



TECHNICAL REQUIREMENTS

CIVIL

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CORROSION PROTECTION AND LINING

PAINTING

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1. SCOPE

- 1.1** This specification defines the general requirements for the painting of equipment, piping, structures, vessels, exchangers and all other surfaces requiring surface protection or safety marking.
- 1.2** Painting shall include surface preparation, priming, finish coatings, inspection, touch-up and clean-up.
- 1.3** Internal coatings and linings are not covered by this standard.
- 1.4** The material requisition of items to be internally coated/lined will detail the whole system to be adopted.
- 1.5** This specification does not specify paint systems operating above 540°C. If such are required, appropriate paint systems must be developed case by case.
- 1.6** This Document specifies application of final paint for shop fabricated items. Nevertheless, for special cases, this activity may be transferred to the field (this exception will be specified in the material requisition of items interested in the modification of standard practice).
- 1.7** Paint system, including surface preparation, paint materials, application, etc. must comply with applicable local laws.

2. REFERENCES

2.1 OL Specifications

OL-TR-GR-000 *General Requirements*

OL-TR-CR-000 *Civil. General*

2.2 Steel Structures Painting Council (SSPC)

SSPC-PA1 *Shop, Field and Maintenance Painting*

SSPC-PA2 *Measurement of Dry Paint Thickness with Magnetic Gages*

SSPC-PA3 *A Guide to Safety in Paint Application*

SSPC-VIS1 *Visual Standard For Abrasive Blast Cleaned Steel*

SSPC-SP1 *Solvent Cleaning*

SSPC-SP2 *Hand Tool Cleaning*

SSPC-SP3 *Power Tool Cleaning*

SSPC-SP6/NACE No. 3 *Joint Surface Preparation Standard Commercial Blast Cleaning*

SSPC-SP10 *Near - White Blast Cleaning*

SSPC-SP11 *Power Tool Cleaning to Bare Metal*

2.3 International Organization of Standardization (ISO)

ISO 4618	<i>Paints and varnishes -- Terms and definitions</i>
ISO 4619	<i>Driers for paints and varnishes</i>
ISO 4626	<i>Volatile organic liquids -- Determination of boiling range of organic solvents used as raw materials</i>
ISO 8501 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness</i>
ISO 8502 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness</i>
ISO 8503 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Surface roughness characteristics of blast-cleaned steel substrates</i>
ISO 8504 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Surface preparation methods</i>
ISO 8623	<i>Tall-oil fatty acids for paints and varnishes -- Specifications and test methods</i>
ISO/NP 11124 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Specifications for metallic blast-cleaning abrasives</i>
ISO/NP 11125 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Test methods for metallic blast-cleaning abrasives</i>
ISO/NP 11126 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Specifications for non-metallic blast-cleaning abrasives</i>
ISO 11127 (all parts)	<i>Preparation of steel substrates before application of paints and related products -- Test methods for non-metallic blast-cleaning abrasives</i>
ISO 11890 (all parts)	<i>Paints and varnishes -- Determination of volatile organic compound (VOC) content</i>
ISO/NP 12944 (all parts)	<i>Paints and varnishes — Corrosion protection of steel structures by protective paint systems</i>
ISO/NP TR 15235	<i>Preparation of steel substrates before application of paints and related products -- Collected information on the effect of levels of water-soluble salt contamination</i>

ISO/NP 15741	<i>Paints and varnishes -- Friction-reduction coatings for the interior of on- and offshore steel pipelines for non-corrosive gases</i>
ISO 17895	<i>Paints and varnishes -- Determination of the volatile organic compound content of low-VOC emulsion paints (in-can VOC)</i>
ISO 19840	<i>Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces</i>
ISO 29601	<i>Paints and varnishes -- Corrosion protection by protective paint systems -- Assessment of porosity in a dry film</i>

2.4 American Society For Testing And Materials (ASTM)

ASTM A123	<i>Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products</i>
ASTM D2371-85	<i>Standard Test Method for Pigment Content of Solvent-Reducible Paints</i>
ASTM D4417	<i>Field Measurement of Surface Profile of Blast Cleaned Steel</i>

2.5 American National Standards Institute (ANSI)

ANSI Z535.1	<i>American National Standard Safety Color Code</i>
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The latest issue of the Industry Standards shall apply.

