

FLUID-APPLIED WATERPROOFING SYSTEMS:  
A CASE STUDY OF KILEY GARDENS

By

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To my parents, especially my mother for all the love and support she has given me over the years. I know that she is proud of me, and in whatever I choose to do in life I know I will have success because I have her behind me. To Thomas, because my accomplishments never quite seem so amazing till he tells me so. I don't know what I would do without him. And finally to my dog Molly, for she will always look adoringly up at me and was there every day, sitting at my feet, while I wrote this.

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FLUID-APPLIED WATERPROOFING SYSTEMS:  
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The idea of waterproofing is presented here in terms of how it affects and influences sustainable construction, the environment, and human involvement through a study of liquid-applied waterproofing systems, in addition to a case study where a waterproofing failure has occurred. Waterproofing is an important element in the manufacturing process of a sustainable system and also is one of the most common forms of failure in a structure. In Florida, where humidity and water intrusion is a constant factor impacting the built environment, waterproofing systems become key to the longevity and subsequent sustainability of a structure, and once that fails the building will become uninhabitable soon afterwards.

By looking into the current trends of waterproofing systems in construction as well as doing laboratory testing, advantages and disadvantages between the latest synthetic rubber and polyester resin based products will be determined and also what sort of implications the product application has on the environment.

This study delves into the volatility and toxicity of liquid-applied waterproofing. Without such technology, green roofs, for example, would never have come to fruition. This idea has

been around for a couple of decades now and just recently has the technology actually been improved enough to sustain a green roof over a number of years.

To illustrate the process, a case study documenting the restoration project, Kiley Gardens in Tampa Florida, is included in this report. At that particular site there was inadequate waterproofing installed roughly 25 years ago and subsequently caused numerous problems to the structure beneath. This case study shows the relationship between old techniques of applying waterproofing and the technology that is now being used to rectify the problems caused by the original inadequacies.

## CHAPTER 1 INTRODUCTION

Advances in construction technology revolutionize the way things have been viewed and done for countless years. But new technologies sometimes create underlying problems while unobtrusively fixing the existing problem. The intent of this research is to take a deeper look into liquid-applied waterproofing systems and determine whether there is an underlying volatile toxic emission problem associated with this technology.

The advent of liquid-applied waterproofing systems has quickly changed the way water resistant membranes are viewed in the construction industry. The conventional methods of using commonplace materials for built-up membranes, such as tar-like bitumen are becoming obsolete when it comes to completely making a structure water-tight. A waterproofing system that is not monolithically applied typically has failures, either by initial application or migration of water over time through seams. The invention of liquid-applied waterproofing has eliminated many problems when correctly applied but little is known about what types of toxics are released during the application process.

Because a chemical reaction occurs to bond the liquid-applied waterproofing system to a substrate, certain questions must be asked in order to fully understand whether this product is harmless or not. During the time taken to apply the system, what are the types of emissions and at what level are they emitted? Do the emissions affect indoor air quality or the ozone when applied outdoors? Are the trained professionals that handle this type of product on a daily basis risking their health after long term exposure? Are there major differences in emissions between acrylic, polyester, and polyurethane based products or are they all similarly VOC (volatile organic compound) emitting products? And finally do the benefits outweigh the risks associated with the application?

Research on the chemical properties and application process will establish a basis to test for emissions of liquid-applied waterproofing. Testing will be done in a laboratory so as to control and negate outside influences; the results will be used to compare and determine whether a current project, used as a case study in this report, which is employing one of the liquid-applied waterproofing is better or worse than the other types, in terms of emissions.

The initial research on general waterproofing will introduce this topic, while more examination will continue by including a case study of the North Carolina National Bank Plaza, which is more commonly known as, and in this paper will be referred to as, Kiley Gardens in Tampa, FL. By intensely perusing the original drawings, historical reports, engineering reports, and approved drawings and specifications for the renovations, the waterproofing failures of the structure will be determined. Another main concern is, to determine with a minimal harm to the environment, whether the new plan will actually repair the issues for any real length of time. This case study catalogs the current trend of liquid-applied waterproofing as well the historic approaches to waterproofing, coupled with a look at the systems dependent on and affected by the waterproofing.

## CHAPTER 2 OVERVIEW OF WATERPROOFING

The term “waterproof” or “water-resistant” describes objects unaffected by water or resisting water passage, or which are covered with a material that resists or does not allow water passage. *Waterproofing* describes making an object waterproof or water-resistant, but in the construction industry that term is defined as the treatment of a surface or structure to prevent the passage of water under hydrostatic pressure. (National Roofing Contractors Association 1996)

There are many different ways and different materials that are used to waterproof parts of a building. The main concern discussed here is to understand the types of waterproofing systems used in below-grade situations, historically as well as recently. The information reviewed and presented here begins with the understanding of a basic sealant, delves into all types waterproofing membranes, and finally settles on the most current trends in waterproofing which uses solvent-based mixtures containing a base of urethanes, rubbers, plastics, vinyls, polymeric asphalts, or combinations thereof. (Kubal 1993)

### **Generic Sealants**

The best way to begin to understand the way a sealant works, prior to delving into a waterproofing system, is to briefly present how generic base components affect the classification parameters of waterproofing. When discussing generic sealants, there are certain classification parameters which determine suitability in particular applications. The parameters include the following:

1. Generic type
2. Cost
3. Movement capabilities
4. Curing mechanisms
5. Recovery properties (Panek and Cook 1991, p. 17)

## **Generic Type and Cost**

A major reason for so many different types of sealants is cost. (Panek and Cook 1991) It has been proven that a urethane sealant has high enough performance that it would suffice in most sealing applications, but because of its high cost it may not be necessary in all applications. (Panek and Cook 1991) Therefore many other generic based sealants have been developed to give the consumer a variety of choices for their basic sealing needs.

## **Movement Capability**

Movement capability is expressed as a + % value, the plus value indicating the amount of movement a sealant can take in extension in a typical joint, and the minus value the amount of movement a sealant can take in a compression in the same joint. (Panek and Cook 1991, p. 18)

For example, a sealant with a  $\pm 50\%$  joint movement capability has the ability to move 50% in either direction of compression or extension based on the original joint dimension.

## **Curing Mechanisms**

The three basic ways that a sealant cures is by oxidation, moisture activation, and by solvent release. Another factor that affects the cure is whether the sealant is one-part or two-part. Typically a one-part sealant is preferred because that eliminates the problem of getting a good mix. (Panek and Cook 1991) The only type of sealant that cures by oxidation is oil-and-resin, which becomes a very rigid material that offers little movement capability. Among the polymer types that cure by moisture activation are polysulfide, urethane, and silicone. And all the sealant types referenced in Table 2-1 that are solvent-based cure by releasing solvents, which could possibly create a problem of poor air quality. If solvent-based products are used in a large area such as in a waterproofing application then they could possibly affect the environment. This will be discussed in a later subsequent section.

Table 2-1. Typical Application Areas for Generic Sealants (Panek and Cook 1991, 19)

Generic Base	Typical Uses
Oil	Small wooden window sash
Oil and Resin	Metal windows
Butyl Noncuring	With polybutene for metal buildings, slip joints, interlocking curtain walls, sound deadening, tapes
Butyl Curing	Home sealants, repair of lock-strip gasket, tapes: with resins for hot melts on insulating glass
Polyisobutylene	Primary seal on insulating glass
Asphalts	With bitumen on gutters, driveway repair; with neoprene on gutters, waterstops, and adhesives
Acrylic Nonplasticized	Water-based for interior-use joints on wallboard
Acrylic Plasticized	Caulks for exterior joints on low-rise housing, with good movement capabilities, excellent weathering
Acrylic Solvent-based	Exterior joints on high-rise construction, around doors and windows with low movement
Block-polymer Solvent-based	For low-rise buildings with good movement
Hypalon Solvent-based	Exterior joints on high-rise construction, around doors and windows
PVC-coal-tar	As a hot melt on airfield runways and highways
Polysulfide One-part	High-rise building joints
Polysulfide Two-part	High-rise building joints, aircraft fuel tank, boating, insulating glass sealant for remedial housing; with coal tar for airport aprons
Urethane One-part	High-rise building joints
Urethane Two-part	High-rise building joints, insulating glass sealant, with coal tar and asphalt for membrane waterproofing compounds
Silicone One-part	Low and medium modulus for high-rise building joints; low modulus for highways and difficult building joints; medium and high modulus for insulating glass with polyisobutylene; structural glazing; home use as bathtub caulk
Silicone Two-part	Mostly in-plant use on prefab units and insulating glass
Neoprene	Fire resistant gaskets, lock-strip gaskets, foam gaskets
EPDM	Gaskets, lock-strip gaskets, foam gaskets
Nitrile Solvent-based	For small cracks and narrow joints
Epoxy	Concrete repair, complex beam construction; potting, molding, sealing transformers; high-voltage splicing, capacitor sealant; with polymers as a concrete coating on bridges
Polyester	Potting, molding, and encapsulating

## **Recovery Properties**

Once a sealant has cured, through whichever method, their recovery properties are affected. Recovery is a term used to describe the shape that a sealant is in after the release of compression or extension, which is also shown as a  $\pm$  percentage like movement capability. Sealants cured through a solvent-release method are hard and exhibit poor recovery. Ones cured by moisture evaporation, become a tough rubber-like consistency with a relatively low recovery. But some sealants, such as silicone or urethane, that are highly plasticized or catalyzed exhibit fair-to-excellent recovery. (Panek and Cook 1991)

## **Waterproofing Membrane Systems**

Waterproofing systems for foundations developed out of the technology for generic sealants and the only difference is that it is applied over a larger area. Tests have been developed to investigate certain characteristics of a sealant as well as a large membrane system. These characteristics are important in explaining the performance of waterproofing and helping a consumer in deciding what type of sealant is appropriate for what type of application.

The following is a partial list of what waterproofing membranes are tested for:

- Movement capability
- Solids content
- Resistance to heat aging
- Tensile adhesion
- Resistance to water
- Modulus of elasticity
- Abrasion resistance
- Color retention
- Hardness
- Percentage of weight loss after heat aging
- Resistance to weathering
- Adhesion-to-peel
- Tear resistance
- Solvent and chemical resistance
- Toxicity
- Staining of masonry and building surfaces

Historically, built-up sheet membranes have been used for waterproofing foundations and below-grade structures. Felts and rubber type sheets are laid down in a tar-like substance and the process mimics the way a roof is waterproofed; mopped on in several layers. They can be categorized into three types according to the application method: hot applied, cold applied and fluid applied. (Maslow 1974) Hot applied refers to a tar-like product that is mopped on from a heated kettle. Cold applied refers to a rubber or plastic sheet type product that is adhered to the substrate either only at the edges or the entire membrane. Fluid applied membranes are sprayed, brushed, troweled or squee-geed on to produce a cured film. The liquid is spread on a number of times to build up a monolithic membrane. (Maslow 1974)

A fluid applied waterproofing membrane should be applied to a relatively smooth surface, but not necessarily a steel troweled finish. A rough or uneven surface takes a greater amount of fluid membrane to fill all voids. (Maslow 1974, p. 464)

Most any type of substrate can be covered by a fluid applied waterproofing system but under no circumstances is light-weight aggregate concrete permitted, since vermiculite or other blown aggregate holds large quantities of water, which never dries out and causes extensive adhesion loss in the membrane over time. (Panek and Cook 1991)

Fluid applied systems are available in the following derivatives and are shown in Table 2-2: urethane (single or two-component), rubber derivatives (butyl, neoprene, or hyphalon), polymeric asphalt, modified urethane (water-based polyurethane), acrylic resin, PVC, and hot applied systems (asphalt). (Kubal 1993) The most common types of membranes are: Built-Up Bituminous Membranes, Vulcanized Elastomers<sup>1</sup> (Thermosets<sup>2</sup>), Nonvulcanized Elastomers...

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<sup>1</sup> *Elastomer*: a polymer with the property of elasticity – usually thermosets can be thermoplastic – monomers included are carbon, hydrogen, oxygen, and/or silicon

<sup>2</sup> *Thermosetting Polymers*: polymer materials that irreversibly cure – (toughening or hardening of polymer material by cross-linking of polymer chains, brought about by chemical additives, ultra-violet radiation, electron beam or heat. For rubber it is called vulcanization.) Thermoset materials are usually liquid or malleable prior to curing and designed to be molded into their final form, or used as adhesives.

Table 2-2. Comparison of Waterproofing Membranes (Compiled from Monroe 1990, p. 8-9)

Type	Format	Description	Assembled on-site	Advantages	Disadvantages
Built-Up Bituminous Membrane	Sheets	Two or more plies of felt, which is saturated with bitumen (asphalt or coal tar pitch)	By bonding each ply together with alternating layers of bitumen		Reflective cracking, Low elongation properties, Deteriorate when exposed to standing water
Vulcanized Elastomers (Thermosets)	Sheets	Elastomeric. Polymers undergo chemical cross-linking during manufacturing: ethylene propylene diene terpolymer (EPDM), neoprene (CR) and butyl (IIR)	Large manufactured sheets are applied directly to substrate and spliced to the next	Excellent weathering properties, High elongation, Good puncture resistance	Sheets are difficult to splice together, field splices are not warranted
Nonvulcanized Elastomers	Sheets	Polymeric sheets not cured (vulcanized) during manufacturing and are usually reinforced with a polyester mat	Small manufactured sheets are applied directly to substrate and spliced to the next	Can be heat welded in the field	Small sheet size results in many seams, Plasticizer loss, Embrittlement
Thermoplastics	Sheets	Compounded from rigid plastics (PVC) and made flexible by the addition of plasticizers, can be reinforced with glass fiber or polyester mats	Large manufactured sheets are applied directly to substrate and heat welded to the next	Low water absorption, Good elongation, Good puncture resistance	Plasticizer loss, Embrittlement
Modified Bituminous Membranes	Sheets	Bituminous sheets modified with synthetic rubbers to improve flexibility, elasticity, and cohesive strength of bitumen	Small manufactured sheets are applied directly to substrate and spliced to the next	More flexible than traditional bituminous membranes	Installation sensitive to site conditions, Small sheet size results in many seams
Hot-Applied Rubberized Asphalt Membranes	Monolithic	Compound of virgin or reclaimed rubber dispersed in asphalt with oil and mineral fillers	Melted in a kettle and applied once hot to form a continuous membrane	No seams	Reflective cracking, Lack of flashing accessories, Quality sensitive to workmanship
Cold-Applied Liquid Membranes	Monolithic	Emulsion or solvent-based liquid polymeric compound that combine one or more of the following: coal tar pitch, modified asphalt, various resins or elastomers (polyurethane)	Single or two component liquid is mixed and applied over substrate to form a continuous membrane	No seams	Reflective cracking, Lack of flashing accessories, Quality sensitive to workmanship

Thermoplastics<sup>1</sup>, Modified Bituminous Membranes, Hot-Applied Rubberized Asphalt Membranes, Cold-Applied Liquid Membranes.

Asphalt and rubber derivative systems are the oldest technology and the least effective over time in most situations, but in comparison to all the rest they are still the most cost effective, which is what keeps these products around. Urethane systems have the most elastomeric capabilities and have good resistance to most chemicals found in below-grade conditions. (Kubal 1993)

The polyurethane systems are comparable to the formations of urethane sealants. A typical two-component elastomeric membrane contains a urethane prepolymer, blended with a small percentage of an isocyanate<sup>2</sup> as one component; the coal tar oil, catalysts, and drying agents to inhibit moisture are packaged as the other components. (Maslow 1974, p. 469)

Table 2-3 shows two of the same type of waterproofing systems but with chemical different bases.

Table 2-3. Physical Properties of Coal Tar Elastomeric Waterproof Membrane (Source: Maslow 1974, p. 47)

Physical Properties of Polysulfide--Coal Tar Elastomeric Waterproof Membrane		Physical Properties of Polyurethane--Coal Tar Elastomeric Waterproof Membrane	
Tensile Strength	100 psi	Tensile Strength	50 psi
Elongation	900%	Elongation	600%
Modulus at 100%	20 psi	Modulus at 100%	10 psi
Modulus at 300%	40psi		
Shore A hardness	12	Shore A hardness	25
Solids Content	100%	Solids Content	100%
Permeability rating--(50 mils)	0.007 perms	Permeability rating--(50 mils)	0.110 perms
Resistance to fungus and bacteria	Excellent	Resistance to fungus and bacteria	Excellent
Cure time	72 hrs.	Cure time	72 hrs.

<sup>1</sup> *Thermoplastic Polymers*: turns into a liquid when heated and freezes to a very glassy state when cooled sufficiently. Ex. Polyethylene and polystyrene

<sup>2</sup> *Isocyanate*: is the functional group of atoms –N=C=O (1 nitrogen, 1 carbon, 1 oxygen). An isocyanate that has two isocyanate groups is known as a diisocyanate. Diisocyanates are manufactured for reaction with polyols in the production of polyurethanes.

It must be stated here that historically, coal tar was used in this type of application but according to the website of the International Agency for Research on Cancer, preparations that include more than 5 percent of crude coal tar are a Group 1 carcinogen. Coal tar is a by-product of the carbonization used to produce coke and/or natural gas. Coal tar creosotes are distillation products of coal tar, while coal tar is a residue produced during the distillation of coal tar. Coal tar pitch volatiles are compounds given off when heated, from products containing coal tar (US Dept of Health 2002), such as the waterproofing systems developed in the past. Such hazards have been documented, but on the Occupational Safety and Health Administration (OSHA) website it states that OSHA “has not established a substance-specific standard for occupational exposure to coal tar pitch volatiles (CTPVs). Exposures are regulated under OSHA's Air Contaminants Standard. Employees exposed to CTPVs in the coke oven industry are covered by the coke oven emissions standard” but not in the construction industry. Coal tar traces can still be found in waterproofing products today, but some will specifically state that they are coal tar free.

