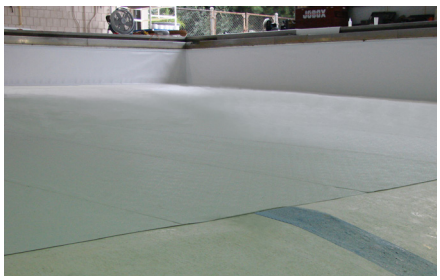
Step 5: Screw compression strip to walls to create a watertight seal.

- **Liquid PVC Edge Sealant** - Liquid PVC is a special sealing compound used to completely close the edge of the membrane material. It is applied to seal and finish the edge of a welded joint.

- **NataStat Microbiocide** - This specially formulated sanitizing agent is applied to the pool surface prior to installing the fleece or lining. NataStat kills fungus, mold spores and bacteria on the pool surface and prevents these organisms from growing under the finished lining.

NataStat is furnished in 32 ounce bottles. Each bottle will effectively treat 500 square feet when properly diluted with water and spray applied.

Step 3: Tack and weld liner panels onto walls.



Step 6: Weld liner to walls and floor.

Step 7: Weld target and inspect all seams.

- **Drive Rivets** - Rivets are used to affix the PVC steel or galvanized steel to the pool surface. One rivet is installed approximately every six inches. Rivets are easily installed by drilling a 3/16" diameter hole and inserting the rivet, which is firmly seated with a hammer blow. A variety of special fasteners are available for attaching or terminating our lining systems to virtually any substrate.

- **Compression Strip** – A two-piece slightly flexible extruded PVC strip consisting of a base section with anchoring holes and a snap-in cover strip. A compression strip is white in color and is used to make a water tight compression seal against a pool wall or floor. Compression strips comes in 10-ft sections.

In addition to the materials and components listed above, a complete selection of special sealing materials, flexible sealants, stainless, nylon and aluminum fasteners, separators and installation accessories are available.

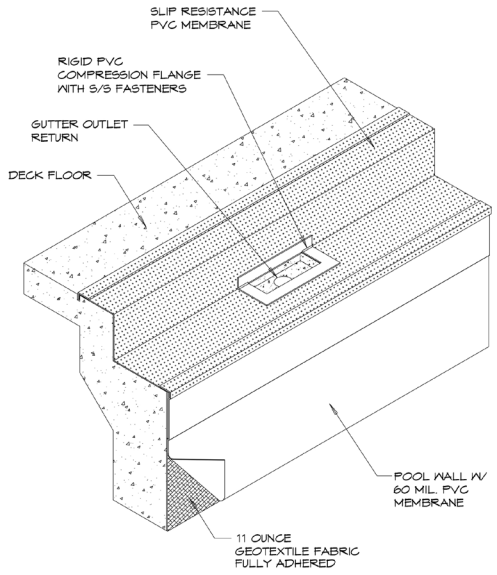
Natatec® PVC Lining Systems Technical Values

Description	Natatec ND is a heavy duty, flexible PVC material with a tough inner core of polyester supporting scrim, which combines UV stabilized PVC, premium coloration and highly durable plasticizers with a polyester supporting scrim. A durable, high damage-resistant lining material, Natatec ND includes special antimicrobial agents to resist microbial attack and staining. A topical coating of acrylic varnish is applied during the manufacturing process to provide additional protection against U.V. rays, stains, scratches, and biodegeneration. Natatec ND is available in a 60-mil fabric reinforced thickness.		
Application and uses	Natatec ND is typically used for new construction or renovation of public, commercial and institutional swimming pool and aquatic facilities. A wide variety of installation techniques are available to provide maximum design flexibility and membrane to result in a flexible and durable lining system.		
Advantages	Highly flexible, easily fabricated and UV-resistant. Excellent weathering. Quick installation. Absolutely waterproof. Chemically resistant. Economical and cost efficient. PVC formulations allow positive heat-welded seams. Reinforced construction.		
Colors	Typically light blue, dark blue or white with other colors available.		
Standard Sizes:	Typically 75 in. x 82 ft. roll (512.6 ft^2) / 1.905 x 25 M (47.63 m^2). Other roll widths available.		
Representative Technical Values (For 60-mil reinforced)	Property	Test Value	Test Method
	Thickness	60-mil (.060-inch/1.50mm)	ASTM D374C
	Specific gravity:	1.22 g/cc	ASTM D792/method A
	Yield tension:	MD 166 lbs/in - XD 160 lbs/in	ASTM D638
	Yield elongation:	MD 60% - XD 60%	ASTM D638
	Break tension:	MD 95 lbs/in - XD 90 lbs/in	ASTM D638
	Break elongation:	MD 110% - XD 104%	ASTM D638
	Secant modulus:	MD 1352 psi - XD 1125	ASTM D5323 (100%):
	Tear resistance:	MD 25 lb. - XD 24.7 lb.	ASTM D1004- Die C
	Low temp. brittleness:	-50°C – Pass	ASTM D1790
	Water absorption:	<0.78%	ASTM D570
	Puncture Resistance:	125 lbs	ASTM D4833
	Plu Adhesion	24 in/2in.	ASTM D413
	UV Resistance:	% change	ASTM D4355
	Tensile Strength @ Yield	MD -12% - XD –16%	ASTM G21-96
	Fungal and Bacteria Resistance	No growth, staining or discoloration	
	Resistance to Chemicals *(Cyanuric Acid, Sodium Dichloroisocyanurate, Trichloroisocyanuric acid, Calcium Hypochlorite, Sodium Hypochlorite with 12PPM solution)*	Excellent resistance	ASTM D543 Procedure 1 (73.4F) for 7 days

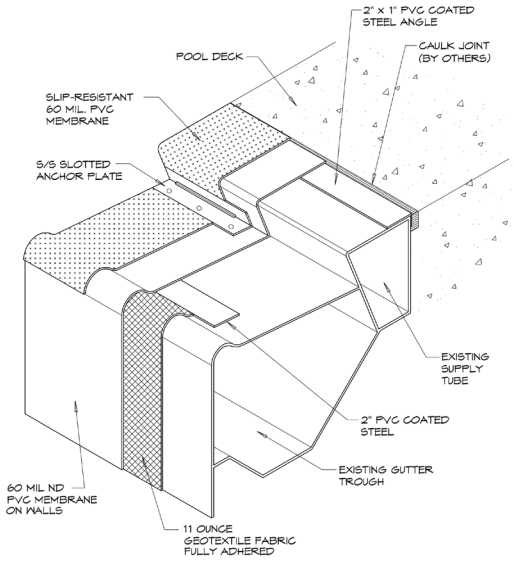
*MD = machine direction; XD = cross machine direction *Average values plus or minus 10%*

Natatec Typicals

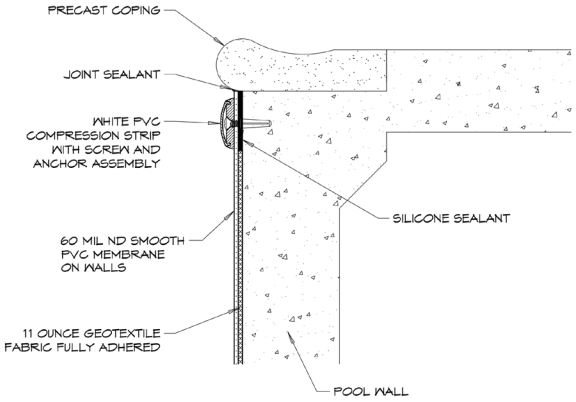
Typical Concrete Gutter Detail



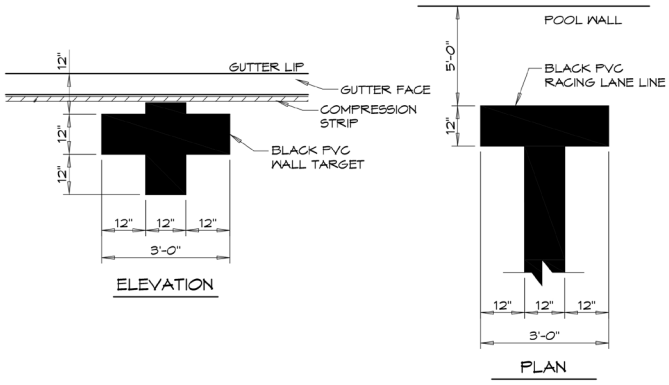
Typical Aluminum Gutter Detail



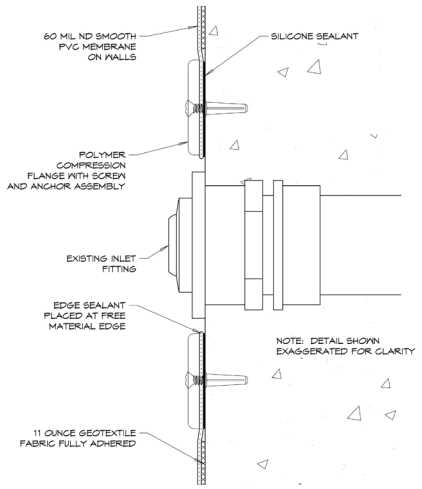
Typical Coping Stone Compression



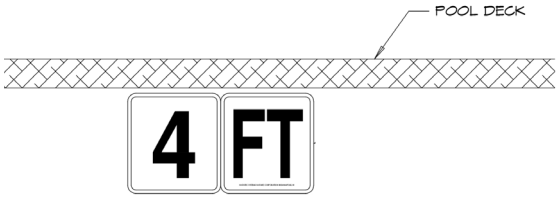
Typical Wall Target/Lane Line Detail



Typical Wall Inlet Detail



Typical Depth Marking Detail

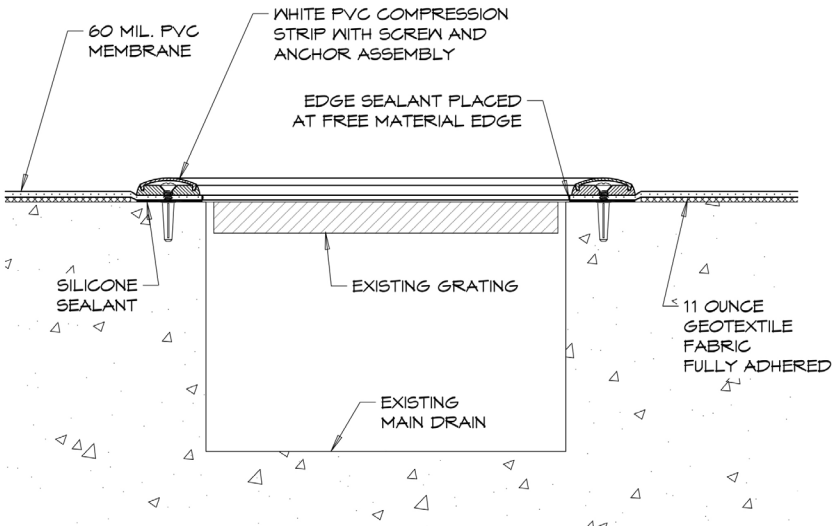


NOTES:
1. ALL NUMBERS TO BE 4" IN HEIGHT
2. ALL LETTERS TO BE 4" IN HEIGHT
3. ALL CHARACTERS TO BE BLACK ON LIGHT GRAY FLEXIBLE VINYL DEPTH MARKER PLATES

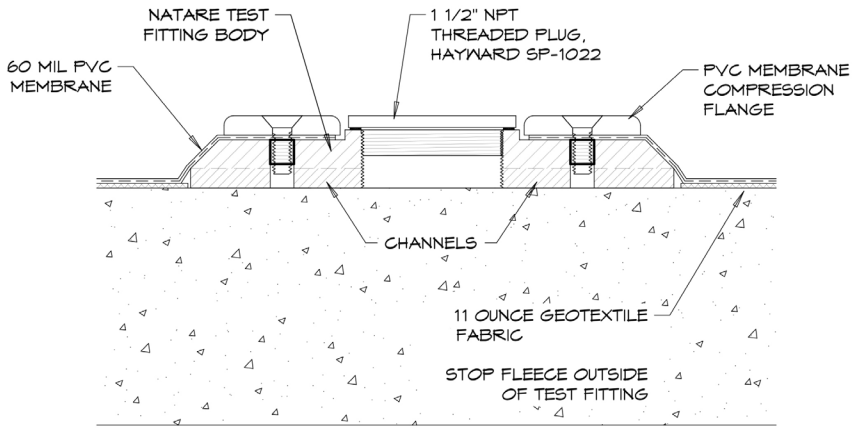
All details on these pages are exaggerated for clarity.