3. TERMS AND DEFINITIONS

C.S. - Carbon steel including 1-1/4 Cr through 9 Cr materials.

S.S. - Austenitic stainless steel, such as 304, 316, 321 and 347.

High Alloy Steel - e.g. Nickel and Chrome based Alloys.

DFT - Dry film thickness.

4. GENERAL

- 4.1** The following surfaces shall not be painted unless otherwise noted in this specification or by special instructions:
- Concrete, concrete block, brickwork and transite;
 - Corrosion resistant metals such as aluminum, stainless steel, copper, or brass;
 - Finished metal operating parts of machinery, valves or other equipment, such as valves, stems, shafts, etc.;
 - Glass, tile or ceramic surfaces;
 - Nameplates, windows, gauge glasses, meter faces and related surfaces;
 - Inside surfaces of carbon steel tanks, towers, exchangers, vessels, and piping except in specific cases indicated in specifications or drawings.

- 4.2** Faying surfaces in friction type joints may require special coating requirements. Refer to Civil Structural specifications and drawings.
- 4.3** Unless otherwise noted, surface preparation, priming and intermediate coats shall be performed in fabrication or manufacturing facilities. Touch-up of shop applied primers and application of finish coats shall be applied in the field.
- 4.4** Pumps, motors, compressors, turbines, valves, hoists and all off-the-shelf items shall be coated with the manufacturers' standard system. No further painting is required, unless specified in the purchase documents.
- 4.5** Portions of galvanized steel structural members which are designated as physical hazards shall be painted with the required ANSI Color Code in the field.
- 4.6** Painting galvanized surfaces is highly dependent on the condition of the galvanized surface. Newly galvanized steel shall be pre-treated with an acid etch to promote adhesion of the color coating. Aged and weathered galvanized does not require pre-treatment.

5. QUALITY CONTROL/ASSURANCE

- 5.1** Measures shall be implemented to assure that completed work is in accordance with the requirements of this specification and the applicable codes and standards. Assurance shall be provided that only accepted coating materials are used.
- 5.2** Inspection of the surface preparation and the coating application shall be implemented for all phases of coating work performed. Records and documentation shall be prepared and maintained to furnish evidence of compliance with procedures and traceability by item or batch to the area of use.
- 5.3** Sub Vendor organizations engaged by the Supplier shall be subject to inspection and audit by the Buyer for compliance with requirements of the procurement documents. This inspection and audit does not relieve the Supplier from the responsibility for conformance to the requirements of the procurement documents.
- 5.4** The Buyer shall be provided a detailed schedule and shall be notified of all required hold and witness points requiring inspection by the Buyer prior to the schedule date for coating activities. Failure to provide adequate notification of hold and witness points may result in reinspection or rework.
- 5.5** A detailed surface preparation and coating verification report in accepted form shall be completed each day during the coating activities and shall be submitted for record. The final verification report shall include a statement of completion conformance verifying that required material was used and that the accepted procedures and specifications were followed.
- 5.6** A list of all coating materials used for the work identifying specific products by manufacturer and catalog number shall be submitted to the Buyer.

6. DESIGN

- 6.1** All coating procedures shall be in accordance with SSPC-PA1, the coating manufacturers' published data sheets and the instructions and requirements specified herein.

