Specifications and Polyurea Elastomeric Coating / Lining Systems

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Abstract:

Before a contractor / applicator can begin the necessary work of applying a polyurea elastomeric coating / lining system, some guidance or direction must be provided for the project. This information must be correct and understood as well as applicable to the current scope of work. While it seems that much of the information being provided in the polyurea industry is verbal or short written instructions, this is not the norm for the general coating / lining industry. Each coating / lining application project should be accompanied by a detailed coating / lining specification. A coating / lining specification is a written, legal document that details mandatory technical requirements of application work involving the use of these protective coating / lining systems, including polyurea systems. This document is crucial to the success of that coating / lining work. This paper will take a look at the major components of a coating / lining specification, show how polyurea technology fits and why it is important to follow that specification.

INTRODUCTION:

A good specification is the basic foundation of any construction, maintenance or coating / lining project. Without one, no one can be completely sure what work needs to be performed.

A particular project may have a general, complete specification where the coating / lining work is a kind of sub-specification within. This can and has resulted in problems especially when various trades are working in the same area as the coating / lining work. Often, a coating / lining specification has been prepared from a template of an earlier specification and many areas within that spec may be outdated or inappropriate for the current work.

For example, the coating / lining specification template may have been designed for a project that is in a dry, hot region and the actual work for the project in question is along the Gulf Coast region during the winter period. Simple template insertion into a new specification without review may lead to a coating / lining failure. This “cut and paste” approach is often used but omission, duplications or not meeting all the requirements of

the present work can been noted. Each project should require a specifically designed specification for the work and location involved.

Specifications must also address United States OSHA, EPA and local requirements for safety, exposure and possible emissions. This is one area of a specification that has been often overlooked or disregarded in polyurea coating / lining applications.

And of course, the most important with regard to polyurea coating / lining systems is the material selection. Is the polyurea system designed / suitable for the application area of the project specification.

Specifications are commonly prepared by the polyurea coating / lining system supplier and will be specific about the product they supply. Typically, an architect or engineer specializing in that type work, prepares specifications. However, clear communication between polyurea technology suppliers and these architects or engineers in necessary to insure that the polyurea technology is suitable for that type coating / lining work.

So in review, a specification provides for the following purposes:

- Obtain a specific desired polyurea coating / lining project
- Assure quality / proper polyurea material and workmanship
- Assure timely completion of work
- Avoid delays and disputes
- Insure minimal or reasonable costs for the work
- Inhibit costly change orders and claims
- Assure that all safety, environmental and legal requirements are met
- To assure that the polyurea coating / lining system is applied to the correct areas

COMPONENTS of a SPECIFICATION:

As noted earlier, a specification is basically an instructional document on how to proceed with a coating / lining application, much like a recipe is for cooking. The "General Guidelines: Polyurea Elastomeric Coating / Lining Systems" from the Polyurea Development Association is an overview, of sorts, of a specification guideline. This paper is not meant to teach one on the preparation of a specification, but to identify certain key areas within a specification that has led to some problems or issues with polyurea coating / lining applications.

There are three basic component of a specification:

- Part 1 – General
- Part 2 – Products
- Part 3 – Execution

Part 1 – General:

Scope of Work:

The General Section contains information related to a summary of the work to be performed. This would include type of coating / lining work to be performed, as well as type of polyurea and related products supplied to the project. This tells us exactly what we are going to be doing, and who will be doing it. This is referred to at the description of work.

I am reminded here of a major bridge coating project that at the onset of the specification preparation called for basic application of polyurea to concrete sections of the bridge. This initial scope was very broad and vague. No indication was made to the surface preparation that would be required; nor, to the fact that the "polyurea" would be in an outdoor, exposed sunlight situation. The only major criterion at that time was the resistance of the "polyurea" to the salt-water environment. When asked about the potential for bugholes, was the "polyurea" to remain bonded to the substrate and was color retention of the "polyurea" required; a change in the specification was immediately addressed.

