[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	**2** (Select the number from "Areas of Technologies Requested")
Title	**Protective Elastomers Coatings**
Submitted by	NIPPON COATING INTERNATIONAL LTD.

- **Applications and Solutions for Areas of Technologies No. 2**

② Treatment of contaminated water

Technology needed

(2) Requirements for treatment technologies

- Polyurea can be used to encapsulate contaminated water vessels allowing safe long term, water and corrosion proof containment for storage above or below ground.

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1. Overview of Technologies (features, specification, functions, owners, etc.)

Polyurea Coating Technologies and Solutions

Technology and Solution Description

Our Polyurea coatings create a durable, elastomeric, seamless, waterproofing membrane which forms an impermeable barrier that is resistant to water, corrosion, and many chemicals.

Our Polyurea protective coating solutions are eco-friendly, non-toxic, contain zero VOCs or solvents.

Our advanced Polyurea systems with ultra high-strength and high-elongation, was originally developed as a blast resistant polymer, with exceptional resistance to abrasion, compared to other spray applied coatings. It can be sprayed to virtually any surface configuration, at any thickness.

Features

- Easily applied and self-priming on most surfaces: metal, wood, concrete, fabric, etc.
- High resistant to extreme environmental conditions such as heat, cold, chemicals, radiology and aging *(approved for 75 years).*
- Seamless & Waterproof
- No solvents, No VOC's, No odor
- Easily decontaminated / high polymer surface
- Low Level Radiation Barrier
- In combination with radiation shielding technologies, increased shielding against Alpha-, Beta-, X- and Gamma rays is achieved.
- Robotic systems can be applied for execution purposes
- Anti corrosion
- Hydrophobic
- Flexible: bridges cracks and expands and contracts with substrate
- Fast application time / Minimal downtime *(sets in seconds)*

- Excellent abrasion resistance
- Easy maintenance
- High Impact resistant
- High tensile strength
- High elongation & hardness *(Structural reinforcement)*
- Resistant to many chemicals

Functions

Our Polyurea coatings are spray applied and provide a monolithic coating which conforms to complex geometric shapes and may be returned to service immediately. These hyper-elastic coatings have been proven as an excellent energy absorbing material for use in mitigating blast effects and reduce damage during seismic events.

Our Polyurea system has a proven record in relation to nuclear decommissioning applications, such as the Hanford Nuclear Facilities (USA), and our solution has been tested to ensure durability (75 years) in radio-active and hazardous environments. In combination with a polyurethane foam, the Polyurea system was selected as best option for containment of a surface (including complex shapes) to avoid airborne contamination during decontamination and decommissioning (D&D) activities and to prepare the reactor for up to 75 years of interim safe storage.

Function examples:

- *Primary & Secondary Containment*
- *Water Proofing*
- *Energy Absorption*
- *Environmental Protection*
- *Chemical Resistance*
- *Hazardous Materials Containment*
- *Corrosion Resistance*
- *Abrasion Resistance*
- *Structural Reinforcement*
- *Seismic Reinforcement*
- *Earth Containment & Erosion Resistant*
- *Fire Retardant & Flame Resistance*
- *Blast & Ballistic Mitigation*
- *Roof & Floor Protective Coatings*

Application Examples

- *Silos & Tanks*
- *Chutes and Hoppers*
- *Decommissioning of Nuclear Facilities*
- *Containment of contaminated materials*
- *Industrial Flooring*
- *Slurry, water and fuel tanks*
- *Truck Liners*
- *Classifier and Shaker Screens*

Owners

Nippon Coating Solutions is representing a collaboration founded to provide solutions to the challenges Japan faces in the aftermath of the 2011 Earthquake. The Collaboration combines the expertise of coating experts, the supply from a global leading polyurea manufacturing company (USA) and the innovative anti radiation technologies provided by a joint venture between an international coating solutions provider and a Japanese entity founded by a leading Professor of Nuclear Energy and Radiation Shielding Technologies.

2. Notes (Please provide following information if possible.)

- *Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)*

- **Technology Readiness**

Polyurea and Polyurethane Coating – ***Available and Ready***

WET PROPERTIES @77 F (25°C)

Solids by Volume	**100%**
Solids by Weight	**100%**
Volatile Organic Compounds	**0 lbs/gal (0g/l)**
Theoretical Coverage DFT	**100 sq. ft. @ 16 mils/gal**
Weight per gallon (approx.)	**8.8 lbs. (3.99kg)**
Number of Coats	**1-3**
Mix Ratio	**1 "A": 1 "B"**
Viscosity (cps) @ 77° F (25 °C)	**A: 900 approx.**
	B: 230 approx.