- 6.2 The latest issue of the coating manufacturers' product data sheets, application instructions and material safety data sheets shall be available and complied with.
- 6.3 All applicable federal, state and local codes and regulations regarding surface preparation, coating application, storage, handling and safety, including the recommendations of SSPC-PA3 shall be followed.
- 6.4 Items shall be coated using the paint system designated on the Painting Schedule, Table A-5.
- 6.5 Painting of welds on vessels, exchangers and other equipment is not permitted before pressure testing.
- 6.6 For shop fabricated piping, priming of welds with inorganic zinc prior to pressure testing is permitted, unless a sensitive leak testing is required.
- 6.7 Machined surfaces such as threads and flange facings shall be coated with a petroleum soluble rust inhibitor (E.F. Houghton's Rust Veto 342 or Exxon's Rust Ban 326).
- 6.8 Weld bevels and surfaces 50 mm from surfaces to be field welded may be coated with weldable rust inhibitor (AACCO's Deoxaluminat or Tempil's Aluminized Bloxide).

7. SURFACE PREPARATION

- 7.1 All sharp or jagged edges, burrs, knurls or other sharp surface profiles shall be ground to a 3 mm (1/8") radius. Weld spatter or burning slag shall be removed.
- 7.2 All surfaces to be painted shall first be cleaned of oil, grease, soil, drawing and cutting compounds, and other soluble contaminants, in accordance with SSPC-SP1.
- 7.3 Following solvent cleaning procedures, surfaces shall be abrasive blast cleaned in accordance with the SSPC procedure specified in Table A-4 for the required Painting System.
- 7.4 Abrasive blast cleaning requires the entire surface to be exposed to the abrasive blast, with the anchor pattern (surface profile) of the blasted steel to be based on the coating system used. Refer to Table A-4.
- 7.5 Abrasives shall be free of all dust, dirt, chlorides, sulfates and other foreign matter. Abrasives shall be kept dry at all times. Abrasives shall not contain more than 0.1% free crystalline silica.
- 7.6 All compressed air used for abrasive blasting or painting shall be free of oil and moisture. Suitable moisture separators/traps and air filters shall be installed on all abrasive blasting and painting pots.
- 7.7 Surfaces cleaned by abrasive blast cleaning shall be primed as soon as practicable, but before any visible rusting occurs. The specified SSPC grade of cleanliness shall exist immediately prior to priming. Any steel not primed shall be re-blasted if any rust develops.
- 7.8 The blasting and painting sequence shall be planned to prevent dusting and contamination of freshly coated surfaces.

- 7.9 The blast cleaned surface shall be dust-free prior to the application of the primer by blowing off the surface with clean, dry air or by using an industrial vacuum cleaner.

8. COATING MATERIALS

- 8.1 The paint products referenced by trade names within this specification are identified to set a standard of quality.
- 8.2 Equivalent paint products of other manufacturers may be acceptable if approved in writing by OL. Any request for approval of alternate materials must include a submittal of technical information for the proposed materials.
- 8.3 Primer and finish coats shall be as specified in the Painting System(s) of Tables A-1 and A-2.
- 8.4 All coating materials applied at a single location shall be from the same coating manufacturer.
- 8.5 Paint shall be stored in areas that are well ventilated and maintained above 4°C. This storage area must be kept clean and free from any accumulation of oily waste, rags, rubbish, etc.
- 8.6 When paint is stored for any length of time, the containers shall be turned weekly to prevent undue settlement of the pigments.
- 8.7 All containers shall be tightly covered at all times to prevent skinning of the surface. If the skinning does occur, it shall be removed before stirring. If necessary, paint from partially filled containers shall be strained before being applied to remove foreign matter which may be present.

9. APPLICATION OF COATINGS

- 9.1 Coatings shall be applied in strict compliance with the recommendations of the manufacturer of the materials.
- 9.2 Coatings may be applied by spray, brush, or roller application methods and shall be in accordance with the manufacturers' recommendation.
- 9.3 All coatings must be uniformly applied to form a smooth, continuous film free from sags, runs, spots or other blemishes. Edges, crevices, nuts and bolts are to receive particular attention; striping shall be applied to those surfaces to assure required coverage.
- 9.4 Surfaces shall not be painted during wet, damp, or foggy weather, or when the metal surface temperature is less than 3°C above dew point. Painting shall not be performed when the metal surface or ambient temperature is below 10°C, unless approved by the Buyer. On surfaces at temperatures above which will cause blistering or porosity the coatings shall be thinned in accordance with manufacturers' instructions.
- 9.5 Paint shall not be applied when the ambient temperature is expected to drop below 4°C before the coating has had time to cure. Paint shall not be applied when extremely windy or dusty conditions exist.
- 9.6 Mixing, thinning, application, surface temperatures, relative humidity and curing requirements shall be in strict accordance with the paint manufacturers' recommendations.

