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SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

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# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **American Shipbuilding Quality Standards Vol. 3 Coatings**

U.S. DEPARTMENT OF THE NAVY  
CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

in cooperation with  
Newport News Shipbuilding

# Report Documentation Page

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# **American Shipbuilding Quality Standards**

**VOLUME 1 HULL**

**VOLUME 2 OUTFITTING**

**VOLUME 3 COATINGS**

National Shipbuilding Research Project

6-97-1

June 1999

## Preface

To achieve success in ship construction, it is necessary for the ship owner and the ship builder to agree on the level of quality in the final product. Classification rules, regulatory requirements, and ship specifications all help to define an acceptable level of construction quality; however, this guidance alone is not sufficient. Therefore, it is up to the shipbuilder to sufficiently describe the level of workmanship that will be reflected in the delivered ship and for the ship owner to effectively communicate his expectations for the final product.

It is the intent of this document to contribute to these objectives in the following ways:

1. To describe a reasonable acceptable level of workmanship for commercial vessels built in the United States.
2. To provide a baseline from which individual shipyards can begin to develop their own product and process standards in accordance with generally accepted practice in the commercial marine industry.
3. To provide a foundation for negotiations between the shipbuilder and the ship owner in reaching a common expectation of construction quality.

The acceptance criteria herein are based on currently practiced levels of quality generally achieved by leading international commercial shipbuilders. These criteria are not intended to be a hard standard with which all U.S. shipyards must comply. Rather, they are intended to provide guidance and recommendations in the key areas that play a major role in customer satisfaction and cost-effective ship construction.

The project that resulted in this standard was developed by the National Shipbuilding Research Program's Marine Industry Standards Panel as part of its charter to promote the value of standardization in commercial ship construction.

## Scope

This standard consists of three volumes: Hull, Outfitting, and Coating. The subjects of these volumes were selected for several reasons. First, the leading commercial shipbuilding nations already have in place widely recognized standards of expectations in these areas. These constitute the most significant areas where workmanship is a critical factor in customer satisfaction. And last, the cost associated with the labor involved in these three areas is a significant factor in construction manhours and overall schedule.

The standard criteria provided in this document are intended to apply to conventional, commercial ship construction. In many cases, specialized, non-conventional vessels using

non-standard materials or built to serve sole requirements may require unique acceptance criteria that are beyond those provided in this document.

Finally, the National Shipbuilding Research Program in funding the development of this standard considers this product to be a start in the development of commercially competitive ship construction standards and techniques, not an end in itself. As U.S. competitiveness in this market segment matures, and as owner expectations evolve, these criteria should be revised to reflect these changes. Only with the proper upkeep and maintenance will this effort be a worthwhile investment in the future competitiveness of the U.S. shipbuilding industry.

# **American Shipbuilding Quality Standards**

**VOLUME 3**

# **COATINGS**

National Shipbuilding Research Project

6-97-1

# ASQS - FOR COATINGS

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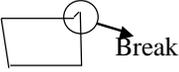
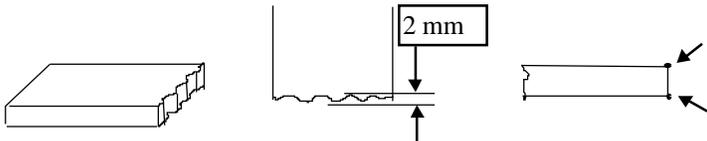
## **I. Introduction**

This American Quality Shipbuilding Standard for Coatings addresses those aspects of coating application inherent in achieving finished product quality that can be measured and warranted as meeting acceptable criteria. Due to the nature of coating systems, where preparation and methodology directly affect finished quality, this standard contains information about processes and application practices, as well as pass/fail criteria of the end product. It should be acknowledged that measuring finished coating attributes cannot determine that good application practices were followed. Therefore, they cannot be used as a sole means of warranting the finished quality of the coating.

## II. General

| No. | Item               | Prerequisites   | Remarks                       |
|-----|--------------------|---|-------------------------------|
| 1   | Type of Vessel     | Commercial and Military   |                               |
| 2   | Tank Coating Area  | No Limitation   |                               |
| 3   | Type of cargo      | Products identified in the specification section.   | Refer to ship's specification |
| 4   | Tank anodes        | In accordance with ship's specifications in Water Ballast Tanks and Slop Retention Tank.  | Refer to ship's specification |
| 5   | Outfitting         | In the case of steel, painting is similar to the surrounding area. Paint shall not be applied to woodwork, polished fittings, gaskets, packing, anodes, non-ferrous material, or other non-corrosive metals and any other surface or fittings and equipment where paint could obstruct their proper function.   |                               |
| 6   | Paint to be used   | As specified by owner. Coatings shall be lead free, chromate free, asbestos free, cadmium free and comply with applicable Federal, State and local Regulations  | Refer to ship's specification |
| 7   | Dry film thickness | Refer to ship's specification and manufacturer's recommendations.   | Refer to ship's specification |
| 8   | Shop primer        | After primary surface preparation, one (1) coat of inorganic zinc silicate type shop primer will be applied in accordance with the paint manufacturer's recommendation, for structural steel not coated with inorganic zinc silicate type shop primer builder shall blast to SSPC-SP 10 and apply first coat of specified system, subject to owner approval. Surface profile to comply with ship's specification. |                               |
| 9   | Holding coat       | As determined by builder with consideration to paint manufacturer's recommendation.   |                               |
| 10  | Painting Process   | Block unit through completion.  |                               |