Other than conveying an historic view on waterproofing components, Table 2-3 does show that fluid-applied systems have elastomeric properties with tested elongation over 500 percent, with recognized testing such as ASTM C-836. This enables fluid applied systems to bridge substrate cracking up to 1/16 inches wide. An advantage with fluid-applied is their self-flashing installation capability. This application enables material to be applied seamlessly at substrate protrusions, changes in planes, and floor—wall junctions. (Kubal 1993)

### **Positive vs. Negative Side**

Waterproofing in below-grade applications can be referred to as negative side or positive side. This reference concerns which side of the structural element the system is installed. Positive

side waterproofing is an application where the source of hydrostatic pressure<sup>3</sup> or water and the system are both on the same side. Negative side waterproofing is an application on the opposite side of the structural element that the hydrostatic pressure is exerting. Basically, in most instances, if there is a CMU block foundation wall for a typical basement, the waterproofing system would be applied on the outside of the house if it is ‘positive side’ and on the inside if it is ‘negative side’.

Field observations indicate that coating or barrier systems applied to the ‘positive side’ perform quite well, presumably because the hydrostatic pressure pushing on the system tends to keep the system in place without allowing the concrete behind it to become excessively damp. Coating systems applied to the ‘negative’ side are often unsuccessful after a time since they tend to disband and then leak if any amount of hydrostatic head later develops... (Pratt 1990, p. 138)

This study focuses on positive side liquid-applied waterproofing systems used in green building roof applications. The positive side waterproofing barrier system is put in place to eliminate or mitigate water intrusion into the substructure of the building and this waterproofing is usually inaccessible after installation. It is now the predominant type of waterproofing used in new construction and consists of all commercially available dampproofing or waterproofing systems. Properly applied positive side waterproofing protects the interior of the facility from moisture infiltration and protects the structural components, including concrete and steel.

(D’Annunzio 2006)

Positive side waterproofing is important mainly for the fact of protecting the structural elements that are susceptible to deterioration when exposed to water and other harmful corrosives. Water (in either vapor or liquid form) will leak or pass through concrete, because it is a porous material, and “in the process it will frequently pick up soluble salts (chiefly sulfates)

---

<sup>3</sup> *Hydrostatic Pressure*: the pressure equivalent to that exerted on a surface by a column of water of a given height. Water exerts a pressure of 62.3 pounds of force per foot (1000 kg per meter) of depth. Therefore, water lying against a barrier exerts a steadily increasing pressure as the depth increases. (National Roofing Contractors Association, 1996)

which dry white when the solution reaches the surface or the concrete; this deposit is termed ‘efflorescence.’ In the process of going through the concrete and picking up soluble salts, the water also will carry ions, which not only attack the concrete but will also attack the steel reinforcement in concrete.” (Pratt 1990, p. 137) Prevention with waterproofing is the only method of addressing this problem.

**Advantages and Disadvantages of Fluid-Applied Waterproofing Systems**

Many of the afore-mentioned waterproofing systems have their advantages and disadvantages, as listed in Table 2-2, but since this study is focusing on liquid-applied systems, it must delve deeper into that specific topic. Table 2-4 lists the major advantages and disadvantages of a monolithic fluid-applied system.

Table 2-4. Properties of Fluid-Applied Systems (Source: Kubal 1993, p. 23)

Advantages	Disadvantages
Excellent elastomeric properties	Application thickness controlled in field
Ease of application	Not applicable over damp or uncured surfaces
Seamless application	Toxic chemical additives

The use of fluid-applied elastomeric systems offers many advantages. They have excellent adhesion properties and provide continuous watertight protection that is fully bonded to the substrate, preventing the lateral movement of water beneath the membrane. (Monroe 1990, p. 122)

Other advantages include: flexible through a wide range of temperatures, light in weight and therefore requiring no added structural support to accommodate the system, typically vapor permeable which allows water to escape from the concrete slab over time, and their elastomeric properties allow for seamless bridging of gaps or cracks within certain limits.

Of the disadvantages, continuous adhesion to the substrate is characteristic of these membranes and therefore puts them in danger of reflective cracking and resultant leakage if proper precautions are not installed (Monroe 1990). Another disadvantage is the fact that

application is controlled in the field. It becomes very difficult to control the thickness of the fluid when applying it in layers.

One other less-used system is a sheet membrane that is supplied in rolls of approximately 3 or more feet in width and 60 mils in thickness. This rubbery sheet is either spot adhered or laid down using an adhesive. The advantage of this system is that it guarantees a fixed thickness. The disadvantages are that it may allow water to flow under the sheet and that it is very difficult to conform to columns, protrusions, corners and cant areas; therefore, skillful installation is needed to make the system work properly. (Panek and Cook 1991, p. 258)

Similarly, the product that was used 20 years ago at Kiley Gardens, a polymer-modified bitumen sheet membrane allowed roots to penetrate at the seams and created a major water intrusion problem to the structure below. An upgrade for this structure involves excavating to the old waterproofing, stripping it, and applying a new monolithic, solvent-based fluid system.

Unfortunately for the progression of waterproofing, these systems contain solvents which make the materials toxic and hazardous, which require safety protection during installation and disposal, and become topic of discussion for environmentally friendly groups. (Kubal 1993)

Better understanding of the chemical make-up of all the material options available for waterproofing the substrate of a large outdoor park will show what type and how bad toxic emissions might be for the environment and to the person doing the application. Until this point, little testing has been done on the toxicity of these materials and its impact on the environment and the user. One resource even states “the toxicity of sealant materials is not a major problem.” (Panek and Cook 1991) The rest of this study will discuss specific characteristics, including the toxic volatility, of typical waterproofing systems used in a below-grade, positive side applications that are on the market today and look at what is being implemented at Kiley Gardens in Tampa, FL.

## CHAPTER 3 METHODOLOGY

In order to understand liquid-applied waterproofing in terms of hazardous emissions during the application process, research and testing is done on the material. Once the waterproofing systems have been analyzed on a material basis, the application process is then observed and the impact of the application process on the material's performance will be determined. All of this data will be used to relate back to the information collected from the Kiley Gardens case study. The obtainment of information for Kiley Gardens is recorded below.

In attempts to completely understand Kiley Gardens, so as to make it a conclusive case study, research began with traveling on October 10, 2008 down to Tampa Fl to visit Skanska, the construction management firm on the project, and obtain all the current construction documents including specifications and photos of the current condition as well as past photos dating back to May 2008. Actual field observations of the project were made every weekday between the dates May 12, 2008 to August 15, 2008 in addition to the October 10, 2008 visit.

From that trip, contact was made via email with Michael DeMeo from RS&H, the engineering firm, to set up a meeting date for October 24, 2008 so that available copies of the historic original drawings that they were able to obtain from the Harvard library could be studied.

From the 200+ drawings that RS&H had collected, fifteen were found that showcased the overall structure, and important details illustrating the original waterproofing specifications. In addition to the original drawings, a copy of the historical evaluation of Kiley Gardens that was done for RS&H by Pressley Associates, Inc., which catalog the intent of the project and contained some important information about the original ideas surrounding the downtown of Tampa, Florida was obtained.

Walter P. Moore, another engineering firm associated with the project, conducted an extensive survey of the parking garage structure located underneath Kiley Gardens and analyzed the effects of the waterproofing failure.

Laboratory testing will be used to determine the volatile content and volatile organic compound content of three different liquid-applied waterproofing products: a polyurethane base, polyester base and another type of synthetic rubber base. The information found from this testing will be used to compare to the waterproofing system being used to restore Kiley Gardens, which will determine whether it was the best choice in terms of the type used in a below grade application as well as the amount of solvents released during application. Since the entire project is outdoors and the concentration of possible toxics become quickly dispersed, the conventional way of testing for emissions will not work. Controlled laboratory testing is the only other way to obtain accurate results. A relatively small sample of the three types of waterproofing was obtained to conduct the testing. The results will be compared and contrasted in terms of the volatile content (ASTM D 2369) and the volatile organic compound content (ASTM D 3960), as well as discussing volatile organic emissions testing (ASTM D 6420 and ASTM D6803).

In summary, the methodology used for the rest of this study is two-fold: extensive research of information for Kiley Gardens to determine the cause and impact of the waterproofing failure and laboratory testing to determine hazardous volatility for individual waterproofing materials, one of which will be used in the repair process.



Wolf used this type of thinking to determine the radius of the tower, floor heights, dimensions, and the frequency of the window openings. The idea then became to extend the fenestration pattern of the tower, based on the Fibonacci pattern, to the plaza so that the buildings would seamlessly sit within the landscape. Dan Kiley agreed to the plan and incorporated the same proportions into the dimensions of the walkways and of the precast pavers. Shown in Figure 4-2 is an image taken once the plaza was completed which conveys a whimsical secret garden feeling within the structured pattern underfoot.



Figure 4-2. Photo circa 1996 (Source: The Cultural Landscape Foundation 1996)

As an influential modern landscape architect during his time, Dan Kiley was influenced additionally by the Moorish revival Tampa Bay Hotel, which is now Plant Hall on the University of Tampa campus and can be seen from the plaza across the Hillsborough River. Elements in the park serve as modern interpretations of the Eastern influence as well as appearing as a Persian carpet when viewed from some stories up in the tower. The intent was to release people into space, for them to experience a markedly different perspective and place than anywhere else in the rest of the city. This concept for Dan Kiley acted like the ancient Persian concept of paradise,

which is a derivative of the Persian word for walled garden, 'pairidaeza'. Typical Persian gardens have a water source which starts in the center and flows toward the four cardinal directions. Kiley Gardens incorporates the water source within its stringent geometrical design and designed runnels to extend the length of the park to carry water to the glass bottom canal. Figures 4-3, 4-4, and 4-5 show the results of a study done by Pressley Associates Landscape Architects; they illustrate the original design, as well as the additions, and demolitions.

### **Current Site Analysis**

The trees that were on the site were comprised of Sable Palm and Crape Myrtle. The white and purple Crape Myrtle trees were removed in 2006, following the series of hurricanes that swept the area and in preparation for repairs to the parking garage. The three reflecting pools located on the lower plaza area were demolished and turned into a vehicular turn around in 2000. Also in 2000, the glass bottom canal was also removed and concrete bleachers were added to serve as a retaining wall for the upper plaza and almost 7 foot elevation change. The water to the runnels and fountains were shut off at that time and the two reflecting pools that were on either side of the parking garage entrance had gravel added to them. The non-historic additions are shown in Figure 4-4.

Most of Kiley Gardens has been retained as is over the years, including the amphitheatre and other ponds, but when the next round of renovations occur, another portion of Kiley Gardens will be lost. Since the park is such a labor intensive piece of land to maintain, it has almost always been neglected and now the water functions will not be fully restored and a large portion of the precast pavers have been cracked due to settling and general neglect and will need to be removed. Casting new pavers is an expense that the City of Tampa cannot afford at this time. Shown in Figure 4-5 is the conditions of the site, before demolition to the Tampa Museum of Art and new construction has begun.



Figure 4-3. Missing historic features of Kiley Gardens (Pressley Associates 2007)

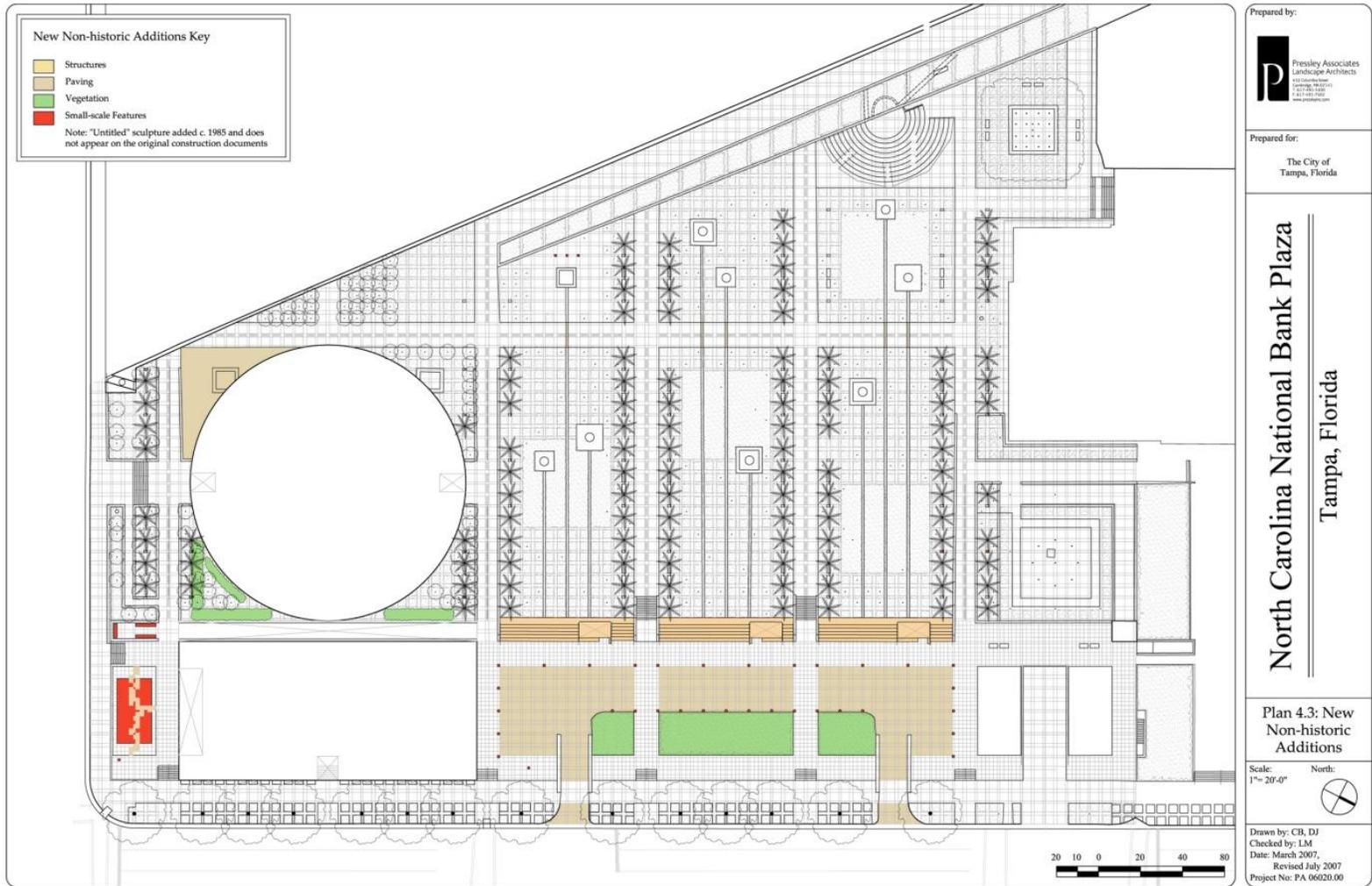


Figure 4-4. Highlighted non-historic additions to the site (Pressley Associates 2007)

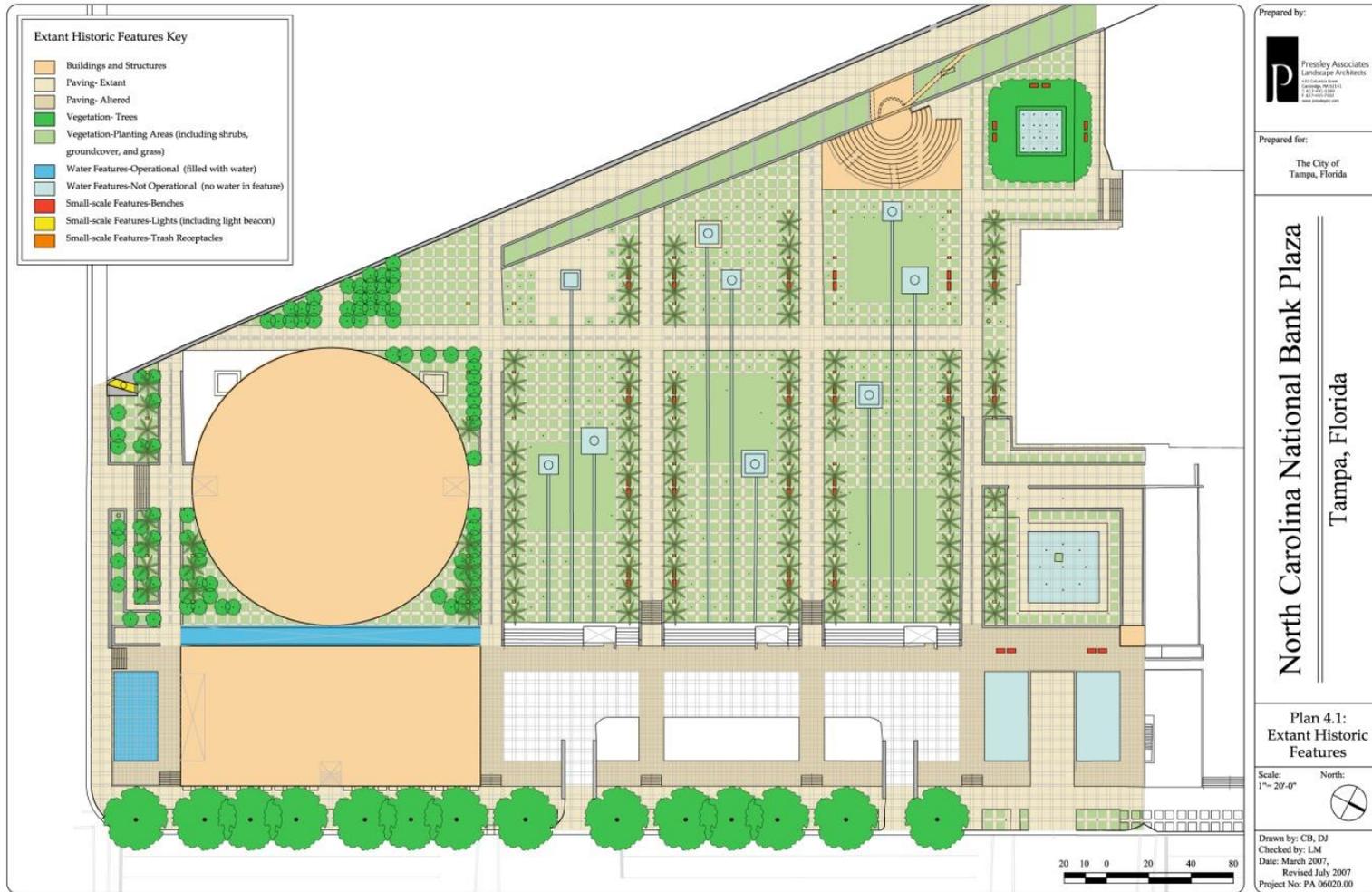


Figure 4-5. Kiley Gardens as of year 2007 (Pressley Associates 2007)

As of May 2008, the park is almost unrecognizable. Figures 4-6 through 4-9 show the park right before construction begins to repair the waterproofing to the structure beneath. This is an extensive process involving removing all of the vegetation, pavers, concrete elements, and dirt in the structure and basically starting from scratch, from the Kiley Gardens standpoint.



