What is polyurea?
Polyurea is an organic polymer that is the reaction of isocyanate with an amine terminated polyether resin, forming a plastic-like or rubber-like compound that may be used in many of the same ways as older technologies - polyurethane, epoxy, vinyl ester, neoprene; to name a few.

Can anyone apply polyurea?
Polyurea requires special training and equipment for field application, whether used as joint filler or as a field applied coating. VersaFlex has an ongoing program of contractor training in place. There are qualified applicators in all regions of the U.S. and an expanding network of qualified applicators throughout the world.

Where can polyurea be used?
As a general rule, VersaFlex polyurea can be employed to contain any substance that may be directly discharged into normal sanitary sewer systems. It may be easier to give examples of environments where polyurea should not be used.

As a general recommendation for constant exposure to direct chemical attack VersaFlex polyurea products may not be installed for attack by:

- Halogenated Solvents:
  1. Carbon tetrachloride
  2. Chloroform
  3. Methylene chloride
  4. Tetrachloroethane
  5. Trichlorethene
  6. Trichloroethane

- Non-Halogenated Solvents And Ketones:
  1. Acetone
  2. Acetonitrile
  3. Acetophenone
  4. Benzene
  5. Butanol
  6. Camphor oil
  7. Cyclohexanone
  8. Diethyl ether
  9. Diisobutyl ketone
  10. Ethyl acetate
  11. Hexane
  12. Methyl ethyl ketone
  13. Methyl isobutyl ketone
  14. Pentane
  15. Phenol
  16. Toluene
  17. Xylene

- Acidic compounds with a total composite pH range equal to or below 4
- Basic compounds with a total composite pH range equal to or above 11
  Note: Non-aqueous (anhydrous and anhydride compounds in granular, crystalline, or powder form) protected by an air drying system may be contained by polyurea. Consult VersaFlex.

- Amine Attacking And Amine Containing Compounds
  Strong, inorganic acids, organic acid halides, aldehydes, isocyanates, organic anhydrides.
  1. Aminoethyllethanolamine
  2. Aniline
  3. Ethylamine
  4. Methylamine
  5. Pyridine
  6. Toluenediamine

What kind of temperatures will polyurea withstand and will it burn?
VersaFlex polyureas begin to develop their physical properties within minutes of application. Among several very desirable properties are their quick gel time and their glass transition temperatures that average -40 degrees F and +480 degrees F. Heat of deflection under no load is +250 degrees F. Safe upper limit of working temperature is +350 degrees F, under no load. Polyurea will exhibit thermal shock debonding when subject to repeated periodic blasts of live steam. While polyurea has high glass transition and heat of deflection temperatures, it will burn when exposed to direct flame. It will self extinguish when flame is removed.

- **Is Polyurea hard or soft?**
Polyurea may be either hard or soft depending on the particular formulation and the intended use. Durometer ratings may range from Shore A 30 to Shore D 80.

- **What is polyurea’s abrasion resistance?**
VersaFlex has run abrasion resistance testing according to ASTM D 4060 using the most aggressive abrader, the H-18 wheel. The abrasion loss is as noted in our material specification data sheets for the appropriate material. This test was utilized because it most nearly typifies the type of abrasion attack found in industrial environments. The industry standard testing for polyurethanes uses the abraser CS-17 wheel. This wheel is a much smoother, less abrading mechanism than the abovementioned H-18 abrader wheel. The most severe utilization of polyurethanes is found on parking deck coating systems. The hard polyurethane topcoats used in these systems generally have CS-17 losses between 5 - 10 milligrams. FSS 45DC and FSS 50DM report H-18 loss between 180 and 250 milligrams. This loss is actually much less severe than a loss of 5 - 10 milligrams on the CS-17 wheel.

- **How well does polyurea adhere to steel?**
VersaFlex polyurea may be applied to properly prepared A-36 metal substrates. The metal should be blasted to Near White or White, and have a blast profile of 5 mils. Adhesion values will exceed 1000 psi without using primer.

- **What factors should be considered about polyurea’s ability to adhere to concrete?**
There is no hard and fast number that is useful to the designer. Generally, an adhesion value is a compromise between the type and condition of concrete substrate, the stresses placed upon the membrane prior to project completion, and the requirements of the membrane to withstand in-place use stresses. Where possible, concrete should have all surface paste removed and be free of laitance of any kind. A texture similar to 80-grit sandpaper as a minimum is desirable. Since concrete has low tensile properties, especially at the surface faces of large plan areas, one rule of thumb is to expect adhesion to range around ten percent (10%) of ultimate compressive strength of the concrete. The best that can be expected is in the range of 350 psi to 450 psi for 4,000 psi concrete properly cured and of sufficient age to acquire its maximum physical properties.