### III. Pre-Surface Preparation Standards

| No. | Item   | Process Standard  | Judgment | Remarks                     |
|-----|--|---|----------|-----------------------------|
| 11  | <b>Free edge<br/>In<br/>Immersion<br/>Service<br/>Areas To Be<br/>Coated</b> | <p>(1) Break 90 degree edges 1 mm minimum.</p> <p>(2) In general, rolled angle edges, bulb flats, etc. (including flat bars) are to be left untreated.</p>    | Visual   |                             |
| 12  | <b>Spatter<br/>In<br/>Immersion<br/>Service<br/>Areas To Be<br/>Coated</b>   | <p>(1) For spatter observed before blasting:<br/>           (a) Remove with a chipping hammer, scraper, etc.<br/>           (b) For spatter not easily removable with a scraper, etc. Use grinder or disc.</p> <p>Note: It is the intent of this standard that all spatter is to be removed before surface prep. Any remaining or additional spatter observed after surface prep shall be removed in accordance with 1(a) and 1(b).</p> | Visual   |                             |
| 13  | <b>Undercut</b>  | Undercut to a depth exceeding 1.6mm and a width smaller than the depth is to be repaired by grinding. If a sharp edge exists with a crest exceeding 3mm grind until irregularity is less than 3mm.  | Visual   | Refer to explanation Page 8 |
| 14  | <b>Surface damage</b>  | Surface damage, pitting, break-off marks to depths exceeding 1 mm are to be repaired by welding or grinding   | Visual   | Refer to explanation Page 8 |
| 15  | <b>Manual welding bead</b>   | Weld beads with surface irregularities exceeding 3 mm or with a sharp crest are to be ground until the irregularity is less than 3 mm.  | Visual   |                             |
| 16  | <b>Automatic welding bead</b>  | In general, no specific treatment is required.  | Visual   |                             |
| 17  | <b>Overlap welding bead</b>  | Overlapping weld beads that create sharp notches are to be repaired as per item No. 13, "Undercut".   | Visual   |                             |
| 18  | <b>Welding arc strike</b>  | Same as Item No. 12, "Spatter", and Item No. 14, "Surface Damage."  | Visual   |                             |
| 19  | <b>Gas cut surface</b>   | <p>Gas cut surfaces are to be ground as follows.</p> <p>(a) Except where hull strength considerations require a smooth finish, notches shall be ground to less than 2mm.</p> <p>(b) Gas slag produced during cutting is to be treated according to Item 11, "Free Edge." Treatment to be accomplished before blasting.</p>                          | Visual   |                             |
| 20  | <b>Lifting lugs</b>  | Where a lifting lug is partially removed by cutting the pad-eye portion off per page 17 of the Hull volume, the remaining stub and surrounding area is to be treated according to item No. 11 "Free Edge", item No. 15 "Manual welding bead", and item No. 19 "Gas cut surface".  | Visual   |                             |

| No. | Item                        | Process Standard   | Judgment                         | Remarks                     |
|-----|-----------------------------|--|----------------------------------|-----------------------------|
| 21  | Moisture                    | To be removed until no visible moisture remains  | Visual                           | Refer to Explanation Page 9 |
| 22  | Oil and grease contaminants | To be removed, by wiping with thinner, fresh water (preferably high pressure wash), wire brush or compressed air or as permitted by paint manufacturer.                | Visual                           |                             |
| 23  | Dust and mud contaminants   | Dust and contaminants are to be removed by compressed air, vacuum or high pressure water cleaning, as necessary.   | Visual<br>Clear Tape Test Method |                             |
| 24  | Chalk or slate pencil marks | To be removed with rag or brush in accordance with manufacturer's recommendation.  | Visual                           |                             |
| 25  | Marking paint               | To be removed by blasting, power tool or other. Marking paint for epoxy does not need to be removed if it is in accordance with coating manufacturer's recommendation. | Visual                           |                             |

#### IV. Surface Preparation Standards

| No. | Item  | Process Standard              | Judgment          | Remarks                     |
|-----|---|-------------------------------|-------------------|-----------------------------|
| 26  | Solvent Cleaning                            | Refer to ship's specification | Visual Standards  | Refer to Explanation Page 9 |
| 27  | Mechanical Cleaning                         | Refer to ship's specification | Visual Standards  |                             |
| 28  | Abrasive Blast Cleaning And Surface Profile | Refer to ship's specification | Visual Standards  |                             |
| 29  | Water Jetting                               | Refer to ship's specification | Visual Standards  |                             |
| 30  | Abrasives                                   | Refer to ship's specification | Written Standards |                             |
| 31  | Repairs                                     | Refer to ship's specification | Visual Standards  |                             |

#### V. Coating Standards

| No. | Item                 | Process Standard  | Judgment | Remarks                      |
|-----|----------------------|---|----------|------------------------------|
| 32  | Stripe Coating Tanks | To achieve the specified DFT, stripe coats shall be applied to: edges of small holes, corners of other flame burned edges, free edges of structural members, and rough welding seams. | Visual   | Refer to Explanation Page 10 |

|    |                     |   |                      |  |
|----|---------------------|---|----------------------|--|
|    |                     |   |                      |  |
| 33 | <b>Overall coat</b> | When more than one coat is specified, subsequent coats shall not be applied until preceding coat has sufficiently cured/dried in accordance with paint manufacturer's recommendation. | Wet gauge and Visual |  |