Figure 4-6. View from on top of the amphitheatre



Figure 4-7. Extent of neglect after crape myrtles were removed



Figure 4-8. Amphitheatre



Figure 4-9. Portion of the plaza not owned by the City of Tampa and maintained as a part of the towers grounds. Rest of neglected Kiley Gardens shown in the distance

In the following section, the final reiteration of Kiley Gardens is discussed and shown in Figure 4-10, which is an analysis done over Figure 4-4 after reviewing the latest construction drawing and interpreting what the site will finally look like.

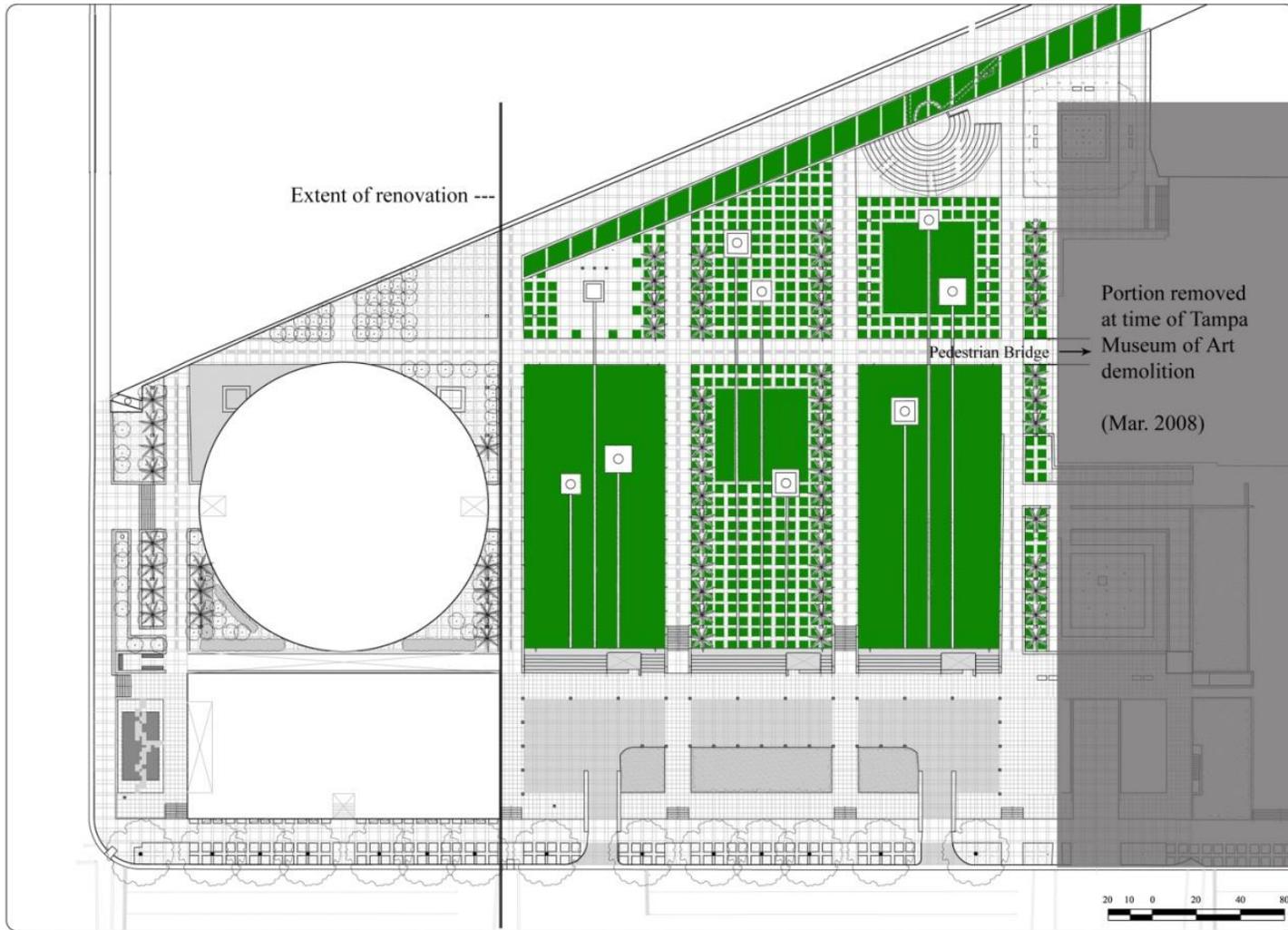


Figure 4-10. Kiley Gardens once the latest renovations are completed

## Final Site Analysis

Over the years, many changes have been made to the site, and after the latest construction Figure 4-10 shows what the site will look like. The fountains will be replaced in their original location but water will not flow to them. The five reflecting pools in the front of the site are now all filled in or removed and the final two ponds were demolished to make room for the re-routing of the garage entrance by extending Twiggs Street along the side of this site. The original intent of having a water source is no longer feasible and has taken away a significant importance to the design little by little every couple of years.

Most of the precast pavers had been cracked and could not be put back to their original location, so the site design was modified to accommodate for paver harvesting without needing to cast new ones, which was a cost that the City of Tampa could not justify spending. This will also cut down on the maintenance, as every paver has to be edged around. These two large sections will now act as more of a lawn which will also work cohesively with the new Curtis Hixon Waterfront Park (CHWP). As well as design linkage, there is physical linkage of the two parks; a new pedestrian bridge has been added to the north side of Kiley Gardens which connects to the main north/south walkway and traverses over the new Twiggs Street road into CHWP.

Which leads to the waterproofing upgrades; the extent of the latest construction is shown in Figure 4-10 and will not include the portion that the tower sits on. The original project was done in two phases: the tower portion and then the garage and there is a large expansion joint that connects the sections together which is getting new sealant in addition to the waterproofing upgrade. The rest of the issues concerning this structure is documented in Chapter 5 and thoroughly explains the reason for the renovations after only twenty five years.

Kiley Gardens has become a modern influential piece of landscape architecture and is most likely to be considered for the National Registry of Historic Places. Since the plaza is only

twenty five years old, the Register will not recognize the place as historic, at the moment, because it does not meet the historic criteria of 50 years. But the site does meet the other final criteria: exemplary significance at the state, local, or national level.

## CHAPTER 5 KILEY GARDENS: WATERPROOFING ISSUES

Kiley Gardens has only been in existence for approximately twenty five years and already is in need of serious repair. If the site is ever to become a historic landmark, then improvements had to be made in order to preserve the structure for longer than another 25 years. Already in danger of becoming structurally compromised by the failure of the waterproofing if the structure was left to deteriorate of its own accord without any intervention, the City of Tampa took control of the situation when it finally became necessary. Rectifying the problems at this stage will hopefully halt the deterioration, and solve the current nuisances caused by the water intrusion.

More than one issue will be addressed and documented in this report of Kiley Gardens and its waterproofing failure. A combination of systems and overall design problems have resulted in the structure deteriorating into the state it is in today. Minor attempts have been made to lessen the water intrusion problem by the owners of the garage, which is documented as well, but as only a temporary fix the attempts were fruitless. The only way to solve the problem is to go to the source, and the only way of going to the source is to understand the problem and subsequently determining its source.

Although a thorough survey and report was done by an engineering firm of the entire property before construction started, what is presented here is a personal account of the case and does not draw from the engineering survey.

### **Issue1: Waterproofing Membrane**

Historically, a modified bituminous waterproofing membrane has been the most cost effective, but in terms of a long term waterproofing solution, it offers almost no protection against water penetration. The system is manufactured in small sheets, and although application is easy enough because the sheets are elastomeric and requires nothing other than a clean, dry

substrate to adhere to, the system acts more like a proverbial waterproof bandage, adhering for awhile and then starting to peel around the edges over time when things start interacting with it. This is precisely what occurs to a bituminous membrane when it sits in water over time; it is made to repel when it comes in contact with water, but only for brief periods of time, not every second of every day for a number of years.

Modified bituminous membranes were a standard in the waterproofing industry over 20 years ago, and even though liquid-applied waterproofing was around, it still remained the more expensive choice and it was not known whether its material properties made it the most suitable for green roof applications.

A monolithic waterproofing system is far more superior to sheet membranes because of the obvious elimination of seams. Water has a vantage point for intrusion from the very beginning with numerous seams in the system, mainly because they are done by hand and human error can play a factor in failures. The seams are also a vantage point for root intrusion from the various plants that are placed in the ground near the waterproofing. Over just a short period of time, roots can easily penetrate the modified bituminous sheets and provide a big enough amount of space for more water to intrude.

The original specifications for Kiley Gardens called for the modified bituminous membrane Bituthene® as the main and only waterproofing material used on the structure as shown in Figure 5-1 and in Figure 5-2.

Once the original waterproofing was unearthed, it was obvious that it was not doing any sort of waterproofing as was originally intended, and merely looked as if someone had buried trash. Clearly shown in Figure 5-2, the outer layer of the membrane had wrinkled from the amount of moisture it had been subjected to over the years, as well as the root intrusion.



Figure 5-1. Modified Bituminous Membrane Sheet Bituthene® from Kiley Gardens (10-10-2009)



Figure 5-2. Bituthene® from Kiley Gardens with clear root penetration and deterioration

When determining how much water intrusion the structure sustained, a metal panel was removed from a portion of the amphitheatre and the underside of the panel was completely rusted and even the concrete from the planter was wet, after twenty five years. Figure 5-3 and a closer image in Figure 5-4 show the extent of the deterioration. The concrete appeared to have been slowly, gravitationally drawing the water that had been sitting in the planters to the metal

panels and subsequently severely corroded them. The hope is to stop this type of corrosion in the rest of the structure.

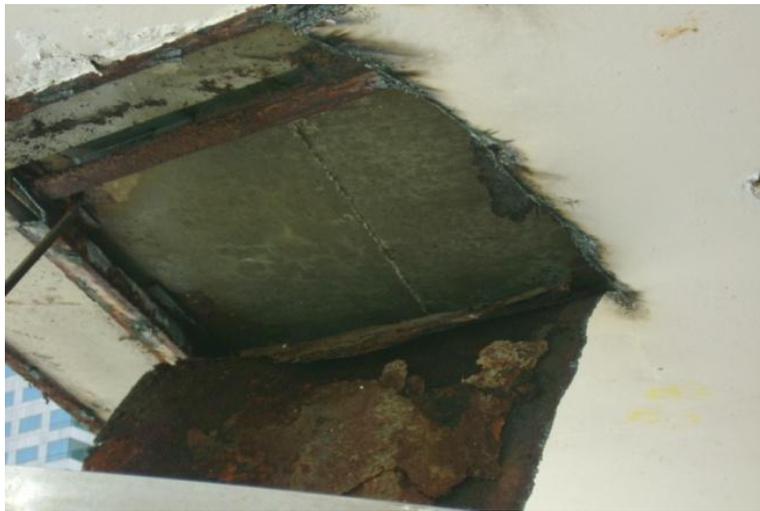


Figure 5-3. Removal of a metal ceiling panel at the amphitheatre



Figure 5-4. Detail of a welded seam at the amphitheatre

### **Issue 2: Drains and Plumbing**

The drains installed within the cells are the type that allows for only water to drain and did not take into the account that dirt might accompany the water as it drained. Subsequently the drains and the plumbing became clogged with dirt over time and therefore could not drain the cells properly. The plumbing for the fountain features, as shown in Figure 5-5, were inadequate

to deal with dirt and became damaged and ineffective over time and cannot be easily replaced or repaired. The scope of this project will not fully restore the fountains. They will be put back in the original location, but water will be absent. The original design had water running from the round pools, which were pumped with water from beneath and then spilled over the side into runnels which ran down the length of the park.



Figure 5-5. Unearthed fountain feature from Kiley Gardens

The extent of the plumbing issues is more clearly seen from underneath Kiley Gardens, inside the parking garage. At the junctions, where the plumbing from the cells came together, leaking almost always occurred since they were clogged with dirt. Leaking occurred from the piping at the intersection of each column as shown in Figure 5-6 by the presence of efflorescence.

At some point in the past, at a couple of the column intersections, quick fixes for overflow were installed and can be seen in Figure 5-7. Presumably the leaking was much more significant than what is shown in Figure 5-6, but even these drain lines that were installed off of the plumbing did not solve the problem.



Figure 5-6. Efflorescence present on B14 column as well as A14



Figure 5-7. Extraneous drain installed after structure was completed

The amount of water flow into the parking garage, through various locations and means, is excessive. This is noticeable at the location shown in Figure 5-8 where the plumbing leaks constantly and in Figure 5-9 where leaking occurs from a couple of points that cannot be specifically shown, but is evident by the amount of water sitting on the floor of the garage.



Figure 5-8. Significant plumbing leak location just below the amphitheatre



Figure 5-9. Ever-present water sitting on the parking garage lower level floor

### **Issue 3: Overall Design**

The overall design is significant to the waterproofing failure as well as the other issues presented here because it directly results in water intrusion into the structure beneath. Kiley Gardens was constructed as the plaza level of the parking garage and was done so by using beam and lintel concrete technology. The appearance makes it look like it is an upside down waffle

slab with large cells. This idea created numerous deep planters in which to add dirt and various types of foliage.

The intent was to create a green roof in this particular situation, but it was poorly executed. The constructed cells are approximately 17'-6" x 6'-0" x 3'-6" and it is common knowledge now that the grass and plants are capable of thriving in 6 to 24 inches of dirt for an intensive green roof. The difference between intensive and extensive green roof types are the soil depth and the types of plants that are planted. The extensive type has 1 to 6 inches of dirt, has a weight of 15-50 pounds per square foot, and is planted with sedums or prairie type flowers which are low to the ground and require less maintenance. The intensive type has over 6 inches of dirt, can be planted like a traditional garden, and allows for a greater variety of plants including hardy perennials, native flowers (more expensive), shrubs, and even trees. These plants require regular maintenance including watering and weeding.

The original design for Kiley Gardens had crepe myrtle and large palm trees in these cells and without knowing the recent data on tree growth in only 2 feet of dirt, the designers overdesigned this structure by an additional 2 feet. Also, as per the original design, the drains and plumbing lines were located approximately 1'-0" off of the cell floor allowing for a foot of water, as shown in Figure 5-10 to sit in the cells for 25 years, and not drain properly. This major design flaw led to significant water intrusion to the structure below. Water mitigation through concrete causes damage to the steel structural system, and in this case study only portions of the parking garages rebar have been surveyed. The extent of the damage is not enough to compromise the structure at this point in time, but would become a major issue if the waterproofing was not replaced.



Figure 5-10. Water sitting in cells for 25 years

To correct this flaw, the floors of the cells have to be raised to the level of the original drains and piping. This was done by installing Styrofoam® (Figure 5-11 and Figure 5-12), so as to not add extra weight, and then placing three inches of concrete, which is sloped toward the new drains, over the foam blocks. The concrete was then hand troweled to give the appropriate slope (Figure 5-13).



Figure 5-11. Installation of Styrofoam® blocks to raise the finished elevation



Figure 5-12. Styrofoam® installation complete with new slope shown



Figure 5-13. Placement of 3” concrete slab troweled finish

Another two design issues has water, from when it rains, entering to garage area from unlikely entry points. The first entry point is through the grated vents; which lead from the lower level of the garage straight up to the street level at Ashley drive. The rain collects and drains into these vents as if they are a part of a storm drain system and then floods a portion of the garage.

The second unlikely entry point for rain water is down the stairwells located towards the northeast portion of the garage. Figure 5-14 shows how the rainwater cascades down the

stairwells causing additional flooding. This becomes a serious slipping hazard since a large portion of the parking garage floor was finished incorrectly. The floor was given a smooth floated finish, as shown in Figure 5-15, whereas all parking garages are supposed to be broom finished or given something in the nature of a non-slip finish. Only half of the garage was finished this way and it presumably was an unintentional flaw, since it was corrected elsewhere.



Figure 5-14. Rainwater entering via stairwell



Figure 5-15. Rainwater reaching smooth finished concrete flooring

#### **Issue 4: Lack of Responsibility**

The final issue associated with Kiley Gardens and its waterproofing failures is the failure of the owners of the structure to take responsibility for repairing the cause of damage. The City of Tampa owns the top portion of Kiley Gardens and maintains the landscaping, which is quite labor intensive, as well as costly. The building of 400 N Ashley Drive, known as the North Carolina National Bank Tower or SYKES, owns the rights to the parking garage, as well as is responsible for the maintenance of that portion of the structure. Over the years, the leaking in the structure has increasingly worsened but the finger pointing and lack of assumption of responsibility for the problem, lead to the conditions documented in this study.

Since the structure has a footprint of over 86,000 square feet, it becomes necessary to address the impacts associated with covering every inch of the plaza level with a liquid-applied waterproofing product, since that is the course of action being taken to rectify the waterproofing membrane issue. In Chapters 6 and 7, testing of waterproofing is discussed; results are reported and are related back to this case study.

## CHAPTER 6 WATERPROOFING MEMBRANE COMPONENTS

In determination of which liquid-applied waterproofing products to consider for testing, research was done on the various types that are on the market today from six of the leading manufacturers of this particular specialized industry. All in all, eleven different products were considered and the information published by the manufacturers in the Material Safety Data Sheets and the Specifications are tabulated in comparison (Table 6-1), and additional research of the key components from these products is discuss in further detail.

The information tabulated in Table 6-1, is the culmination of all testing of the waterproofing membranes' performance characteristics, which are defined in Chapter 2. The purpose of comparing a wide variety of liquid-applied waterproofing products which are commercially available was to determine which particular ones would be sufficient for testing. One of course, is the type employed at Kiley Gardens, which is annotated as E1, and the others chosen for testing should be comparable in statistics, but of different chemical components. The sample decision was made after researching these products.