References and Standards:

There will also be a section of reference material including all related documents for the specification / project. For coating / lining projects, this would include, but not necessarily limited to:

- American Society for Testing and Materials (ASTM)
- National Association of Corrosion Engineers (NACE)
  - would include Recommended Procedures, Standards
- The Society for Protective Coatings (SSPC)
  - Technical Updates, Visual Standards
- International Concrete Repair Institute (ICRI)
  - Technical Guidelines, Visual Standards
- Polyurea Development Association (PDA)
  - General Guidelines, Definitions
- Product Material Safety Data Sheets (MSDS)
- Product Specification Data Sheets

All of these documents will provide reference to testing that may be required on the product or once installed, i.e. adhesion, thickness, spark testing, etc. Other documents may outline required surface preparation standards and visual comparison for the substrate cleanliness. Polyurea product spec data sheets identify the product, performance / physical property results and application requirements. Material Safety

Data Sheets will identify the hazards associated with working the polyurea products and other related products.

Definitions:

It is also common to have a definition section with of terms that relate to the scope of work of the specification. These may include terms like bugholes, terminations, holiday, supplier, applicator, shelf life, etc. These would be terms that may be subject to different interpretation.

Since this paper focuses on polyurea coating / lining systems, a definition of polyurea would also be appropriate. If a specification calls for a polyurea system, then those products considered must be a polyurea system as defined by the Polyurea Development Association. Under this definition by the PDA, there are no provisions for a percentage polyurea, say 70% for example, only full polyurea systems.

Submittals:

This is an important area that is not always specified by the project owner. They are very important though so as to insure that the proper application / system is being used and the customer is getting what they paid for. The submittals should be kept to a minimum but give an indication of the appearance of the final polyurea coating / lining project.

Often, the common submittal will be actual sprayed samples of the polyurea coating / lining system or a small mock-up area. Care should be exercised here so that samples submitted actually reflect the end work appearance. For example, submission of small coupons of polyurea coating / lining that have a smooth / glassy surface are acceptable as long as the final coating / lining project with the polyurea system has a smooth / glassy finish. Often, the actual spray finish in a fast set polyurea spray coating / lining installation has "spray lines" that do not affect performance, even though they do not look like the submitted samples. As a result the "customer" may be unhappy with the work and may delay payment until some resolution or explanation is given.

Mock-ups are an important part of some major projects. It is important to note that these should be performed and approved **before** the polyurea coating / lining work begins. Mock-ups done after the project starts may result in application changes that are costly to the contractor / applicator and do not fall under a change order. Mock-up also provide for practice / experience outside the areas of the actual application site.

The following Figure 1 is an example of a small (20' X 20" area) over a geotextile fabric prior to proceeding with an EAP regulated polyurea spray landfill lining application.

Figure 1: Mock-up Area for Landfill Lining Application

Quality Assurance:

This section provides for quality assurance in the polyurea coating / lining work. Often, quality assurance in confused with quality control. Quality control is the physical portion of quality assurance. Quality assurance is that planned and systematic action necessary to provide confidence that the polyurea coating / lining work will perform as expected.

We use quality control to monitor materials, methods of application and workmanship to insure that the final polyurea coating / lining work meets the specifications. Often, quality assurance section may address contractor / applicator issues concerning experience in the particular coating / lining project area.

This is not to keep out certain contractors / applicators or polyurea system suppliers but to help insure that the polyurea product is being supplied and applied by those experienced with the specific material and procedures of application. This will help insure that the application is done correctly and in a timely manner. A recent polyurea lining project had a fairly sound specification but this was the contractor's first job. The polyurea lining phase of the project should have required 7 – 10 days to complete. After 3 months, the contractor was still on site performing some lining work. This can be a very costly proposition for the contractor, not to mention potential for coating / lining issues down the road.