## **VI. Coating Repair Standards**

| No. | Item                                | Process standard   | Judgment             | Remarks                      |
|-----|-------------------------------------|--|----------------------|------------------------------|
| 34  | <b>Sagging</b>                      | Sagging with a height of 2 mm or more is to be repaired in accordance with the paint manufacturer's recommendations.                         | Visual               | Refer to Explanation Page 11 |
| 35  | <b>Spray dust</b>                   | Dry spray, over spray, and spray dust is to be removed before painting in accordance with the manufacturer's recommendations.                | Visual               |                              |
| 36  | <b>Foreign matter</b>               | Foreign matter in the paint film shall be removed. Damaged film is to be repaired in accordance with the manufacturer's recommendations.     | Visual               | Refer to Explanation Page 12 |
| 37  | <b>Crater, pinholes and bubbles</b> | Defects are to be repaired in accordance with the manufacturer's recommendations.  | Visual               |                              |
| 38  | <b>Blushing</b>                     | Excepting the final coat film, visible blushing on the film surface is to be repaired in accordance with the manufacturer's recommendations. | Visual               |                              |
| 39  | <b>Mechanical damage</b>            | Touch up is to be equivalent to the original specification, unless otherwise noted in the Painting Plan.                                     | Visual               |                              |
| 40  | <b>Insufficient film thickness</b>  | Areas with insufficient film thickness are to be repaired in accordance with the manufacturer's recommendations.                             | Visual/Dry Film Gage | Refer to Explanation Page 13 |

## **VII. Film Thickness Measurement Standards**

| No. | Item   | Process standard   | Judgment  | Remarks                      |
|-----|--|--|---|------------------------------|
| 41  | <b>Film thickness measurement of tank plate</b>                | Film thickness to be measured for every five square meters for flat panels or corrugated bulkheads. Film thickness is to be measured at two (2) points in each panel of plating bounded by transverse and longitudinal members. (Note: <i>this excludes panel breaker, or panel stiffeners</i> ) | Micro tester or electro-magnetic film thickness gauge | Refer to Explanation Page 13 |
| 42  | <b>Film thickness measurement of tank longitudinal members</b> | Film thickness to be measured at two points between transverse members on each side of web and face plates (Note: <i>this excludes panel breakers and panel stiffeners</i> )   | Micro tester or electro-magnetic film thickness gauge |                              |
| 43  | <b>Film thickness measurement of tank transverse members</b>   | Film thickness to be measured at three points between longitudinal girders or bulkhead on each side of web and face plates.  | Micro tester or electro-magnetic film thickness gauge |                              |

### VIII. Environmental Painting Standards

| No. | Item  | Process standard  | Judgment  | Remarks                           |
|-----|---|---|---|-----------------------------------|
| 44  | <b>Temperature (During painting, and drying)</b>          | Steel and air temperatures are to be in accordance with the paint manufacturer's recommendations.   | Measure with a thermometer                                    | Refer to Explanation Page 14      |
| 45  | <b>Humidity (During painting, and initial drying)</b>     | Paint shall not be applied during periods of rain, snow, fog or mist in the open air or when ambient relative humidity exceeds manufacturer recommendation.   | Measure with a hygrometer. Measure with a surface thermometer | Refer to Explanation Pages 14, 15 |
| 46  | <b>Ventilation (Immediately before blasting to paint)</b> | Air change rate to be two times per hour, or more as directed by the manufacturer's product data sheet.   | Check ventilating requirement                                 |                                   |
| 47  | <b>Ventilation (During paint drying)</b>                  | Air change rate to be five times per hour or more. Dehumidifying capacity to be according to ventilation requirements. If the external air humidity is above 85%, air change rate may be decreased to the capacity of the dehumidifier.   | Check ventilating requirement                                 |                                   |
| 48  | <b>Erection of scaffolding</b>                            | Make sure that scaffolding does not interfere with painting, ventilation, illumination, blasting and inspection ( builder shall attempt to maintain a 150 mm clearance wherever possible). If not possible (to maintain the 150 mm clearance), the Owner shall be informed of the particular area and review during the scaffolding inspection. | Visual  |                                   |
| 49  | <b>Removal of scaffolding</b>                             | Care must be taken not to damage the film.  | Visual  | Refer to explanation Page 16      |
| 50  | <b>Illumination</b>                                       | Effective illumination to be provided to ensure proper inspection of the blast and coated surface is achieved.  | Visual  |                                   |

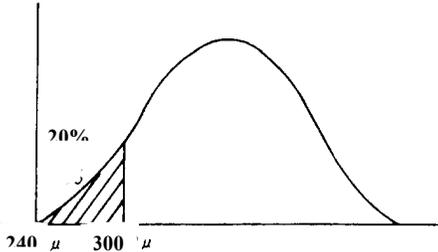
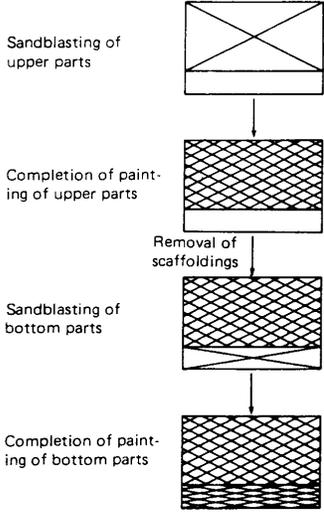
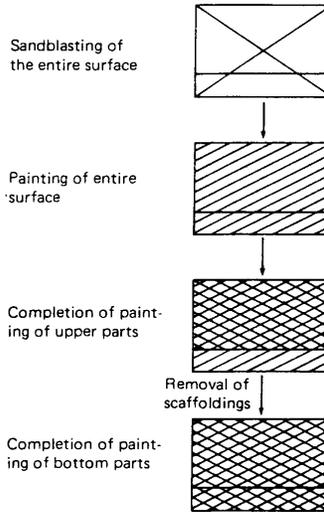
**IX. Inspection Standards**