- **What is the life expectancy of a polyurea spray elastomer system?**
The following letter by Dudley Primeaux, Primeaux and Associates, was made in response to numerous inquiries for an answer to the probable life expectancy of polyurea when subjected to immersion in salt water and polyurea subjected to ultraviolet light. The original polyurea formulations alluded to in this letter are those that VersaFlex uses in manufacturer of its aromatic and aliphatic spray materials. Note: Dudley Primeaux is the holder of several patents for Polyurea Technology secured while he was the lead chemist for Texaco Chemicals and Huntsman Corporation. Mr. Primeaux is currently employed as a consultant and has been president of the Polyurea Development Association. The testing processes cited in this letter are those that are current industry standards. The evaluations and conclusions drawn in this letter are those of Mr. Primeaux and are considered the most expert opinions available within the industry. (Electronic File of Letter from Dudley Primeaux, Primeaux and Associates, to David Cerchie, President, VersaFlex Incorporated)

May 24, 2002
Dear David:

A question has recently been asked as to the life expectancy of a polyurea spray elastomer system as it relates to an application in an immersed saltwater environment. While this question is really not new to the technology, it seems that there has not been any published data or information to support any direct claims that may have been made. But we still would like to know, “How Long Will it Last”?

As you are aware, the polyurea spray elastomer technology is relatively new to the industry with respect to conventional polyurethane and epoxy type coating systems. Since the development in 1986 and first commercial use in 1988, true life history is only slightly over 10 years. This has provided somewhat of a “brick wall” if you will as to the real performance of the material. There is data and information available on the technology though that might suggest the long-term performance. This data includes accelerated testing on the technology compared to the basic physical properties.

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

During that work, the aromatic systems were exposed to a total of 3800 hours, using the UVB-313 bulbs, 50° C. The type bulbs have been shown to give higher UV output, faster testing and improved uniformity in the test. After this exposure, the samples were re-tested and compared to the original physical property data. What was shown was that the physical property retention was at least 80% of the elastomer’s original physical property results. 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.

That testing was halted at 3800 hours for no particular reason. The test samples were good the data was just required at that moment. I have attached an original chart of that data as published by Texaco Chemical Company.

We also performed a similar study 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 here was greater than 90%, with little to no color fade in the elastomer samples.

From this data on the aliphatic polyurea systems, they have then been evaluated for use in automotive interior trim applications. The available test data here suggests that dash and door panels made of the aliphatic system would have at least a 20 year life. That is significantly improved of the conventional plasticized PVC that has been used for years and tends to show cracking after about 5-8 years of exposure. Source of information here is from Goodyear Tire & Rubber.

I have attached a sheet that addresses many of the questions as to how does this data equate to real life data. Though no one will put the information in writing, it has been suggested that 2000 hours equates to about 20 years of exposure.
The other testing that has been done is the ASTM B 117 (Practice for Operating a Salt Spray (Fog) Apparatus). This has commonly been referred to as Salt Spray Testing. For this, similar aromatic polyurea systems were applied to prepared steel substrates and then a crosscut was made through the coating system to the steel substrate. The coated panels were placed in the salt fog cabinet and exposed to the salt environment, 50°C, for a period of 3000 hours. The panels are 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 (ASTM B 117) is a comparative test, the results showed that the polyurea systems gave excellent performance after the 3000-hour exposure when compared to comparable polyurethane and epoxy coating systems. It has recently been suggested that the new ASTM G 85 (Practice for Modified Salt Spray (Fog) Testing) is an improved method of testing. This is sometimes referred to as prohesion testing. I am not aware of this work being done with polyurea system.

Another unique testing procedure is that involving polymer morphology. 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 system do not have a true glass transition temperature. Instead, 2 distinct Tg's can be noted, one corresponding to the melting point of the soft block in the polymer and 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 Tg is noted at about -50°C with a high temperature Tg of about 230°C to 260°C. The response curve between these two points remains relatively flat. This would be the performance range, temperature wise, for a polyurea elastomer system. In lay terms, the polyurea elastomer systems would tend to show some significant stiffening at temperatures less than -50°C with some polymer softening, or possible decomposition, at temperatures above 230°C to 260°C.

As you are aware, there is a major construction project in Boston, MA, the CA/T Project or Big Dig as some call it. This is a project under the direction of Bechtel, Parsons Brinckerhoff, a major engineering firm. In the initial stages of the project, Bechtel decided to use the polyurea spray elastomer technology as the primary waterproofing system for the tunnel section. The polyurea elastomer would be applied to the exterior of the concrete tunnels for both the cut-and-cover sections as well as the harbor immersed tube section. This is a saltwater environment.

Bechtel had required a 75-year life expectancy on the applied coating system and contacted Texaco Chemical Co / Huntsman Corp. While Texaco / Huntsman could not directly supply that information, we did supply all of the above noted information of this letter. Upon review and evaluation of the elastomer physical properties, Bechtel was satisfied that the coating system would provide the expected service of the project. The applied thickness of the polyurea coating system is 100 – 120 mils.

Another major project is the San Mateo Bridge Upgrade project in the San Francisco, CA area. Here, a polyurea system is being applied to the concrete beam and piling to protect from the salt environment corrosion issues. It has been reported that 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 available accelerated testing and elastomer physical property information. Applied thickness of the polyurea coating system here is about 60 – 70 mils.

