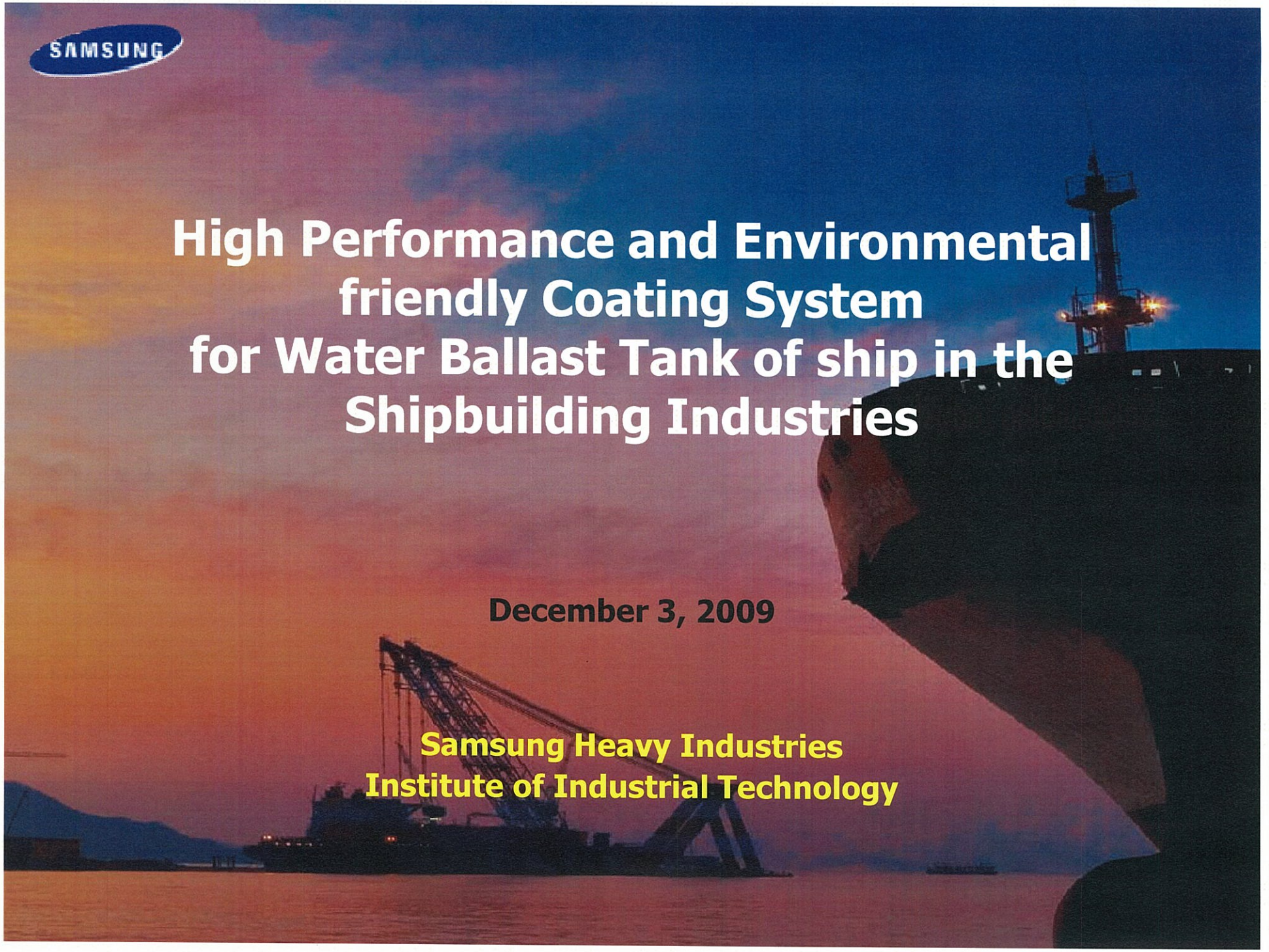
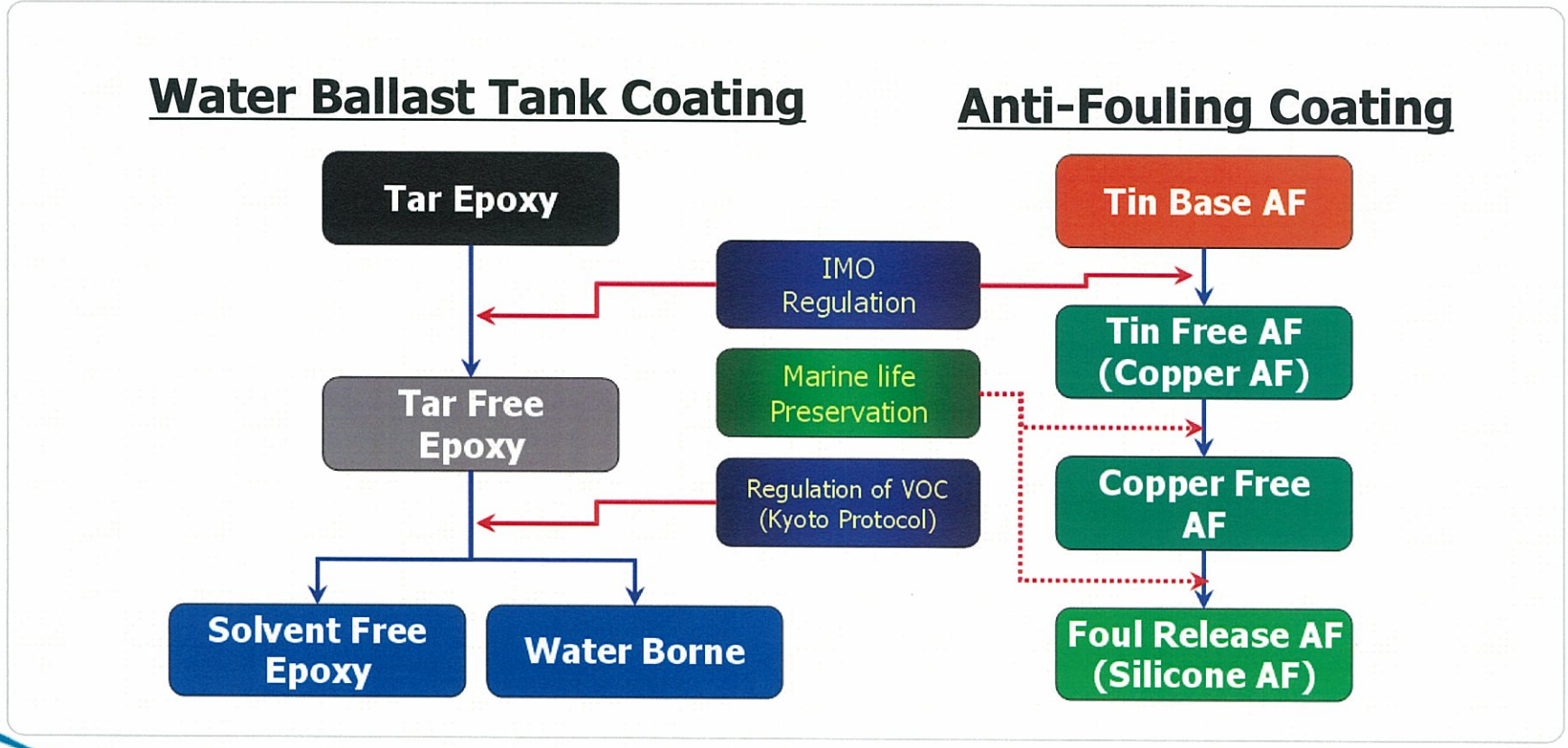