| No. | Item                               | Standard                                     | Control |          |                    |
|-----|------------------------------------|--|---------|----------|--------------------|
|     |                                    |  | Owner   | Shipyard | Paint Manufacturer |
| 51  | Pre-Surface Preparation            | Refer to Pages 3 and 4                       | △       | △        | △                  |
| 52  | Surface Preparation                | Refer to Page 4                              | △       | △        | △                  |
| 53  | Stripe Coating                     | Refer to Page 10                             |         | △        | △                  |
| 54  | Film Thickness                     | Refer to Pages 7 and 13                      |         | △        | △                  |
| 55  | Final Inspection                   | Final confirmation of completion of painting | △       | △        | △                  |
| 56  | Temperature Humidity and Dew Point | Refer to Page 14                             |         | △        | △                  |
| 57  | Gas Concentration Of solvent       | Refer to Page 15                             |         | △        | △                  |
| 58  | Ventilation                        | Refer to Page 14                             |         | △        | △                  |

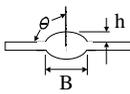
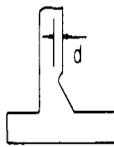
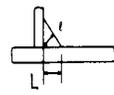
# ASQS

## EXPLANATIONS

### II. General

| N0. | Item  | Explanation  |
|-----|---|--|
| 4   | Tank anodes   | <p>(1) Anodes may be installed in ballast tanks which are often loaded with sea water.</p> <p>(2) Anodes are not to be installed when dissolution of zinc into the tank contents presents problems (as in the case of jet fuel, etc.).</p>   |
| 7   | <p><b>Dry film thickness for Ballast Tanks, Fore/Aft Peak Tanks, Wet Spaces and Water Tanks shown. See note for all other spaces.</b></p> | <p>Measurements at 80% of total measuring points must verify a film thickness exceeding or equal to a specified value (e.g., 300 microns). For the remaining 20%, the measured film thickness must be equal to or over 80% (e.g., 240 micron) of the specified thickness. <i>(Note: All other tank spaces the 90-10 rule shall apply, All other surfaces to SSPC-PA 2)</i></p>    |
| 10  | <p><b>Tank painting process (Typical; guideline only, deviations are acceptable)</b></p>  | <p>(1) For tank coating, block painting, painting in a dry dock, afloat painting, or any combination is considered. However this standard is based on afloat painting only.</p> <p>(2) For abrasive blasting and painting in tank, the following two systems may be considered:</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p><b>System A</b></p>  </div> <div style="text-align: center;"> <p><b>System B</b></p>  </div> </div> |