- 9.7 All ingredients in any container of paint shall be thoroughly mixed before use and shall be agitated frequently during application to maintain the correct degree of mixing. Dry pigments which are separately packed shall be uniformly blended into paints.
- 9.8 When succeeding coats of the same color are specified, a manufacturers' approved tinting material shall be added to the undercoat to produce enough contrast to insure complete coverage by the succeeding coats.
- 9.9 When top coating over inorganic zinc primers, a mist coat may be necessary to avoid bubbling. Mist coat may be a thinned coat or applied by a quick pass of the spray gun prior to applying the full coat.
- 9.10 Shop applied primers shall be pressure water washed prior to application of field finish coats.
- 9.11 Single coat high build applications of coal tar epoxy or epoxy phenolic shall be made in a cross-hatched, wet, slow and flowing coat.
- Two coat applications of coal tar epoxy shall be performed by the same coating applicator. The second coat shall be applied as soon as the first coat is firm (will not thumb print). The maximum recoat time shall not be exceeded.
- 9.12 Weld areas shall be cleaned by the SSPC-SP11 method and the anchor profile established as required for the coating system specified. Adjacent areas with undamaged coatings shall be slightly roughened and feathered. Prior to coating application, clean the entire weld area to SSPC-SP1.
- 10. SPECIAL PROCEDURES FOR AUSTENITIC STAINLESS STEEL**
- 10.1 All stainless steel and high alloy materials shall be protected from blasting, overspray and coatings intended for carbon steel and low alloy materials.
- 10.2 Austenitic stainless steel piping components, such as valves, steam traps, strainers, etc. in piping systems specified to be coated with zinc coatings shall not be coated.
- 11. TOUCH-UP**
- 11.1 Prior to application of any coat, all damage to previous coats shall be touched-up with the specified coating called out in Tables A-1 or A-2.
- 11.2 Damage to finished work shall be thoroughly solvent cleaned by SSPC-SP1 method and spot blasted, as allowed, or SSPC-SP2 and/or SP3 methods.
- 11.3 Adjacent undamaged surfaces shall be slightly roughened and feathered to tie into the touch-up coatings.
- 11.4 Cured inorganic zinc primer shall not be touched-up with inorganic zinc. Touch-up with organic zinc rich epoxy for operating temperatures 93°C and less; *International's "Intertherm 237"*, zinc rich silicone acrylic, for operating temperatures 94°C through 260°C; and silicone for operating temperatures 261°C and above.
- 11.5 Items supplied with the manufacturers' standard coating system shall be touched-up with the same generic coating system or repainted, using *International's "Interplus 256"*, aluminum epoxy mastic, as a tie-coat between the manufacturer's coating and the final coat, specified in Table A-1 or A-2.

12. CLEANLINESS

- 12.1** Sufficient drop cloths, shields and other protective equipment shall be used to prevent-over spray from fouling surfaces not being painted.
- 12.2** Empty containers, saturated rags, and waste shall be removed from the work area at the end of each day.
- 12.3** Upon job completion, all debris and rubbish shall be removed, and adjacent surfaces which have been marred, oversprayed or spotted shall be cleaned or repaired to restore them to original condition, at the sole expense of the coating applicator.