Shelf Life Unopened Containers
@ 60-90oF (15-32oC) **Six months**

Minimum material/container temperature for spray application is 70°F (21 °C).

DRY PROPERTIES @ 34 mils (0.8 mm)**

Tensile Strength ASTM D 412	**>5500 psi (34.75 mpa)**
Elongation @77°F (25°C)	**>300%**
Hardness (Shore A)	**96**
Hardness (Shore D)	**57**
Modulus @ 100% Elongation ASTM D412	**>1800 psi (12.51 mpa)**
Modulus @ 200% Elongation ASTM D412	**>3000 psi (20.85 mpa)**
Modulus @ 300% Elongation ASTM D412	**>4700 psi (32.67 mpa)**
Service Temperature	**-50°F - +200°F** **(-45°C - +93.3°C)**
Tear Resistance ASTM D624	**690 PLI (120/82KN/m) Avg.**
Abrasion Resistance 1kg. 1000 rev.	**CS-17 wheel | 2.0mg. lost** **H-18 wheel | 33.0 mg. lost**

Curing Schedule

Gel	**± 9 sec.**
Tack Free (to touch)	**± 22 sec.**
Post Cure	**24 hours**
Recoat	**2 min. -12 hours**

***All cured film properties are approximate since processing parameters, ad-mixture types, and quantities will change physical properties of cured elastomers.*

Planning & Execution Expertise – ***Available and Ready***

Our coatings specialist, with almost 40 years in the industrial coatings industry and insulation industries, has performed as an applicator, a project foreman and manager, a contractor, an inspector, an application and equipment instructor, specification writer, estimator and industry consultant. He has the ability and readiness to deploy a full team required to execute the applications (including applicators, engineers, etc).

He provided his services to the Department of Energy of the United States of America as a consultant performing testing of polyurea coatings for various nuclear remediation projects. This

includes the 75 year cocooning of reactors at the **Hanford Nuclear Reservation** utilizing innovative technologies, polyurea and polyurethane foam being chosen as one of the technologies.

He participated as the developer/applicator in a program to lock down radioactive dust using polyurea as a tacking agent to adhere the surface dust to allow workers to enter and dismantle interior structures and limiting radioactive dust contamination.

He received training to achieve a Radiation Worker II certification, which is the highest level nuclear workers can achieve in the USA.

- **Cases of Application**

Nuclear Decommissioning examples

Savannah River Site, SC
Concrete Coatings
- for recovery of radiological contaminated areas
- 2000 to present

Rocky Flats, CO
Concrete Coatings
- De-Con Work
- Flooring in nuclear application
- Tacking down contaminated dust and debris to the surface

US Department of Energy
Gondola Rail Car lining
- Fluor Daniel / Boston Transit
- Transfer of low level nuclear waste
- 1999

Hanford, underground leakage
Contaminated Ground Umbrella / Cap
- 70,000 ft2
- Completed 2008
- The entire area of 70.000sq ft is effectively sealed from rain and snow melt and by way of a lined trench, water is diverted outside to an infiltration area located in a clean area north of the farm.

Oak Ridge Nuclear Labs
Encapsulation
- Completed 2010

Non-Nuclear Applications examples

Water Conservation

Three galvanized steel flumes originally constructed in 1984 were corroded and leaking. The replacement of the flumes and other repair methods were evaluated, but not feasible due to cost. The irrigation district chose the Polyurea system for its corrosion resistance, its ability to bond to steel, and it was determined to be the most economical solution.

Solution:
Preparation of the flumes consisted of grit-blasting a 3 to 4 mil anchor profile. One flume was so badly corroded that blasting created holes in the steel. The Polyurea system was used to coat the outside of the flume.

This section then acted as a mold form for the interior to be blasted and sprayed. The result was a new flume section consisting of the Polyurea system applied at 50 mils to the exterior and 100 mils on the interior of this section.

Results:
In 2008, the flumes were re-inspected. Initially the Polyurea system was to be a temporary fix. Nine years later, not having to replace the steel, it is estimated to have saved the client a substantial amount. According to the inspection: there was no sign of wear, and the product is performing like new.

Secondary Containment for Hazardous Waste Drum Storage Pads

26,000 square feet, March 2000.

Job Description:
Concrete storage pads with curbing used to store hazardous waste drums developed cracks throughout the surface, producing a potential path for leakage to enter the ground. The concrete pads were originally coated with a clear sealer only. The owner had previously used our polyurea system with good results, making it an easy decision to choose it again to control the cracks and possible leaks.