The attempt was made to compare all the products in all of the areas recorded along the right side of Table 6-1 but not all of the manufacturers did all of the same tests or published the same data. In the areas where 'No Data' is recorded, the information on that specific topic was either not applicable to that particular product or not published record, whether or not it is relevant is not shown from this comparison.

From this comparison, certain characteristics were more important in the decision of which to sample, since they needed to be comparable to the type used at Kiley Gardens, which is mostly horizontal application, so only formulas used for vertical application were not considered.

Table 6-1. Manufacturer's Comparison of Liquid-Applied Waterproofing Systems (Source: Compiled from Buildsite)

Manufacturer	A	A	A	B	B	C
Product	A1	A2	A3	B1	B2	C1
Surface	Horizontal	Vertical	Horizontal or Vertical	Horizontal	Vertical	Horizontal or Vertical
Single or Dual-component	Single	Single	Dual	Single	Single	Dual
Composition	Modified Polyurethane	Modified Polyurethane	Water-based Asphalt Emulsion	Moisture Cure Urethane	Moisture Cure Urethane	Synthetic Rubber
Cold or Hot Applied	Cold	Cold	Hot	Cold	Cold	Cold
Application Method	Squeegee: 1 coat	Roller: 2 coats	Spray: 1 or multiple coats	Squeegee: 1 coat	Roller or Spray: 2 coats	Trowel or Spray: 2 coats
Finished Product Thickness	60 mils	60 mils	60 mils	60 mils	60 mils	120 mils
Coal-tar Free	Yes	Yes	No Data	No Data	No Data	No Data
Tack Free Time	16 hrs @ 77°F	16 hrs @ 77°F	No Data	16 hrs	16 hrs	2-4 hours
Cure Time	36 hrs @ 77°F	36 hrs @ 77°F	Initial Cure: 10 minutes	36 hrs @ 75°F	36 hrs @ 75°F	No Data
Solids Content	82% (+/-2)	82% (+/-2)	Solvent Free	85%	90%	100%
VOC Content	No Data	No Data	No Data	>250 g/l	>250 g/l	75 g/l
Hardness	ASTM D2240: 30 Shore A (min)	ASTM D2240: 30 Shore A (min)	No Data	ASTM D2240: 20 Shore A	ASTM D2240: 25 Shore A	No Data
Elongation	ASTM D412: 575%	ASTM D412: 600%	ASTM D412: +1300%	ASTM D412: 650%	ASTM D412: 650%	ASTM D412: 500%
Resilience	No Data	No Data	ASTM D3407: 98% recovery	No Data	No Data	No Data
Tensile Strength	ASTM D412: 250 psi	ASTM D412: 400 psi	No Data	ASTM D412: 250 psi	ASTM D412: 300 psi	No Data
Water Vapor Permeance	ASTM E96: 0.07384 perms	ASTM E96: 0.07176 perms	ASTM E96: 0.02 perms	ASTM E96 (B): 0.09 perms	ASTM E96 (B): 0.09 perms	ASTM E96 (B): 0.08 perms
Adhesion to Concrete	(Primed Concrete) ASTM D4541: > 150 psi	(Primed Concrete) ASTM D4541: > 150 psi	No Data	ASTM C794: 20 psi	ASTM C794: 20 psi	No Data
For Reinforced Systems Also Use:	Polyester Reinforcing Fabric = 40" x 324'	Polyester Reinforcing Fabric = 40" x 324'	Polyester Reinforcing Fabric = 40" x 324'	No Data	No Data	Reinforcement Mesh

Note: Information was obtained from MSDS and specifications of the individual manufacturers

Table 6-1. Continued

Manufacturer	C	D	D	E	F
Product	C2	D1	D2	E1	F1
Surface	Vertical	Horizontal or Vertical	Horizontal or Vertical	Horizontal or Vertical	Horizontal or Vertical
Single or Dual-component	Single	Single	Single	Dual	Single
Composition	Synthetic Rubber	Modified Rubberized Asphalt	Modified Rubberized Asphalt with 20% post consumer recycled content	Polyester Resin and Catalyst Powder	Modified Polyurethane
Cold or Hot Applied	Cold	Hot	Hot	Cold	Cold
Application Method	Trowel	Squeegee	Squeegee	Roller or Brush	Spray, Roller, Trowel or Squeegee
Finished Product Thickness	60 mils	180 mils and 250 mils	180 mils and 250 mils	70 mils	60 mils
Coal-tar Free	No Data	No Data	No Data	No Data	Yes
Tack Free Time	2-4 hours	No Data	No Data	4 hrs	No Data
Cure Time	No Data	Cools Down, Does not cure	Cools Down, Does not cure	3 days	No Data
Solids Content	100%	Solvent Free: 100%	Solvent Free: 100%	No Data	88-92%
VOC Content	75 g/l	No Data	No Data	42 g/l	95 g/l
Hardness	No Data	No Data	No Data	ASTM D2240: 40 Shore A	ASTM C836: 58-64 Shore 00
Elongation	ASTM D412: 500%	ASTM D5329: 1000% min	ASTM D5329: 1000% min	ASTM D412: 55%	No Data
Resilience	No Data	ASTM D3407: 40% min	ASTM D3407: 40% min	No Data	No Data
Tensile Strength	No Data	No Data	No Data	ASTM D751: > 90 lb/in	No Data
Water Vapor Permeance	ASTM E96 (B): 0.08 perms	ASTM E96 (E): 0.3 ng/Pa(s)m <sup>2</sup>	ASTM E96 (E): 0.3 ng/Pa(s)m <sup>2</sup>	ASTM E96: 0.27 perms	No Data
Adhesion to Concrete	No Data	ASTM D3407: Pass @ 0°F (-18°C)	ASTM D3407: Pass @ 0°F (-18°C)	No Data	No Data
For Reinforced Systems Also Use:	Reinforcement Mesh	Flex-Flash F or Flex-Flash Vertical	Flex-Flash F or Flex-Flash Vertical	Polyester Reinforcing Fleece	No Data

Note: Information was obtained from MSDS and specifications of the individual manufacturers

## Synthetic Rubber

Most of the products that are available today are similarly made of different combinations of synthetic rubber, which is any type of artificially made polymer material which acts as an elastomer. Synthetic rubber offers a wider range of capabilities than natural rubber, which comes from latex and is mostly polymerized isoprene with a small amount of impurities in it. Polymerization of a variety of monomers such as isoprene, butadiene, chloroprene, or isobutylene form the basis of some liquid-applied waterproofing and with the addition of other various proportions of monomers to the mix can create copolymerization, which gives the product a wide range of physical, mechanical and chemical properties. A few of the most common types of synthetic rubber are found in Table 6-2.

One of the most common occurrences of a synthetic rubber in liquid-applied waterproofing is polyurethane. When a monomer from the isocyanate group reacts with the hydroxyl functional group that forms a urethane linkage. If a diisocyanate is reacted with a compound containing two or more hydroxyl groups (a polyol), long polymer chains are formed, which is known as polyurethanes.

Isocyanates are powerful irritants to the mucous membranes of the eyes and gastrointestinal and respiratory tracts. Direct skin contact can also cause marked inflammation. Isocyanates can also sensitize workers, making them subject to severe asthma attacks if they are exposed again. (National Institute for Occupational Safety and Health 2009)

The most commonly used type of isocyanate is the diisocyanate and one that can be found in liquid-applied waterproofing is toluene diisocyanate, which in addition to causing asthma is on the list of Group 2B possible carcinogen to humans as stated by the International Agency for Research on Cancer (IARC) on their website.

Table 6-2. Different Types of Synthetic Rubber (Source: Wikipedia)

ISO Standard	Chemical Name	Common Names
BR	Polybutadiene	
CIIR	Chloro Isobutylene Isoprene	Chlorobutyl, Butyl
CR	Polychloroprene	Chloroprene, Neoprene
CSM	Chlorosulphonated Polyethylene	Hypalon
ECO	Epichlorohydrin	ECO, Epichlorohydrin, Epichlore, Epichloridrine
EP	Ethylene Propylene	
EPDM	Ethylene Propylene Diene	EPDM, Nordel
EVA	Ethylene Vinyl Acetate	EVA
FKM	Fluorinated Hydrocarbon	Viton, Kalrez, Fluorel
HNBR	Hydrogenated Nitrile Butadiene	HNBR
IR	Polyisoprene	(Synthetic) Natural Rubber
IIR	Isoprene Butylene Butyl	Butyl
NBR	Butadiene Acrylonitrile	NBR, Nitrile, Perbunan, Buna-N
PU	Polyurethane	Polyurethane
SBR	Styrene Butadiene	SBR, Buna-S, GRS
SI	Poly-Siloxane	Silicone Rubber

### Asphalt

Asphalt is a sticky, black and highly viscous liquid or semi-solid that is present in most crude petroleum and is still widely used in liquid-applied waterproofing but modified with synthetic rubber additives. The term ‘bitumen’ is used interchangeably with ‘asphalt’ and is the main component in the waterproofing system that was originally installed at Kiley Gardens (modified bituminous membrane). Asphaltic products have good water resistant capabilities but must be refined from certain crude oils by the processes which expend a lot of energy.

## **Carbon Black**

Carbon black is a material that can be found in liquid-applied waterproofing that are black in color is they are not specifically an asphalt or bitumen product already. This is a material that is produced by the incomplete combustion of heavy petroleum products such as coal tar and FCC tar. Carbon black is a form of amorphous carbon and has a moderately high surface area to volume ratio, and is mostly used as a pigment and reinforcement in rubber and plastic products, therefore making it a viable product to use in waterproofing. The downside of using carbon black frequently is that it is also on the IARC list of Group 2B carcinogen to humans. Carbon black dust is generally the form in which discomfort to the upper respiratory tract is associated with, and it has not been proven to be carcinogenic yet.

## **Styrene**

With less elasticity, but with greater strength and durability, styrene is also known as vinyl benzene and is named after the styrax tree from which benzoin resin can be extracted. Styrene makes up a large portion of vinyl based (resin type) liquid-applied waterproofing products, and is an organic compound with a high volatility rate and has a sweet smell, although can be less pleasing if in high concentrations at one time. Because of the presence of the vinyl group, styrene is capable of polymerization and can therefore be used in many different applications, as well as making it a precursor to polystyrene, which is one of the most common type of plastics in use today. The polymerization capabilities allow styrene to become a type of synthetic rubber when mixed with butadiene and creates greater elastomeric potential.

## **Volatility**

‘Volatility’ is the tendency of a substance to vaporize and ‘volatile content’ is defined as the percentage of volatiles which are driven off as a vapor. Volatile organic compounds (VOC’s) are organic compounds that can vaporize under normal temperature and pressure. The

understanding and tracking of volatile organic compounds that are produced by the numerous chemical products is important because of the impact to the environment as well as humans who come in contact with products that continue to emit VOC's for years after they are installed. This is also a contributing factor to sick building syndrome. According to the Environmental Protection Agency's (EPA) website, the term "sick building syndrome" (SBS) is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified.

### **Acute Inhalation Toxicity**

Included in some of the Material Safety Data Sheets is the toxicology information from testing on animals that determine acute inhalation toxicity, acute dermal toxicity and acute oral toxicity. Although, the data from animal testing cannot be directly correlated to humans, the warning must be given to avoid the same concentrations as they are potentially dangerous or even deadly.

Acute inhalation toxicity is the total of adverse effects caused by a substance following a single uninterrupted exposure by inhalation over a short period of time (24 hours or less) to a substance capable of being inhaled. The LC50 (median lethal concentration) is a statistically derived concentration of a substance that can be expected to cause death during exposure or within a fixed time after exposure in 50% of animals exposed for a specified time. The LC50 value is expressed as weight of test substance per standard volume of air (mg/l), or as parts per million (ppm). (Organisation for Economic Co-Operation and Development 1981, 1)

The lower the number \*mg/l the test results are, the more toxic the substance, and it is possible for a substance to be more toxic via inhalation than by oral ingestion or via skin contact. It is also possible for a substance to be more toxic if swallowed and not toxic at all if inhaled. Table 6-3 was obtained from the Canadian Centre for Occupational Health and Safety's website and shows a breakdown of LC50 results and what the concentration means. The Material Safety Data Sheets in Appendix A for liquid-applied waterproofing show a relatively high toxicity

rating for the LC50 test (ex. 11.8 mg/l [styrene] and 10 mg/l [toluene diisocyanate] for rat at 4hrs).

Table 6-3. Toxicity Classes: Hodge and Sterner Scale (Source: Canadian Centre for Occupational Health and Safety 2005)

		Oral LD50	Inhalation LC50	Dermal LD50	
Toxicity Rating	Commonly Used Term	(single dose to rats) mg/kg	(exposure of rats for 4 hours) ppm	(single application to skin of rabbits) mg/kg	Probable Lethal Dose for Man
1	Extremely Toxic	1 or less	10 or less	5 or less	1 grain (a taste, a drop)
2	Highly Toxic	1.0-50	10-100	5.0-43	4 ml (1 tsp)
3	Moderately Toxic	50-500	100-1000	44-340	30 ml (1 fl. oz.)
4	Slightly Toxic	500-5000	1000-10,000	350-2810	600 ml (1 pint)
5	Practically Non-toxic	5000-15,000	10,000-100,000	2820-22,590	1 liter (or 1 quart)
6	Relatively Harmless	15,000 or more	100000	22,600 or more	1 liter (or 1 quart)

As this data shows, the risk in handling volatile substances is dependent not only on the toxicity but also on the volatility. “For a risk assessment, toxicity based on an LC50 value may not be sufficient on its own, but should always be considered together with the volatility of the substance.” (Organisation for Economic Co-Operation and Development 1981, 9)

CHAPTER 7  
TESTING PROCEDURE AND ANALYSIS

As discussed in Chapter 6, eleven product types were researched and three different types were chosen for testing. In reference to Table 6-1, product types C2, E1, and F1 are used in the following testing for volatile content and VOC emissions. These products are all solvent-reducible and do not have the presence of water. C2 is a single component system, E1 is a dual component system (part A is a liquid and part B is a powder catalyst), and F1 is a dual component system (part A and part B are both liquids). The chemical composition is tabulated in Table 7-1.

Table 7-1. Product Composition of Samples used for Testing

Product	Part	Chemical Name	Weight %
C2	A	Calcium Oxide	25.0-50.0
		Castor oil based ester	1.0-10.0
		Distillates, petroleum, hydrotreated heavy naphthenic	50.0-100.0
		Quartz	1.0-10.0
		Zinc oxide	1.0-10.0
	B	Styrene-Butadiene block copolymer	50.0-100.0
E1	A	Styrene	25.0-50.0
	B	Catalyst	25.0-50.0
F1	Single	Aromatic process oil	40.0-70.0
		Polyurethane Polymer	30.0-60.0
		Calcium Carbonate (Limestone)	10.0-30.0
		Calcium oxide	3.0-7.0
		Carbon Black	3.0-7.0
		Stoddard solvent (Mineral Spirits)	1.0-5.0
		Anthracene	1.0-5.0
		Dioctyl phthalate	< 1.0
		2,4-Toluene diisocyanate	< 1.0
		Toluene-2,6 Diisocyanate	<0.1
Crystalline Silica (Quartz)/Silica Sand	<0.1		

Note: Information was obtained from MSDS of the individual manufacturers. Refer to Appendix A.

## Volatile Content

The ASTM test used for the volatile content of coatings is ASTM D 2369, which is the test method that was followed to determine the volatile percentage as well as the nonvolatile percentage of three types of liquid-applied waterproofing. The test required the use of a forced draft oven and takes the following steps:

1. Separate the samples into their own aluminum tins (2 for each type of waterproofing sampled), weighing the tin first and using the same amount of each type of specimen. 7g of specimen was used in this test.
2. The samples are then heated in a forced draft oven at  $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$  for 60 minutes.
3. After 60 minutes, removal of the samples to a desiccator until their temperature cools is required.
4. The samples are then weighed together with the tin and the data is used to calculate the percent volatile matter,  $V$ , in the liquid coating in the equation provided.

$$V_A = 100 - [(W_2 - W_1)/S_A] * 100]$$

Where:

$V_A$  = % volatiles (first determination),

$W_1$  = weight of dish,

$W_2$  = weight of dish plus specimen after heating,

$S_A$  = specimen weight, and

$V_B$  = % volatiles (duplicate determination; calculate in the same manner as  $V_A$ ). (ASTM D 2369)

$$V = (V_A + V_B)/2$$

$V$  is reported when the mean of the duplicate determination and the first determination has a relative percent difference of 1.5% or less, if not repeat the test. The percent of nonvolatile matter,  $N$ , can be calculated as follows:

$$N = (N_A + N_B)/2$$

Where:

$N_A = 100 - V_A$ , and

$N_B = 100 - V_B$ . (ASTM D 2369)

Table 7-2 has the data that was collected and the outcome from the two equations.

Table 7-2. Determination of Volatile Content of Coatings

	A	B	A + B	C	C-A	D	E	(D+E)/2	100-D	100-E	
	Weight of aluminum dish (grams)	Weight of specimen (g)	Weight together before heating (g)	Weight of dish and specimen after heating (g)	Weight of specimen after heating (g)	VA = % of volatiles (first determination) (%)	VB = % of volatiles (duplicate determination) (%)	V = mean % of volatiles (%)	NA = % of nonvolatiles (%)	NB = % of nonvolatiles (%)	N = mean % of nonvolatiles (%)
C2.1 (A + B)	11.2	7.0	18.2	17.8	6.6	5.7			94.3		
C2.2 (A + B)	11.2	7.0	18.2	17.8	6.6		5.7			94.3	
C2 Total								5.7			94.3
E1.1 (Part A)	11.2	7.0	18.2	16.1	4.9	30.0			70.0		
E1.2 (Part A)	11.3	7.0	18.3	16.2	4.9		30.0			70.0	
E1A Total								30.0			70.0
E1.3 (A + B)	11.2	7.0	18.2	17.2	6.0	14.3			85.7		
E1.4 (A + B)	11.2	7.0	18.2	17.1	5.9		15.7			84.3	
E1 Total								15.0			85.0
F1.1	11.2	7.0	18.2	18.0	6.8	2.9			97.1		
F1.2	11.1	7.0	18.1	18.0	6.9		1.4			98.6	
F1 Total								2.1			97.9

Note: Data is reported as stated in ASTM D 2369

Figure 7-1, 7-2, and 7-3 are graphical representations of the data tabulated in Table 7-2.