Natatec Typicals (Continued)

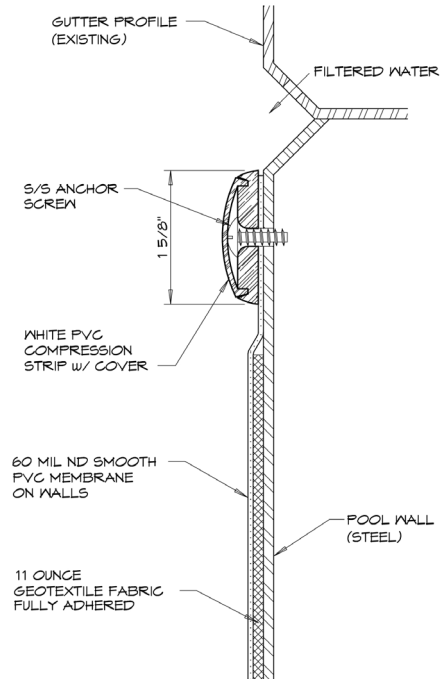
Typical Concrete Main Drain Detail



Typical Test Fitting Detail



Stainless Steel Gutter Termination



Underwater Membrane with Stainless Steel Gutter Termination

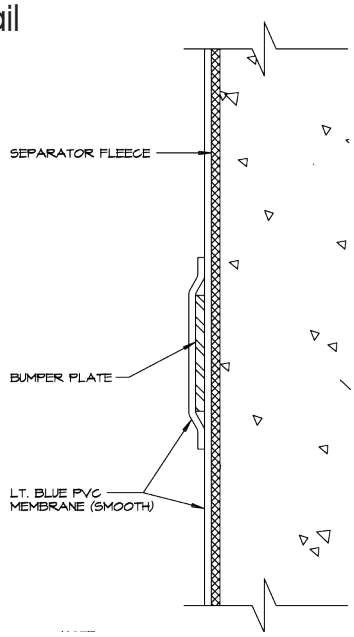
The PVC membrane shall be terminated below normal pool water level via the use of a 12 gauge T-304 stainless steel compression skirt which shall be continuously welded to the stainless steel gutter system. The compression skirt shall be fabricated as detailed and shall provide a uniform, smooth surface onto which the membrane shall be compressed.

The PVC membrane material and a silicone impregnated sponge gasket shall be compressed between a rigid PVC profile and the stainless steel compression skirt through the installation of 1/4-20 stainless steel screws located no greater than 3" O. C. around the entire pool perimeter. A semi-rigid PVC interlocking cover strip shall be furnished and installed over the completed termination to cover fasteners and to provide a smooth and uninterrupted surface.

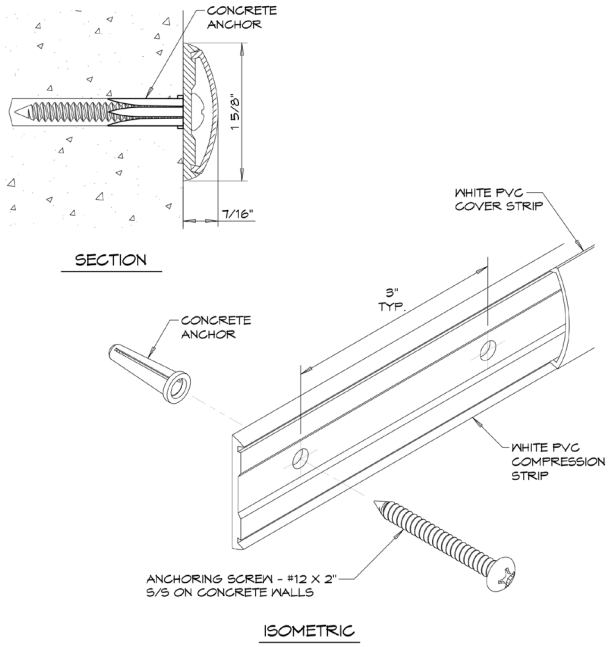
Only those systems utilizing a stainless steel compression skirt continuously welded to the stainless steel gutter system will be acceptable.

Natatec Typicals (Continued)

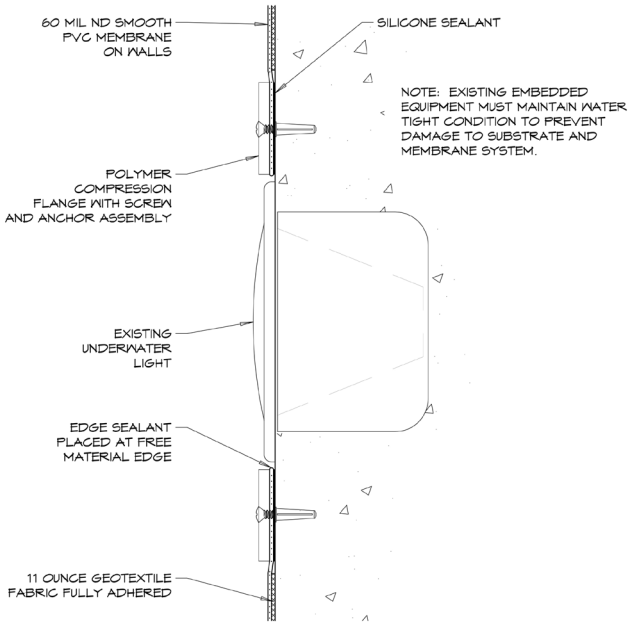
Typical Ladder Bumper Plate Detail



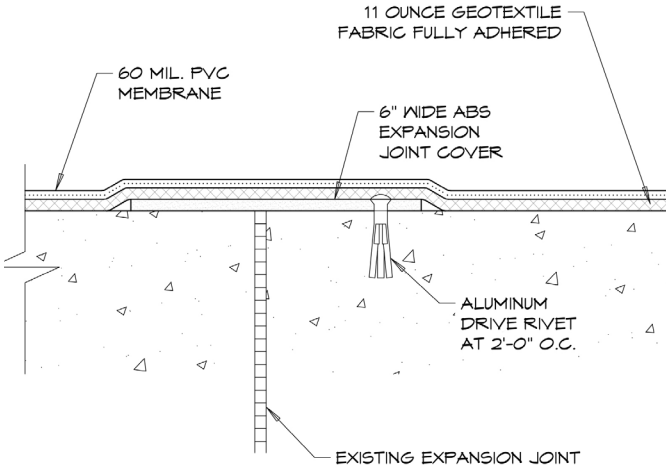
PVC Compression Strip Detail



Typical Underwater Light Detail



Typical Expansion Joint Detail



All Natare specifications are available on-line or on compact disk.

ASTM Testing - Why it Matters to Your Project

As one who is contemplating the installation of a swimming pool membrane lining system, we believe it is important to be aware of the critical need to establish proper performance specifications detailing the materials to be utilized as a part of your project.

Once such performance criteria is established, literal compliance with such specifications is a must. The only means by which a membrane product may be fairly and accurately specified is to establish strict specifications, based upon material test values as defined by ASTM and to demand that each and every bidder offer only products meeting or exceeding the specified test values.

While there is no standard that specifically defines what a swimming pool membrane should be, a collection of test values or standards has been compiled from an assortment of standardized ASTM tests. These tests allow comparison and measurement of swimming pool membrane materials by using established average test values from materials proven suitable on similar applications.

In construction and manufacturing, ASTM test values are utilized to assist manufacturers, suppliers, architects and engineers to specify and then to prove compliance on products ranging from concrete, lumber and steel to piping, bolts and wire. These ASTM specifications are utilized to establish a level of quality and anticipated service life. The reasons that these tests and standards are used in industry are exactly the same reasons that we believe ASTM test compliance should be a mandatory part of your pool membrane product selection criteria.

To demonstrate the importance of preparing proper specifications, based upon proven and accepted test criteria, we refer to the following individuals and their work pertaining to specifying geosynthetic materials.

In his article, *Specifying By Function*, which appeared in the January/February, 1991 issue of Geotechnical Fabrics Report, Ryan R. Berg stated that “Geosynthetic properties should be specified as minimum values, with assessment and acceptance criteria specifically addressed.”

Further Mr. Berg stated that “The intent of this specification is to insure that the geosynthetic(s) shall possess sufficient material properties and shall be installed correctly to function safely as designed, over the life of the structure.”

Also Mr. Berg wrote that “Only specific physical, mechanical and endurance properties that are relevant to the geosynthetic functioning as designed, over the design life, should be included. Then, insofar as is practicable, the properties specified should be measurable by standardized test methods.”

In his book *Designing With Geosynthetics,* Dr. Robert Koerner, Ph.D., P.E. describes design by specification, utilizing accepted standards, for geomembranes and geotextiles.

“Geotextile design by specification is very common and is used almost exclusively when dealing with public agencies. In this method (of specification) several categories of use are listed together with (their) critical properties (usually minimum values are listed). Those geotextiles available are then checked for their properties versus the recommended values in the specification.”

The performance specification provided for the Natatec™ Swimming Pool Membrane system contains a section referring to specific ASTM test criteria that any proposed membrane must meet or exceed to be considered for use. These test values were derived from product systems that have been proven successful in commercial and public swimming pool applications for more than thirty years.

To assist you in better understanding what an ASTM test is and why the particular tests listed have been selected, we have prepared the following.

ASTM (American Society of Testing Materials) is a body dedicated to developing manufacturing standards and standardized test methods for a variety of materials and methods. The primary purpose of ASTM is to provide industry with a benchmark by which practically any material or method may be universally measured and evaluated. ASTM tests and standards are primarily utilized to prove or demonstrate compliance with a specification.

1. Mechanical Properties: Measures items such as tear resistance, puncture resistance, break strength and break elongation. These tests are used to measure the anticipated performance of a material or resistance of a material to physical or mechanical damage.