The concrete pads were water blasted at 40,000 psi to remove the sealer and to establish a profile. The Polyurea system was applied at 50-mil, allowing the elimination of a primer, followed by a tack coat into which blast sand was added for a skid-resistant surface. The method is touted as the best system to repair and control concrete cracks at the facilities.

Follow-up Inspections:
The client was extremely pleased with the results.

Tank Farm Containment Linings

A company, owning Tank Farms, was looking for a containment liner that could be easily monitored. Other containment systems require liners to be buried under sand, gravel, or earth. They needed a system that could be exposed to the environment without fear of degradation or cracks. This contract involved six tank farms in coastal Alaska. Each battery contains numerous tanks and piping for a variety of fuels.

All floors and walls are concrete and received 100 mils of Polyurea Coating over Amoco #4599 geo-textile fabric. The perimeter of the tanks were abraded, primed, and masked to approximately 1' above the floor. The geo-textile fabric was used to counter-flash over tank chines, as an expansion joint. Polyurea was then sprayed on to the geo-textile fabric up to the masked line on the tanks, forming a seamless liner.

The Polyurea Containment Lining System is typically anchored around the perimeter, eliminating the need for ballast sand. The company's Project Manager stated, "Since the Polyurea system does not require sand ballast, it **is easy to visually monitor leaks**. In the event of a spill, there is no contaminated sand to remove prior to cleanup."

Results:
The company stated,"After looking for several years into liners for tank farms, we have found the Polyurea System with geo-textile to be the best liner system on the market today." The owner was pleased with the application and awarded the contractor 14 additional tank farms, completed in 1997.

Secondary Containment Systems

Methane Gas Protection

Job Description:
Line interior of leachate collection box with the Polyurea system for protection from deterioration caused by methane gas. Installing contractor applied concrete primer but due to a high water table and the temperatures required for the primer, it was necessary to heat the concrete. There was also water in the bottom of the leachate collection boxes. Due to the application requirements, which involve the removal and drying out of the substrate, a primer was needed to heat the concrete substrate.

Follow-up Inspection:
The site was revisited in March 1998. The engineer was very satisfied with the performance of the coating. There was no deterioration noted in the Polyurea coating.

Secondary Containment Systems

One-Piece Protective Liner

Job Description:
The two 30,000 gallon tanks were cleaned, then sprayed with 6" of 2# density polyurethane foam. A protective coating of the Polyurea system was then applied at 40 mils for the finished surface. In addition to the tanks, the broom finished concrete dikes were sprayed with black Polyurea at 40 mils for secondary containment.
The Polyurea system was chosen because it is a fast set abrasion resistant, bird proof, seamless, fast-set, high-build liner with superior adhesion.

Follow-up Inspection:
1½ yrs after the application, the job site was inspected and the Polyurea system is performing well. The owner is pleased with the application and the coating is showing minor discoloration.

Other Coatings Evaluated for Project**:** *Urethanes*

NOTE: The examples presented in this document are merely a sample of the many applications the Polyurea system has been successfully utilized.

All possible Applications and Solutions for Areas of Technologies requested

(1,2,4,5)

① Accumulation of contaminated water

Technology needed

(1) Requirements for the welded type of tanks

- Internal and external waterproofing and corrosion protection using (US department of Energy tests for projected lifespan at least 75 years) polyurea coating/membrane/liner.
- Polyurea has very high elongation (300% to 400%) and very high tensile strength (55 mpa) therefore it moves with the tank during temperature changes and seismic events (ie. earthquakes), supplying additional strength and rupture protection to the tank.
- Our special anti-radiation materials can be applied, in addition to the polyurea coating, to the inside of the tank. The combination provides shielding properties, aimed to mitigate the Bremsstrahlung X-rays produced inside the tanks.

(2) Other requirements for tanks

- Polyurea is a coating/membrane/liner which is suitable as a waterproofing and corrosion protection for above and below ground liquid storage. It protects most type of materials, metals, wood, concrete, glass, fabric, geo-textiles, etc.

(4) Facilitating removal of the bolted type of tanks

- Our solutions can shorten working time and mitigate the radiation exposure of workers. The Collaboration also provides radiation shielding materials able to block levels of Alpha-, Beta-, X-, and Gamma rays. Currently, special safety suits have been developed from our unique material, which when tested against showed significant shielding properties against gamma radiation.

② Treatment of contaminated water

Technology needed

(2) Requirements for treatment technologies

- Polyurea can be used to encapsulate contaminated water vessels allowing safe long term, water and corrosion proof containment for storage above or below ground.