Delivery, Storage and Handling of Materials:

As simple as it may seem delivery, storage and handling of materials for the project seems to be a major issue and is often overlooked. Smaller project may necessitate that the polyurea coating / lining system and related products be delivered to the contractor /

applicator location. This may be ideal for storage provided there is indoor warehouse space. This will then require that the product be transported back and forth from the site.

Larger projects may allow for the polyurea coating / lining system and related products to be delivered directly to the job site. This may be ideal from the contractor / applicator perspective but does not always allow for proper indoor storage of the materials. On a new construction site, the products may remain on pallets outdoors exposed to the environment. Depending on the temperature and weather conditions, this may not be good for the product. Keep in mind that the isocyanate component of a polyurea elastomeric coating / lining system may begin to chemically "freeze" at temperatures below about 70°F (25°C).

Materials must be stored properly as this could affect reactivity / cure, installation and performance in the polyurea coating / lining project. Materials must always be stored according to the manufactures / supplier's stated storage procedures.

Pre-jobsite Visit, Conference and Project Conditions:

Most of the major polyurea coating / lining projects will require a jobsite visit and conference as well as a review of the project conditions. Here, the scope of work can be reviewed as well as complete review of the specification and any issues that may exist. In many cases, these reviews and conferences may be held throughout the application procedure to monitor progress of the coating / lining work. Open communication is important to the success of a project and potential future work.

This allows for inspection of the site and conditions prior to commencement of the work. Conditions that might affect the work will be contained in this section. For example, the facility may still be in operation and the need to work around other trades could create some application concerns. Also included here will be the utilities available to the contractor / applicator as well as any safety and hazardous environments that may exist on site.

Also contained here may be information relating to any type of re-construction that may be required before coating / lining work in an existing facility. Special attention must be given to this area as to who will be responsible for this work and that it be completed prior to the start of the coating / lining work.

This section will also contain information concerning scheduling of the complete project as well as what other trades will be working in the area. If the coating / lining project runs over or other trades start in the same area, this could create some major delays in the coating / lining work. One such issue is having traffic in the area, as the coating is being applied or very soon after application. Figure 2 shows a nice aquarium-lining project that had exceeded the application schedule and the next trade erected scaffolding on the partially completed lining work.

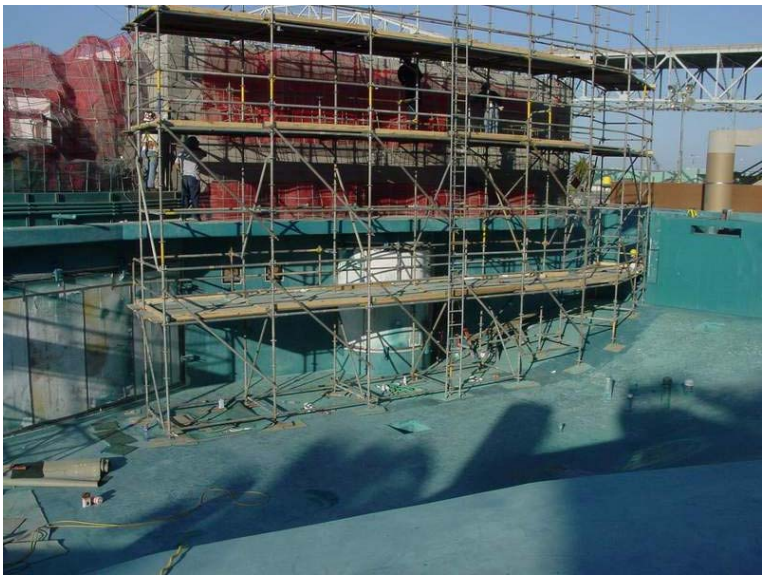

Figure 2: Scaffold Erection in Coating Application Area

One of the most important items in this section will also address safety and hazard issues associated with this project. This would include projects that require work in high spaces where fall protection is required. Also common for polyurea coating / lining projects is work in confined spaces. All of these safety issues are regulated by OSHA, EPA, NIOSH and local regulations.