### III. Preparation Standards for Steel

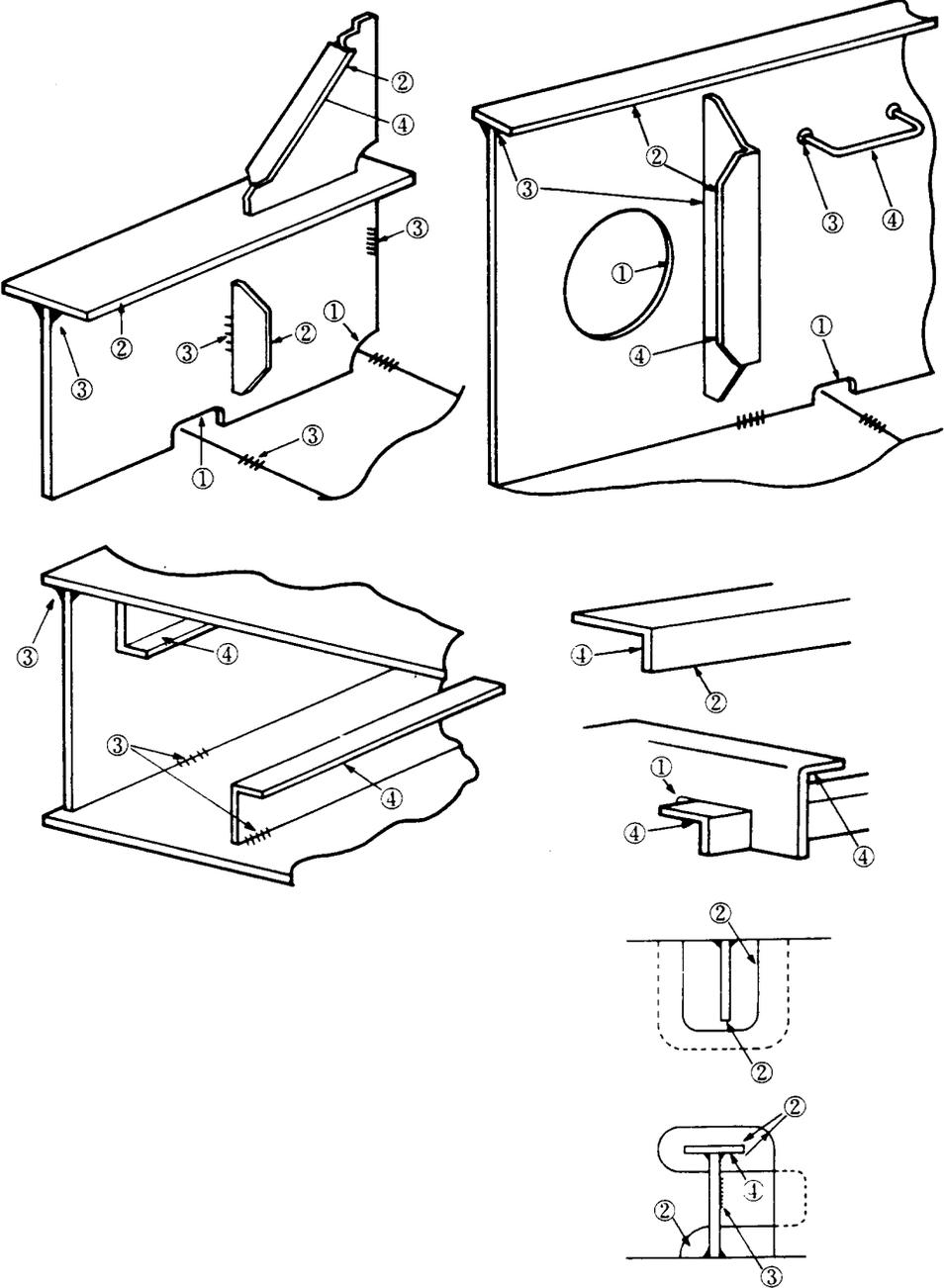
| No.          | Item           | Explanation              |   |  |   |   |   |
|--------------|----------------|--------------------------|---|--|---|---|---|
|              |                | Division                 |   | Welding                                |   |   |   |
|              |                | section                  | Sub-section   | Item                                   | Tolerance Limits  | Remarks   |   |
| 13           | Undercut       |                          | hgt. of reinf. brth. of bead, flank of ang.   |  |  <p>h: not defined<br/>B: not defined<br/><math>\theta = 90^\circ</math></p>  |  <p>In cases where <math>\theta</math> is over <math>90^\circ</math>, repair by grinding or welding to make <math>\theta = 90^\circ</math></p> |   |
|              |                |                          | under-cut (butt weld)   | Skin plate and face plate between 0.6⊗ | Over 90 mm continuous<br>$d = 1.6\text{mm}$   |    | To be repaired by welding electrode or other, (carefully avoid short bead for higher tensile steels). |
|              |                |                          | under-cut fill  | Others                                 | $d = 1.6\text{mm}$  |   |   |
|              |                |                          | leg lgth.   |  |  <p><math>d \leq 1\text{mm}</math></p>  |   |   |
|              |                |                          |   | Compared with correct ones             |  <p>L: Leg length<br/>l: Throat depth<br/><math>L \geq 0.9</math><br/><math>l \geq 0.9</math></p>  | If over tolerance, fill weld to correct.  |   |
| 14           | Surface damage | Division                 |   | Material                               |   |   |   |
|              |                | section                  | Sub-section   | Item                                   | Remarks   |   |   |
|              |                | surface flaw             | Pit   | Grade of pitting                       | <ol style="list-style-type: none"> <li>Grade A is considered slight and no repair is necessary. Grade B is medium and is to be repaired if necessary. Grade C requires some repair.</li> <li>Pitting or flaking on boundaries of grade "A" and "B", grade "B" and "C", and grade "A" and "C" shall be classified as grade "A", grade "B" and grade "A" respectively.</li> <li>Repair method of surface flaw: depth of defect = <math>d</math>, plate thickness = <math>t</math> (<math>d = .07 t</math> remove by grinding (but in no case <math>d = 3 \text{ mm}</math>), <math>.07 t = d = .2 t</math> grinding followed by welding.</li> </ol> |   |   |
| surface flaw | Flaking        | Grade of surface flaking | <ol style="list-style-type: none"> <li>Grade A is considered slight and no repair is necessary. Grade B is medium and is to be repaired if necessary. Grade C needs some repair.</li> <li>Pitting or flaking on boundaries of grade "A" and "B", grade "B" and "C", and grade "A" and "C" shall be classified as grade "A", grade "B" and grade "A" respectively.</li> <li>Repair method of surface flaw depth of defects = <math>d</math>, plate thickness = <math>t</math>, <math>d = .07 t</math> removed by grinding (but in no case <math>d = 3 \text{ mm}</math>), <math>.07 t = d = .2 t</math> grinding followed by welding.</li> </ol> |  |   |   |   |

|    |   |  |
|----|---|--|
| 21 | <b>Moisture</b>                         | Rainwater inflow and moisture in the air may produce sweat on steel surface. After secondary surface preparation, moisture may cause turning or hinder adhesion. Appropriate measures must be taken to prevent rainwater from flowing in.  |
| 22 | <b>Oil and grease contaminants</b>      | In general, remove with a rag and thinner/cleaner. For heavy adhesion of grease and oil, first dissolve with a brush soaked in thinner/cleaner, then wipe off with a clean rag. Detect oil visually with a black light or water spray bottle (water break test).   |
| 23 | <b>Dust and non-visual contaminants</b> | Check for dust with clear tape, clean cloth or pictorial standard in accordance with ISO 8502-3. Remove dust by compressed air or vacuum. Non-visual contaminants may be removed in accordance with SSPC-SP 12/NACE No. 5 as applicable to meet the ship's specification and manufacturer's recommendation. Check for soluble salts according to ISO 8502-6 when required by manufacturer or ship's specification. |
| 24 | <b>Chalk or slate pencil marks</b>      | Remove with a rag or brush. When marks enter an anchor-pattern concavity and are difficult to remove, use a hard brush.  |