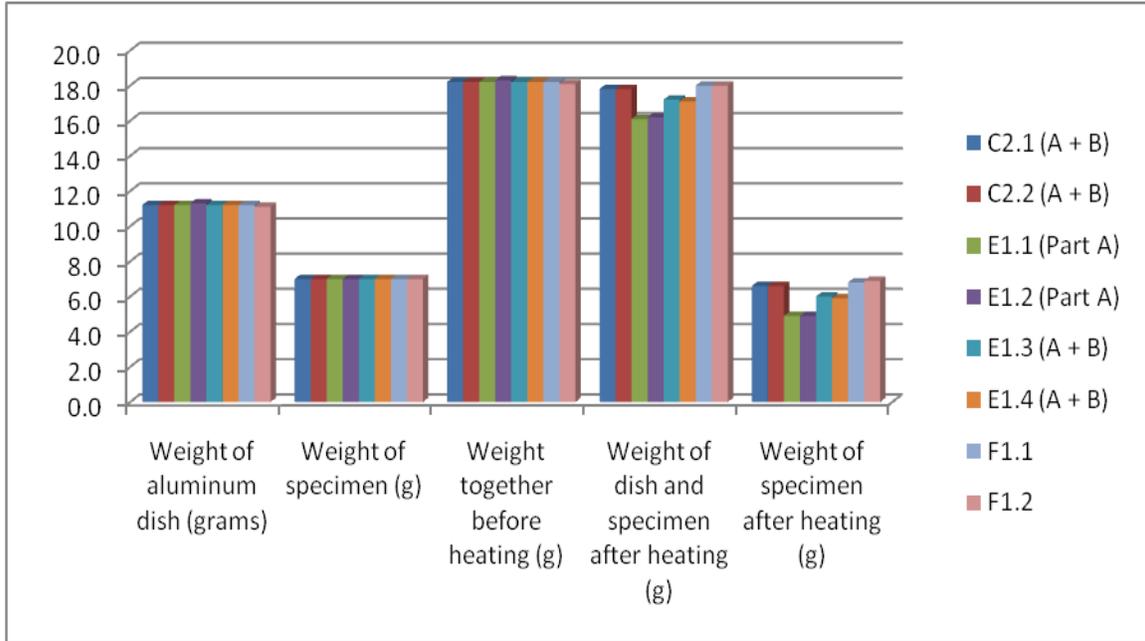


Figure 7-1. Difference in weight before and after heating

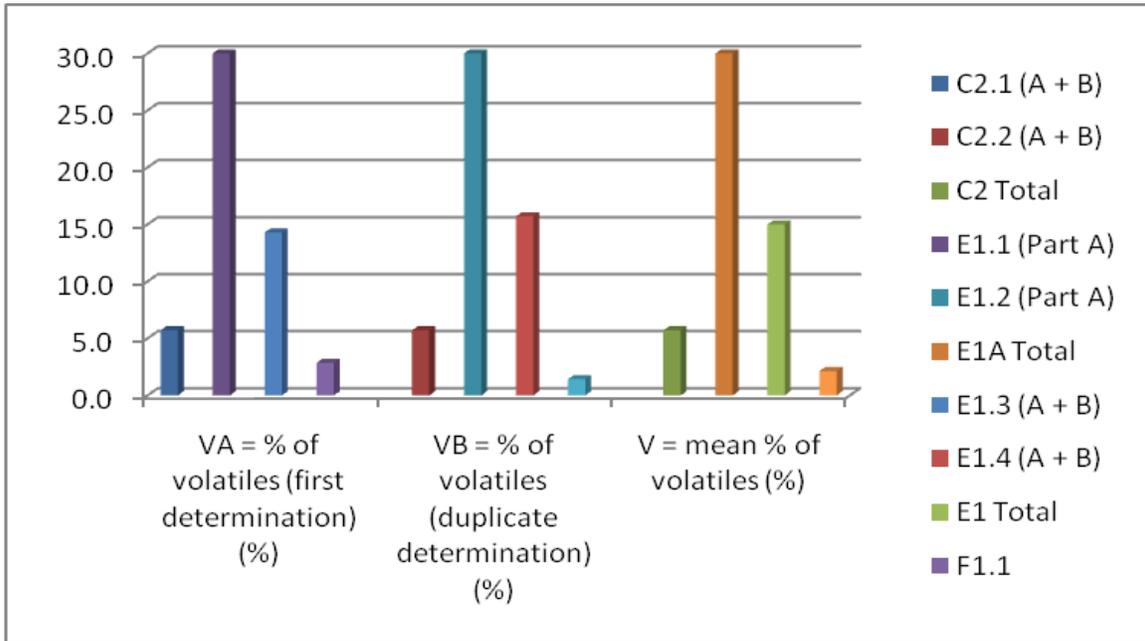


Figure 7-2. Percentage of volatiles

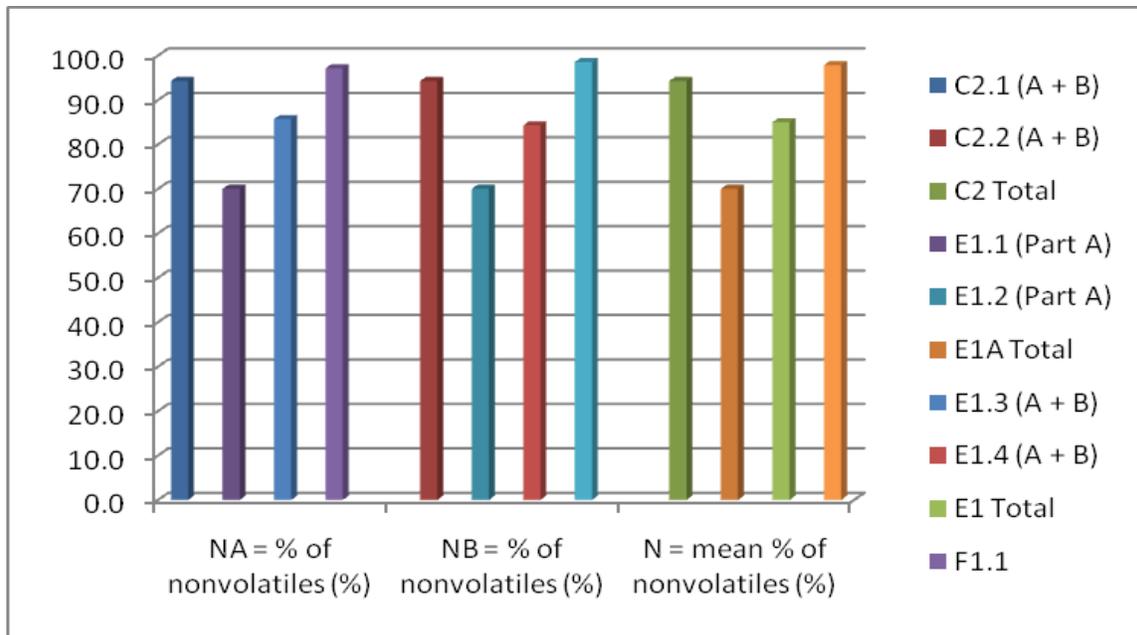


Figure 7-3. Percentage of nonvolatiles

The percentage of volatiles lost to the air after one hour for the C2 product is only 5.7%, which is not a very large percentage. As it appears on in Table 7-2, E1 is shown twice; once only Part A was used in the test and the second time Part B was added to cure the compound. Since Part A is a liquid (gallons) and Part B is in a powder form (grams), it was necessary to determine the amount of catalyst per liquid. It was already known that one bucket containing 2.2 gal of liquid uses three parts of catalyst powder which come in a 102 gram packet, so the mixture is a 3 to 1 ratio. The bucket containing the liquid was weighed at 23.68 lbs, minus the bucket weight of 2.36 lbs; the liquid weight was approximately 21.32 lbs. The conversion rate of pounds to grams is 1 lb = 453.6 grams. The liquid weight of 21.32 lbs to grams is 9670.6 grams, that divided by 3 (the 3 to 1 ratio) is 3223.5 grams. 3223.5 grams of liquid divided by 102 grams of the catalyst yields 1 gram of catalyst powder to a rounded 31.6 grams of liquid.

E1 (Part A only) yielded 30% of volatiles lost to the air, almost a third of its volume, which is a significant amount. Part A will not cure on its own, or when exposed to air. The

solvents will release and the compound will become more viscous due to its percentage of volatiles lost. Curious to see how the catalyst (Part B) has an effect on Part A, a second test was done using both parts. The E1 product begins to cure as soon as the catalyst is entered into the liquid and will become too difficult to work with after approximately an hour. Once the sample was mixed, it was immediately put into the forced draft oven and fully cured after an hour. The percentage of volatiles lost was only 15% when the catalyst was introduced and since the liquid-applied waterproofing cured within the time it was in the oven, the curing mechanism actually trapped much more of the volatiles than when Part A only was tested. Still 15% is a moderate loss to its volume.

Product F1 had the least percentage loss of volatiles after an hour, of the three products tested, at 2.1%. The chemical components of products C2 and E1 do not have data about whether any are carcinogenic but F1 has two chemicals which are possible carcinogens (Group 2B). The amount of volatiles being given off of these products is important when analyzed in conjunction with the type of volatiles being given off. What type and how much determine whether a product is toxic or not.

### **Volatile Organic Compound Content**

ASTM D 3960 is the Standard Practice for Determining Volatile Organic Compound Content of Paints and Related Coatings, which measures the VOC content once the volatile content is established by using the ASTM test D 2369.

Certain organic compounds that may be released under the specified bake conditions are not counted toward coating VOC content because they do not participate appreciably in atmospheric photochemical reactions. Such negligibly photochemically reactive compounds are referred to, as exempt volatile compounds in this practice (ASTM 2006, 465)...[and] the following exempt volatile compounds have been used in coatings: methylene chloride (dichloromethane), methyl chloroform, parachlorobenzotrifluoride (PCBTF), siloxanes, acetone, perchloroethylene (tetrachloroethylene), methyl acetate, and t-butyl acetate. (ASTM 2006, 470)

When referring to Table 7-1, it is shown that none of the exempt volatile compounds listed here are used in the chemical makeup of either of the samples tested. This means that all of the solvents which were released during the baking process of the previous test were indeed volatile organic compounds. “VOC content is calculated as a function of the volume of coating less water and exempt volatile compounds, the volume of solids, and the weight of solids.” (ASTM 2006, 465) Since these liquid-applied waterproofing samples do not have water or exempt volatile compounds incorporated in their mix, it will be easy to determine the VOC content, which is expressed as the mass of VOC per unit volume of coating. The calculation is as follows:

$$\text{VOC} = (W_v)(D_c)/100\%$$

Where:

$W_v$  = weight of total volatiles, %

$D_c$  = density of coating, g/L, at 25°C. (ASTM 3960)

Table 7-3. Determination of Volatile Organic Compound (VOC) Content

	Weight of specimen (g)	Volume (mL)	Volume (L)	Density (g/L)		
C2 (A + B)	7.00	5.50	0.00550	1272.73		
E1 (A + B)	7.00	7.00	0.00700	1000.00		
F1	7.00	5.75	0.00575	1217.39		
	Mean weight after heating (g)	Mean volume (including air) after heating (mL)	Mean volume (including air) after heating (L)	Density after heating (g/L)	Mean % of volatiles (%)	VOC (g/L)
C2 (A + B)	6.60	14.17	0.01417	465.77	5.7	26.5
E1 (A + B)	5.95	5.55	0.00555	1072.07	15.0	160.8
F1	6.85	7.39	0.00739	926.93	2.1	19.5

Products C2 and F1, after heating, had some air entrapped inside the specimen which lowered the density a small amount. The air entrapped in specimen C2 significantly altered the volume after it was baked. To obtain an accurate volume, the specimen should not be heated, and left to cure as per specifications of the product instead of following ASTM 3960 test procedure.

But once the calculations are complete it shows that C2 had 26.5 g/L VOC content, which should be at least two to three times higher if the entrapped air did not alter the ‘after heated volume’. Product F1 had 19.5 g/L, which appears to be a close approximation, since only a very small amount of air was entrapped into this specimen. Still, with regards to the air, these numbers both suggest that they are both low VOC producing products, and once the material cures then it stops producing high amounts of VOC emissions.

Product E1 did not have any air trapped in the specimen after heating, and it is shown in Table 7-2 as well as Table 7-3 that a high amount of volatiles were released during the one hour heating period, which means that the product will become denser once the VOC’s are released. The final VOC content is 160 g/L for E1. According to the National VOC Emission Standards for Architectural Coatings, 600 g/L is the limit for waterproofing sealers and treatments (EPA) before a manufacturer must change the formula or utilize the exceedance fee or tonnage exemption provisions. But also per the EPA, a low VOC coating or sealant contains 50 g/L or less. Anything over 50 g/L will cause short term adverse health effects if the product is not used in a well ventilated area.

### **Volatile Organic Compound Emissions**

The final step in establishing whether a product is toxic or has hazardous volatility is to determine the type of compounds that are released in a gaseous form. If they are the types that meet the EPA’s standards for harmful substances then in conjunction with the amount that is released, the product is deemed toxic and preventative measures should be taken when handling the product. But the two possible methods involving the analysis of emissions are complicated and lengthy ones, and although the methods are discussed in this subsection, they are not carried out.

The first method uses gas chromatography-mass spectrometry (GC/MS) to identify different substances within a test sample. Here is an explanation of a portion of the process:

Gas Chromatography (GC) is used to separate volatile components of a mixture. A small amount of the sample to be analyzed is drawn up into a syringe. The syringe needle is placed into a hot injector port of the gas chromatograph, and the sample is injected. The injector is set to a temperature higher than the components' boiling points. So, components of the mixture evaporate into the gas phase inside the injector. A carrier gas, such as helium, flows through the injector and pushes the gaseous components of the sample onto the GC column. It is within the column that separation of the components takes place. (Welder 2008, 1)

The mass spectrometer becomes the detector of the substances that are separated in the gas chromatograph, which is basically a computer connected to the GC which has recognition software installed. The standard test method for determination of gaseous organic compounds by direct interface gas chromatography-mass spectrometry located in *The Annual ASTM Standards* is D 6420.

In theory, this sounds like the optimal way to analyze the VOC's released from liquid-applied waterproofing products, but the problem is that the samples are too viscous and cure to a solid in a small amount of time. Liquids are injected, not semi-solids. Another issue is that the concentration of volatiles of the samples is far too great for the gas chromatograph, which is typically used to determine trace amounts of volatile compounds. Trying to perform this test would completely saturate the columns and subsequently would have to be discarded.

The second method involves using a small environmental chamber to capture the volatile organic compounds emitted from the samples under controlled conditions. ASTM test D 6803 describes the procedure for collection of VOC's on sorbent tubes and carbonyl compounds on silica gel treated with 2,4-dinitrophenylhydrazine (DNPH) and can be analyzed by the procedure in ASTM D 6196. VOC's can also be collected in charcoal tubes using the environmental chamber and analyzed following the procedure in ASTM test D 3687.

More simply put, the small environmental chamber is 1 meter<sup>3</sup> in volume and can accommodate for a sample of liquid-applied waterproofing that has been applied to a small piece of untreated wood. The sample is then put into the chamber and the VOC's are sampled using pumps to draw air into sorbent tubes, which are then analyzed by thermal desorption (TD) and gas chromatography (GC), using flame ionization detector (FID) for quantifying the VOC's and a mass spectrometer (MS) for the identification of compounds. (Yu and Crump 2003)

Directly injecting compounds which are already in a gaseous state into the gas chromatograph is preferable to even injecting a highly volatile liquid and waiting for it to off-gas, since the GC's intended use is to separate gaseous molecules from dissimilar ones. Although, it is possible to use the first method alone to identify volatile organic compounds if the product was a liquid, in this case of using highly viscous material, it is necessary to employ the use of a small environmental chamber as the first step in the process of VOC identification.

## CHAPTER 8 SUMMARY AND CONCLUSIONS

As far as waterproofing goes, technologies have advanced materials used in the field to become more reliable, resilient, elastic, etc. and those qualities are found in the latest liquid-applied membranes. The methods used historically deteriorate over time, as was in the case of Kiley Gardens, but the methods used today are more harmful to the environment. They are for certain, more volatile because of the solvent-borne curing mechanism that most of the latest membranes use, but are more efficient for the built environment.

This leads to the sustainability debate of whether it is right to sacrifice the environment for the built environment or vice versa. The current trend is to find ways of harmoniously working with the environment or basically sustainably subsidize portions of a structure while neglecting others. With regards to the sustainable standard of the moment, Leadership in Energy and Environmental Design (LEED), waterproofing seems to fall into the category of necessary evils for building. Since the membrane is applied outdoors, it does not affect indoor environmental quality, and since it does not affect water or energy consumption, waterproofing products do not fall into any of the standard LEED categories.

These products are proven to be harmful when used in a non-ventilated area because of the volatile content and the VOC content, but since the products are applied outdoors, sometimes respiratory protective equipment are neglected because of the natural ventilation already available; this is the case in regards to the application process of the product (E1) on Kiley Gardens. The square footage is approximately 86,000, and since it is outdoors there were not any regulatory restrictions to the types of products that were chosen to be used on the structure. To lessen the impact that the project had on the environment, one of the other two products that were tested in this study should have been used (C2 or T1). T1, in particular, lost minimal

volume due to solvent loss, and since it is a single-component polyurethane product, it retained higher elastomeric properties as well as taking out a portion of human error (not requiring the use of mixing two parts together) that the other products still include. In addition to environmental impact, product E1 is a polyester resin base which has much less elastomeric qualities than most products on the market today, and will most likely cause other problems in the next twenty five years. Deterioration of resin based products happens over time once exposed to chemicals and acids commonplace in soils, even the engineered soil that was installed at Kiley Gardens.