Tests Commonly used for Mechanical Properties

Tensile Strength at Yield: Measures the maximum strength of a material at its initial failure point. (ASTM D638)

Tensile Strength at Break: Measures the maximum stress applied to the material at its breaking point.(ASTM D638)

Tear Resistance: Measures the resistance of a material to tearing forces. (ASTM D1004)

ASTM Testing (continued)

Puncture Resistance: Measures the resistance of a material to puncture forces. (ASTM D4833)

Secant Modulus: Measure of the stress/strain relationship of a material, i.e., measured strength of a material at a defined strain. (ASTM 5323)

Break Elongation: Measure of the ability of a material to elongate or stretch before failure. (ASTM D638)

Yield Elongation: Measure of the ability of a material to stretch or elongate before initial failure begins. (ASTM D638)

2. Physical Properties: Measures the physical properties of a material after manufacturing. The physical property tests measure items such as thickness, weight and specific gravity and provides a means by which manufacturing conformance may be proven.

Tests Commonly used for Physical Properties of a Membrane

Thickness: Measure of the thickness and uniformity of a plastic product. (ASTM D374C)

Specific Gravity: A measure of the density of a material, based upon the principle of the specific gravity being the weight of an object in air, divided by its weight in water. (ASTM D792/method A)

3. Durability Properties: Measures the long term anticipated performance of a material. These tests measure items such as water absorption, low temperature brittleness and UV resistance. Generally, durability testing is utilized to determine how a material will respond to adverse environmental conditions.

Tests Commonly used for Durability of a Membrane

Liquid Absorption: A measure of the amount of liquid that may be absorbed into a material. This provides one indication of a geomembrane materials' durability. This test measures the swelling of a material due to water migration and water absorbed by weight. Water absorption is an undesirable characteristic as such absorption may cause premature delamination and failure of the membrane material. (ASTM D570)

Low Temperature Brittleness:A measure of the maximum low temperature at which a material will fail, given repeated cycles of mechanical stresses. The test actually measures the quality of the plasticizers in the material and its flexibility at low temperatures. (ASTM D1790)

UV Resistance: A measure of the ability of a material to resist degradation due to exposure to ultraviolet light. This test measures the performance of a material in accelerated exposure to high levels of ultraviolet light. (ASTM D4355)

Manufacturers of substandard products or products which don't meet quality control standards simply don't like ASTM testing. Often, such manufacturers or suppliers will attempt to make a case that conformance with ASTM testing is not critical to evaluating a swimming pool membrane material. These arguments simply do not hold water. There are swimming pool membranes available on the market which claim to be as good as the product systems available from Natare. However, many of these products do not come with any verifiable evidence to support their claims of equality. Many PVC membrane products look alike in terms of thickness, color and texture, but none of these appearance factors provides any evidence of a materials' ability to survive in a swimming pool environment over an extended period of time.

The ASTM standards listed in the Natatec performance specification have been derived from the test results of a swimming pool membrane material with a proven track record of over thirty years of successful applications.

In other words, these tests reflect the characteristics of membrane materials which work in the long term. Beauty is only skin deep, but unfortunately, our industry has yet to develop a reference standard that defines, for all, exactly what a pool membrane is to be. By utilizing and adhering to the accepted ASTM standards, you are insured of receiving a membrane that meets or exceeds the mechanical, physical and durability properties of the swimming pool membrane system that literally set the standard.

Why Slips and Fall Occur

Quite simply, we really don't know. No two people are alike. Therefore, different strides, varying walking speeds, age, height and weight can greatly influence the potential for slips and falls. The type of flooring used – rubber, vinyl, carpet, ceramic tile, or other materials – will determine the resistance slips to varying degrees. Even shoe sole construction, the shape of the foot, body type and physical characteristics can make a difference. Obviously, certain activities enhance the possibility for slips and falls.

According to ASTM F 1637-95, the Standard Practice for Safe Walking Surfaces, slip resistance is defined as "the relative force that resists the tendency of the shoe or foot to slide along the walkway surface. Slip resistance is related to a combination of factors, including the walkway surface, the footwear bottom, and the presence of foreign material between them." In reality, friction between a person's bare foot or shoe sole and a walking surface is the phenomenon that can keep a person from slipping. But – friction can be easily lost. Unfortunately, swimming pools, bath tubs, showers, natural walks, and unimproved paths are beyond the scope of this Standard, according to ASTM.

THE STATIC COEFFICIENT OF FRICTION
The measurement to assess the slip resistance of any floor surface is called the Static Coefficient of Friction (SCOF). It measures the traction between a person's bare foot or shoe sole and the walking surface. It is used to determine the slip resistance of any floor surface. The American Society for Testing Materials (ASTM) currently sets the national standards for slip resistance. The two most common SCOF tests for flooring surfaces are ASTM D 2047 (resilient flooring) and ASTM D 1028 (ceramic or quarry tiles). The U.S. Department of Commerce requires a minimum SCOF of 0.5 according to test method ASTM D 2047, otherwise known as the James Slip Test. But, in the U.S. and all over the world, there continues to be debate about testing methods for slip resistance. Very few building codes specify slip-resistant floor surfaces. Specialists continually disagree about which slip testing method should be the standard, as many prove to be unreliable – particularly in wet testing. However, in the absence of a definitive Standard, Natare will continue to use compliance with ASTM D 1028 to establish a minimum for slip resistance in a swimming pool or aquatic environment.

SLIPS - F1637-95 Standard Practice for Safe Walking Surfaces

1. Scope

1.1 Scope -This practice covers design and construction guidelines and minimum maintenance criteria for new and existing buildings and structures. This practice is intended to provide reasonably safe walking surfaces for pedestrians wearing ordinary footwear. These guidelines may not be adequate for those with certain mobility impairments.

1.2 Application -This practice addresses elements along and in walkways including floors and walkway surfaces, sidewalks, short flight stairs, gratings, wheel stops, and speed bumps. Swimming pools, bath tubs, showers, natural walks, and unimproved paths are beyond the scope of this practice.

1.3 Conformance with this practice will not alleviate all hazards; however, conformance will reduce certain pedestrian risks.

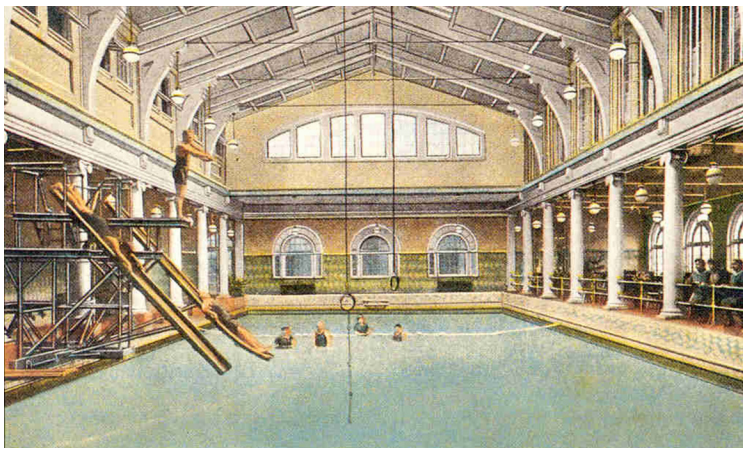
1.4 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.5 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

PVC Membrane Liner History

Industry Grows into a Global Network for Pool Construction and Renovation

Over 70 years ago, the spark of innovation combined with wartime technology to result in a product that has changed how pools and aquatic facilities are built and renovated worldwide. In a span of 45 years, the Polyvinyl chloride (PVC) membrane liner industry has grown from a single manufacturer in Germany to a global distribution network.



German Linoleum Works had been manufacturing linoleum, textile, and plastics since the 1800s. During World War II, they also began manufacturing rubber, plastic and PVC sheets to be used by the military for such things as drinking water transport. After the war, a decision was made to seek new markets for these products. Swimming pool liners and secondary water containment liners—often used for liquid transport—proved to be natural market choices PVC membranes.

A special PVC lining material was developed for these markets. It consisted of two sheets of PVC meshed together with a polyester core. This was thicker, stronger, and more durable and flexible than any previous lining material.

As the European swimming pool market grew during the 1960s, sales soared. A number of European manufacturers began incorporating PVC membrane technology in the fabrication and installation of residential swimming pool systems. This new technology soon became the favored means of constructing cost-effective, durable, and attractive back yard pools.

With over thousands of successful installations in Europe, news about this exciting innovative technology soon spread to the U.S.

Coming to America

During the 1980s, the people of Natare heard about the concept of PVC swimming pool membranes, and preliminary investigations led to cooperation to introduce PVC membrane linings to North America. At that time, Natare was one of the largest distributors of swimming pool goods and systems in the U.S. and had developed a number of unique product systems for the commercial and public swimming pool and water feature market.

“Our first thought was no, we didn’t think the U.S. market was ready for the product,” said Michael Walsh, of Natare Corporation. “The Germans were looking at the U.S. as a huge market because we have millions of swimming pools, and they saw us moving large quantities of the liner product. What the Germans didn’t understand was that there were several factors that would make the PVC membrane technology a tough sell in the U.S.”

The marketing of a PVC liner was expected to be difficult. Builders, consumers, and public officials already had preconceived negative ideas about vinyl liners as fairly inexpensive residential pool construction techniques. The second factor was the ‘throw-away culture’ of the U.S, where the life span of structures and facilities are measured in 10’s of years—not hundreds of years like in Europe. The cost of the PVC membrane lining system was expensive in residential applications, and most commercial operators were hesitant to trust their pool with a PVC liner. The only swimming pool lining systems in the U.S. at the time were found in residential pools and consisted of fairly thin, non-reinforced vinyl. Many of these had an image of being little more than heavy-grade trash bags.

However, Natare truly believed that a substantial need for PVC membrane lining technology existed in the U.S. for public and commercial pool renovation and construction. Thousands of older pools were in critical need of a cost-effective and long-lasting

solution, which would allow communities the opportunity to renovate their pool facilities at a cost, which was feasible in light of the limited recreation budgets of the 1980s. If the basic German concept of the PVC membrane lining system could be tailored to the particular needs of the U.S. market, and techniques were developed that would allow PVC membrane lining systems to be successfully installed in public and commercial pools, such systems could be the savior for deteriorating public and municipal pools.

During the fall of 1986, the concept of a PVC membrane to the U.S. public pool market during the National Recreation and Park Association conference. In the years that followed, the original concept of using a PVC membrane lining has evolved into Natare's complete system of products and techniques for renovating and constructing swimming pool facilities.

Overcoming misconceptions

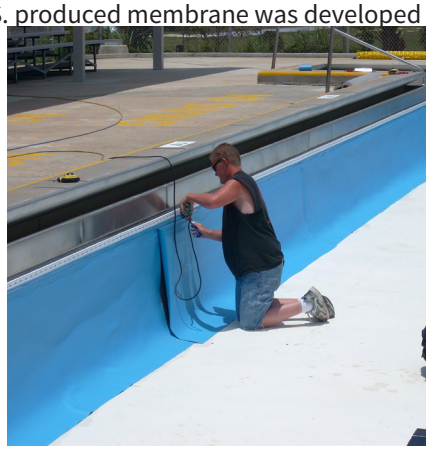
The original introduction of PVC membrane lining systems met with tremendous skepticism, and the first marketing task was to try to differentiate between thin, residential grade 20 mil vinyl liners that had fueled the expansion of inexpensive backyard swimming pools and 60 mil PVC membrane liners. Those first few installations were for facilities faced with the prospect of closing or finding some other way to fix their pools on very limited budgets. The first few customers were trying it on blind faith and in desperation!