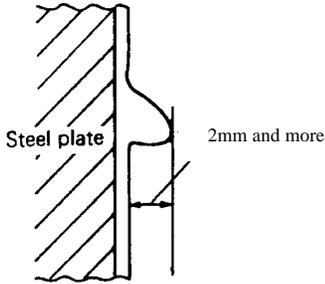
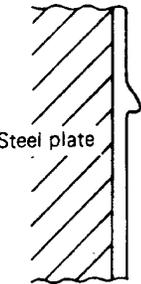
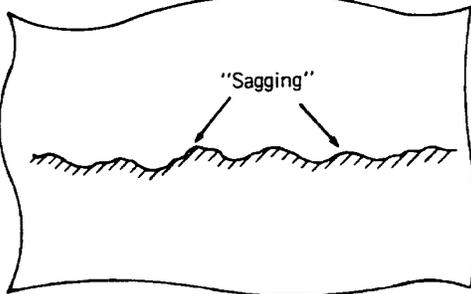
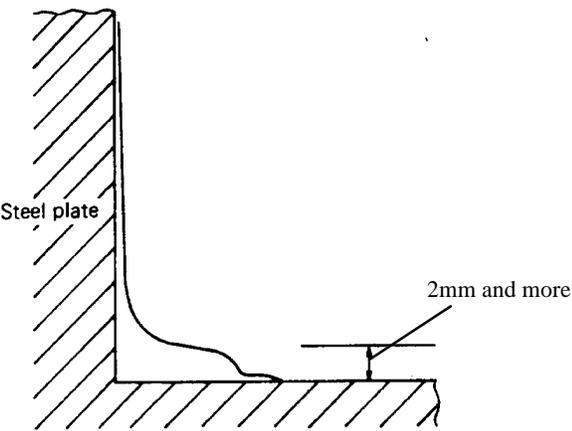
#### **IV. Surface Preparation Standards**

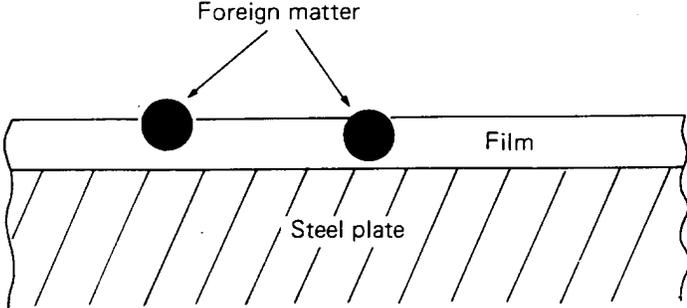
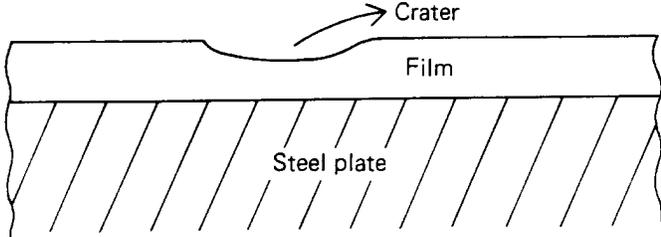
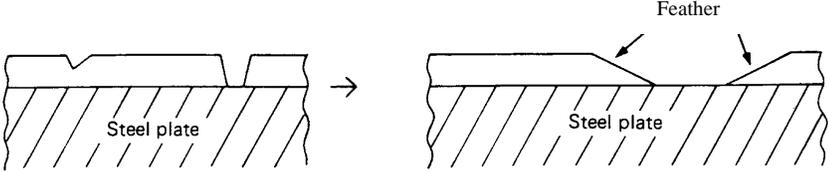
| <b>No.</b> | <b>Item</b>                            | <b>Explanation</b>   |
|------------|--|--|
| 26         | <b>Solvent Cleaning</b>                | Surface cleanliness is to be in accordance with SSPC-SP 1. Note: SSPC-SP 1 is required prior to all other surface preparation methods.   |
| 27<br>52   | <b>Mechanical Cleaning</b>             | SSPC-SP 3 is the minimum accepted method of repair for non-immersion service substrates. (SSPC-SP 2 may be substituted where SSPC-SP 3 is impractical). SSPC-SP 11 is the minimum accepted method for repair of immersion service substrates.<br>To determine surface cleanliness, refer to the SSPC-VIS 3 photographic standard.<br>To determine surface profile use ASTM D 4417 Method A or B. |
| 28<br>52   | <b>Abrasive Blast Cleaning</b>         | SSPC-SP 10 is the minimum accepted surface preparation for pre-construction primer and for immersion service substrates.<br>SSPC-SP 7 may be used in place of SSPC-SP 3 when practical.<br>For cleanliness refer to SSPC-VIS 1-89 photographic standard.<br>To determine surface profile use ASTM D 4417 Method A or B.  |
| 29<br>52   | <b>Water Jetting</b>                   | Where acceptable according to the ship's specification and manufacturer's recommendations, clean in conformance with SSPC-SP 12/NACE No. 5.<br>Refer to SSPC-VIS 4(1)/NACE No. 7 photographic standard.<br>To confirm pre-existing surface profile use ASTM D 4417.  |
| 30         | <b>Abrasives</b>                       | Blast surface color tends to vary depending on the abrasive material used. As long as the same grade of cleanliness is used, a difference in color does not affect the film performance.<br>Abrasives to be determined according to SSPC-AB 1.<br>Recycled Abrasive Cleanliness to be determined according to SSPC-AB 2.   |
| 31         | <b>Repairs to shop primed surfaces</b> | (1) In general shop primer in the cargo oil and slop retention tanks shall be removed in accordance with manufacturer's recommendation to a visual acceptance.<br>(2) All other spaces intact shop primer may remain and over coated in accordance with manufacturer's recommendation.<br>(3) In no way does the above supercede the ship's specification  |