In summary, liquid-applied waterproofing should be studied further in terms of the type of emissions they produce and at what amount. Since these products will be ever-changing with the advancement of technologies, it should be in a direction that is more sustainable and emission efficient.

## CHAPTER 9 RECOMMENDATIONS

As for recommendations of further research on this subject, determination of the types of volatile organic compounds emitted from samples of liquid-applied waterproofing using the methods described at the end of Chapter 7 would be a good starting point. Actually creating a new way to test waterproofing samples using a gas chromatograph would be inventive and most likely could support an entire additional report. The thought process involved with the analysis is extensive, time-consuming and requires possibly a chemical or engineering background. Also the testing itself is expensive and cannot be accomplished by one single person in any feasibly short timeline.

In this particular case, referring to this research collectively, resources were limited and although an attempt was made to outsource to other colleges in the university, the funds to support emissions testing were not available nor the educational background to personally analyze the data.

Another recommendation would be to develop a life cycle analysis of different types of liquid-applied waterproofing products and determine the industry's impact on the environment. Since the products incorporate chemicals as well as minerals with little or no room for recycled material in the mix, it would be interesting to see if the impact was something to be concerned about.

APPENDIX A  
MATERIAL SAFETY DATA SHEETS (MSDS)

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor 20 Part A  
MSDS ID Number: M-85745

MSDS Date: 12/31/04

**SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION**

**Product Name:** Procor 20 Part A  
**MSDS Number:** M-85745  
**Cancelled MSDS Number:** M-85720  
**MSDS Date:** 12/31/04  
**Chemical Description:** Napthenic oils and inorganic filler  
**Product Use:** Waterproofing Products  
**CAS # (Chemical Abstracts Service Number):** Mixture-NA

**Manufactured by:**

W.R.Grace & Co.-Conn.	Grace Canada, Inc.
62 Whittemore Avenue	294 Clements Road West
Cambridge, MA 02140	Ajax, Ontario L1S 3C6

**In Case of Emergency Call:** (617) 876-1400

**SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS**

Ingredient	CAS#	Percent (max)
Calcium oxide	001305-78-8	25-50
Castor oil based ester	NJ801415063P	1-10
Distillates, petroleum, hydrotreated heavy naphthenic	064742-52-5	50-100
Quartz	014808-60-7	1-10
Zinc oxide	001314-13-2	1-10

**SECTION 3 - HAZARDS IDENTIFICATION**

**Emergency Overview:**

**Caution!**

Causes eye irritation.  
Causes skin irritation.  
Causes digestive tract irritation if ingested.  
Product supplied as two component package and part A reacts with partB (and with water). A&B (and A with water) Reaction is exothermic, releasing heat.  
Fumes may also be released if unused mixed product is allowed to sit in containers or if thicknesses exceed 120 mils.  
Mixed A&B product may reach temperatures of 300°F.  
Reacting material is sticky and will adhere to skin.  
Contact with hot materials will result in burns.  
Do not seal containers once mixed with part B or contaminated with water.  
Sealed containers may explode due to pressure from the reaction.

**HMIS Rating:**

Health:	1
Flammability:	1
Reactivity:	1
Personal Protective Equipment:	B,G (See Section 8)

**Potential Health Effects:**

**Inhalation:** When mixed material is allowed to react in a container, temperatures up to 300°F can be reached, liberating water vapor, carbon disulfide and other hydrocarbons. Inhalation of these materials can cause irritation.  
Prolonged inhalation can cause lung damage.  
Effects include: Flu-like symptoms (metal fume fever).  
**Eye Contact:** Eye contact causes irritation.  
**Skin Contact:** Skin contact causes irritation. Product reacts with other component (part B) and also with water. Contact with hot material will result in burns.  
Reacting material is sticky and hot and will adhere to skin if touched before fully cured.

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor 20 Trowel Grade Part A  
MSDS ID Number: M-85745

MSDS Date: 12/31/04

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**Skin Absorption:** Not expected to be harmful if absorbed through the skin.  
**Ingestion:** Due to the physical nature of this product, ingestion of this product is not likely.  
If ingested, causes irritation to the linings of the mouth, esophagus and stomach.  
Effects include the following: Nausea, vomiting, sneezing, coughing, labored breathing and burns.

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**SECTION 4 - FIRST AID MEASURES:**

**Skin Contact:**

In case of skin contact, clean fingernails and wash skin with soap and water. If residue remains, clean with waterless hand-cleaners or abrasive soap. Never use solvents.  
If discomfort or irritation persists, consult a physician.  
Remove contaminated clothing and wash before reuse.

**Eye Contact:**

If discomfort or irritation persists, consult a physician.  
Flush eyes with water for at least 15 minutes while holding eyelids open.

**Ingestion:**

If ingested, consult a physician.  
Never give anything by mouth to an unconscious person.  
Do not induce vomiting.

**Inhalation:**

If symptoms develop, get fresh air.  
If symptoms persists, consult a physician.  
If breathing has stopped, give artificial respiration then oxygen if needed.

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**SECTION 5 - FIRE AND EXPLOSION HAZARD DATA**

<b>Flash Point:</b>	Not Determined
<b>Flash Point Method:</b>	Not Applicable
<b>Lower Explosion Limit:</b>	Not Available
<b>Upper Explosion Limit:</b>	Not Available
<b>Auto-Ignition Temperature:</b>	Not Available

**NFPA Rating:**

<b>Health:</b>	1
<b>Flammability:</b>	1
<b>Reactivity:</b>	1

**Extinguishing Media:** In case of fire, use dry chemical, Carbon dioxide or foam.

**Special Fire Fighting Procedures:**

Wear self-contained breathing apparatus and complete personal protective equipment when potential for exposure to vapors or products of combustion exist. Water may be used to cool containers to prevent pressure build-up and possible auto-ignition or explosion. Avoid breathing hazardous vapors or products of combustion. Keep upwind. Isolate area and keep unnecessary people away. Prevent run-off from fire control or dilution from entering streams or drinking water supplies.

**Unusual Fire and Explosion Hazards:**

None known for this product.

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**SECTION 6 - ACCIDENTAL RELEASE MEASURES:**

**Spills/Leaks:**

Use proper personal protective equipment. According to EPA (40 CFR § 261.3) waste of this product is not defined as hazardous. Do not flush to sewer or allow to enter waterways. Keep unnecessary people away.

Oils spills released directly to waterways may be subject to reporting requirements. Immediately contact your company's environmental coordinator or the Grace Environmental Health and Safety Department.

**W. R. GRACE**  
**MATERIAL SAFETY DATA SHEET**

Product Name: Procor 20 Trowel Grade Part A  
 MSDS ID Number: M-85745

MSDS Date: 12/31/04

**SECTION 7 - HANDLING AND STORAGE**

**Precautionary Measures:**

Avoid contact with eyes, skin and clothing.  
 Do not take internally.  
 Practice good personal hygiene to avoid ingestion.  
 Use only with adequate ventilation.  
 Wash clothing before reuse.  
 Wear respiratory protection indoors or where ventilation is inadequate.  
 Product supplied as two component package and part A reacts with part B (and with water). A&B (or A & water) Reaction is exothermic, releasing heat,  
 Fumes may also be released if unused mixed product is allowed to sit in containers or if thicknesses exceed 120 mils.  
 Reaction product is sticky and will adhere to skin.  
 Contact with hot material will result in burns.  
 Do not touch material once thickening (reaction) begins, and until cured and cool.  
 Procor 20 (parts A and B) are supplied in mixing pails. Once component A&B are mixed, use all product within 30-60 minutes of mixing to avoid heat build up due to exothermic reaction (release of heat and fumes). Reaction times may vary depending upon temperature and mixing conditions.  
 Promptly cleanse hands after handling.  
**FOR PROFESSIONAL USE ONLY. KEEP OUT OF CHILDREN'S REACH.**

**SECTION 8 - EXPOSURE CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT**

**EXPOSURE GUIDELINES (US)**

Ingredient	ACGIH TLV			OSHA PEL			Other
	TWA	STEL	Ceiling	TWA	STEL	Ceiling	
Calcium oxide	2 mg/m3 TWA	-	-	5 mg/m3 TWA (not in effect as a result of reconsideration)	-		
Castor oil based ester	-	-	-	-	-		
Distillates, petroleum, hydrotreated heavy naphthenic	-	-	-	-	-		
Quartz	0.05 mg/m3 TWA (respirable fraction)	-	-	0.1 mg/m3 TWA (respirable dust)	-		
Zinc oxide	2 mg/m3 TWA (respirable fraction)	10 mg/m3 STEL (respirable fraction)	-	5 mg/m3 TWA (fume); 10 mg/m3 TWA (total dust); 5 mg/m3 TWA (respirable fraction)	10 mg/m3 STEL (fume)		

Respirable Quartz (Crystalline silica) can result in lung disease (i.e. silicosis and or lung cancer). However, due to the physical nature of this product (liquid) exposures are not expected unless after product dries it is abraded and airborne dust is created.

**EXPOSURE GUIDELINES (CANADA)**

Employers should consult local Provincial regulatory limits for exposure guidelines which may vary locally.

**Engineering Controls:** Provide local exhaust ventilation to prevent vapor build-up during application. This is particularly important in enclosed or confined areas where natural ventilation may not be adequate. Provide enough ventilation to maintain exposure levels below regulatory limits.

**Personal Protective Equipment:**

**Respiratory Protection:** Respiratory protection is not normally required in well ventilated areas. However, indoors or where ventilation is inadequate, the use of respirators equipped with organic vapor cartridges is required. The specified respirator may not adequately protect against exposure during actual working conditions, which must be assessed before and throughout product application periodically as work progresses. (See Work/Hygienic Practices.)

**Skin Protection:** Impervious (PVC, or nitrile) gloves should be worn anytime direct contact is possible.

**W. R. GRACE**  
**MATERIAL SAFETY DATA SHEET**

Product Name: Procor 20 Trowel Grade Part A  
 MSDS ID Number: M-85745

MSDS Date: 12/31/04

**Eye Protection:** Safety glasses or goggles should be worn.

**Work/Hygienic Practices:** Use good personal hygiene practices.

Carbon disulfide and other potentially harmful gases, vapors and fumes may evolve as a result of exothermic reactions ("hot product") when components are mixed. Carbon disulfide may be detected by odor at about 1 ppm, but the ability to smell fatigues (diminishes) rapidly, therefore, odor does not serve as a good warning property. If eye or respiratory irritation is present, or if a foul odor is detected, you may be experiencing exposure to Carbon disulfide and other organics. Leave the area immediately and seek fresh air.

Quartz (Crystalline silica) is a naturally-occurring mineral that is commonly contained in materials that are mined from the earth's surface such as sand, limestone, clay and gypsum (Calcium sulfate). Total quartz is a value usually representing the combined fractions of large, nonrespirable sized particles and of respirable sized particles (less than ten microns in aerodynamic diameter). It is only the respirable fraction of total quartz that is recognized as hazardous by professionals in the field of Occupational Health and by most regulatory agencies.

This product contains compounds subject to exposure guidelines and/or identified as carcinogens (See section 8 and 11).

Due to the physical nature of this product, (liquid) these compounds are not likely to reach exposure limits unless after product dries, it is abraded and airborne dust is created.

**SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES**

<b>Physical State:</b>	Liquid
<b>Appearance/Odor:</b>	A brownish semi-viscous liquid with an aromatic odor.
<b>Odor Threshold:</b> (ppm)	Not Determined
<b>pH:</b>	Not Applicable
<b>Vapor Pressure:</b> (Mm Hg)	Not Determined
<b>Vapor Density:</b> (Air = 1)	Not Determined
<b>Solubility In Water:</b>	Insoluble
<b>Specific Gravity:</b> (Water = 1)	~1.28
<b>Evaporation Rate:</b> (Butyl Acetate = 1)	Not Determined
<b>Boiling Point:</b>	Not Determined
<b>Viscosity:</b>	Unknown
<b>Bulk Density:</b> (Pounds/Cubic Foot)(Pcf)	~83
<b>% Volatiles:</b> (70°F) (21°C)	75 g/l

**SECTION 10 - STABILITY AND REACTIVITY**

<b>Chemical Stability:</b>	Stable
<b>Conditions To Avoid:</b>	Heat, Strong oxidizers, Strong acids, Organic materials, Water, phosphorous pentoxide, magnesium, rubber, linseed oil, hydrogen flouride and boric acid.
<b>Hazardous Polymerization:</b>	Will not polymerize.
<b>Hazardous Decomposition Products:</b>	Carbon dioxide and toxic fumes of zinc oxide.

**SECTION 11 - TOXICOLOGICAL INFORMATION**

<b><u>Ingredient(No data unless listed.)</u></b>	<b><u>CAS Number</u></b>	<b><u>LD50 and LC50</u></b>
Zinc oxide	001314-13-2	Oral LD50 Mouse: 7950 mg/kg

**Carcinogenicity:**

Ingredient	IARC Group 1	IARC Group 2A	IARC Group 2B	NTP Known	NTP Suspect	OSHA
Calcium oxide	No	No	No	No	No	No
Castor oil based ester	No	No	No	No	No	No
Distillates, petroleum, hydrotreated heavy naphthenic	No	No	No	No	No	No
Quartz	Yes	No	No	Yes	Yes	Yes
Zinc oxide	No	No	No	No	No	No

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor 20 Trowel Grade Part A  
MSDS ID Number: M-85745

MSDS Date: 12/31/04

**Mutagenicity:** Not applicable.  
**Teratogenicity:** Not applicable.  
**Reproductive Toxicity:** Not applicable.

**SECTION 12 - ECOLOGICAL INFORMATION**

**Environmental Fate:** No data available for product.  
**Ecotoxicity:** No data available for product.

**SECTION 13 - DISPOSAL CONSIDERATIONS**

**Waste Disposal Procedures:**  
Consult all regulations (federal, state, provincial, local) or a qualified waste disposal firm when characterizing waste for disposal. May be subject to industrial or special waste classification. According to EPA (40 CFR § 261), waste of this product is not defined as hazardous. Dispose of waste in accordance with all applicable regulations.

**SECTION 14 - TRANSPORTATION INFORMATION**

**Proper Shipping Name:** Not Applicable  
**UN/NA Number:** Not Applicable  
**Domestic Hazard Class:** NonHazardous  
**Surface Freight Classification:** Adhesive cements N.O.I.  
**Label/Placard Required:** Not Applicable

**SECTION 15 - REGULATORY INFORMATION**

**REGULATORY CHEMICAL LISTS:**

**CERCLA (Comprehensive Response Compensation and Liability Act):**  
**(None present unless listed below)**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>	<u>CERCLA RQ</u>
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**SARA Title III (Superfund Amendments and Reauthorization Act)**

**SARA Section 312/Tier I & II Hazard Categories:**

Health Immediate (acute)	No
Health Delayed (chronic)	No
Flammable	No
Reactive	No
Pressure	No

**302 Reportable Ingredients (Identification Threshold 1%):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>	<u>SARA 302 TPQ</u>
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**313 Reportable Ingredients (Chemicals present below reporting threshold are exempt):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
Zinc compounds	RR-00578-7	3.10831

**National VOC Emissions Standard for Architectural Coatings:**

Volatile Organic Content gr/l 75 g/l (as applied)

**WHMIS Classification(s):** D2 B

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR). This MSDS contains all the information required by the CPR.

**State Regulatory Information:**

**California Proposition 65:** This product may, upon mixing, release small amounts of Carbon disulfide, a substance found on California's Proposition 65 list.

**Massachusetts Hazardous Substance List(Identification threshold 0.001%(1ppm)):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
Quartz	014808-60-7	6.72

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor 20 Trowel Grade Part A  
MSDS ID Number: M-85745

MSDS Date: 12/31/04

**New Jersey Hazardous Substance List(Identification threshold (0.1%)):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
Zinc compounds	RR-00578-7	3.10831

**Pennsylvania Hazardous Substance List(Identification threshold 0.01%):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
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**CHEMICAL INVENTORY STATUS:**

All chemicals in this product are listed or exempt from listing in the following countries:

US	CANADA		EUROPE	AUSTRALIA	JAPAN	KOREA	PHILIPPINES
TSCA	DSL	NDSL	EINECS/ELINCS	AICS	ENCS	ECL	PICCS
Yes	No	Yes	Yes	Yes	Yes	Not Determined	Not Determined

**SECTION 16 - OTHER INFORMATION**

**Non-Hazardous Ingredient Disclosure:**

Chemical Name

CAS Number

<b>Prepared by:</b>	EH&S Department
<b>Approved by:</b>	EH&S Department
<b>Approved Date:</b>	12/31/04

**Disclaimer:**

"The data included herein are presented in accordance with various environment, health and safety regulations. It is the responsibility of a recipient of the data to remain currently informed on chemical hazard information, to design and update its own program and to comply with all national, federal, state and local laws and regulations applicable to safety, occupational health, right-to-know and environmental protection."

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor Part B (Procor 10,20, and 75)  
MSDS ID Number: 85743

MSDS Date: 12/30/04

**SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION**

**Product Name:** Procor Part B (Procor 10,20, and 75)  
**MSDS Number:** M-85743  
**Cancelled MSDS Number:** M-85723  
**MSDS Date:** 12/30/2004  
**Chemical Description:** SBR Rubber Emulsion.  
**Product Use:** Waterproofing Products  
**CAS # (Chemical Abstracts Service Number):** Mixture-NA

**Manufactured by:**

W.R.Grace & Co.-Conn. 62 Whittemore Avenue Cambridge, MA 02140	Grace Canada, Inc. 294 Clements Road West Ajax, Ontario L1S 3C6
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**In Case of Emergency Call:** (617) 876-1400

**SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS**

Ingredient	CAS#	Percent (max)
Styrene-Butadiene block copolymer	009003-55-8	50-100

**SECTION 3 - HAZARDS IDENTIFICATION**

**Emergency Overview:**

**Caution!**

Causes eye irritation.

Causes skin irritation.

Product supplied as two-component package and part A reacts with part B (and with water). A&B (or A & water) Reaction is exothermic, releasing heat.

Fumes may also be released if unused mixed product is allowed to sit in containers of thicknesses exceeds 120 mils.

Mixed A&B (or A & water) product may reach temperatures of 300°F.

Reaction product is sticky and will adhere to skin.

Contact with hot material will result in burns.