SAMSUNG
High Performance and Environmental friendly Coating System for Water Ballast Tank of ship in the Shipbuilding Industries
December 3, 2009
Samsung Heavy Industries
Institute of Industrial Technology

# Contents

# I. Background

**Coating materials of shipbuilding have been changed toward**

- **Environment-friendly**
- **Health and Safety**

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# I. Background

## Current Situation of Shipbuilding Coating

**▪ For Anti-fouling Coating**

- Tin-free AF
- Foul Release AF (Silicone paint)

**▪ For Water ballast Tank**

- Solvent Borne Epoxy Paint (60 ~ 70 Solid Volume %)
- Approx. 5~10% additional Thinning
- Multi-coating (Basically 2-spray coating & 2-Stripe coating)

**VOC (Volatile Organic Compound) emission is inevitable**

**Environment-friendly coating systems are requested**

# I. Background

## Why Solvent Borne Epoxy Paint?

- Low viscosity
- Good Anti-corrosion Properties

## Why Additional Thinning?

- Easy application using current spray equipment
  ( Especially, **in winter season**)

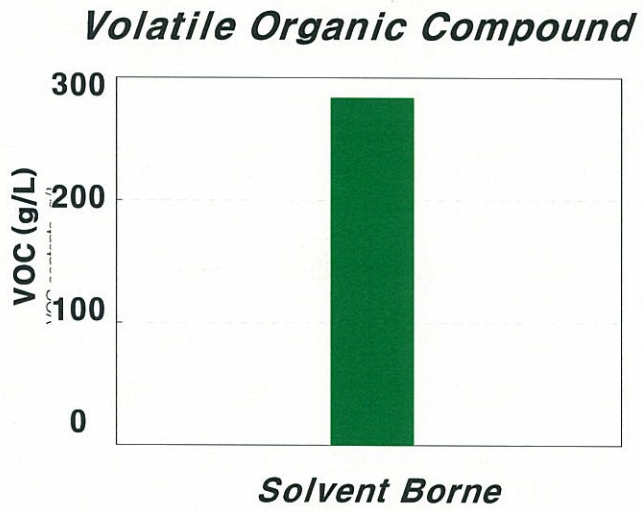
## Why Multi-coating?