The first installation of a PVC membrane was scheduled for the spring of 1987, using German-supplied material, for the renovation of a 50-meter outdoor pool in Lebanon, Indiana. The Lebanon City pool had experienced massive deterioration, concrete cracking, and leaks that required the output of a large well running continuously to maintain water in the pool. Faced with renovation costs that far exceeded the capital budget of the City and facing the prospect of closing the only City pool in Lebanon, the Lebanon pool was an ideal candidate for the PVC lining system.

With the advent of the Lebanon installation and the trust of a few other large, municipal pool facilities, the introduction PVC lining systems was well underway. The Lebanon pool installation was completed successfully and, for the first time in years, that community enjoyed a pool with clean and warm water. The Lebanon project and its success served as a show place for demonstrating the effectiveness of PVC pool linings. What began as a single project in early 1987 lead to approximately 10-12 additional installations later that summer, and then to a steady stream of projects around the U.S. By the turn of the century, thousands of installations are completed each year around world by Natare Corporation, their network of builders/distributors, and others in the PVC membrane lining industry.

The market emerges

During 1989, two separate events restructured the PVC membrane liner industry in the U.S. Two other European firms and two U.S. competitors entered the domestic U.S. market, and the Buy American Act was being enforced on federally funded projects. The Act required that only American-manufactured products be used on such projects, particularly military and various Federal projects. While Natare continued to import PVC material from Germany, a high-quality U.S. produced membrane was developed to comply with the Buy American Act and compete with other locally produced materials. A new U.S. PVC membrane material was developed, and today is known as Natatec, which is the primary material used throughout North America for PVC pool lining systems.



Since that time, Natare has continued to develop the technology for PVC membrane lining systems and currently provides a full range of swimming pool products, including the Natatec PVC membrane system, for swimming pool, water feature and containment uses, and distributes these products throughout the world.

With the success of the original installations and the need for cost-effective solutions for similarly challenged public and commercial pools, the Natatec PVC membrane system became recognized as the perfect solution for repairing or renovating older or damaged

PVC Membrane Liner History (Continued)

pools. Since the system can be installed over virtually any existing material, very little preparation work was required other than draining and lightly cleaning the pool. Simple surface patching and leveling is often all that is needed, and the membrane can be installed directly over existing tile, plaster or other pool surfaces. Even deteriorating aluminum swimming pools and failed installations of fiberglass coatings could easily be cured at a fraction of the costs involved with other renovation methods or replacement costs. When completed, the Natatec PVC membrane lining system provides a water tight, flexible PVC shell within the pool shell. Custom fit and hot air welded on-site, Natatec membrane systems can be installed in virtually any pool.

The success of the Natatec system lay in its simplicity. By taking a blanket of heavy, reinforced PVC material and custom tailoring a lining to the contours of the pool interior, it is possible to cost effectively and permanently make even the worst pools attractive, leak proof and easily maintained. After 26 years and thousands of successful installations, Natatec PVC membranes have been demonstrated to work where others fail. Cracked and leaking pool shells, shifting or moving expansion joints, even failing plaster or fiberglass are quickly and permanently cured with the Natatec swimming pool membranes. Permanent, cost effective renovations are possible for any pool, and there are no paint, plaster, or interior coatings to fail.

The advent of the Natatec PVC membrane system has also allowed older pools to be re-configured to meet current requirements for increased depth, more shallow water, even a complete rearrangement of the pool length and width. Changes to the depth, shape, slope or design of a pool that was once a major undertaking (and often prohibitively expensive) could now be accomplished because the Natatec PVC membrane lining system could provides a watertight, flexible PVC shell within the pool structure. Even pool main drains could be replaced or increased to support code requirements and higher turnover requirements.

Throughout North America., Natatec PVC membrane systems have been used to renovate and refurbish even the largest public, municipal, and institutional pools. Renovation of city, county and state parks and recreation facilities with PVC membrane systems has now become the standard, with such systems having become the choice for eliminating replacing paint, plaster, or fiberglass because of longevity, durability and the leak proof capabilities. Military swimming pools and training facilities now make extensive use of PVC membrane systems as do many health and fitness facilities. The educational community has adopted PVC membrane lining systems for both competitive and recreational pools in the schools with numerous high school and collegiate installation, with major university projects utilizing Natatec PVC membrane systems.

In high-rise construction, whether for hotels, apartments, or condominiums, absolute watertight construction is a necessity. Natatec PVC membrane systems have been used to ensure that both existing and new elevated (above-ground) pools, whether on rooftops or suspended in the structure of a building, are absolutely watertight. In fact, one of the largest elevated pools in the world is the upper floor of a major floating casino in Mississippi. The Natatec PVC membrane system ensures that the several hundred thousand gallons of water hanging over the gambler's heads stays where it belongs.

Natatec PVC Membrane Systems tackle the toughest challenges

The City of Chicago operates dozens of public swimming pools. By early spring of 2012, many of these pools had deteriorated to an extent that the continued use was questionable, and it appeared that many of the most popular and heavily used outdoor pools would not open for the season. After much research of potential solutions, the Chicago Park Department turned to Natare and their local Chicago area Builder/Distributor in a last-ditch effort to restore the worst of their outdoor pools to a useable condition. Contracts for 18 of the worst pools were awarded by late spring, and the renovated and watertight pools were able to be opened to the public by late June. After a successful 2012 and 2013 swimming season, the Chicago Parks pools are a demonstration of the cost efficiency and effectiveness of the Natatec PVC membrane system.

PVC Membrane systems are not just for renovation

With the success in the renovation market, more and more pool designers and contractors have realized that a Natatec pool lining guarantees years and years of attractive, leak proof service in new construction. In fact, the Natatec PVC membrane system lets the pool designer or contractor take advantage of the strength of concrete construction while eliminating the difficulty in making pools watertight.

Today, a Natatec PVC membrane system with is often combined with package pool components, concrete block construction, modular steel and stainless steel pool systems and even wood wall pools to construct even the largest public or commercial pools quickly using cost effective, readily available materials. The Natatec PVC lining membrane provides the attractive watertight interior finish and allows unparalleled freedom in design and material selection.

Natatec membrane systems aren't just for pools. Virtually any structure or construction can be made virtually waterproof, watertight, and easy to maintain. Whether for decorative ponds or landscaping, water containment applications or any application where keeping water in or out is important, Natatec membrane provides cost effective, permanent solutions.

In most instances where Natatec PVC membrane systems are used, total project costs are very reasonable when compared to the cost of other renovation programs or new construction systems. Not only does the Natatec PVC membrane lining system compete favorably with other pool interior systems, the unique combination of flexible, strong and watertight construction allow the use of less expensive construction methods or materials in pool construction and renovation. Additionally, a 10-year warranty is provided with the Natatec system, and such extended guarantees are unheard of with other pool interior systems.

PVC membrane lining systems around the world

With the success of Natare Natatec PVC lining systems in the North America and Europe, other countries have begun to adopt the PVC membrane system for pool construction and renovation although each has different applications and swimming pool construction needs.

Since the first successful installation of a PVC lining system in Indiana, Natatec PVC membrane systems are the standard for pool renovation throughout North America from the North Slope of Alaska to the resorts of costal Mexico. Natatec PVC pool systems and materials are now supplied from the U.S. to Europe and are used for successful swimming pool and water feature construction and renovation around the world, from New Zealand to Australia to Hong Kong, Siberia to Moscow, and Spain to England.

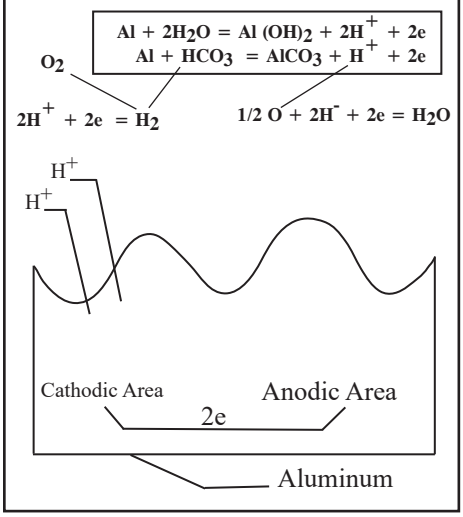
Corrosion Control in Aluminum Swimming Pools

Swimming pools, like other forms of construction, are important long-term investments. We expect pools to still be in top condition after five, ten or even twenty years of service. Due to the corrosive nature of the swimming pool environment and the general lack of corrosion resistance in many of the construction materials used, pools often fail to deliver the quality and durability expected for the investment they require. In the case of aluminum pools, many, after only a few years, face extensive maintenance, service and repair.

Evidence of corrosion can occur as rust stains, corroding chrome, discoloration of underwater light face plates, galvanic attack of piping and leaks in filter lines. Early signs of corrosion in aluminum pools include peeling or flaking paint, small circular pits in the metal surface, or a white deposit on the metal. Metals respond to corrosive attack in a number of different ways. General tarnishing or rusting, localized corrosion at the junction of two different metals or an overall deterioration of the entire pool is now becoming common. It is impossible to predict the overall corrosive effect of swimming pool water on aluminum alloys from simple water analysis, nor will an in-depth evaluation of the pool water provide a reliable answer.

Corrosion is basically an electro-chemical reaction. Electricity flows between metal(s) through water, the conducting solution. Swimming pool water with exceptionally high levels of chemicals, large amounts of total dissolved solids and widely varying pH levels is often an ideal conducting solution. Deterioration (corrosion) occurs when the current leaves the metal and enters the conducting solution. The area at which the current leaves the metal is called the “anode.” The point at which the current returns to the metal is called the “cathode.” The anode and the cathode may be from two different metals, or different locations on the same piece of metal (see figure 1).

Figure 1
Corrosion Cell on Surface of Aluminum in Water



Differences in voltage (potential) surrounding the anode and cathode cause a current to flow between them. This flow of electrons or current causes corrosive damage to pool structures. Anode-cathode relationships form on the opposite faces of metals when exposed to solutions of varying pH.

The corrosion of metals in water can be likened to a dry cell battery. Two metals or different sections of the same metal are separated from each other by an electrolyte (a solution which conducts electricity, such as pool water). Each metal undergoes chemical reactions and based upon their unique characteristics one becomes the cathode and the other the anode. Electrical energy is generated by these reactions and the flow of current occurs between the cathode and the anode. The anode will deteriorate and corrode while the cathode is considered to be protected and will not corrode.

Forms of corrosion are classified into several categories. Many common types of corrosive conditions will occur simultaneously. The following paragraphs outline some of the problems aluminum pools must face. *Remember, these corrosive effects are not limited to aluminum pools.

The basic form of swimming pool corrosion is uniform attack. This form of corrosion occurs as a general wasting away of the pool's surface. As a result of this process, a bi-product forms a protective layer on the metal. The protective layer slows the corrosion process. In aluminum swimming pools, the corrosion bi-product is often water soluble; it constantly dissolves, leaving the surface unprotected. Thus, the corrosion proceeds at an even greater rate.