13. INSPECTION

- 13.1** Inspection, in order to ensure compliance with all inquiry documents, shall be performed by the Supplier. All materials, equipment and work shall be available to the Buyer's representative at all times.
- 13.2** Records shall be available to the Buyer's representative to verify that the correct degree of cleanliness was performed, the depth of the anchor profile was achieved, specified dry film thicknesses were obtained and the weather conditions at the time of surface preparation & priming were in the correct range. A daily inspection report shall be kept.
- 13.3** The following inspection points shall be established:
 - a) Prior to start of work;
 - b) Immediately following the surface preparation;
 - c) Immediately prior to the coating application;
 - d) Following the application and curing of each coat; and
 - e) After final inspection and sign-off in accordance with the project requirements.
- 13.4** The Supplier shall furnish the necessary testing and inspection instruments, properly calibrated and maintained and shall be available for use by the Buyer.
- 13.5** The following functions shall be performed:
 - 13.5.1 Materials**
 - a) Verify that coating and blasting materials are as specified.
 - b) Verify that storage conditions for the materials are adequate and properly maintained.
 - c) Verify that shelf life of materials has not been exceeded.
 - 13.5.2 Equipment**
 - a) Verify adequacy of coating, cleaning and blasting equipment, hoses, spray guns, etc.
 - b) Verify blasting air supply is free of moisture and oil.
 - 13.5.3 Surface Preparation**
 - a) Confirm that atmospheric conditions and metal temperature are as specified for proper surface preparation.
 - b) Inspect correctness of surface preparation for specified cleanliness and anchor profile.
 - 13.5.4 Application**
 - a) Verify correctness of mixing, including screening of inorganic zinc rich primers.

- b) Confirm that atmospheric conditions are as specified for proper coating application.
- c) Verify that inorganic zinc paint pot is continuously agitated.
- d) Verify that "pot life" is not exceeded.

13.5.5 Film Thickness

- a) Monitor first coat application of non-zinc rich primers for correct wet film thickness.
- b) Verify that DFT of zinc rich primer is as specified.
- c) Monitor finish coat application of organic coatings for correct film thickness.
- d) Verify that total DFT of shop applied coatings is as specified.

13.5.6 Adhesion

- a) Verify that primer is sufficiently cured before application of the finish coat.
- b) Inspect surface between the prime and intermediate coats to assure bonding between coats.

13.5.7 Repairs

- a) Verify that all repairs have been made.

13.5.8 Cure

- a) Verify coating is cured as specified by coating manufacturers' instructions for recoat intervals.

13.6 Blast cleaned surfaces shall be inspected for proper cleaning and anchor profile using SSPC visual comparators, prior to painting. SSPC-VIS 1 shall be used as a visual standard for confirming the degree of surface cleanliness, when adequacy of cleaning is in question.

13.7 Anchor profile shall be verified by using either course or extra course replica tape, as required by profile depth, and a spring loaded micrometer, in accordance with ASTM D4417, Method C (or ISO 8503-3).

13.8 Wet film thickness shall be checked during the application of each coat, except for inorganic zinc rich primers, to assure the specified DFT will be met.

13.9 The DFT of each coat shall be checked in accordance with the procedures defined by SSPC-PA 2 using a magnetic gage that has been properly calibrated. Gages shall be calibrated on smooth, clean (no mill scale) steel and a known thickness of plastic shim.

13.10 It is the responsibility of the Supplier to correct any work found not to be in accordance with requirements specified herein.

14. SAFETY

14.1 All necessary and prudent precautions shall be taken to insure the safety of personnel and property. Heavy concentrations of volatile or toxic fumes must be avoided. In confined spaces, blowers or exhaust fans may be necessary. Where good practice dictates, masks, non-sparking tools and other such special equipment shall be used.

14.2 All equipment being used shall comply with the municipal codes and other agencies having jurisdiction thereto. All electrical installations shall comply with the National Electrical Code.