Do not seal containers once Part A is mixed with part B (or A with water.)

Sealed containers may explode due to pressure from the reaction.

**HMIS Rating:**

Health:	1
Flammability:	0
Reactivity:	0
Personal Protective Equipment:	B,G (See Section 8)

**Potential Health Effects:**

**Inhalation:** When mixed material (A&B) is allowed to set in the container, temperatures up to 300°F can be

reached, liberating water vapor, Carbon Disulfide and other Hydrocarbons. Inhalation of those materials can cause irritation. Prolonged inhalation can cause lung damage.

Effects include: Flu-like symptoms (metal fume fever).

**Eye Contact:** Eye contact causes irritation.

**Skin Contact:** Skin contact causes irritation. Product reacts with component A.

Contact with hot material will result in burns.

Reacting material is sticky and hot and will adhere to skin if touched before fully cured.

**Skin Absorption:** Not expected to be harmful if absorbed through the skin.

**Ingestion:** Due to the physical nature of this product, ingestion of this product is not likely. If ingested, causes irritation to the linings of the mouth, esophagus and stomach. Effects include the following: Nausea, vomiting, sneezing, coughing, labored breathing and burns.

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor Part B (Procor 10,20, and 75)  
MSDS ID Number: 85743

MSDS Date: 12/30/04

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**SECTION 4 - FIRST AID MEASURES:**

**Skin Contact:** In case of skin contact, clean fingernails and wash skin with soap and water. If residue remains, clean with waterless handcream or abrasive soap. Never use solvents.

If discomfort or irritation persists, consult a physician.

Remove contaminated clothing and wash before reuse.

**Eye Contact:**

Flush eyes with water for at least 15 minutes while holding eyelids open.

If discomfort or irritation persists, consult a physician.

**Ingestion:** Do not induce vomiting.

Never give anything by mouth to an unconscious person.

If discomfort or irritation persists, consult a physician.

**Inhalation:** If symptoms develop, get fresh air. If symptoms persist, consult a physician.

If breathing has stopped, give artificial respiration then oxygen if needed.

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**SECTION 5 - FIRE AND EXPLOSION HAZARD DATA**

<b>Flash Point:</b>	>300°F
<b>Flash Point Method:</b>	Estimated
<b>Lower Explosion Limit:</b>	Not Available
<b>Upper Explosion Limit:</b>	Not Available
<b>Auto-Ignition Temperature:</b>	Not Available

**NFPA Rating:**

<b>Health:</b>	1
<b>Flammability:</b>	1
<b>Reactivity:</b>	0

**Extinguishing Media:** In case of fire, use dry chemical, Carbon dioxide or foam.

Use water spray only if component A is not present.

**Special Fire Fighting Procedures:**

Wear self-contained breathing apparatus and complete personal protective equipment when potential for exposure to vapors or products of combustion exist. Water may be used to cool containers to prevent pressure build-up and possible auto-ignition or explosion. Avoid breathing hazardous vapors or products of combustion, keep upwind. Isolate area and keep unnecessary people away. Prevent run-off from fire control or dilution from entering streams or drinking water supplies.

**Unusual Fire and Explosion Hazards:**

None unless noted below.

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**SECTION 6 - ACCIDENTAL RELEASE MEASURES:**

**Spills/Leaks:**

Use proper personal protective equipment. Do not flush to sewer or allow to enter waterways. Keep unnecessary people away.

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**SECTION 7 - HANDLING AND STORAGE**

**Precautionary Measures:**

Avoid contact with eyes, skin and clothing.

Do not take internally.

Practice good personal hygiene to avoid ingestion.

Use only with adequate ventilation.

Wash clothing before reuse.

Wear respiratory protection during spray applications or where ventilation is inadequate.

Product supplied as two component package and part A reacts with part B (and with water).

A&B (or A & water) Reaction is exothermic, releasing heat.

Fumes may also be released if unused mixed product is allowed to sit in containers or if thicknesses exceed 120 mils.

Reaction product is sticky and will adhere to skin.

Contact with hot material will result in burns.

**W. R. GRACE**  
**MATERIAL SAFETY DATA SHEET**

Product Name: Procor Part B (Procor 10,20, and 75)  
 MSDS ID Number: 85743

MSDS Date: 12/30/04

Do not touch material once thickening (reaction) begins, and until cured and cool.  
 Procor 10 and 20 are supplied in mixing pails. Once component A&B are mixed, use all product within 30-60 minutes of mixing to avoid heat build up due to exothermic reaction (release of heat and fumes).  
 Reaction times may vary depending upon temperature and mixing conditions.  
 Procor 75 is packaged for machine application and should not be hand mixed.  
 Promptly cleanse hands after handling.  
 FOR PROFESSIONAL USE ONLY. KEEP OUT OF CHILDREN'S REACH.

**SECTION 8 - EXPOSURE CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT**

**EXPOSURE GUIDELINES (US)**

Ingredient	ACGIH TLV			OSHA PEL			Other
	TWA	STEL	Ceiling	TWA	STEL	Ceiling	
Styrene-Butadiene block copolymer	-	-	-	-	-	-	

**EXPOSURE GUIDELINES (CANADA)**

Employers should consult local Provincial regulatory limits for exposure guidelines which may vary locally.

**Engineering Controls:** Provide local exhaust ventilation to prevent vapor build-up during application. This is particularly important in enclosed or confined areas where natural ventilation may not be adequate. Provide enough ventilation to maintain exposure levels below regulatory limits.

**Respiratory Protection:** Respiratory protection requirements vary by product application. Consult respiratory protection section of the "Part A" MSDS's For Procor 75, Procor 20 and Procor 10.

**Skin Protection:** Impervious (PVC, or nitrile) gloves should be worn any time direct contact is possible.

**Eye Protection:** At minimum, safety glasses with side shields should be worn where exposure to excessive dust or spray is likely.

**Work/Hygienic Practices:** Use good personal hygiene practices.

Carbon disulfide and other potentially harmful gases, vapors and fumes may evolve as a result of exothermic reactions ("hot product") when component A&B are mixed. Carbon disulfide may be detected by odor at about 1 ppm, but the ability to smell fatigues (diminishes) rapidly, therefore, odor does not serve as a good warning property. If eye or respiratory irritation occurs, or if a foul odor is detected, you may be experiencing exposure to Carbon disulfide and other organics. Leave the area immediately and seek fresh air.

**SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES**

<b>Physical State:</b>	Liquid
<b>Appearance/Odor:</b>	A milky white aqueous dispersion with mild aromatic odor.
<b>Odor Threshold:</b> (ppm)	Not Determined
<b>pH:</b>	9-12
<b>Vapor Pressure:</b> (Mm Hg)	Unknown
<b>Vapor Density:</b> (Air = 1)	Unknown
<b>Solubility In Water:</b>	Miscible
<b>Specific Gravity:</b> (Water = 1)	1.0
<b>Evaporation Rate:</b> (Butyl Acetate = 1)	Unknown
<b>Boiling Point:</b>	>212°F/100°C
<b>Viscosity:</b>	Unknown
<b>Bulk Density:</b> (Pounds/Cubic Foot)(Pcf)	~60
<b>% Volatiles</b> (70°F) (21°C)	Not Determined

**SECTION 10 - STABILITY AND REACTIVITY**

<b>Chemical Stability:</b>	Stable
<b>Conditions To Avoid:</b>	Strong oxidizers.
<b>Hazardous Polymerization:</b>	Will not polymerize.
<b>Hazardous Decomposition Products:</b>	Carbon dioxide and Carbon monoxide.

**W. R. GRACE**  
**MATERIAL SAFETY DATA SHEET**

Product Name: Procor Part B (Procor 10,20, and 75)  
 MSDS ID Number: 85743

MSDS Date: 12/30/04

**SECTION 11 - TOXICOLOGICAL INFORMATION**

**Ingredient(No data unless listed.)**                      **CAS Number**                      **LD50 and LC50**

**Carcinogenicity:**

Ingredient	IARC Group 1	IARC Group 2A	IARC Group 2B	NTP Known	NTP Suspect	OSHA
Styrene-Butadiene block copolymer	No	No	No	No	No	No

**Mutagenicity:** Not applicable.  
**Teratogenicity:** Not applicable.  
**Reproductive Toxicity:** Not applicable.

**SECTION 12 - ECOLOGICAL INFORMATION**

**Environmental Fate:** No data available for product.  
**Ecotoxicity:** No data available for product.

**SECTION 13 - DISPOSAL CONSIDERATIONS**

**Waste Disposal Procedures:**  
 Consult all regulations (federal, state, provincial, local) or a qualified waste disposal firm when characterizing waste for disposal. According to EPA (40 CFR § 261), waste of this product is not defined as hazardous. Dispose of waste in accordance with all applicable regulations.

**SECTION 14 - TRANSPORTATION INFORMATION**

**Proper Shipping Name:** Not Applicable  
**UN/NA Number:** Not Applicable  
**Domestic Hazard Class:** NonHazardous  
**Surface Freight Classification:** Adhesive Cements N.O.I.  
**Label/Placard Required:** Not Applicable

**SECTION 15 - REGULATORY INFORMATION**

**REGULATORY CHEMICAL LISTS:**

**CERCLA (Comprehensive Response Compensation and Liability Act):**  
**(None present unless listed below)**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>	<u>CERCLA RQ</u>
1,3-Butadiene	000106-99-0	.001	10 lb final RQ; 4.54 kg final RQ
Styrene	000100-42-5	.08	1000 lb final RQ; 454 kg final RQ

**SARA Title III (Superfund Amendments and Reauthorization Act)**

**SARA Section 312/Tier I & II Hazard Categories:**

Health Immediate (acute)                      No  
 Health Delayed (chronic)                      No  
 Flammable    No  
 Reactive    No  
 Pressure    No

**302 Reportable Ingredients (Identification Threshold 1%.):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>	<u>SARA 302 TPQ</u>
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**313 Reportable Ingredients (Chemicals present below reporting threshold are exempt):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
1,3-Butadiene	000106-99-0	.001
Styrene	000100-42-5	.08

**National Volatile Organic Compound Emission Standards For Architectural Coatings:**

**Volatile Organic Content:** (gr/L)                      75 g/l (as applied)

**W. R. GRACE**  
MATERIAL SAFETY DATA SHEET

Product Name: Procor Part B (Procor 10,20, and 75)

MSDS ID Number: 85743

MSDS Date: 12/30/04

**WHMIS Classification(s):** D2 B

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR). This MSDS contains all the information required by the CPR.

**State Regulatory Information:**

**California Proposition 65:** WARNING! This product contains substances known to the state of California to cause cancer, birth defects or other reproductive harm.

**Massachusetts Hazardous Substance List(Identification threshold 0.001%(1ppm)):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
1,3-Butadiene	000106-99-0	.001
Styrene	000100-42-5	.08

**New Jersey Hazardous Substance List(Identification threshold (0.1%)):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
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**Pennsylvania Hazardous Substance List(Identification threshold 0.01%):**

<u>Chemical Name</u>	<u>CAS #</u>	<u>Wt %</u>
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**CHEMICAL INVENTORY STATUS:**

All chemicals in this product are listed or exempt from listing in the following countries:

US	CANADA		EUROPE	AUSTRALIA	JAPAN	KOREA	PHILIPPINES
TSCA	DSL	NDSL	EINECS/ELINCS	AICS	ENCS	ECL	PICCS
Yes	Yes	No	Yes	Yes	No	Yes	No

**SECTION 16 - OTHER INFORMATION**

**Non-Hazardous Ingredient Disclosure:**

<u>Chemical Name</u>	<u>CAS Number</u>
Water	007732-18-5

**Prepared by:** EH&S Department  
**Approved by:** EH&S Department  
**Approved Date:** 12/30/2004

**Disclaimer:**

"The data included herein are presented in accordance with various environment, health and safety regulations. It is the responsibility of a recipient of the data to remain currently informed on chemical hazard information, to design and update its own program and to comply with all national, federal, state and local laws and regulations applicable to safety, occupational health, right-to-know and environmental protection."



## Material Safety Data Sheet

**Product: Kemperol BR M Waterproofing**

**MSDS Date:** 2-9-07  
**Product Name:** Kemperol BR M Waterproofing  
**Manufacturer:** Kemper System, Inc.

### I. Product and Company Description

Kemper System, Inc.  
1182 Teaneck Road  
Teaneck, N.J. 07666

**Emergency Phone Number:**  
(800) 424-9300 CHEMTREC

**For Product Information:**  
(800) 541-5455

**Product Description:**  
Sealing

### II. Chemical Composition

Component	CAS#	%Composition
Styrene	100-42-5	25-50

### III. Hazards Identification

#### A. Emergency Overview:

**Physical Appearance and Odor:**  
Transparent liquid with aromatic odor.

#### B. Potential Health Effects:

**Acute Eye:**  
Contact may cause irritation, redness and pain.

**Acute Skin:**  
May cause irritation.

**Acute Inhalation:**  
May irritate the upper respiratory tract if inhaled.

**Acute ingestion:**  
Harmful or fatal if swallowed.

**Chronic effects:**  
None



## Material Safety Data Sheet

**Product: Kemperol BR M Waterproofing**

### **IV. First Aid Measures**

#### **First Aid Measures for Accidental Exposure:**

##### **Eye Exposure:**

Immediately flush eyes with plenty of water. Get medical attention, if irritation persists.

##### **Skin Exposure:**

Wash affected area with soap and water; remove contaminated clothing and wash before reuse. Get medical attention if irritation develops or persists.

##### **Inhalation:**

Remove to fresh air. Seek medical attention if respiratory irritation develops or if breathing becomes difficult.

##### **Ingestion:**

Seek medical attention immediately. Never give anything by mouth to an unconscious person.

### **V. Fire Fighting Measures**

#### **Fire Hazard Data:**

**Flash Point:** 32°C (90°F)

**Ignition Temperature:** 480°C (896°F)

**Flammability Limits (vol/vol%):** Lower: 1.2 Upper: 8.9

##### **Extinguishing Media:**

CO<sub>2</sub>, extinguishing powder, sand

##### **Special Fire Fighting Procedures:**

If excessive fumes or smoke is encountered, wear self-contained breathing apparatus and full protective equipment.

##### **Unusual Fire and Explosion Hazards:**

None

##### **Hazardous Decomposition Materials (Under Fire Conditions):**

Oxides of carbon and nitrogen, smoke, hydrocarbons, alcohols, aldehyde, ketone, carbon acids (phthalic acid, etc.), aromatics.

### **VI. Accidental Release Measures**

#### **Cleanup and Disposal of Spill:**

Contain and collect spillage with non-combustible absorbent materials, e.g. sand, earth, vermiculite, diatomaceous earth and place in container for disposal. Do not allow product to reach sewage system or water bodies. Use protective measures as outlined in Section VIII below. Avoid contact with eyes, skin or clothing.



## Material Safety Data Sheet

**Product: Kemperol BR M Waterproofing**

Dispose of materials according to the applicable Federal, State, or local regulations.

**VII. Handling and Storage**

**Handling:**

Keep container tightly closed. Isolate from sources of heat, sparks and open flame. No sparking tools should be used. Avoid skin and eye contact. Smoking, eating and drinking should be prohibited in application area. For personal protection see Section 8.

**Storage:**

Store away from foodstuffs and in a cool, well-ventilated area.

**VIII. Exposure Controls / Personal Protection**

**Exposure Guidelines:**

Component	Exposure limits		
	ACGIH	NIOSH	OSHA-PELs
Styrene	170 mg/m <sup>3</sup> , 40 ppm	ND	200 ppm ceiling

**Engineering Controls:**

Ventilation must be adequate to maintain the ambient workplace atmosphere below the exposure limit(s) outlined in the MSDS.

**Respiratory Protection:**

Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or EN approved respirator when necessary.

**Eye / Face Protection:**

Wear appropriate safety glasses with side shields or chemical goggles as described by OSHA's eye and face protection regulations in 29CFR 1910.133 or European Standard EN166.

**Skin Protection:**

Chemical resistant gloves recommended, such as neoprene or nitrile rubber. Body covering clothing should be utilized.

**IX. Physical and Chemical Properties**

<b>Physical Appearance:</b>	Transparent liquid
<b>Odor:</b>	Aromatic
<b>pH:</b>	ND
<b>Specific Gravity:</b>	1.16
<b>Water Solubility:</b>	0.3 g/l
<b>Melting Point Range:</b>	ND
<b>Boiling Point:</b>	145°C (293°F)
<b>Vapor Pressure:</b>	6.0 hPa (5 mm Hg)
<b>Vapor Density:</b>	ND
<b>%Volatile by volume:</b>	ND
<b>Evaporation Rate:</b>	ND



## Material Safety Data Sheet

**Product: Kemperol BR M Waterproofing**

### X. Stability and Reactivity

**Chemical Stability:**

Stable under standard use and storage conditions.

**Conditions to Avoid:**

Sources of ignition

**Materials / Chemicals to be Avoided:**

None

**Hazardous Decomposition Products:**

Oxides of carbon and nitrogen, smoke, hydrocarbons, alcohols, aldehyde, ketone, carbon acids (phthalic acid, etc.), aromatics.

**Hazardous Polymerization:**

Should not occur.

### XI. Toxicological Information

**Acute Oral Toxicity:**

LD50: 5000 mg/kg (rat)

**Acute Dermal Toxicity:**

ND

**Acute Inhalation Toxicity:**

LC 50/4h: 11.8 mg/l (rat)

**Chronic Toxicity:**

ND

### XII. Ecological Information

**Ecotoxicological Information:**

Degradation: Not Determined

Accumulation: Not Determined

Fish-Toxicity: EC0: 72 mg/l (bacteria)

EC50-OECD202: 182 mg/l (daphnia)

EC50-OECD203: 25 mg/l (LEPOMUS MACROCHIRUS); 23 mg/l (daphnia)

**Chemical Fate Information:**

Not Determined

### XIII. Disposal Considerations

**Waste Disposal Method:**

Discard any product, residue, disposable container or liner in full compliance with federal, state, and local regulations.



## Material Safety Data Sheet

**Product: Kemperol BR M Waterproofing**

**Container Handling and Disposal:**

Dispose of container and unused contents in accordance with federal, state, and local regulations.