When the surface of the metal(s) breaks down in specific areas, a localized form of corrosion called pitting occurs. This process is started when an opening develops in the corrosion bi-product on the metal surface. This opening acts as an anode, while the remainder of the surface becomes a cathode.

Typical swimming pool water causes localized breakdowns of the surface metal(s) associated with pitting corrosion.

Galvanic or bimetallic corrosion, the contact of dissimilar metals and alloys, is a common and persistent form of corrosion in swimming pool systems. This corrosion is characterized by an accelerated rate of deterioration for one metal and protection for the other(s). A galvanic corrosion attack causes rapid corrosion.

Each metal has a different likelihood of corrosion, those with the greatest tendency to corrode are considered anodic or prone to corrosion. Those which are the least likely to corrode are considered cathodic or protected. The relative behavior of different metals may be predicted from the "galvanic series of metals." The series is a table that ranks metals from the most likely to corrode to the most protected or non-corrosive.

In general, the coupling of two metals in the galvanic series (see figure 2) will result in accelerated corrosion of the metal higher in the series. The effect of these requirements places importance on the series. The series predicts which metals are safe to use in conjunction with each other, and indicates which metals will produce strong, or weak, galvanic corrosion.

Galvanic corrosion is sometimes used as an attempt to protect aluminum pools. "Sacrificial" magnesium anodes are used in the hope that they will be attacked and leave the aluminum protected. Although this method is somewhat effective, it will not solve long-term problems.

Figure 2

Galvanic Series of Metals

Corroded (anodic or least noble)	
Magnesium	Zinc
Aluminum	Mild Steel
Cast Iron	Lead
Tin	Brass
Copper	Bronze
Silver	Gold
Platinum	
Stainless Steel (passive)	
Protected (cathodic or most noble)	

The galvanic effect or the deterioration of metals is often confused with electrolysis or stray current corrosion. In galvanic corrosion, a flow of current occurs between dissimilar metals or between different area on the same metal where the anodic or least protected corrodes.

During electrolysis, a stray DC current flows from an external source through the metal, causing a current to enter the pool water and carry metal ions. Stray currents come from a number of sources and it is virtually impossible to determine where the current enters and leaves the pool structure.

Corrosion Control

It is difficult to define the exact cause of corrosion in a swimming pool environment. Efforts to suppress or retard the anodic reaction are only occasionally successful in protecting the metal structure. Two different options, chemical monitoring and protective coverings, are available to extend the life of an aluminum pool. The effect of these procedures can not be absolutely predicted, but these procedures can greatly extend the life of aluminum swimming facilities.

Water Chemistry

Many factors of water chemistry accelerate the corrosion rate in aluminum swimming pools. The control of chlorine levels, pH levels, total alkalinity and dissolved solids is directly proportional to the control of corrosion. To keep corrosion under control through chemical monitoring, the following is suggested.

First, complete testing of the pool water must be done to determine the chemical make-up and necessary treatment needed to bring water chemistry values to acceptable levels. Second, a maintenance program must be developed to continue controlling the chemical balance. Third, installation of an automatic water treatment control center to monitor and make appropriate adjustments to chlorine and pH levels is suggested. Finally, the elimination of chlorides or halides through the use of a primary sanitation system such as ozone will become necessary.

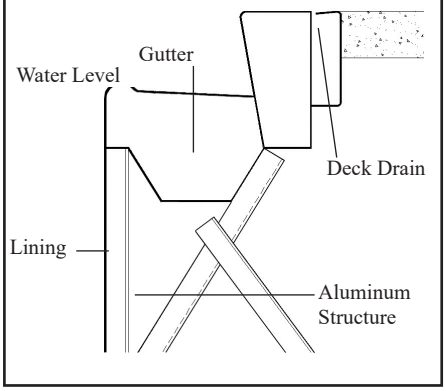
Protective Coatings

Aluminum swimming pools are commonly painted with solventized paint products, such as chlorinated rubber based pool paint. The resulting paint film is very porous and does little to prevent contact between pool water and the aluminum pool shell. While these paint systems help to improve the aesthetic appearance of the aluminum pool, they do little to prevent corrosion. In some cases, the paint film can actually encourage certain forms of corrosive damage.

It is suggested that the Natatec Membrane System, a fabric-reinforced blanket of soft PVC, be utilized to provide a new surface lining for aluminum pools. The membrane is a thick, flexible blanket of PVC with a strong inner core of spunbond mesh fabric. The smooth, poreless surface eliminates pitting, corrosion and makes cleaning simple and inexpensive. Pool maintenance is greatly reduced or virtually eliminated. Expensive reconstruction, waterproofing and renewal of protective coatings are eliminated because the Natatec covers pin holes and other defects with its thick, tough and watertight blanket. Its neutral surface lowers chemical consumption needed to maintain water stability and ends chemical concentration and electrolysis problems. The membrane's versatility and durability can turn deteriorated swimming pools into profitable, long-term investments.

The Natatec Membrane System's unique installation system is ideal for all types of swimming pools. Previously difficult installations become possible. Unlike conventional protective coatings, the membrane can be installed in a short period of time and in a variety of climates and temperatures. The sheets are heat welded to produce a watertight pool that will stay that way.

Typical Aluminum Pool Wall Section **Figure 3**



Over 70,000 wear-tested PVC installations worldwide, some over 30 years old, prove the Natatec Membrane System to be the right pool coating choice. This fact indicates that the membrane reduces construction and renovation costs, limits maintenance and chemical usage and dramatically increases the usefulness of swimming pool facilities.

The corrosion control remedies outlined should prove effective and add substantial life expectancy to aluminum swimming pools. The best ways of controlling and preventing corrosion are sound engineering design and the proper selection of corrosive resistant materials. (Analysis has shown that aluminum swimming pools are not corrosion resistant.)

It must be realized that corrosion occurs at a fairly rapid rate in many aluminum pools. If preventative steps are not taken immediately, it can be safely assumed that these facilities will be unusable in the near future. The Natatec Membrane System can correct extensive damage already present, or prevent corrosive damage from occurring.

Using Fiberglass as a Swimming Pool Coating System

For the past several years, field applied fiberglass has been promoted as a repair or renovation coating system for swimming pools. While the uninitiated may view fiberglass as an ideal product for use as a swimming pool coating, even cursory investigation will demonstrate that fiberglass is not viable for pool renovation or repair. Quite simply, the proposed "cure" is far worse than the illness.

The purpose of this report is to provide the information necessary to make an accurate, educated evaluation of fiberglass swimming pool coatings.

The term "fiberglass" is generally considered to describe conventional FRP (Fiber Reinforced Polyester) resin systems, also referred to as GRP (Glass Reinforced Polyester).

This product is produced by combining glass fibers, within random strands or woven into a flat mat (woven roven) with a polyester or plastic resin. When cured, this gelatious mat results in a rigid, reinforced product. To produce an acceptable finish on the fiberglass surface, a paint-like material called gel-coat is used to provide a semi-gloss or glossy surface in the desired color, typically white. Combinations of resin and glass are also molded under high heat and pressure to form stable shapes.

The potentially corrosion-resistant characteristics of polyester resin systems have long been recognized. For that reason, fiberglass has been used to produce a wide variety of industrial and construction related products such as bath tubs, shower enclosures, storage tanks and spa tubs.

During the 1960s and 1970s, many manufacturers experimented with FRP resin systems finished with a variety of gel-coat products. Many of the products once manufactured of gel-coat fiberglass have been abandoned due to the deficiencies identified in fiberglass of this type. They are now manufactured using molded acrylic sheets with fiberglass reinforcements.

"Fiberglass" spas, pool wall systems and other pool products are examples of this learning process and evaluation. In short, these manufacturers found that gel-coated fiberglass is not suitable for prolonged contact with water.

To utilize fiberglass as a field applied system for pool renovation or repairs, the fiberglass is applied using randomly placed (chopped) glass fibers which are mixed with the polyester resin and sprayed upon the pool surfaces. Unfortunately, the limitation of field application force the installer to use those procedures found to be most prone to failure by fiberglass producers worldwide.
Numerous problems become apparent only when fiberglass is applied as a pool coating. These problems begin with the surface preparation process and continue throughout the installation. The following comments are intended to define and clarify a few of the more common problems associated with field applied fiberglass systems.

Surface Preparation

Fiberglass, as with any coating that needs to adhere to the pool shell, requires a great deal of surface preparation prior to application. Unfortunately, the very low bond strength of the polyester resin system gives rise to great concern with the cleanliness of the surface. When fiberglass is applied, the pool shell must be sandblasted until all previous coatings are absolutely and completely removed. Sandblasting is essential to provide a surface that is totally free of incompatible previous coatings and to provide a surface profile that will allow adherence of the resin to the pool shell.

In addition to sandblasting and grinding rough areas—filling spalled areas, repairing cracks and removing expansion joints is required as part of the substrate or surface preparation.

The success or failure of a fiberglass application relies greatly on the surface preparation. The inherently low bonding strength of fiberglass means that delamination or detachment from the application surface is not simply a concern, but a reality. The fiberglass surfacing must be applied thick enough and with enough individual fiber reinforcement, to produce a structurally stable section. In short, the application process attempts to create a fiberglass "baggie" in the pool because a continuing bond to the pool surface cannot be expected or anticipated.

Fiberglass Application - Mixing and Installation Concerns

The field application of a fiberglass coating requires a variety of factors to be absolutely perfect to obtain successful results. A chemical reaction must take place in order for the fiberglass to cure properly. Variables such as temperature, relative humidity, substrate temperature, resin to catalyst ratio and many other factors affect the chances of the proper reaction occurring. Should even one or more of these variables be less than ideal, the potential for an unsuccessful reaction is present. This results in a coating that is subject to premature delamination and failure.

The environmental and formulation requirements of fiberglass have been a problem for the producers of fiberglass products since their inception. Product manufacturers have taken great pains to attempt to control the environmental factors which affect the fiberglass curing process. Even with state-of-the-art production in controlled environments, 100% success with fiberglass application is virtually unheard of.

Obviously, the field application of fiberglass in conditions which are absolutely uncontrollable is simply inviting disaster. Field applied fiberglass results in a pool coating which is of inconsistent thickness. Many fiberglass applicators promote their pool coatings as being of uniform thickness with the coating being 1/8" to 1/4" thick overall. Controlling the application thickness of fiberglass in the field is virtually impossible. An average coating thickness of approximately 1/4" to 1/8" may sound reasonable, but in any given installation there will be significant variations in the thickness of the coating. Many areas may be applied much thinner than is acceptable. These inconsistencies in application tolerances result in a coating with areas having greatly reduced tensile strength. This quickly leads to early delamination, stress cracking and rapid failure.

The bond strength of fiberglass to the substrate averages 120 PSI, as compared with the typical epoxy paint bond strengths of approximately 500 PSI. Regardless of the quality of resins used or the extent of the substrate preparation, the potential for delamination from the pool surface is high.

Additionally, the expansion coefficient of the fiberglass coating and most pool surfaces differ greatly. As a result of this, the pool shell and the fiberglass coating are expanding and contracting at different rates, thus accelerating delamination from the shell.

Resins and Treated Water

The FRP resins utilized in fiberglass systems are incompatible with many of the swimming pool water treatment and maintenance chemicals currently in use. In fact, many producers of these resins specifically disclaim the suitability or prohibit the use of their resins when in contact with chlorine. The gel-coat used as a finish coating on the fiberglass does somewhat reduce the degree of chemical attack on the FRP resins. However, all gel-coated surfaces are porous and will allow the chemically treated swimming pool water to penetrate to the resin and begin deterioration.