As a contractor / applicator bidding on a project where the specification notes that confined space work will be done, the contractor / applicator is required to have all the necessary tools and equipment for doing that work. Failure to follow the confined space entry program for that work may result in a serious injury or possible death.

Part 2 – Products:

Now we get into the meat of what type of polyurea products may be required. This may include actual named polyurea product descriptions or a type of polyurea product based on certain performance characteristics. In many cases, a specific polyurea product is named or specified either due to past experience or certain qualifications the material has in the application area of the project specification. Keep in mind, not all polyurea systems are the same or are they created equal!

For example, in a potable water tank-lining situation, only polyurea systems that have the actual ANSI/NSF-61 approval may be used. They cannot be polyurea systems that meet the requirements of this approval; they must have the actual approval. These polyurea systems have undergone specific testing and extractability evaluations and carry

certification from either the National Sanitation Foundation (NSF) or Underwriters Laboratory (UL) here in the United States.

In another example, Polyurea System A was specified by the Department of Energy for gondola car lining work due to the high tensile strength of the material. These cars are used to transport low level nuclear waste. During application of the lining system, test samples were also sprayed to insure the polyurea system met the performance criteria noted in the specification. Evaluation of these samples gave the following results:

Table I
Polyurea System A: Reported / Specified Values vs. Tested Samples

Physical Property Value	Specified / Reported	Field Tested
Tensile strength, psi	3288	1625
Elongation, %	752	295
Tear strength, pli	494	215
Shore D Hardness	50	37

At first, one would say that the material has not been processed correctly hence the low physical properties. However, the system was processed according to the polyurea system supplier's recommendations. Another item to note with the project as well is that the contractor / applicator was also shipped small pails of another material to mix into the resin side of the polyurea system before application of the Polyurea System B. This "formulating in the field" has lead to numerous coating / lining failures.

From this application, the polyurea product being used does not meet specifications. While the application work should have been halted, all the lining work was continued and all cars within the scope of the project were lined. This could potentially lead to a serious failure of this lining work.

Section 2 also provides for information on related materials to be used with the primary coating / lining system. This would include items such as:

- Repair / resurfacing materials for concrete
- Primers to be used
- Topcoating systems
- Other products such as bughole fillers, aggregates, geotextile fabric

For the related products noted, you need to insure compatibility between the polyurea system and these products. With respect to primer system, one should insure that the primer will hold up to the conditions of the coating / lining project as well and that the window of re-coat over the primer is not exceeded.

The following example illustrates what will happen when a primer is used that is not suitable for the conditions or exposure in the coating / lining project. A good penetrating primer was used over a concrete pit area where constant immersion in an aqueous environment was present. When the polyurea lining system was applied, there were areas of incomplete coverage, i.e. voids and pinholes. The "water" was able to get through the polyurea lining, soften the primer system and resulting is major disbondment of the polyurea lining system. (Figure 3)

Figure 3: Disbonding of the polyurea system

Some related products might also include products that remove soluble salts from the substrate. These are very important items, especially in metal substrate coating / lining application. It has been shown that residual soluble salt contamination can lead to blistering / delamination of the polyurea coating / lining system. Proper application procedure of these products calls for a specific removal procedure before application of the polyurea system. If this is not followed, then failure of the coating / lining application can occur.

The following Figure 4 shows where a polyurea elastomer coating system was applied to a properly prepared aluminum substrate that had been treated with the soluble salt removal system. Failure to properly remove the soluble salt treatment system resulted in residual product on the substrate. This then led to easy delamination of the polyurea coating system.

Figure 4: Delamination of Polyurea of Non-removed Soluble Salt Treatment

Part 3 – Execution:

Now that we have identified the scope of the coating / lining work, and the products to be used, we are "ready" to move on to the installation. This section will detail all surface preparation that will be required as well as application of the polyurea coating / lining system.