- Low build-up property due to **low SVR (60 ~ 70%)**
- Sagging of applied paint due to excessive dilution of thinner

# I. Background

## Side effects of Current Solvent Borne Epoxy coating

- High VOC emission (Environmental pollution)
- Hazard to health & Safety of Worker

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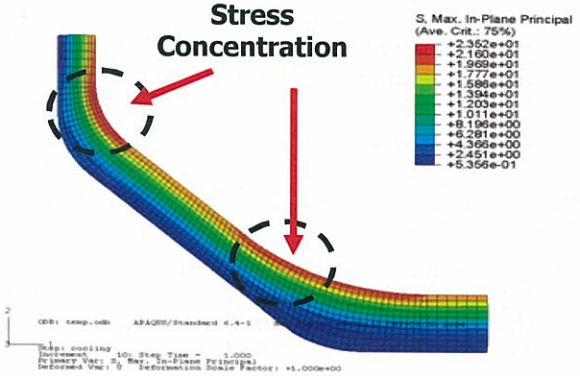
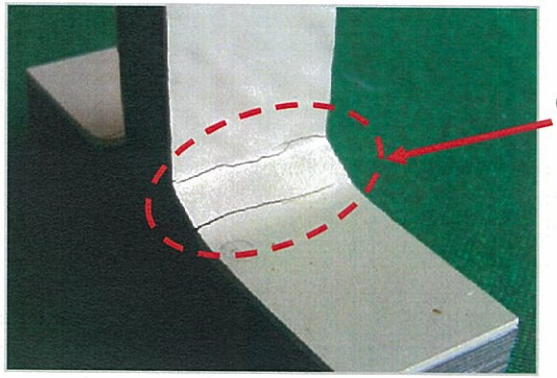
# I. Background

## Side effects of Multi-coating & Solvent Evaporation

- Possibility of Decreasing the Crack Resistance on Corner and Welding seam due to

  excessive over spray (Multi-coating) and Solvent evaporation




- Possibility of Solvent Entrapment due to improper evaporation of Solvent

# I. Background

- **To prevent following issues**
  - Environment Pollution
  - Safety and Health of worker
  - Multi-coating

- **To achieve high coating performance (Low maintenance cost)**

High performance and Environment-Friendly Coating System are highly required on Shipbuilding Industries

**Solvent Free Epoxy coating systems are raised as one of the solutions**

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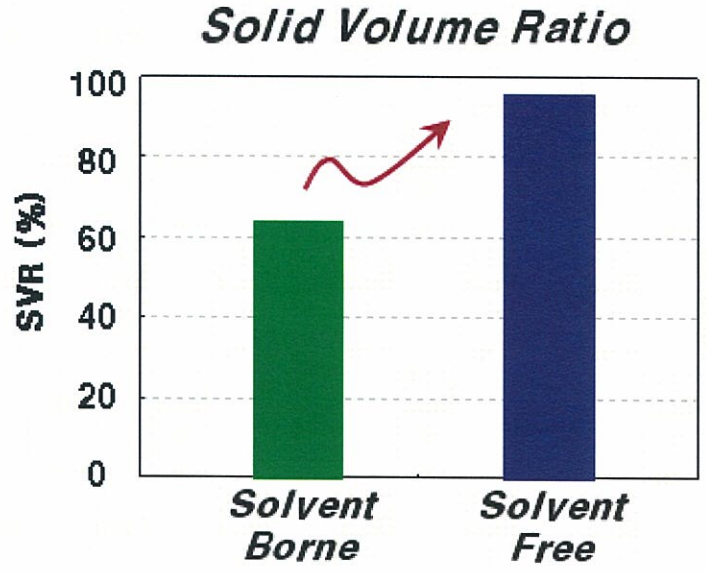
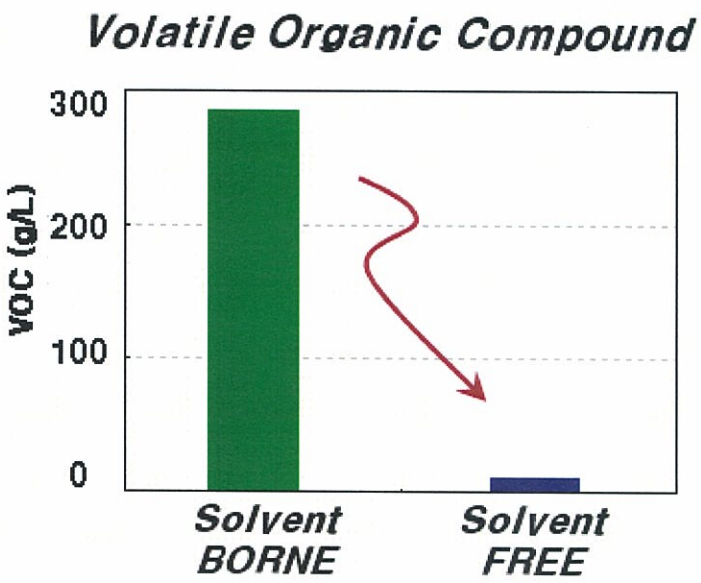
# II. Comparison Between Solvent Borne & Free