APPENDIX A. PAINTING SYSTEMS

Table A-1. Paint Systems for Normal Applications

System	Baril	International	Ameron
I. <u>Primer</u> (1)			
A. Epoxy	16378 UniCure Miox (200°C)	Interseal 670HS (7) (121°C)	Amercoat 385 (93°C)
B. Inorganic Zinc	19511 ZincSil S-HB (2)(3) (400°C)	Interzinc 22 (2)(3)(8) (399°C)	Dimetcote 9 (2)(3) (399°C)
C. Epoxy-Phenolic	Bariphenolic EP (6) (200°C)	Interline 390 (6) (177°C)	Amercoat 90 S (6) (200°C)
D. Coal Tar Epoxy (9)	19633 UniBar TR (6) (150°C)	Interzone 954 or Interseal 670HS (6) (121°C)	Amercoat 78 HBC (6) (149°C)
II. <u>Finish</u> (1)			
A. Epoxy	16838 UniCure HSC (200°C)	Interseal 670HS (121°C)	Amercoat 385 (121°C)
B. Silicone Acrylic	15841 Baritherm (4) (550°C)	Intertherm 875 (260°C)	Amercoat 878 HS (5) (399°C)
C. Silicone	15841 Baritherm (4) (550°C)	Intertherm 50 (8) (540°C)	Amercoat 878 HS (538°C)

Notes:

(°C) Dry Temperature Resistance

- (1) Primers and finishes do not need to be supplied from the same manufacturer, EXCEPT for High Temp. Systems (Table A-2).
- (2) Touch-up with materials specified (refer to Touch-up section).
- (3) Percent by weight of Zn in dry film - 85 to 92%.
- (4) Requires heat (177°C+) to achieve final cure. See manufacturers' data.
- (5) Requires heat (149°C+) to achieve final cure. See manufacturers' data.
- (6) Finish Paint must be shop applied.
- (7) Finish paint or an intermediate coat of *Intergard 475HS* (125-205 µm) must be shop applied.
- (8) The dry temperature resistance of the coating system *Interzinc 22* / *Intertherm 50* is 540°C.
- (9) Coal tar products are banned.

Table A-2. Special High Temperature Paint Systems

System	Baril	International	Ameron
I. <u>Primer</u> (1) E.High Temp. System	15711 Baritherm Zimox (550°C) 75 to 100 µm DFT one coat	Interzinc 22 (4) (400°C) 50 µm DFT one coat	Dimetcote 9 (2) (538°C) 75 to 100 µm DFT one coat
II. <u>Finish</u> (1) D. High Temp System	15841 Baritherm HR (3) (550°C) 40 to 50 µm DFT one coat	Intertherm 50 (4) (540°C) 50 µm DFT two coats	Amercoat 878 HS (2) (538°C) 25 µm DFT one coat

Notes:

(°C) Dry Temperature Resistance

- (1) For High Temperature Systems shown, primer & finish paint MUST be from the same manufacturer. Purchaser to specify exact materials to be used for each application.
- (2) Not recommended for Thermal Cycling Services. Can be used to 648°C as shown. Consult manufacturer for applications to 1093°C.
- (3) Requires heat (177°C+) to achieve final cure. See manufacturers' data.
- (4) The dry temperature resistance of the coating system *Interzinc 22 / Intertherm 50* is 540°C.
- (5) Not suitable for use over 454°C.

Table A-3. Dry Film Thickness

System	Dry Film Thickness
I-A	100 to 150 µm DFT in one coat
I-B	75 to 100 µm DFT in one coat
I-C	200 to 250 µm DFT total, applied in one or two coats per manufacturers' recommendations
I-D	400 µm DFT total, applied in one or two coats per manufacturers' recommendations
I-E	See Table A-2
II-A	100 to 150 µm DFT in one coat
II-B	25 to 40 µm DFT in one coat
II-C	25 to 40 µm DFT in one coat
II-D	See Table A-2