Surface Preparation:

Surface preparation is crucial to the success of any coating / lining project, not just polyurea applications. It has been estimated that 70 – 80% of all coating / lining failures are due to poor or inadequate surface preparation. This is especially true with the polyurea coating / lining systems, due to the very fast reactivity and cure of the technology. Another major contributing factor has been the lack of experience by many of the polyurea coating / lining applicators in field environments.

In the case of steel coating / lining work, a form of abrasive blasting is commonly required to create a surface profile to allow for mechanical adhesion. This is extremely important in lining application work. Don not use a low-pressure water blast procedure as this may merely just "clean" the surface. Figure 5 shows a bolted wastewater storage tank lined with polyurea that failed within a couple weeks. Only a water wash technique was used and the polyurea applied over rust.

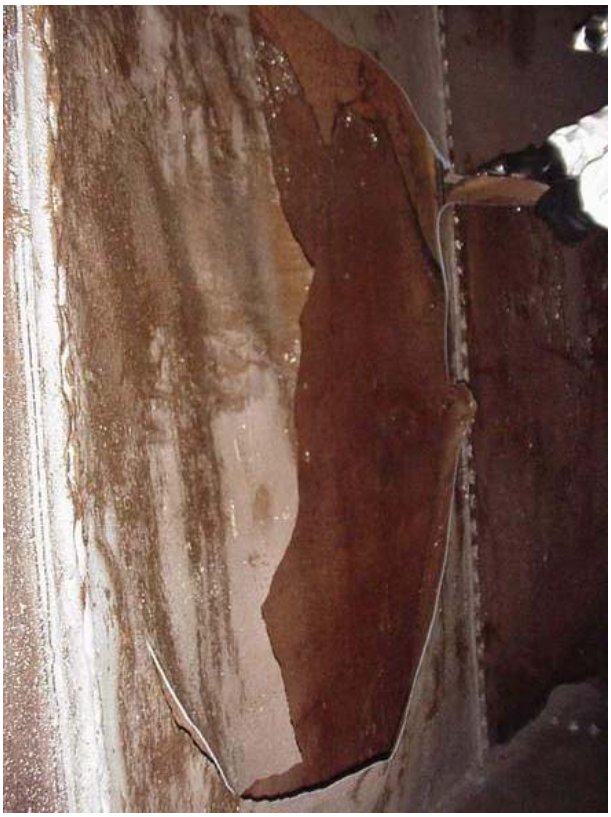

Figure 5: Wastewater tank lining failure

Many feel that concrete is an easy substrate to coat. However, concrete may be one of the most difficult substrates to encounter. It can be referred to as a living, breathing substrate that is porous and weak at the surface. This porosity allows for penetration of many contaminants that can wreak havoc on any coating / lining project if they are not removed. The surface can be very "dusty" and provides for a weak bonding surface.

There are different methods of substrate preparation for concrete that are based on the type of exposure, condition of the concrete and the type of coating / lining system being used. In all cases, the top laitance layer must be removed, as well as any contaminants within the concrete. Another very important issue to consider with concrete is moisture vapor emission through the concrete. This can potentially disbond and blister the best coating / lining system used.

Whatever the coating / lining project for concrete is, a simple sweeping of that substrate will not be enough. Figure 6 shows a failure of a polyurea system applied to a major casino parking garage where the surface preparation was a simple sweeping of dirt from the substrate, and no use of a primer.

Figure 6: Casino Parking Garage Failure

Another issue to face with concrete coating / lining work is bugholes and pinholes. If bugholes are not prefilled, or if pinholes exist in the coating / lining system, failures will occur. These voids, contrary to what some have noted in the polyurea industry, go completely through the coating / lining system to the substrate. This will allow liquid to get to the substrate and result in leakage or attack of that substrate. The ultimate result is failure. Figure 7 shows a failure situation in a concrete lift station lined with polyurea where numerous pinholes were present.