- High SVR (Higher than 95%)
- Low VOC (Less than 2 g/L)




**Solvent Free Epoxy showed high environment-friendly material**

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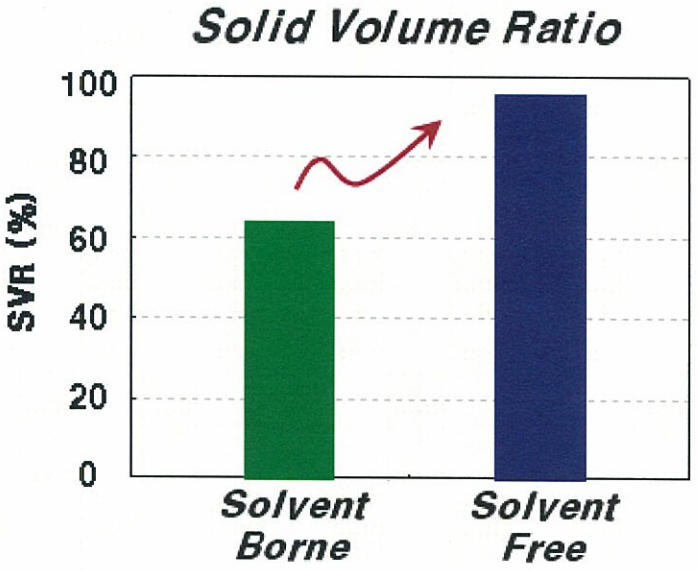
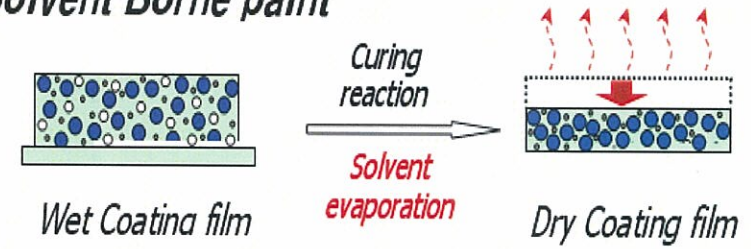
# II. Comparison Between Solvent Borne & Free

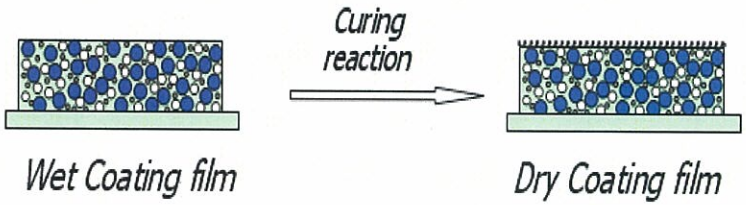
## ▪ Coating thickness




▪ Solvent Borne paint




▪ Solvent Free paint




**Very efficient material to give proper coating thickness without thickness loss by solvent evaporation**

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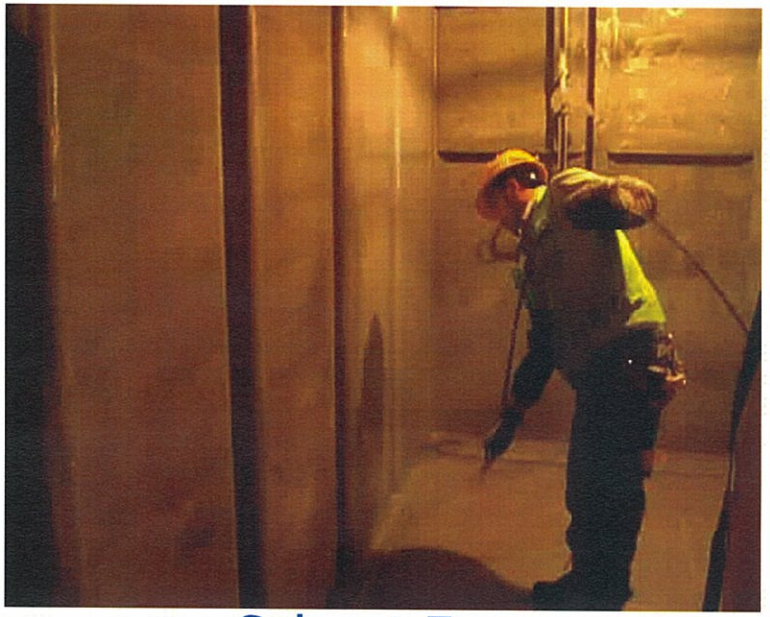
# II. Comparison Between Solvent Borne & Free