④ Management of contaminated water inside the buildings

Technology needed

(1) Technologies to block water inside the buildings

- Through the use of soil injection technology Polyurea and/or polyurethane foam water stops are possible. The injection technology can be made to be robotic.
- Polyurea is hydrophobic and does not react with water; making it a good material even when in direct contact of water or high humidity.
- Soil injected polyurethanes can be moisture catalyzed therefore it will dry water to itself and react, and turn to a sold material. Utilizing both polyurea and polyurethane, is also a possibility depending on the condition of the soil and geological requirements.
- Combining our special anti-radiation materials with our coating systems, our solutions are able to provide shielding benefits against Alpha-, Beta-, X-, and Gamma rays.

(2) Technologies for soil improvement

- The injection technology can be made robotic in high radiation areas.
- Horizontal and trenchless drilling techniques can be utilized with injection technology.
- By utilizing different formulas of materials a slow to quick reaction time can be used with different soil conditions to allow optimum penetration levels.

⑤ Management measures to block groundwater from flowing into the site

Technology needed

(1) Construction technologies for impervious walls

- Polyurea sprayed on woven geotextile fabric provides a membrane ground cover that is used in tank farms as secondary containment, landfills and at Hanford Nuclear Reservation in the USA to cover an underground tank farm to prevent rain water from penetrating the tank farm. This water is then funneled in to a holding pond also created by the geotextile Polyurea technology.
- This membrane technology and the unique physical properties of Polyurea allow to spray polyurea from the geotextile fabric and then onto any adjoining structures, walls, tanks (function as a protective coating) leaving a seamless ground and structure waterproof system. Full encapsulation of an area and its structures is achievable.

(2) Technique for covering surfaces

- Please refer to (1) Construction technologies for impervious walls – above.

- **Challenges**

Initial on site evaluation survey by our coating expert is required to properly assess the project and working environment to design and plan the coating application.

Working hours: In case of manual execution of the project, the execution time is negatively affected by the limited time a worker is permitted to access the contaminated areas. Therefore more information needs to be gained to properly assess project estimated execution time.

Robotics can be used in case of high levels of contamination, where manual work is not permitted. Robotics are currently being used in factory applications to spray Polyurea and could be adapted for field use.

Soil injection equipment can also be adapted to perform unmanned when high levels of radiation are in areas where soil stabilization is needed.

- **Others (referential information on patent if any)**

For nearly 40 years, the producer's R&D team has developed over 7000 different formulations, of which more than 30 have come to market. The Polyurea producer also holds several other patents relating to polyurea, applications and equipment.

Furthermore, the producer has developed in cooperation with the US Navy protective armor solutions based on Polyurea. The armor system is co-patented by the two parties.

Tests performed for the U.S. Department of Energy, Office of Environmental Management, Office of Science and Technology, have illustrated that The Polyurethane foam and Polyurea system are ideally suited for any D&D activities that require fixation of contaminated equipment, walls, floors, and ceilings, especially where thick, durable coatings are desired that are resistant to oxidation and radioactive aging. Prior small-scale demonstrations indicated that polyurea film is resistant to abrasion, hydrophobic, and useful for radioactive debris transport vehicle liners, building roof components, and valve pits. This is also a very effective encapsulant for lead, lead-based paint, and asbestos. It can be used as a pond liner or spill barrier and secondary containment for aggressive chemical groups, including acids, alkalis, salts, oils, solvents, refined petrochemical products, and polychlorinated biphenyls (PCBs).

The tests concluded that this technology is potentially valuable for any D&D project, and it is of particular value at sites where equipment may be either internally or externally contaminated. The applications of foams and films are a useful alternative in environments where airborne contamination caused by D&D operations is not acceptable.

The DOE, the U.S. Nuclear Regulatory Commission, and the U.S. Environmental Protection Agency all have potentially wide use of this technology at nuclear facilities under their jurisdiction. Private-sector remediation and demolition contractors will also be interested.

In 2008, our Polyurea solution has been applied at the Hanford Tank Waste Water facilities as a Tank Farm Interim Surface Barrier (TISB), a barrier to reduce water infiltration as the driver for subsurface contamination to ground water.

In 2006, Shenandoah Laboratories performed shock tests on bulkheads, with results showing no damage to the polyurea coating.

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)
(2) Treatment of contaminated water (Tritium, etc.)
(3) Removal of radioactive materials from the seawater in the harbor
(4) Management of contaminated water inside the buildings
(5) Management measures to block groundwater from flowing into the site
(6) Understanding the groundwater flow