## V. Coating Standards

| No. | Item                     | Explanation  |
|-----|--------------------------|--|
| 32  | Stripe coating in tanks. | <p>Where airless spraying is difficult and the film thickness can not be maintained, apply stripe coating with a brush before or after spraying.</p> <p>Stripe coating locations are as follows:</p> <ul style="list-style-type: none"> <li>(a) Inside and edges of holes ..... ①</li> <li>(b) Free edges ..... ②</li> <li>(c) Welding beads ..... ③</li> <li>(d) Where painting is difficult ..... ④</li> </ul>  |

## VI. Coating Repair Standards

| No. | Item    | Explanation   |
|-----|---------|---|
| 34  | Sagging | <p>The "sagging" of the film needs repair due to the following causes:</p> <ol style="list-style-type: none"> <li>(1) Spray dust, dust, etc. tend to collect.</li> <li>(2) Sag having a large film thickness. Solvent tends to collect on high film thicknesses.</li> </ol> <p>If coating is applied over the "sagging" area, solvent evaporation becomes more difficult leading to possible cracks in the film.</p> <p>"Sagging" to be repaired is as follows:</p> <ol style="list-style-type: none"> <li>(a) Sagging with the height of 2mm and more.           <div style="display: flex; align-items: center; margin-top: 10px;">  </div> </li> <li>(b) Wide "sagging"           <div style="display: flex; align-items: center; margin-top: 10px;">  <div style="margin-left: 20px;">  </div> </div> </li> <li>(c) "Sagging" in the bottom corners           <div style="display: flex; align-items: center; margin-top: 10px;">  </div> </li> </ol> |

| No. | Item                                  | Explanation   |
|-----|---------------------------------------|---|
| 36  | <b>Foreign matter</b>                 | <p>When abrasives are used in surface preparations (blasting), abrasives remaining may adhere to the substrate and be trapped in the film during painting.</p>  <p>Foreign material shall be removed by screen, sanding, etc. as directed by the paint manufacturer.</p>  |
| 37  | <b>Craters, pinholes, and bubbles</b> | <p>(1) Pinholes tend to occur at the pit of manual welding bead.<br/> (2) Craters tend to occur when surface tension becomes uneven during the film drying process. A crater is a concave, and reduces film thickness.</p>  <p>(3) Bubbles occur when paint mixed with air is applied in the airless painting.</p> <p>Repairs to coating to be in accordance with manufacturer recommendations. Generally, surface will be feathered by sanding or screening and coating applied to achieve desired DFT.</p> |
| 39  | <b>Blushing</b>                       | <p>The film will “blush”, due to humidity absorbed by the hardening agent. When humidity rises or dew is produced before curing, this may occur. Blushing is confined to the film surface and does not affect film performance. However, excessive blushing must be repaired because it hinders adhesion of overcoating.</p>  |
| 40  | <b>Mechanical damage</b>              | <p>The surface of the film shall be lightly abraded with sandpaper, screen, or as recommended by coating manufacturer and coating applied to the desired DFT.</p>   |

## VII. Film Thickness Measurement Standards

| No. | Item  | Explanation   |
|-----|---|---|
| 40  | <b>Film thickness measurement in tanks.</b><br><b>For other areas see Note.</b> | (1) Measuring equipment to be adjusted once a day by using a reference plate with a thickness nearest to the film thickness to be measured. |
| 41  |   | (2) The measured value of film thickness to be marked at a measuring point using a specified marking material.                              |
| 42  |   |   |
| 43  |   | Film thickness measuring point (x mark)   |
| 44  |   | (a) Bottom part   |
|     |   | <p>Bottom transverse</p> <p>Longitudinal girder</p> <p>Bottom longitudinal</p> <p>Bottom shell</p>  |
|     |   | (b) Deck part   |
|     |   | <p>Deck plate</p> <p>Deck longitudinal</p> <p>Deck girder</p> <p>Deck transverse</p>  |
|     |   | <p>NOTE:<br/>           ( For all other areas, measure every 93m<sup>2</sup> (1,000 ft<sup>2</sup>) in accordance with SSPC-PA 2)</p>       |