- **Improvement of working environment**

Solvent Borne



Solvent Free

**Dust and VOC generation was dramatically reduced by solvent free epoxy coating application**

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# III. Performance Test of Solvent Free Epoxy

## ▪ Objectives

To evaluate and compare the performance of **solvent free and solvent borne** epoxy coating material used in Shipyard

## ▪ Test Materials and Application methods

| | Solvent Borne | Solvent Free |
|---|---|---|
| Coating Material | 3 kinds of commercial products | 3 kinds of commercial products |
| Number of Coating | 2-spray & 2-strip | 1-spray & 1-strip |
| Spray system | Single Pump | Dual Pump |

# III. Performance Test of Solvent Free Epoxy

## ▪ Test Items (Total 7 kinds of test were completed)

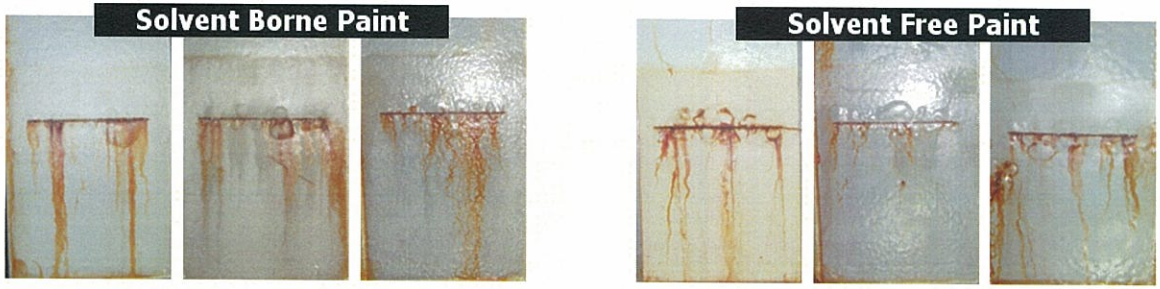
| Category | Item | Remarks |
|---|---|---|
| Corrosion Resistance | Cyclic test | ISO20340 (Norsok M501) |
| | Sea Water Immersion test | WBT simulation test |
| | Crack resistance test | Samsung Standard |
| Build-up Property | Edge Retention test | Edge treatment (1C, 3C) |
| | Sag Property | ASTM D 4400 |
| General Inspection | Vacuole test | Micro Scope Observation |
| | Pin hole test | ASTM D5162 |

# III. Performance Test of Solvent Free Epoxy

## ▪ Results of Cyclic test (Corrosion Resistance Test)

QUV exposure (72hrs) → Salt Spray (72hrs) → Exposure in -20℃ (24hrs)

**168hrs (7days) per cycle** **Total : 25 cycles (4,200hrs)**




**No difference between both paint systems by visual inspection**

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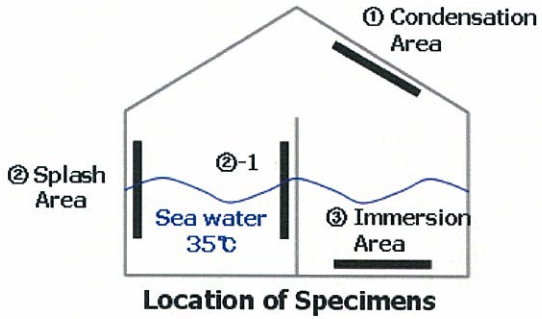
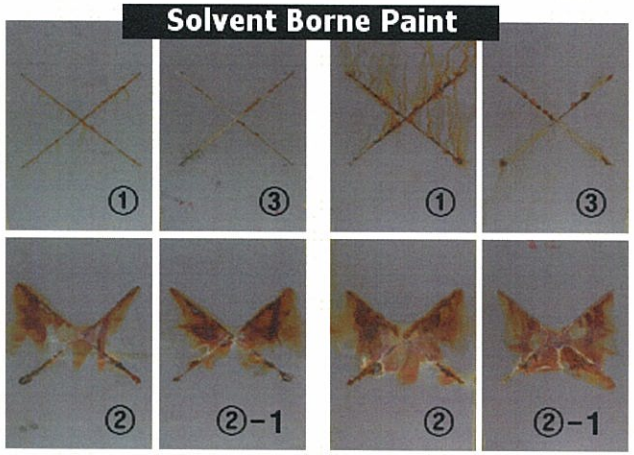
# III. Performance Test of Solvent Free Epoxy

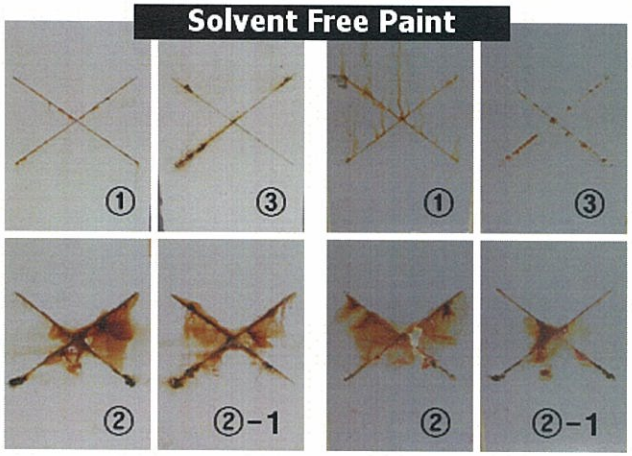
## ▪ Results of sea water immersion test (Corrosion Resistance Test)