Leaching and Capillary Action

Field applied fiberglass gains its strength from randomly oriented strands of fiberglass, many ending up perpendicular to the final surface. Each perpendicular fiber creates an open conduit, connecting the resin systems with pool water. Any glass fibers which were not fully encapsulated by resin and gel-coat will provide a pathway for chemically treated water to enter the fiberglass resin composite through capillary action to accelerate the deterioration process. The reaction between pool water and the fiberglass produces gases which then cause black blisters which bleed an objectionable fluid toward pool side. This condition is commonly referred to as "cobalting"

Environmental and Health Hazards

Exposed fiberglass strands, whether from the break down of the gel-coat or from the inherent inability of the gel-coat to seal the pool surface, have been demonstrated to be a primary factor in a variety of skin disorders, described under the broad terms of “Contact Dermatitis”. This irritation, coupled with the ever present bacteria in a swimming pool environment can cause serious skin infections. Additionally, the rapid breakdown of the fiberglass surface releases thousands of minute strands of fiberglass into the pool water where they are imbedded into the skin or ingested into the lungs and esophageal tract.

Both conditions produce disorders similar to those experienced from improper handling of fiberglass insulation.

Hazardous Materials Exposure

The EPA has established a maximum contaminant level for styrene of .005 MG/L (.005 PPM) (5.0 PPB). Styrene is one of the principal components of fiberglass resin systems and is slowly “leached” into pool water by the breakdown of the resin system. The process is greatly accelerated through the varying pH levels and chlorine concentrations commonly encountered in a pool environment.

Further Findings

In attempting to research the long-term performance of fiberglass structures we learned that little verifiable information, research data, or engineering analysis was available relating to this subject. To that extent, we have determined that one of the most common structural applications for fiberglass is in underground storage tanks.

Very little specific data is available relative to the use of fiberglass as a pool coating. In an attempt to gather accurate and objective information to predict the long-term suitability of fiberglass in a pool environment, the similarity to fiberglass storage tanks are striking. Even though fiberglass storage tanks are produced “in plant” under closely controlled conditions, there is currently much concern and debate centered around the installation and long term risks associated with fiberglass underground storage tanks (UST’s).

A number of federal and state agencies are actively involved in research, and are conducting hearings relative to fiberglass structures. We believe that many of the conclusions reached with regard to fiberglass storage tanks directly relates to fiberglass when utilized as a pool coating.

Dr. Roderick Wallace submitted a report in testimony before the Environmental Protection Agency during regulatory hearings in Washington D. C., titled, *Serious Environmental Concerns Regarding Fiberglass-Reinforced Plastic Underground Storage Tanks: The MGM Grand Hotel Effect.* In this report, Dr. Wallace has identified many of the concerns relative to the suitability of fiberglass structures as containment vessels.

In summary, Dr. Wallace’s findings substantiate the wildly held theory that fiberglass, when used as a pool coating, is subject to cracking and rapid failure.

The application of fiberglass as a pool coating or lining is not a viable long-term solution. The difficulty in controlling the many variables which can adversely affect the performance of the fiberglass application and the minimal suitability of the product for swimming pool use should reasonably preclude field applied fiberglass from being considered for any pool project. Long-term safety and environmental issues could expose pool patrons to significant risks, even in the best controlled installation.

Using Fiberglass as a Swimming Pool Coating System (continued)

Key Concerns of Field Applied Fiberglass Pool Coating

1. *Substrate Preparation:* Absolute perfection is required to achieve even temporarily satisfactory results.

2. *Application:* Environmental conditions and application ratios must be near perfect to achieve desired results.

3. *Adhesion:* FRP resins are not intended to act as adhesives, thus delamination of the fiberglass from the substrate is to be expected.

4. *Suitability of product for pool use*: Simply stated, fiberglass is not intended for use in long-term exposure to or containment of treated swimming pool water. Exposure to styrene being leached into the pool water exposes pool users to health risks. Exposed and suspended glass fibers may cause skin infection in pool users.

Natatec® Swimming Pool Membrane System

The problems which plague fiberglass pool coatings are eliminated with the Natatec Swimming Pool Membrane System. Natatec membrane is a fabric supported PVC material specifically designed and formulated for use in commercial swimming pools. The Natatec System will provide you with swimming pools that are completely watertight, attractive, extremely long lasting and virtually maintenance free.

The Material

The Natatec membrane is a PVC material, which is manufactured by fully encapsulating a layer of polyester mesh between two layers of PVC. The Natatec material is formulated with an anti microbial agent which deters the growth of bacteria and algae. Natatec is UV stable (resistant to degradation from exposure to sunlight).

Natatec is a manufactured product and is delivered to the project site in its finished state. The problems associated with consistency and uniformity are virtually non-existent.

Surface Preparation

Surface preparation for the installation of Natatec is minimal. Since the Natatec membrane is mechanically fastened to the substrate rather than adhered, sandblasting and grinding are not required.

A soft, thick layer of 100% polyester fleece material separates the Natatec membrane from the pool shell, protecting the material from incompatible previous coatings and minimizing minor surface irregularities. Specially designed and fabricated PVC coated steel is mechanically fastened to the pool shell around the upper perimeter, at steps and at sharp transitions. The Natatec is then hot air welded to the coated steel. This provides a pool coating that cannot possibly peel, flake, crack or delaminate from the substrate.

Application

The Natatec material is delivered to the job site in rolls, each roll manufactured and quality checked to insure adherence to exacting standards. The material is cut to fit and welded on site to insure you of a pool coating that is completely watertight, attractive and long lasting. Additionally, Natatec's flexibility completely eliminates concerns with cracking and delaminating.
Environmental conditions, temperature, humidity etc. are not concerns with the installation of Natatec™. The hot air welding process and mechanical fastening techniques may be successfully completed in almost any weather. Black Natatec NGT is used to permanently apply lane markings, targets

Natatec PVC Pool Lining System Specification

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provision of the Notice to Bidders, Instructions to Bidders, Proposals, General Conditions, Supplementary Conditions, General Requirements, related Sections and other Divisions of these documents if used as part of this project are included as a part of this Section as though bound herein.

1.2 SUMMARY

A. It is the intent of this specification to describe the installation of a complete reinforced PVC membrane lining system specifically designed and formulated for use in swimming pools. The system shall consist of two layers of flexible PVC totally encapsulating a polyester inner reinforcement in combination with required accessory items to complete the installation. The sections of material shall be fuse bonded together at the site to form a watertight continuous membrane lining. The system shall be installed in accordance with the configuration as detailed on the drawings, including all necessary equipment within this specification. Individual rolls of reinforced PVC membrane shall be custom fitted and welded together at the job site using hot air welding techniques. Upon completion, the system shall provide a waterproof, yet flexible membrane, complete with all necessary fittings, attachments, flange transitions and markings.

B. The performance characteristics and installation qualifications as established herein reflect the minimum requirements for any membrane system to be utilized on this project. Systems not meeting the minimum requirements established for this project will not be considered.

C. This specification includes, but is not limited to, the following components:

D. Flexible PVC membrane

E. Slip-resistant reinforced PVC membrane

F. Separator fleece

G. PVC steel edging & sheets

H. Galvanized, Polymer and/or Stainless Steel edging & sheets

I. Sanitizing agents

J. Transition flanges

K. Edge sealants

L. Adhesives

M. Refer to Section _____, Alternates, for alternates that may affect the Work of this Section.

N. This Specification describes Natatec® PVC Membrane Lining System as illustrated by the drawings. Should the requirements of this specification contradict any other section of the project specifications, this section shall govern.

1.3 Scope of Work:

A. Work Included: The work specified herein and as indicated on the drawings includes, but is not necessarily limited to, furnishing all the labor, materials, equipment, appliances, services and drayage to all the operations related to the fabrication and installation of the PVC Membrane System. The Work shall be as herein specified and as denoted on the accompanying drawings.

B. Related Work and Responsibilities Assigned to Others: Coordinate all activities with the appropriate party. Advise owner's representative

if proper conditions are not maintained or if responsibilities of others are not properly completed. Related work responsibilities generally include, but are not limited to the following:

1. Provide and maintain appropriate and suitable environmental conditions, including temporary heat shelter and weather protection for the completion of the work.
2. Surface preparation beyond the scope of normal surface patching of concrete, surface repair or cleaning of the existing interior surfaces prior to system installation.
3. Perimeter sealant, caulking, or other sealing except sealants that are integral to the PVC Membrane System.
4. Removal and reinstallation of deck and accessory equipment.
5. Provide means for storage and disposal of scrap material, coating debris, and other material in close proximity to pool area.
6. Electrical work, including grounding of the pool, installation of underwater lights or other components, or any related electrical work.
7. Temporary facilities, including electrical power close to the installation site.
8. Provide temporary water at fifty (50) psi (to gallons per minute) minimum for cleaning, rinsing, and test purposes, as well as facilities for draining pool and maintaining workable conditions within the pool area.
9. Final cleaning of pool area outside of the PVC Membrane System.
10. Provide and maintain all necessary barricades, signs, lights, flares, and other security as required protecting workmen and the public.
11. Drain pool, coordinate with contractor to ensure proper hydrostatic relief is maintained. Closely monitor water table around pool to minimize hydrostatic damage to pool shell.
12. Immediately after installation, protect pool from damage, contamination, spatter, and spillage caused by construction work of other trades. This shall include covering of pool with protective materials when necessary, and responsibility for prompt repair or corrective measures in the event of damage.

C. Where items of the architectural, mechanical, or electrical general conditions, special conditions, and specifications are repeated in this Section of the Specifications or Project Documents, it is intended to call particular attention or qualify these items or to indicate that the requirements of this Section shall govern in the event of conflict with other Sections. It is not intended that any other parts of the documents shall be assumed to be omitted if not repeated herein. Should the requirements of any other Section of the project documents contradict this section, the requirements of this section shall govern.

1.4 DEFINITIONS

A. References Standards: Certain applicable reference standards are incorporated herein to the extent such references are relevant, with the latest revision applicable including, but not limited to:

1. Fabrication standards:
   ASTM - American Society for Testing Materials
   ANSI - American National Standards Institute
   NSF - National Sanitation Foundation
2. The following are utilized as applicable:
   NCAA - National Collegiate Athletic Association
   FINA - Federation Internationale de Natation Amateur
   USS - United States Swimming Incorporated

B. The intent of these specifications is not to establish specific quantities, amounts, or dimensions. Thus, the reference to “one”, “each”, “an”, “a”, or like wording is for semantic purposes only. Unless specifically stipulated otherwise, provide materials, equipment, and items as detailed on the drawings or as reasonably required for complete, operational PVC Membrane System installation(s).

1.5 SUBSTITUTIONS

A. The PVC Membrane System has been the subject of a detailed investigation, and the design and operation of adjoining equipment and systems is based upon the specified membrane system. All base bids shall include only that equipment and systems listed herein or

subsequently approved by addendum. The Owner reserves the right to reject any and all substitutions without cause and for any reason whatsoever, and the contractor is obligated to provide only the products, equipment or systems as described by the specified manufacturer.