## VIII. Environmental Painting Standards

| No.      | Item  | Explanation   |
|----------|---|---|
| 45       | <b>Temperature<br/>(During painting and drying)</b>       | <p>(1) Lowest temperature</p> <p>(a) Temperature must be 3° C or more above the dew point. Theoretically the steel plate surface temperature is used. However the air temperature in tank is practically used herein.</p> <p>(b) Curing of epoxy resin slows down when the temperature drops below 10° C and 5° C is the lowest limit. It is preferable to keep the temperature above 10° C and in conformance with the paint manufacturer's recommendation.</p> <p>(2) Highest temperature</p> <p>The maximum temperature is affected by the type of paint used and the painting process. Consult the paint manufacturer for maximum allowable temperature for application and cure.</p>   |
| 46       | <b>Humidity<br/>(During painting, and initial drying)</b> | <p>Relative humidity is to be below 85% .</p> <p>This value applies when the painted surface temperature is equal to or above the atmospheric temperature.</p>  |
| 47<br>48 | <b>Ventilation</b>  | <p>(1) The amount of ventilation required during painting and drying is greater than that required for blasting due to the following reasons:</p> <p>(a) The film begins hardening with evaporation of solvents in the film.</p> <p>(b) Solvent evaporation is greatly influenced by ventilation and temperature.</p> <p>(c) Retained solvents affect film performance.</p> <p>(2) Air change rate</p> <p>This standard is determined for correct film performance and this varies depending on tank capacity. These standards are different from OSHA 29 CFR 1915.35 and OSHA 29 CFR 1926.57. Consult "Industrial Ventilation, 20<sup>th</sup> Edition"<sup>1</sup> and OSHA Technical Manual Section III: Chapter 3 for guidance.</p> <p>(3) Air change rate for high humidity (85% RH or above). With high humidity, dew must be prevented after painting, from blasting stages up to the film hardening stages. Otherwise, the following may occur:</p> <p>(a) Turning of blasted surfaces</p> <p>(b) Film defects (Blushing, poor adhesion)</p> <p>As described above in (1) insufficient ventilation also deteriorates film performance. Consequently it is preferable to ventilate at least three times per hour even with high humidity for two days (this varies according to the type of paint) immediately after painting.</p> |

| No.                  | Item  | Explanation   |
|----------------------|---|---|
| 48<br>58             | <b>The safety and Health Standards for Painting</b>       | <p>(1) The safety and Health Standards for Painting</p> <p>(a) When gas concentration reaches 10% of the lower explosion limit (LEL), stop operations and evacuate workers.</p> <p>(b) When gas concentration exceeds 10% of the lower explosion limit (LEL), take appropriate measures such as adding fans and reducing the number of paint sprayers. Refer to OSHA 29 CFR 1915.35 and 29 CFR 1926.57 Consult “Industrial Ventilation, 20<sup>th</sup> Edition”<sup>1</sup> OSHA Technical Manual Section III: Chapter 3 for guidance.</p> |
| 45<br>46<br>47<br>48 | <b>Instruments for measuring environmental conditions</b> | <p>(1) For humidity and dew point:</p> <p>Sling psychrometer and psychrometric tables or battery operated psychrometer according to ASTM E 337 Standard.</p> <p>(2) Surface temperature</p> <p>Magnetic contact surface thermometer.</p> <p>(3) Anemometer</p> <p>Used to measure the ventilation volume and rate.</p>  |
| 49                   | <b>Erection of scaffoldings</b>                           | <p>(1) Scaffolding pieces</p> <p>Scaffolding pieces not to be removed are recommended to be of stainless steel.</p> <p>(2) The distance between painted surfaces and scaffolding is to be between 150 and 300 mm (to prevent unpainted portions).</p> <p>(3) Scaffold planks of expanded metal or similar open design to assist in abrasive removal and ventilation.</p> <p>(4) Height of scaffolding; 1,700 to 1,900 mm (to ensure easy and satisfactory work).</p>  |
| 50                   | <b>Illumination</b>                                       | Explosion-proof lighting is to be used during painting and drying.  |

### References

1. Industrial Ventilation, 20<sup>th</sup> Edition, *A Manual of Recommended Practice*, 1988, Committee on Industrial Ventilation, American Conference of Governmental Hygienists (ACGIH), 6500 Glenway Avenue, Building D-7, Cincinnati, OH 45211

# ASQS

## REFERENCED STANDARDS

### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D4417 Test Methods for Field Measurement of Surface Profile of Blasted Steel

### INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8502-3 Assessment of Dust on Steel Surfaces prepared for painting (Pressure-Sensitive Tape Method)

ISO 8502-6 Extraction of Soluble Contaminants for Analysis – The Bresle Method

### NACE INTERNATIONAL (NACE)

NACE No. 5 Surface Preparation and Cleaning of Steel and Other Hard Materials by High-and Ultrahigh-Pressure Water Jetting Prior to Re-coating (SSPC-SP 12)

NACE No. 7 Interim Guide and Visual Reference Photographs for Steel Cleaned by Water Jetting (SSPC-VIS 4(1))

### STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC-AB 1 Mineral and Slag Abrasives

SSPC-AB 2 Specification for Cleanliness of Recycled Ferrous Metallic Abrasives

SSPC-PA 2 Measurement of Dry Coating Thickness With Magnetic Gages.

SSPC-SP 1 Solvent Cleaning

SSPC-SP 2 Hand Tool Cleaning

SSPC-SP 3 Power Tool Cleaning

SSPC-SP 7 Brush-Off Blast Cleaning

SSPC-SP 10 Near-White Blast Cleaning

SSPC-SP 11 Power Tool Cleaning to Bare Metal

SSPC-SP 12 Surface Preparation and Cleaning of Steel and Other Hard Materials by High-and Ultrahigh-Pressure Water Jetting Prior to Re-coating (NACE No. 5)

SSPC-VIS 1-89 Visual Standard For Abrasive Blast Cleaned Steel

SSPC-VIS 3 Visual Standard for Power- and Hand- Tool Cleaned Steel

SSPC-VIS 4(1) Interim Guide and Visual Reference Photographs for Steel Cleaned by Water Jetting (NACE No. 7)

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