Location of Specimens

Total : 180 days (4,320 hrs)




**Solvent free paint showed better corrosion resistance than solvent borne paint**

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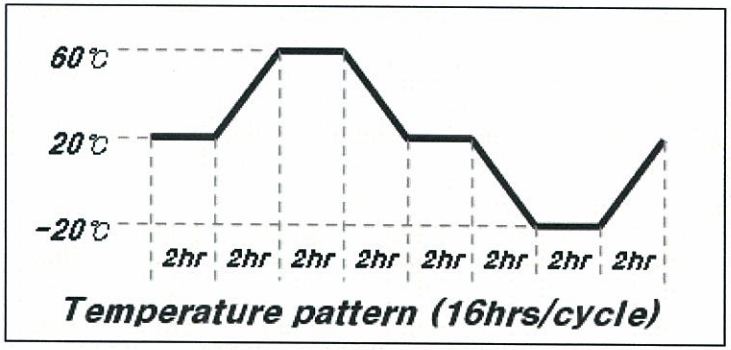
# III. Performance Test of Solvent Free Epoxy

## ▪ Results of Crack resistance test (Corrosion Resistance Test)



Temperature pattern (16hrs/cycle)

**Samsung Standard**

**(The most severe condition)**

**Total : 100 cycles (1,600 hrs)**

| Type | Thickness (㎛) | Crack initiation | Remark |
|---|---|---|---|
| Solvent borne | 800~1000 | No crack | - |
| | 1200~1500 | 80 cycle | Occurred only one sample |
| Solvent Free | 800~1000 | No crack | - |
| | 1200~1500 | No crack | - |

**Solvent free and borne paints showed good crack resistance except one solvent borne paint with high coating thickness**

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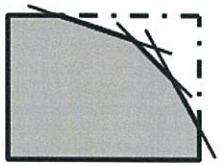
# III. Performance Test of Solvent Free Epoxy

## ▪ Results of Edge retention test (Build-up property)

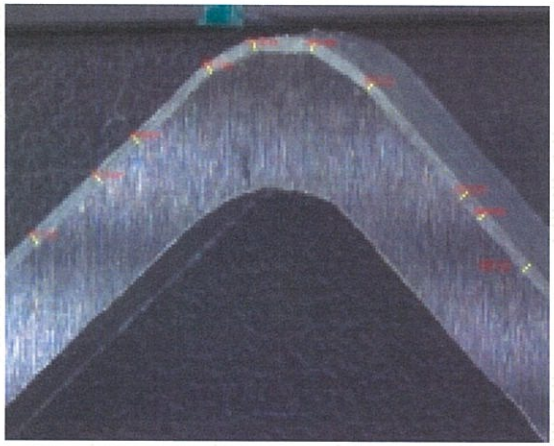
**ERR (Edge Retention Ratio)**

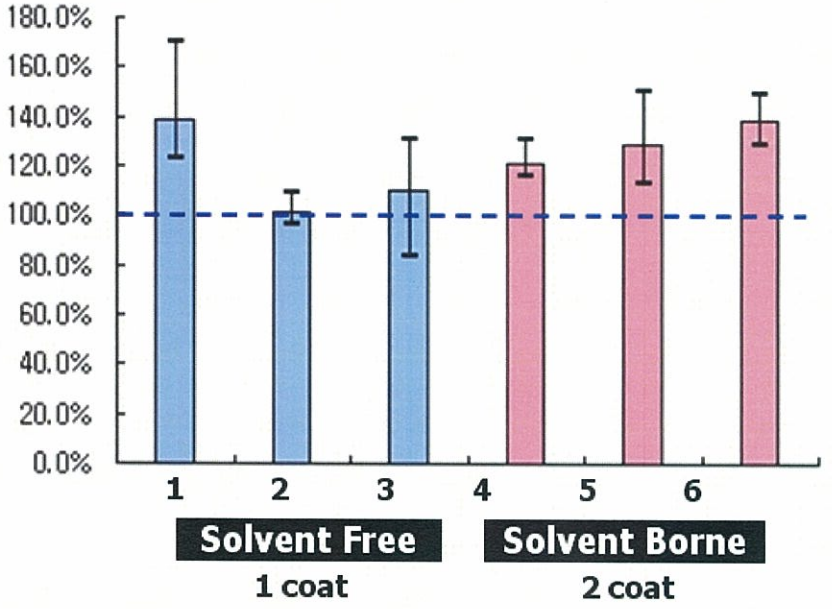
$$= \frac{\text{DFT at Edge}}{\text{DFT at Flat area}} \times 100\ (\%)$$