1.6 TRADE NAMES

A. When a particular manufacturer's product, system or brand name is designated in the project documents, either in the drawings, specifications or addenda thereto, only such designated products or systems by the named manufacturer may be provided.

1. When reference is made in the project documents to trade names, brand names or the products of a particular manufacturer, such references are made solely to indicate what products or systems may be furnished under the base bid and are not intended to restrict competition. Should any bidder desire to use products, systems or trade or brand names that are different from those mentioned in the project documents, application for the approval of such different products, systems, trade names or brand names must be provided to the Architect in writing a minimum of 10 days prior to the date set for the opening of bids.
2. The burden of proving acceptability rests with the applicant and any application for approval must be accompanied with adequate and sufficient technical data, drawings and details to clearly and convincingly establish beyond all doubt that the proposed product or system meets or exceeds all express requirements of the project documents.
3. Unless requests for approval of other products, systems, trade names or brand names have been received and approvals have been published by addendum, only such designated products or systems by the named manufacturer may be provided.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate all work activities and installation of the PVC Membrane System with other building components and the work activities of other trades

1.8 DRAWINGS:

A. The drawings are generally diagrammatic and are intended to convey the scope of work and indicate general arrangement. The drawings are intended for contractors having experience, skill and discretion in the execution of the work implied by the drawings.

B. If directed by the Consultant or required for the successful completion of the project, the contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work. Under no circumstances shall any sizes be decreased or increased significantly or radical changes made in any part of the installation without the written consent of the Consultant or the Owner.

1.9 SUBMITTALS

A. Upon notice to proceed under this Contract, installation details and submittal documents shall be provided, fully illustrating the materials and procedures to be utilized. <u>These details and submittal documents, once accepted by the Owner or Owner's Representative, shall be the basis for the fabrication, installation and inspection</u>.

B. Product Data: Submit manufacturer's technical information and product data including basic materials and installation instructions for the PVC Membrane System including the following:

1. List each material finished and application and cross-reference to the shop drawing(s).
2. Provide dimensional shop drawings showing all pertinent dimensions.

C. Program and Procedures: Prepare and submit a summary of the installation program which involves scheduling, preparation and installation procedures, quality control and project close-out. Submit to architect for approval.

D. Submit comprehensive operations and maintenance manuals. Include recommendations for corrective action of typical situations that may be encountered.

1. Submit recommended and required values for swimming pool water chemistry and other operational aspects of maintaining the swimming pool facilities.
2. Maintenance Instructions and Maintenance Program: Provide complete descriptive information detailing proper care, maintenance and cleaning of the system.

1.10 QUALITY ASSURANCE

A. This is a performance specification. The complete and functional reinforced PVC membrane system, as specified herein and shown on the drawings, is to be the basis for receiving bids. While it is not the intent of these specifications to, in any way, limit competition or restrict the bidder in the preparation of their bid, the bidder shall offer products and materials in literal compliance with these specifications. The bidders are cautioned that offering products or systems failing to meet these specifications will be considered non-responsive.

B. The PVC Membrane System shall be the product of a firm having at least ten (10) years experience in the design, manufacture and installation of PVC Membrane Systems used in swimming pool, aquatic or water feature applications. The firm also must have at least ten (10) installations of similar projects currently in satisfactory operation for no less than three (3) years. All systems shall be in compliance with the code requirements that govern in the State of the installation.

1. In the event an alternate manufacturer's system is approved, all contractors will be so advised per addendum prior to bid opening to allow for inclusion of such a system or equipment in their bids. In the absence of approval for an alternate manufacturer, only the specified manufacturer's system may be incorporated in the project.

2. Listing or subsequent approval of a particular manufacturer as an approved manufacturer does not constitute acceptance of the manufacturer's standard configuration, materials, or equipment, except as they specifically meet or can be made to conform to the requirements defined in this specification. Any bid shall be assumed to include any and all costs to change, modify or otherwise comply fully with the requirements of this specification. Claims for additional compensation to comply with these specifications after bid for any reason whatsoever will not be considered. Only materials, equipment, or systems that absolutely comply with these specifications in all regards will be accepted. Any substitute systems from alternate manufacturers shall be in compliance with all requirements of these specifications.

C. Warranty**:** The PVC Membrane System shall be guaranteed for workmanship, materials and performance for a period of ten (10) years with an option extended warranty for 15-years. This warranty shall not include or cover abusive or improper treatment to the PVC Membrane System by others either during construction or when operational.

D. A sample copy of the warranty statement in accordance with these specifications must be provided prior to approval.

1.11 DELIVERY, STORAGE AND HANDLING:

A. The PVC Membrane System components shall be delivered to the job site adequately packaged to prevent damage. Unloading and storage shall be executed by the Contractor. The materials shall not be stacked or stored in any manner which could cause damage or deformity. Site assembly or fabrication of any part of the PVC Membrane System without the complete coordination and supervision of the manufacturer or his representative is strictly prohibited.

1.12 Project Site Conditions:

A. The project site shall be in accordance with the Manufacturers' technical bulletins. Access for the installation of the PVC Membrane System will be provided by others.

B. All surface preparation necessary to produce a reasonably smooth, firm, clean and dry surface shall be completed prior to the onset of installation. The surface must be free of angular materials, bubbles, voids and large cracks. These irregularities shall be filled with suitable patching material or covered with galvanized or stainless steel sheet as detailed on the drawings. Tar, oil, or petrochemical compounds must be removed or isolated. Surface preparation is part of this contract.

1.13 COORDINATION:

A. The manufacturer shall provide complete descriptive information detailing the design, construction and installation. The contractor shall include all costs for visits to the project site to coordinate various aspects of design, construction, installation and commissioning of the lining system. Coordination shall include the cost for aspects of the installation and to coordinate manufacturing, testing and commissioning programs with the main contractor(s), and other suppliers. Such visits shall take place immediately upon notice to proceed to enable all contractors to be briefed, and a complete production and installation program to be established.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturer: Natare Corporation, Indianapolis, Indiana or Renolit Corporation (worldwide). All bids shall include only PVC Membrane Lining Systems from these manufacturers.

B. The system specified is based upon either the Natatec® Swimming Pool Membrane System or Renolit AlkorPlan 2000, which are proprietary products of these manufacturers. The characteristics, standards and criteria listed herein have been established as the minimum acceptable values for any membrane product to be offered on this project. As all aspects and equipment within the pool system have been designed to utilize this system, products not approved and listed prior to bidding as meeting the minimum requirements listed will not be accepted as that could adversely affect the performance of the system.

C. If alternate systems are approved prior to bidding, all bidders will be notified by addendum.

D. Source Limitations: Provide all PVC Membrane System components through one source from a single manufacturer.

2.2 Materials

A. Ensure that all materials used are compatible with the swimming pool environment, and that these materials are supplied as a system.

2.3 Components and Equipment

A. Flexible Reinforced PVC Membrane: The flexible PVC membrane shall be installed to the dimensions detailed on the drawings and as required. The membrane shall consist of two (2) layers of PVC fuse, bonded to a polyester mesh substrate. The membrane shall be no less than 60.0 mil in thickness (.060-inch/1.5 mm), and shall conform strictly with the following chemical and physical properties as listed herein. Only those membranes specifically formulated for swimming pool use shall be considered. Roofing membranes, general waterproofing membranes, and vinyl liners shall not be acceptable. Additionally, only those swimming pool membranes meeting or exceeding the following ASTM test values, substantiated by independent documentation from a certified testing laboratory, shall be acceptable. The membrane shall be furnished in a color scheme as detailed by the drawings or in a standard color as selected by the owner.

B. The flexible PVC membrane shall be furnished with a proprietary acrylic polymeric MicroShield coating to resist abrasion, staining, UV deterioration and microbial action. The polymeric coating shall be Natare MicroShield™ coating or Renolit AklorPlan 2000.

C. *Chemical and Physical Properties:

Thickness:	**60 mil**	**ASTM D374C**
Specific gravity:	1.22 g/cc	ASTM D792/method A
Yield tension:	MD166 lb./in – XD160 lb./in	ASTM D638
Yield elongation:	MD 60% - XD 60%	ASTM D638
Break tension:	MD 95 lb./in - XD 90 lb./in	ASTM D638
Break elongation:	MD 110% - XD 104%	ASTM D638
Secant modulus	MD 1352 psi - XD 1125 psi	ASTM D5323 (100%):
Tear resistance:	MD 25 lb. - XD 24.7 lb.	ASTM D1004- Die C
Low temp. brittleness	-50°C – Pass	ASTM D1790
Water absorption:	<.79%	ASTM D570
Puncture Resistance:	125 lbs	ASTM D4833
Ply Adhesion	24 in/2 in.	ASTM D413
UV Resistance: Tensile Strength @ Yield	MD 12% - XD 16%	ASTM D4355
Fungal and Bacteria Resistance	No growth, staining or discoloration	ASTM G21-96
Resistance to Chemicals	Excellent resistance	ASTM D543
(Cyanuric Acid, Sodium Dichloroisocyanurate, Trichloroisocyanuric acid, Calcium Hypochlorite, Sodium Hypochlorite with 12 ppm solution)		Procedure I (73.4 F) for 7 days

MD = machine direction; XD = cross machine direction *Average values plus or minus 10%

D. Slip Resistant Flexible Reinforced PVC Membrane: A slip resistant reinforced PVC membrane, 67.0 mil in thickness (.067-inch/1.7 mm),, and identical in chemical and physical properties to the flexible reinforced PVC membrane described above, which includes a specifically

designed embossed surface suitable for high traffic areas, shall be installed as detailed on the drawings. The slip-resistant surface shall be certified by independent ASTM Laboratory testing to comply with the requirements of ASTM C1028. Furnish in the color scheme as detailed by the drawings or as selected by the owner.

E. Separator Fleece: The interior surfaces of the swimming pool shall be covered with an engineered polyester fleece separator, a minimum of 150.0 mil in thickness (.150-inch/3.81 mm), weighing at least 10.5 ounces per square yard. The fleece separator must be resistant to freeze, thaw, moisture, soil-chemical abrasion, or ultraviolet deterioration and shall conform strictly to the following chemical and physical properties. All fleece separators shall be certified and guaranteed to be free of foreign materials, which could potentially be damaging to the liner.

F. Chemical and Physical Properties (Property Unit Value Test)

Weight:	10.5 oz./sq.yd.	ASTM D-3776
Thickness:	150 mils	ASTM D-1777
Grab strength:	390/330 lb.	ASTM D-4632
Grab elongation:	75/85%	ASTM D-4632
Trapezoid tear strength:	135/120 lb.	ASTM D-4533
Puncture resistance:	155 lb.	ASTM D-3787
Mullen burst strength;	550 psi	ASTM D-3786
Water flow rate:	100 gpm/ft	
Permeability:	0.52 cm/sec	

H. PVC Steel Edging: A PVC-coated steel sheet, at least 20 gauge with PVC laminated on one side shall be used to form edges, angles, corners, or other transitions where a firm surface is necessary to weld the PVC membrane.

I. Stainless Steel and Polymer Sheet: At least 20-gauge stainless steel or polymer sheet shall be used as required for reinforcement, shaping, or separation as required. It shall be installed over expansion joints when sealants or caulking have been installed.

