The *PILECOAT* System

Durability, versatility, ease of application, and longevity are sought-after qualities when repairing or improving a marine facility. Successfully meeting these characteristics, PILECAP, Inc. has developed the proprietary formulation: the *PILECOAT* System.

The *PILECOAT* System is a marine adapted, polyurea spray elastomer coating, designed specifically for use on concrete, steel and timber surfaces, protecting them from the harshest of marine and industrial environments. While *PILECOAT* is relatively new to the marine industry with respect to antiquated polyurethane and epoxy type coatings, this cost effective method of corrosion mitigation is second to none, providing properly prepared substrates with 75(+) years of serviceability.

Developed in 1986, and first applied in 1988, this type of polyurea spray elastomer coating has only 20 years of "true life" application and testing. However, the following data and information based on accelerated testing methods suggests long-term performance of aromatic and aliphatic coatings.

The most common testing with regard to accelerated exposure is commonly referred to as weatherometer testing. At Texaco Chemical Company, several aromatic based polyurea systems were exposed to ASTM G 53, which is The Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials. The number of hours of exposure can be extrapolated to years of outdoor service.

First, the aromatic-based systems were exposed to a total of 3800 hours, using the UVB-313 bulbs, 50°C. These bulbs have been shown to give higher UV output, faster testing and improved uniformity in the test. Post exposure, the samples were compared against the control. Findings indicate that the physical property retention of the sample was at least 80% of the elastomer's original physical property. While the surface of the elastomer did show discoloration (yellowing,) this was only at the surface. There was no chalking or cracking of the elastomer surface after exposure.

A similar study was performed using the aliphatic-based polyurea spray technology, which is the "color-stable" version. For this, samples were exposed to over 6000 hours under the same test conditions. Elastomer physical property retention was greater than 90%, with little to no color fade in the elastomer samples.

Commonly referred to as Salt Spray Testing, ASTM B 117, which is the Practice for Operating a Salt Spray (Fog) Apparatus, was conducted on aromatic polyurea systems which were applied to properly prepared steel substrates. The coated panels were crosscut through the coating system to the steel surface and placed in the salt fog cabinet and were

exposed to the salt environment, 50°C, for a period of 3000 hours. The panels were removed and inspected for corrosion at the scribe, adhesion of the polyurea to the panels, and any deterioration of the polyurea samples. While this test is a comparative test, the results showed that the polyurea systems gave excellent performance after the 3000-hour exposure when compared to antiquated polyurethane and epoxy coating systems.

Polyurea elastomer systems are amorphous in nature, not crystalline like polyurethane systems. This amorphous nature is similar to that of epoxy type systems, except that polyurea systems do not have a true-glass transition temperature. Thus, polymer morphology, another testing procedure, is utilized. In so doing, two distinct T_g's can be noted; one corresponding to the melting point of the soft block in the polymer, the other corresponding to the melting point of the hard block in the polymer. From Dynamic Mechanical Spectroscopy evaluations of typical polyurea elastomer systems, a low temperature T_g is noted at about -50°C, with a high temperature T_g of about 230°C to 260°C, but the response curve between these two temperatures remains relatively flat. Simply, the polyurea elastomer systems would tend to show significant stiffening at temperatures less than -50°C, while some polymer softening or possible decomposition, at temperatures above 230°C to 260°C. This is the temperature performance range for a polyurea elastomer system.

In addition to the aforementioned testing, another accelerated test commonly performed (typically with polyurethane foam systems) is a humid-age / thermal-age test. The following ASTM methods have been suggested and used: ASTM C 1246 - Effects of Heating on Weight Loss, Cracking, and Chalking of Elastomeric sealants After Cure, and ASTM D 5510 - Heat Aging of Oxidatively Degradable Plastics. For each test, the polyurea system would be exposed to an elevated temperature, normally 80°C (175°F), and the elastomer properties are monitored during the exposure time. Given the high thermal resistance of polyurea technology, this nominal temperature has little to no effect on the polymer.

From the accelerated weatherometer testing, Salt Spray Testing, thermal aging, polymer morphology and typical performance values for polyurea systems, (when applied to a properly prepared substrate with the appropriate film thickness,) the life expectancy of a marine adapted, polyurea spray elastomer coating can be determined when the number of hours of exposure can be extrapolated to years of outdoor service. Results indicate every 2000-hours QUV plus(+) 1000-hours thermal aging = 20-year life span (this applies to the polymer, not the application to the substrate.) Evaluating the coating for "X" hours, or until there is 50% loss in elastomer physical properties or other failure, *PILECOAT* has a conservative life expectancy of 75+ years.

Applied film thickness is as follows:

Walls (non-immersion)	30-60 mils
Pedestrian Traffic	40-60 mils
Below Grade Waterproofing	50-60 mils
Immersion Service	50-100 mils
Vehicular	60-80 mils
HD Vehicular / High Abuse	80-125 mils

*Typical film thickness of *PILECOAT* when applied to PILECAP Systems*

The need for a superior, marine adapted, protective coating was growing and sparked the research reported. A couple of projects of great magnitude, which utilize the marine adapted coating include:

A major construction project in Boston, MA, under the direction of Bechtel, Parsons & Brinkerhoff, a major engineering firm, required a 75-year life expectancy on the applied coating system in a saltwater application environment. Bachtel contacted Texaco Chemical Co / Huntsman Corp, who conducted the weatherometer testing. Upon review and evaluation of the elastomer physical properties, Bechtel was satisfied that the coating system would provide the expected 75 years of service for the project. The applied thickness of the polyurea coating system for this project was 100 – 120 mils.

Another major project is the San Mateo Bridge Upgrade project in the San Francisco, CA area. Here, a polyurea system was applied to the concrete beams and piling to protect them from the salt environment corrosion issues. CalTrans has given a 100-year life span on this project. A large part of the decision to complete this work with the polyurea technology was due to the availability of the aforementioned accelerated testing and elastomer physical property information. Applied thickness of the polyurea coating system on this project was 60 – 70 mils.

Based on the available information, it is felt that a properly formulated and prepared polyurea elastomer system, especially versions adapted to specific marine use such as *PILECOAT*, would survive a minimum of 75 years in a saltwater environment. This is based on the overall testing results, flexibility of the system, chemical resistance and thermal properties. This does not take into account extraneous circumstances such as high abrasion, undo impact and highly corrosive chemical / solvent introduction into the environment.

Polyurea Life Expectancy Discussion
Testing and results by: Primeaux Associates, LLC
161 Forrest Drive, Elgin, TX 78621