Figure 7: Lift Station failure

Polyurea Application:

Once we have addressed the specified surface preparation, it is time to apply the coating / lining system. This may first involve application of a primer system, followed by the polyurea coating / lining material and possible topcoating. Here, the specification will note the required minimum film thickness of the polyurea coating / lining system. On a recent polyurea lining project, there was some issue with the application work that called for an inspection of the site. One of the items monitored was applied film thickness of the system. This was then compared to the specified thickness. Table II notes the results of that evaluation.

Table II
Specified, Bid and Applied Polyurea Lining Thickness

Polyurea	**Specified, mils**	**Bid, mils**	**Applied, mils**
Base coat	80	50	80 - 140
Top coat	15 – 20	4 – 10	5 -20

Polyurea applied film thickness tested using POSITECTOR 100 Ultrasonic Gauge, ASTM D 6132

These results show that somewhere there may have been a misunderstanding of what the specification was for this project. Clearly the applicator has bid less than was specified but applied almost three times the amount of coating / lining system that was bid. This is due primarily to the applicator's lack of experience on this type of project.

This section may also note what other field quality control evaluation may be required. This could include adhesion testing as well as holiday or spark testing. Whichever the case, this must be done in a specified sequence. Figure 8 shows the spark / holiday testing of a polyurea lining system applied to concrete. This called for testing after the base coat of polyurea, but before application of the more expensive topcoating. However, testing was done after the application of the topcoating system and numerous holidays were found. This then required sanding off of the topcoat, reapplication of the base coat in some areas, direct treatment of some of the void areas followed by reapplication of the topcoating system. A very expensive and project delaying operation.

Figure 8: Spark Testing of a Polyurea Lining Project

CONCLUSION:

A coating / lining specification is a recipe or cookbook on how a coating / lining project should progress. It describes the quality of materials and method of construction as well as defining the amount of work. Just like in cooking, if a step is omitted or changed, one may not be completely sure of the outcome or result of that work. The owner, general contractor and contractor / applicator must be familiar with all sections of the coating / lining specification before the coating / lining work begins.

When properly prepared, the specification is like a road map for that well deserved vacation one might be taking. When followed, all seems to go well with only the minor issues that may come up. If a coating / lining specification is poorly written, or worse yet not followed, a coating / lining failure is inevitable. It may not be the polyurea product that failed, but it is a failure none the less and it hurts our industry.

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BIOGRAPHY:

Dudley J. Primeaux II

Dudley received a M.S. Degree in Organic Chemistry from Lamar University in Beaumont, Texas in 1984. He then joined Texaco Chemical Company - Austin Research Labs where he was involved in the development of rigid and flexible polyurethane foam systems and applications. It was under this area where he developed and first demonstrated the 100 % solids polyurea spray elastomer technology. In 1987 he joined the Performance Polymers Group where he has been involved in polyurea RIM and spray elastomer development and applications development of amine catalyst in polyurethane foam systems.

In 1994 following the sale of Texaco Chemical Company, Dudley became part of Huntsman Corporation. Here, he was a Research Chemist in the Thermoset Applications Group devoting his efforts to marketing and applications development of the polyurea spray elastomer technology. In October 1998, Dudley became Managing Partner / Chief Chemist with EnviroChem Technologies. Dudley was responsible for all formulation development for the *EnviroLastic*® polyurea product line and marketing of those systems and applications. He also interacted with the Certified Contractor Network on products and application techniques. Application equipment setup, training and servicing also fell under his responsibilities.

In November 2000, Dudley left the association with EnviroChem Technologies to pursue a personal consulting business, Primeaux Associates LLC. This work relates to the polyurea industry, equipment, application, inspection and training throughout the world. Dudley is also part of The Polyurea Training Group, specializing in training efforts relating to polyurea technology, equipment and applications.

Dudley is active in the National Association of Corrosion Engineers (NACE), SSPC: The Society for Protective Coatings and Past-President of the Polyurea Development Association (PDA). He is named inventor of 23 US Patents and 7 European Patents on polyurethane and polyurea foam applications as well as polyurea spray elastomer systems/applications. He also has 29 technical publications on the polyurea elastomer technology.