※ DFT : Dry Film Thickness



*Edge Treatment (3C)*






**More than 100% of ERR is achieved by application of solvent free paint at 3C treatment**

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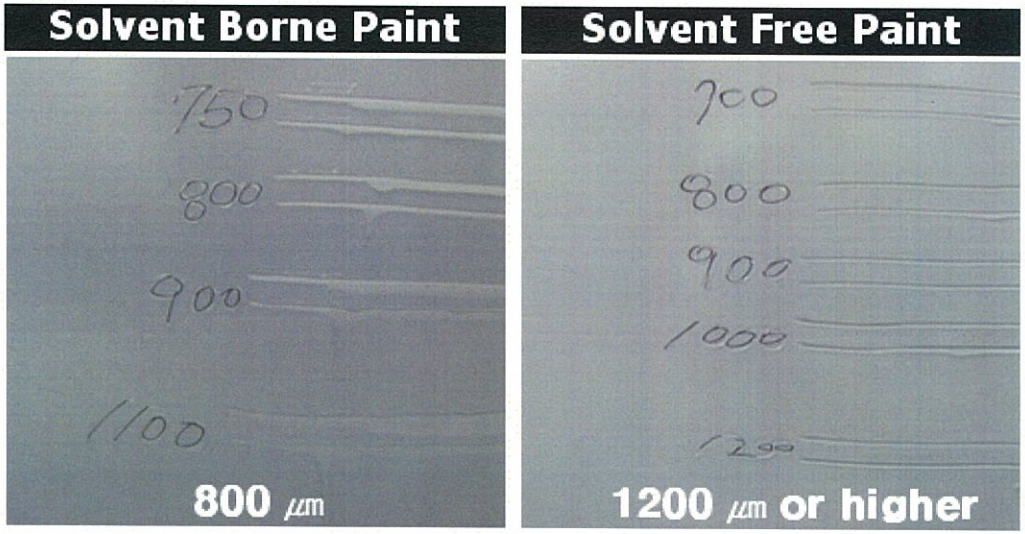
# III. Performance Test of Solvent Free Epoxy

## ▪ Results of Sagging Test (Build-up property)




| | |
|---|---|
| 495㎛ (DFT) | 1140㎛ (DFT) |
| 68% SVR, 10% thinning | 95% SVR, No thinning |

**Solvent free paint has better sag property so it is more advantageous than solvent borne paint for application of high coating film thickness**

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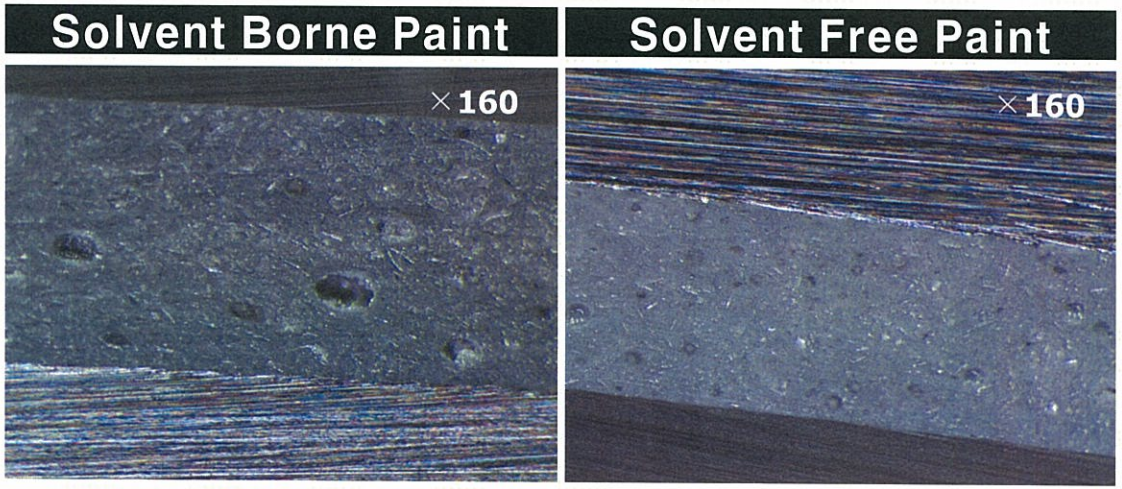
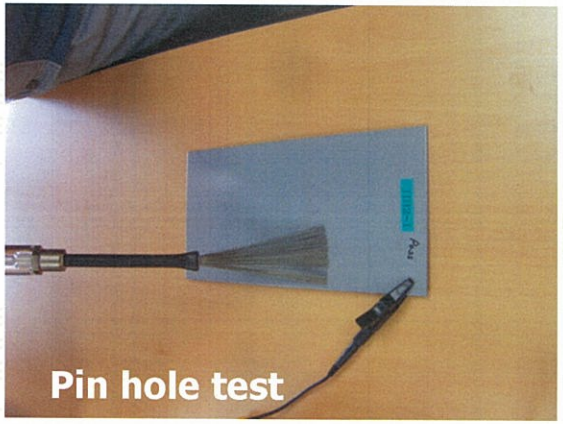
# III. Performance Test of Solvent Free Epoxy

## ▪ Results of Vacuole & Pinhole Test (General Inspection)




Vacuole test

※ Vacuole is a void inside of coating layer being able to cause corrosion




※ If there is electrical contact through pin hole, the detector ring the alarm.