**XIV. Transportation Information**

**US Department of Transportation Shipping Name:**

<b>US Department of Transportation</b>	<b>Proper Shipping Name</b>	Resin Solution (styrene monomer, stabilized)
	<b>Hazard Class</b>	3
	<b>ID Number</b>	NA 1866
	<b>Packaging Group</b>	III

**XV. Regulatory Information**

**Federal Regulations:**

**SARA Title III Hazard Classes:**

Fire Hazard: YES  
 Reactive Hazard: NO  
 Release of Pressure: NO  
 Acute Health Hazard: YES  
 Chronic Health Hazard: YES

**SARA Section References:**

Section 302 (RQ)  
 None  
  
 Section 302 (TPQ)  
 None  
 Section 313  
 None

**Toxic Substances Control Act (TSCA):** All components are included in the inventory or are not required to be listed.

**Other Regulations:**

**State:**

The components identified with an X are present on the respective state's Right To Know lists:

Component	MA	PA	MI	MN	CA	NJ
Styrene						

California Prop. 65: Acetaldehyde is known in the state of California to cause cancer.



## Material Safety Data Sheet

**Product: Kemperol BR M Waterproofing**

### **XVI. Other Information**

#### **National Fire Protection Association Hazard Ratings – NFPA(R):**

Health Hazard:	2
Flammability:	3
Reactivity:	0

#### **Key Legend Information:**

N/A – Not Applicable

ND – Not Determined

ACGIH – American Conference of  
Governmental Industrial Hygienists

OSHA – Occupational Safety and Health  
Administration

TLV – Threshold Limit Value

PEL – Permissible Exposure Limit

TWA – Time Weighted Average

STEL – Short Term Exposure Limit

NTP – National Toxicology Program

IARC – International Agency for Research on  
Cancer

**The information contained herein is based on the data available to us and is believed to be correct. However Kemper System, Inc. makes no warranty, expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof.**

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**SECTION 1 - PRODUCT IDENTIFICATION**

Trade name	:	TREMPROOF 201/60 - R
Product code	:	859509 805
COMPANY	:	Tremco Incorporated 3735 Green Road Cleveland, OH 44122
Telephone	:	(216) 292-5000 8:30 - 5:00 EST
Emergency Phone:	:	(216) 765-6727 8:30 - 5:00 EST After Hours: Chemtrec 1-800-424-9300
Product use	:	Coating

**SECTION 2 - HAZARDS IDENTIFICATION****Emergency Overview**

Black / Brown. Semi-Solid. May cause drowsiness, weakness, and fatigue. Vapor and/or mist may irritate nose and throat. May cause moderate irritation to the respiratory system. May cause allergic respiratory sensitization. Move to fresh air. If required, artificial respiration or administration of oxygen can be performed by trained personnel. Leave area to breathe fresh air. Avoid further overexposure. If symptoms persist, get medical attention.

**Acute Potential Health Effects/ Routes of Entry**

Inhalation	:	May cause drowsiness, weakness, and fatigue. Vapor and/or mist may irritate nose and throat. May cause moderate irritation to the respiratory system. May cause allergic respiratory sensitization.
Eyes	:	Vapor and/or mist may cause eye irritation.
Ingestion	:	May cause irritation to the mouth, throat and stomach. May cause gastrointestinal irritation, nausea, and vomiting.
Skin	:	May cause sensitization resulting in irritation, itching and redness.

**Aggravated Medical Conditions**

Pre-existing eye, skin, liver, kidney, and respiratory disorders may be aggravated by exposure.

**Chronic Health Effects**

Overexposure may cause dermatitis, asthma, skin and respiratory sensitization and decreased lung function. Repeated overexposure to vapors and/or material may injure the liver, kidneys and respiratory system unless suitable engineering controls and/or personal protective equipment are used. Aromatic tar contains polycyclic aromatic hydrocarbons, some of which have been shown to cause skin cancer following prolonged and repeated skin contact. Should be considered potentially carcinogenic by inhalation. Carbon black is classified by IARC to be a known animal carcinogen and a possible human carcinogen (Group 2B). Di(2-ethylhexyl) phthalate, (dioctyl phthalate) given in the diet, produced increased incidence of liver cancers in female rats and male and female mice. An increased incidence of liver cancers or neoplasms were observed in male rats. A long-term NTP study showed that oral exposure to toluene diisocyanate (TDI) caused cancer in rats and mice. A lifetime inhalation study sponsored by the International Isocyanate Institute did not show carcinogenic activity in rats. May cause allergic skin and respiratory sensitization. Prolonged or repeated exposure to mineral spirits (petroleum naphtha or stoddard solvent) may cause defatting, drying, and irritation of the skin, dermatitis, central nervous system (CNS) effects, and adverse liver, kidney, and lung effects.

**Target Organs:** Eye, Lung, Liver, Kidney, Skin, Nerve

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**SECTION 3 - PRODUCT COMPOSITION**

Chemical Name	CAS-No.	Weight %
Aromatic process oil	64742-90-1	40.0 - 70.0
Polyurethane Polymer	NJ TSRN# 51721300-5024P	30.0 - 60.0
Calcium Carbonate (Limestone)	1317-65-3	10.0 - 30.0
Calcium oxide	1305-78-8	3.0 - 7.0
Carbon Black	1333-86-4	3.0 - 7.0
Stoddard solvent (Mineral Spirits)	8052-41-3	1.0 - 5.0
Anthracene	120-12-7	1.0 - 5.0
Diethyl phthalate	117-81-7	- <1.0
2,4-Toluene diisocyanate	584-84-9	- <1.0
Toluene-2,6-Diisocyanate	91-08-7	- <0.1
Crystalline Silica (Quartz)/ Silica Sand	14808-60-7	- <0.1

**SECTION 4 - FIRST AID MEASURES**

Get immediate medical attention for any significant overexposure.

Inhalation	:	Move to fresh air. If required, artificial respiration or administration of oxygen can be performed by trained personnel. Leave area to breathe fresh air. Avoid further overexposure. If symptoms persist, get medical attention.
Eye contact	:	Flush with water for at least 15 minutes while holding eye lids apart. Get medical attention immediately.
Skin contact	:	Wash area of contact thoroughly with hand cleaner followed by soap and water. If irritation, rash or other disorders develop, get medical attention immediately.
Ingestion	:	Do not induce vomiting unless advised by a physician. Call nearest Poison Control Center or Physician immediately.

**SECTION 5 - FIRE FIGHTING MEASURES**

Flash point	:	89 °C, 192 °F
Method	:	Setaflash Closed Cup
Burning rate	:	Non-flammable solid
Lower explosion limit	:	Not available.
Upper explosion limit	:	Not available.
Autoignition temperature	:	Not available.
Extinguishing media	:	If water fog is ineffective, use carbon dioxide, dry chemical or foam.
Hazardous combustion products	:	Carbon monoxide and carbon dioxide can form. Smoke, fumes. Hydrocyanic acid and nitrogen oxides can form.
Protective equipment for firefighters	:	Use accepted fire fighting techniques. Wear full firefighting protective clothing, including self-contained breathing apparatus (SCBA).



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Fire and explosion conditions : Product may ignite if heated in excess of its flash point. Closed container, may burst when exposed to extreme heat. Empty containers may contain ignitable vapors. Vapors may travel to sources of ignition and flashback.

**SECTION 6 - ACCIDENTAL RELEASE MEASURES**

Use appropriate protective equipment. Avoid contact with material. Remove sources of ignition immediately. Stop flow of material if safe to do so. Contain spill and keep out of water courses. Ventilate area.

**SECTION 7 - HANDLING AND STORAGE**

Prevent inhalation of vapor, ingestion, and contact with skin eyes and clothing. Keep container closed when not in use. Precautions also apply to emptied containers. Change soiled work clothes frequently. Clean hands thoroughly after handling. Do not smoke, weld, generate sparks, or use flame near container. To prevent generation of static discharges, use bonding/grounding connection when pouring liquid. Extinguish all ignition sources including pilot lights, non-explosion proof motors and electrical equipment until vapors dissipate. Store under dry warehouse conditions away from heat and all ignition sources.

**SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION**

**Personal protection equipment**

- Respiratory protection : Wear appropriate, properly fitted NIOSH/MSHA approved respirator when airborne contaminant level(s) are expected to exceed exposure limits indicated on the MSDS. Select positive pressure supplied air respirator (TC19C or equivalent) for isocyanates.
- Hand protection : Use suitable impervious nitrile or neoprene gloves and protective apparel to reduce exposure.
- Eye protection : Wear appropriate eye protection. Wear chemical safety goggles and/or face shield to prevent eye contact. Do not wear contact lenses. Do not touch eyes with contaminated body parts or materials. Have eye washing facilities readily available.
- Skin and body protection : Prevent contact with shoes and clothing.
- Protective measures : Use professional judgment in the selection, care, and use.
- Engineering measures : Use only in well ventilated areas. Provide maximum ventilation in enclosed areas. Use local exhaust when the general ventilation is inadequate.

**Exposure Limits**

Chemical Name	CAS Number	Regulation	Limit	Form
Calcium Carbonate (Limestone)	1317-65-3	OSHA PEL:	5 mg/m3	Respirable fraction.
		OSHA PEL:	15 mg/m3	Total dust.
		ACGIH TWA:	3 mg/m3	Respirable particles.
		ACGIH TWA:	10 mg/m3	Inhalable particles.
		OSHA TWA:	15 mg/m3	Total dust.
		OSHA TWA:	5 mg/m3	Respirable fraction.

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<u>Chemical Name</u>	<u>CAS Number</u>	<u>Regulation</u>	<u>Limit</u>	<u>Form</u>
Calcium oxide	1305-78-8	ACGIH TWA: OSHA PEL: OSHA TWA: OSHA TWA:	2 mg/m3 5 mg/m3 15 mg/m3 5 mg/m3	Total dust. Respirable fraction.
Carbon Black	1333-86-4	ACGIH TWA: OSHA PEL: OSHA TWA: OSHA TWA:	3.5 mg/m3 3.5 mg/m3 15 mg/m3 5 mg/m3	Total dust. Respirable fraction.
Stoddard solvent (Mineral Spirits)	8052-41-3	ACGIH TWA: OSHA PEL:	100 ppm 2,900 mg/m3	
Diocetyl phthalate	117-81-7	ACGIH TWA: OSHA PEL:	5 mg/m3 5 mg/m3	
2,4-Toluene diisocyanate	584-84-9	ACGIH TWA: ACGIH STEL:	0.005 ppm 0.02 ppm	
Toluene-2,6-Diisocyanate	91-08-7	ACGIH TWA: ACGIH STEL:	0.005 ppm 0.02 ppm	
Crystalline Silica (Quartz)/ Silica Sand	14808-60-7	OSHA TWA: OSHA TWA: OSHA PEL: OSHA PEL: ACGIH TWA:	0.1 mg/m3 0.3 mg/m3 15 mg/m3 5 mg/m3 0.025 mg/m3	Respirable. Total dust. Total dust. Respirable fraction. Respirable fraction.

**SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES**

Form	: Semi-Solid
Color	: Black / Brown
Odor	: Solvent odor
pH	: Not available.
Vapour pressure	: Not available.
Vapor density	: Heavier than air
Melting point/range	: Not available.
Freezing point	: Not available.
Boiling point/range	: Not available.
Water solubility	: Negligible
Specific Gravity	: 1.2
% Volatile Weight	: 7 %

**SECTION 10 - REACTIVITY / STABILITY**

Substances to avoid : Strong acids.Strong bases.Amines.Water or moisture.Alcohols.

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Stability : Material is stable under normal storage, handling, and use.  
 Hazardous polymerization : Will not occur under normal conditions.

**SECTION 11 - TOXICOLOGICAL INFORMATION**

Diocyl phthalate, CAS-No.: 117-81-7  
 Acute oral toxicity (LD-50 oral) 25,000 mg/kg ( Rat ) 30,000 mg/kg ( Mouse ) 33,900 mg/kg ( Rabbit ) 26,300 mg/kg ( Guinea pig )  
 Acute dermal toxicity (LD-50 dermal) 10,000 mg/kg ( Guinea pig ) 25,000 mg/kg ( Rabbit )

2,4-Toluene diisocyanate, CAS-No.: 584-84-9  
 Acute oral toxicity (LD-50 oral) 5,800 mg/kg ( Rat )  
 Acute inhalation toxicity (LC-50) 14 mg/l for 4 h ( Rat ) 10 mg/l for 4 h ( Mouse ) 13 mg/l for 4 h ( Guinea pig ) 11 mg/l for 4 h ( Rabbit )

**SECTION 12 - ECOLOGICAL INFORMATION**

No Data Available

**SECTION 13 - DISPOSAL CONSIDERATIONS**

Disposal Method : Subject to hazardous waste treatment, storage, and disposal requirements under RCRA. Recycle or incinerate waste at EPA approved facility or dispose of in compliance with federal, state and local regulations.

**SECTION 14 - TRANSPORTATION / SHIPPING DATA**

**TDG / DOT Shipping Description:**  
 NOT REGULATED

**SECTION 15 - REGULATORY INFORMATION**

**North American Inventories:**

All components are listed or exempt from the TSCA inventory.  
 This product or its components are listed on, or exempt from the Canadian Domestic Substances List.

**U.S. Federal Regulations:**

SARA 313 Components	:	Anthracene	120-12-7
		Diocyl phthalate	117-81-7
		2,4-Toluene diisocyanate	584-84-9

SARA 311/312 Hazards : Acute Health Hazard  
 Chronic Health Hazard

OSHA Hazardous Components :

Aromatic process oil	64742-90-1
Calcium Carbonate (Limestone)	1317-65-3

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Calcium oxide	1305-78-8
Carbon Black	1333-86-4
Stoddard solvent (Mineral Spirits)	8052-41-3
Anthracene	120-12-7
Diocetyl phthalate	117-81-7
2,4-Toluene diisocyanate	584-84-9
Toluene-2,6-Diisocyanate	91-08-7
Crystalline Silica (Quartz)/ Silica Sand	14808-60-7

OSHA Status: Considered : Irritant  
 hazardous based on the Sensitizer  
 following criteria: Carcinogen

OSHA Flammability : Not Regulated

Regulatory VOC (less water and : 93 g/l  
 exempt solvent)

VOC Method 310 : 7 %

Chemical is listed as an IARC, NTP, OSHA, or ACGIH Carcinogen:  
 Carbon Black 1333-86-4

**U.S. State Regulations:**

MASS RTK Components	:	Calcium Carbonate (Limestone)	1317-65-3
		Calcium oxide	1305-78-8
		Carbon Black	1333-86-4
		Stoddard solvent (Mineral Spirits)	8052-41-3
		Anthracene	120-12-7
		2,4-Toluene diisocyanate	584-84-9
		Toluene-2,6-Diisocyanate	91-08-7
		Crystalline Silica (Quartz)/ Silica Sand	14808-60-7
Penn RTK Components	:	Aromatic process oil	64742-90-1
		Polyurethane Polymer	NJ TSRN# 51721300-5024P
		Calcium Carbonate (Limestone)	1317-65-3
		Calcium oxide	1305-78-8
		Carbon Black	1333-86-4
		Stoddard solvent (Mineral Spirits)	8052-41-3
		2,4-Toluene diisocyanate	584-84-9
NJ RTK Components	:	Aromatic process oil	64742-90-1
		Polyurethane Polymer	NJ TSRN# 51721300-5024P
		Calcium Carbonate (Limestone)	1317-65-3
		Calcium oxide	1305-78-8
		Carbon Black	1333-86-4
		Stoddard solvent (Mineral Spirits)	8052-41-3

**WARNING!** Contains chemicals known to the State of California to cause cancer, birth defects and/or other reproductive harm:

64742-90-1	Aromatic process oil
1333-86-4	Carbon Black
117-81-7	Diocetyl phthalate
584-84-9	2,4-Toluene diisocyanate
91-08-7	Toluene-2,6-Diisocyanate
14808-60-7	Crystalline Silica (Quartz)/ Silica Sand

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**SECTION 16 - OTHER INFORMATION**

**HMIS Rating :**

Health	2
Flammability	1
Reactivity	1
PPE	

0 = Minimum  
 1 = Slight  
 2 = Moderate  
 3 = Serious  
 4 = Severe

**Further information:**

For Industrial Use Only. Keep out of Reach of Children. The hazard information herein is offered solely for the consideration of the user, subject to their own investigation of compliance with applicable regulations, including the safe use of the product under every foreseeable condition.

**Prepared by: Rich Mikol**

**Legend**

ACGIH - American Conference of Governmental Hygienists  
 CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act  
 DOT - Department of Transportation  
 DSL - Domestic Substance List  
 EPA - Environmental Protection Agency  
 HMIS - Hazardous Materials Information System  
 IARC - International Agency for Research on Cancer  
 MSHA - Mine Safety Health Administration  
 NDSL - Non-Domestic Substance List  
 NIOSH - National Institute for Occupational Safety and Health  
 NTP - National Toxicology Program  
 OSHA - Occupational Safety and Health Administration

PEL - Permissible Exposure Limit  
 RCRA - Resource Conservation and Recovery Act  
 RTK - Right To Know  
 SARA - Superfund Amendments and Reauthorization Act  
 STEL - Short Term Exposure Limit  
 TLV - Threshold Limit Value  
 TSCA - Toxic Substances Control Act  
 TWA - Time Weighted Average  
 V - Volume  
 VOC - Volatile Organic Compound  
 WHMIS - Workplace Hazardous Materials Information System

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## BIOGRAPHICAL SKETCH

Sarah Vasconi was born in Clearwater, Florida and went to a private school until high school, which she attended Tarpon Springs HS and graduated Summa Cum Laude with a GPA of 4.2. The only college that she applied to was the University of Florida and was accepted straight from high school in 2003. In deciding which major to pursue, Sarah stuck to her strengths and passions of design and art. She received a Bachelor Degree of Architecture in May 2007, but felt that she had more to learn about the physical construction of buildings. Sarah therefore applied and was accepted to the Construction Management Master Program at The M.E. Rinker Sr. School of Building Construction and concentrated on a Sustainable Construction. With the completion of this thesis, and subsequent graduation, she will begin work August 2009 as a project engineer with Skanska in Tampa, FL.