While maybe not directly applicable, there is some additional data on some nuclear irradiation evaluation of polyurea spray elastomer systems. The basis of this information has provided for the use of the aromatic polyurea spray elastomer technology in a variety of nuclear facilities, and continues to be used today. This
includes Westinghouse Savannah River Works, Hanford Nuclear Site and the Department of Energy.

While this is a considerable amount of data and supporting application work, we still have not fully addressed the question of life expectancy. I am of the opinion that there is no exact answer in general as many factors come into play. However, we should be able to provide for some sort of calculation of such.

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It has been shown that polymer durability / toughness is a factor of the elastomer physical properties, applied thickness and environment of exposure. Given that, the best elastomer physical property relationship possible should be used for the application areas. This sounds somewhat confusing but I will explain. Life expectancy of the polyurea system should include not only the physical properties but factors such as long term adhesion, applied film thickness and chemical exposure / environment.

Urea has been described as an organic rock. The polyurea systems are a derivation of that “rock”. As the reaction mechanism proceeds without the use of a catalyst, as opposed to polyurethane system, there is no catalytic breakdown evident in the polyurea polymer system like that of a polyurethane.

In addition to the accelerated and other testing done as described in this letter, I would suggest another accelerated test commonly performed with polyurethane foam systems. This is a humid age / thermal age test. The following ASTM methods have been used and are suggested:

ASTM C 1246: “Effects of Heating on Weight Loss, Cracking, and Chalking of Elastomeric Sealants After Cure”

ASTM D 5510: “Heat Aging of Oxidatively Degradable Plastics”

For each of these, the polyurea system would be exposed to an elevated temperature, normally 80\(^\circ\)C (175\(^\circ\)F), and the elastomer properties monitored over the exposure time. Given the high thermal resistance of the polyurea technology, this nominal temperature will have little to no effect on the polymer. It is suggested that a higher temperature be used, say 100\(^\circ\)C (212\(^\circ\)F).

Polyurea systems have also shown excellent results in freeze/thaw cycling testing. This would take the polymer from -20\(^\circ\)C to 50\(^\circ\)C in 9 cycles.

From the accelerated weatherometer testing, thermal aging and typical performance values for polyurea systems, one could apply the following conservative calculation:

Evaluate the hours until there is a 50% loss in elastomer physical properties or other “failure”,

For every 2000-hours QUV plus 1000-hours thermal aging = 20-year life span

This applied to the polymer, not necessarily the application.

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I would feel very comfortable with this calculation and moving into the environment of application of the polyurea system provided the following parameters are met:

1. Applied film thickness is as follows
   Pedestrian Traffic 40-60 mils
Vehicular 60-80 mils
HD Vehicular / High Abuse 80-125 mils
Immersion Service 50-100 mils
Walls (non-immersion) 30-60 mils
Below Grade Waterproofing 50-60 mils

2. Proper substrate preparation and application techniques are employed

Based on the available information we have to date, it is felt that a properly formulated and prepared polyurea elastomer system, like that of the VersaFlex product line, would survive a minimum of 75 years in your saltwater application area. This is based on the testing, flexibility of the system, chemical resistance and thermal properties. This does not take into account extraneous circumstances such as high abrasion, undue impact and highly corrosive chemical / solvent introduction into the environment.

I know that I have been somewhat longwinded here but I did want to provide you with sufficient background and information to address your questions. I trust that this information will be of help to you. Please feel free to contact me should you have any additional questions.

Sincerely Yours,

Dudley J. Primeaux II

·How should polyurea be prepared for overcoating after initial cure of the polyurea?
Prior to overcoating polyurea make sure it is clean. For the first several hours after polyurea has gelled it may be suitable for overcoating without further preparation.
If polyurea base coat material has been in place for longer than six hours there could be problems with inter-coat adhesion. Since fewer products are carried in aromatic solvent, which tackify polyurea you must undertake this process. To assure inter-coat bond apply a liberal amount of denatured alcohol (or more aggressive solvent such as acetone or MEK) to polyurea and allowed to evaporate completely. This will re-tack the polyurea base coat and allow proper adhesion of the follow-on overcoat. This same procedure should be used when bonding polyurea to polyurea after initial cure has taken place.

·What's the difference between aromatic and aliphatic polyurea systems?
Actually there are two different types of aliphatic polyurea systems currently on the market. One is the typical high pressure/temperature sprayed systems and the other is what is known as a "polyaspartic polyurea" type system. This polyaspartic system is different in that it uses an ester based resin component and has a longer pot life. It can be hand applied using close nap rollers; brushes; rakes or even airless sprayers. The aspartic systems are not the high build coating typical of the "hot spray" polyurea systems.

The typical aromatic polyurea systems must be processed through high pressure, heated plural component pumps and sprayed through an impingement type spray-gun. This is true also for the aliphatic version of this type of system, the primary difference being the color stability of the aliphatic systems.