**Solvent free paint showed less vacuoles and no pinholes observed both solvent borne and free coatings**

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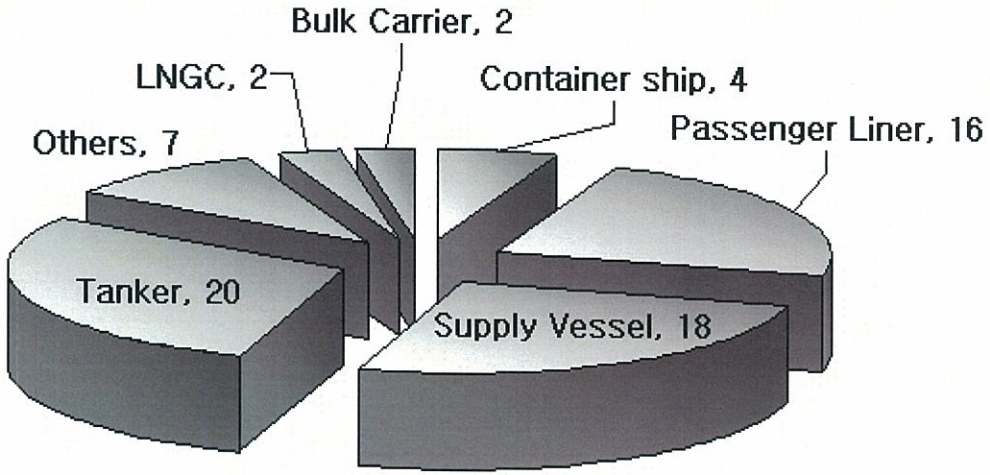
# III. Performance Test of Solvent Free Epoxy

## ▪ Summary

| Category | Item | Solvent Free | Solvent Borne | Remarks |
|---|---|---|---|---|
| Corrosion Resistance | Cyclic test | Equivalent | Equivalent | 6 months |
| | Sea Water Immersion test | Better | Good | 180 Days |
| | Crack resistance test | Better | Not Good at high DFT | 100 cycles |
| Build-up Property | Edge Retention test | GOOD (100%) | Better | 3C treatment |
| | Sag Property | 1140 ㎛ ↑ | 495 ㎛ | Dry film thickness |
| General Inspection | Vacuole test | Better | Good | Less than 5% |
| | Pin hole test | Equivalent | Equivalent | No pin hole |

# IV. Implementation Records of Solvent Free Epoxy

- Solvent free epoxy paint has been applied for 841 vessels so far
- 69 of 841 vessels have been applied using 1 coat system since 2000
- The system has been mostly applied to water ballast tank
- It has been reported that the applied area was in good condition during survey in the next dry docking




| Total | 69 |
|---|---|
| Container ship | 4 |
| Passenger Liner | 16 |
| Supply Vessel | 18 |
| Tanker | 20 |
| LNGC | 2 |
| Bulk Carrier | 2 |
| Others | 7 |

# V. IMO Performance Standard for Protective Coatings

## ▪ Provision in Current PSPC

- Epoxy-based systems
- Minimum of 2-stripe coat & 2-spay coat
- Tolerance for reduction of 2nd stripe coat to avoid unnecessary over-thickness

| | |
|---|---|
| Coating type | Epoxy-based systems.<br><br>Other coating systems with performance according to the test procedure in annex 1.<br><br>A multi-coat system with each coat of contrasting colour is recommended.<br><br>The top coat shall be of a light colour in order to facilitate in-service inspection. |
| Job specification | There shall be a minimum of two stripe coats and two spray coats, except that the second stripe coat, by way of welded seams only, may be reduced in scope where it is proven that the NDFT can be met by the coats applied, in order to avoid unnecessary over-thickness. Any reduction in scope of the second stripe coat shall be fully detailed in the CTF. |

# VI. Conclusion

## Why Solvent Free Epoxy Paint ?

- Environment-friendly to avoid pollution and hazard to worker
- High performance (Low maintenance cost)
- Possibility of 1-coating & 1-stripe coating
- Sufficient implementation record in various vessels

## For Application of Solvent Free Epoxy Paint

- Development of cost competitive material for commercial use
- Investment in spray equipment (dual pump system)
- Skilled workers
- Standardization of Solvent free epoxy paint for shipbuilding including 1-coating & 1-stripe coating

# *Thank you*

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