J. Sanitizing Agents: Sanitizing agents, formulated from a mixture of halogenated organic compounds, and specifically designed for this purpose, shall be applied to the pool surface, beneath the pool liner, to prevent the growth of microbes or fungus.

K. Transition Flanges: Compression flanges fabricated of rigid, white polymer, 1/4 inches thick, shall be furnished at all membrane penetrations or openings to the swimming pool. All transition flanges shall be secured with stainless steel anchoring systems.

L. Edge Sealant: Liquid PVC edge sealant solution shall be applied to all free material edges after welding. This process is to provide a properly detailed edge on material lap joints. Only those membrane systems utilizing an edge sealant solution will be considered, as this process is critical to the overall durability of the membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The supervising representative or installer shall verify that the site conditions are in accordance with the Manufacturers' requirements, shop drawings and/or technical bulletins and are suitable for the installation of the membrane.

3.2 Preparation

A. Surface preparation shall be completed prior to the commencement of installation. The surface shall be reasonably smooth without oil or tar-based materials present. Deteriorated surfaces or voids shall be filled with cementitious patching compounds. Areas immediately surrounding fittings, lights, and other transitions or entrances to the pool shall be sound and suitable for drilling of ½ inch diameter anchor holes for the installation of the PVC compression flanges.

3.3 Installation and Application

A. All work to be performed by skilled technicians having adequate experience with, and specific training in, the field welding and fabrication of flexible PVC swimming pool membrane systems. Additionally, to ensure the overall integrity of the installation, the installing crew shall be supervised by a crew leader having had no less than two (2) years experience in the application of PVC membrane systems on at least five (5) pool projects similar in size and scope to this project.

B. To ensure the integrity of the membrane installation and to secure a single source of responsibility for any required warranty service, all membrane system installation personnel shall be full-time, regular employees of the prime bidder, system manufacturer or shall be a factory trained licensee of the Manufacturer. No sub-contractor or independent membrane installers shall be utilized without prior approval. The contractor shall be required to submit installers experience with any proposed alternate systems in writing to the consultant for approval prior to project bid.

C. If requested, the Contractor shall submit the personnel and supervisor's experience in writing to the for approval prior to award of contract

D. All work is to be performed in accordance with the manufacturer's technical bulletins. Should the requirements of these bulletins contradict this or any other section of the specifications, the procedures called for in the bulletins shall govern. The work under this section shall be performed by or directed by an authorized licensee of the system manufacturer so that the complete installation will function in accordance with the intent of these specifications.

E. (Optional) Connection to existing perimeter gutter systems: When installing the PVC Membrane System in swimming pool or aquatic facilities with existing stainless steel perimeter gutter systems, a 12 gauge T-304 stainless steel compression skirt shall be continuously welded to the stainless steel gutter system.

F. The compression skirt shall be fabricated as detailed on the drawings and shall provide a smooth, uninterrupted surface onto which the membrane shall be compressed. The PVC membrane and a silicone impregnated sponge gasket shall be compressed between a rigid PVC profile and the compression skirt through the installation of ¼"-20 stainless steel screws, located no greater than 3" O.C. A semi rigid interlocking cap strip shall be installed over the PVC profile to finish the installation. Due to the critical nature of insuring a positive, permanent and enduring watertight seal between the PVC membrane and the stainless steel gutter system, only those systems incorporating a fully welded, stainless steel membrane compression skirt will be allowed.

G. One method of meeting these requirements is furnished by Natare Corporation of Indianapolis, Indiana and is available under license for use by any contractor installing a PVC Membrane System in a swimming pool facility.

1. (Optional) The PVC membrane contractor is responsible for pressure testing the existing stainless steel gutter supply tube and hydrostatic testing of the return trough prior to installing the compression skirt to ensure that the gutter system is watertight.

3.4 Sequence of Work

A. Attach the fleece to the pool wall and/or the bottom with the appropriate adhesives in the amounts adequate to secure the fleece. Isolate deteriorated surfaces of voids, cracks, or any other areas with moisture proof composition board or galvanized sheet (20-gauge) as required.

B. As required for the configuration of the pool, the flexible reinforced PVC membrane shall be securely welded to PVC coated steel, which has been attached to the pool surface with appropriate anchors approximately four (4) inches (100-mm) on center.

C. Install PVC coated steel or shaped galvanized sheet as necessary to form angles, edges, corners, or other transitions.

D. Weld the flexible reinforced PVC membrane in accordance with the procedures established by the manufacturer. The joints shall be hot air welded with a minimum of two (2) inches of overlap. Probe all seams with a hand-held lance or air lance to ensure complete welding. Completely close the seam edge using a PVC edge sealing compound.

E. All seams in the membrane shall be one-piece, single overlap seams. Patching and overlaying of multiple layers of the membrane material is not acceptable. All material sections are to be applied in full roll widths and lengths except where pool conditions dictate otherwise. No scrap or short-roll material is to be utilized in the membrane installation. To minimize visible seams, the membrane is to be applied to the pool walls in horizontally oriented sheets. Applying the membrane to the pool walls in vertically oriented sheets is not acceptable. Any areas of the membrane which are damaged during installation are to be completely removed and replaced with new material. There are to be no visible patches on the completed membrane.

F. Apply special markings, targets, lines, etc., as indicated on the drawings or as specified. The owner's representative is to provide detailed instructions as to necessary markings.

G. After installation of the PVC membrane, apply an appropriate elastomeric sealant to all transitions between construction materials, utilizing only sealants suitable for submerged application, and compatible with the flexible reinforced PVC membrane.

H. All inlets, outlets, drains, underwater lights, skimmers, stanchion posts, and other required membrane penetrations shall be fitted with rigid PVC compression flanges securely anchored to the pool structure to ensure a watertight seal. The "wrapping and clamping" of the membrane material around stanchion posts, ladder rails, and other protrusions through the membrane will not be considered acceptable. Only rigid compression flanges shall be utilized for all membrane penetrations.

I. The PVC membrane shall be continuous throughout recessed steps and any other recessed areas in the pool wall. Compression flanging around recessed steps will not be considered acceptable.

3.5 Adjusting & Cleaning

A. After installation is complete, "broom" clean all surfaces. Remove all scraps, debris, or construction material and dispose of properly

3.6 Field Quality Control

A. Limit access to the project site to minimize possibility of damage to the membrane. Materials and equipment shall not be dragged across the surface of the liner or allowed to slide down the slopes. All parties working on the liner shall wear soft soled shoes. Immediately following installation, verify completion and testing of all seams. Retesting may be necessary to ensure complete sealing.

B. Upon completion of installation and testing, the completed PVC Membrane System shall be hydrostatically tested by filling the pool or water feature to the typical operating level and operating all systems for a period of 6 hours without evidence of leakage.

3.7 Demonstration and commissioning

A. Provide at least three full sets of bound operation and maintenance manuals which fully detail the proper system operation and maintenance techniques.

B. In the company of the Owner's representative, inspect the completed installation, make final adjustments, place the system in operation and give operating instructions relative to its care and use.

C. Prepare a complete "Project Completion Report and Warranty Application," documenting the proper completion of the project, training of Owner's personnel, and application for warranty. Provide to Owner's representative for review and signature prior to turning over project to Owner.

Sample Warranty

Statement of Extended Warranty
Natatec® Lining Systems

(Installed by Natare Corporation or authorized installer)

NATARE CORPORATION ("Natare") hereby provides exclusively to the original Owner the warranties contained herein ("Warranty"), related to the **Natatec Membrane System** provided by Natare for a project ("Project"), and it is expressly understood and acknowledged by Natare and the Owner that the Project and this Statement of Warranty relate solely to a commercial transaction.

Natare expressly WARRANTS that the **Natatec Membrane System** is comprised of new materials, which were manufactured in a workmanlike manner in accordance with Natare's drawings, submittals, specifications, and technical details. Natare further expressly warrants that the **Natatec Membrane System**, if installed and utilized in accordance with Natare's written instructions, industry standards and proper practice, will perform in a proper and workmanlike manner under normal and intended use and service for a period of one (1) year beginning on the Effective Date of Warranty as written below. Natare expressly represents only that any work or labor performed by Natare has been performed in a reasonable and workmanlike manner. This express warranty covers solely the Natatec Membrane System components.

Natare further expressly WARRANTS that, commencing upon the delivery of the materials to the Owner, the Natatec materials shall retain their integrity as a watertight membrane and not peel, flake, crack, tear or delaminate **for a period of ten (10) years** from the effective date of warranty (the "Warranty Period").

In the event that the **Natatec Membrane System** materials or workmanship shall be found to be to be defective during the specific terms set forth in this Warranty, Natare agrees that it shall, as soon as practical after receipt of written notice from the Owner, and at its option, either **repair or replace the defective part or parts of the system, or refund to the Owner the portion of the purchase price attributable to the defective part or parts of the system. Any materials or equipment claimed to be defective must be returned to or inspected by Natare, and Natare shall have the sole right to determine coverage under this Warranty. This warranty covers solely the Natatec Membrane System components and does not include labor or installation costs and does not cover inspection costs or labor charges for material replacement, regardless of whether this Warranty applies to claims made hereunder.**

Specifically exempted from these warranties are claims arising from: **normal wear and tear; undue wear and tear, damage or failure due to accident, misuse, abuse, neglect or other conditions exceeding normal use; improper or incorrect operation or maintenance; any use of the product other than the particular use for which the product was intended; structural or earth movements; or acts of God.**

Natare further disclaims any and all implied warranties, including but not necessarily limited to the implied warranties of merchantibility and fitness for a particular purpose.

In no event shall Natare be liable for any consequential or other damages, losses, or expenses, whatsoever, direct or indirect arising in connection with the use or inability to use the Natatec Membrane System for any purpose, except as expressly agreed to by Natare in writing. There are no other warranties or guaranties, expressed or implied, given by Natare or its agents except those provided herein. Goods or equipment not manufactured by Natare are covered only by the standard warranty of the manufacturer, though sold, provided, installed, or operated with the Natatec Membrane System. The express warranties described herein are conditional upon payment in full to Natare for any and all charges related to the Natatec Membrane System. Any claims against Natare arising out of or related to this Statement of Warranty must be made in detail and in writing and must be provided to Natare within ten (10) days of the date on which the warranty claim was discovered or reasonably should have been discovered. Any and all disputes, controversies or claims arising out of or related to this Warranty shall be settled by binding private arbitration, which arbitration shall be conducted in accordance with the American Arbitration Association Construction Arbitration Rules then in effect. The parties shall endeavor to mutually agree to an arbitrator who shall hear and decide the dispute. If the parties are unable to agree to an arbitrator, the arbitrator shall be selected through the American Arbitration Association. This Warranty shall be governed by, and interpreted, enforced and construed in accordance with the laws of the State of Indiana. The Owner hereby submits itself to both the subject matter and personal jurisdiction of the State of Indiana, and waives any objection thereto. The Owner agrees that any action brought under this Warranty shall be arbitrated in Marion County, Indiana. All Natare warranties and other duties with respect to material, equipment, systems, or services furnished by Natare shall be conclusively presumed to have been satisfied one day after the expiration of the warranty period as set forth herein. This Warranty supersedes any and all written or oral warranties, promises, or representations made by Natare regarding the **Natatec Membrane System.**

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