Table A-4. Surface Preparation

System	Surface Preparation
I-A / II-A	SSPC SP-6, 25 to 50 µm surface profile
I-B	SSPC SP-6, 25 to 75 µm surface profile
I-B / II-B	SSPC SP-10, 25 to 40 µm surface profile
I-B / II-C	SSPC SP-10, 25 to 40 µm surface profile
I-C	SSPC SP-10, 50 to 75 µm surface profile
I-D	SSPC SP-6, 50 to 75 µm surface profile
IE / II-D	SSPC SP-10, 25 to 40 µm surface profile
Galv./11-A	Clean per Manufacturers' Recommendations

Table A-5. Painting Schedule

Surface	Primer	Finish (1)
A. Structural Steel 1. Supports for Pipe, Equipment, Lighting, etc. a. Exposed b. Under Fireproofing 2. Ladders, Platforms, Handrails, etc. 3. Miscellaneous (NOT Galvanized) 4. Portions of Galvanized steel requiring ANSI color coding	Galvanized Galvanized Galvanized I-A Galvanized	N/A N/A N/A II-A II-A
B. Vessels, Towers and Exchangers (2) 1. Un-Insulated Equipment a. Operating 93°C or Less b. Operating 94°C to 260°C c. Operating 261°C to 399°C d. Operating 400°C to 538°C (3) 2. Insulated Equipment a. Under Insulation 1) Operating 149°C or Less 2) Operating 150°C to 399°C 3) Operating 400°C to 538°C (3) b. Exposed Nozzles, Supports, etc. 1) Operating 149°C or Less 2) Operating 150°C to 260°C 3) Operating 261°C to 399°C 4) Operating 400°C to 538°C (3)	I-A I-B I-B I-E I-C I-B None I-C I-B I-B I-E	II-A II-B II-C II-D None None None None II-B II-C II-D
C. Pumps and Machinery (Incl. Drivers Guards & Skids)	Mfg's Std.	Mfg's Std.
D. Electrical 1. Transformers, Switchgear, Panel, etc. 2. Conduit and Connections 3. Cable Trays and Supports 4. Reflectors and Fixtures	Mfg's Std. None None Mfg's Std.	Mfg's Std. None None Mfg's Std.
E. Piping 1. Below Ground 2. Aboveground - Exposed a. Operating 93°C or Less b. Operating 94°C to 260°C c. Operating 261°C to 399°C d. Operating 400°C to 538°C (3) 3. Aboveground - Insulated a. Operating 149°C or Less b. Operating 150°C to 399°C c. Operating 400°C to 538°C (3)	I-D I-A I-B I-B I-E I-C I-B None	None II-A II-B II-C II-D None None None

Notes:

- (1) All finish paints are field applied.
- (2) Finish coat not required under fireproofing and inside vessel skirts.
- (3) Equipment and piping operating at these temperatures are not normally painted. These systems should only be used when project specific requirements dictate that painting is required. Paint manufacturer should be consulted to verify the adequacy of these systems for the intended application.

Table A-6. Color Coding for Safety Equipment and Safety Hazards

Process/Hazard Description	Munsell Notation	Descriptive Color
Firefighting Piping and Equipment	7.5 R4.0/14	Safety Red
Fire Extinguisher Locations	7.5 R4.0/14 & N1.0 (5R-5Y)	Safety Red & White Stripes
Dangerous Parts of Machinery	5.0YR 6.0/15	Safety Orange
Safety Relief Devices	5.0YR 6.0/15	Safety Orange
Handrails, Ladder Cage Entrances and Exits Personal Hazards, Pillars, Posts & Barricades	5.0Y 8.0/12	Safety Yellow
First Aid Equipment	7.5G 4.0/9.0	Safety Green
Safety Eye Wash and Shower Station	7.5G 4.0/9.0 & N1.0 (5R-5Y)	Safety Green & White Stripes
Boilers and Ducts, Heaters, Preheaters and Stacks	N5.0	Safety Black
Flare System (incl. Drum, Exposed Steel and Associated Piping)	---	Flat Black

APPENDIX B. PAINTING SYSTEMS – ALTERNATIVE SUPPLEMENT

B-1. General

B-1.1 In addition to items listed in par. 4.1 of this specification, the following surfaces shall not be painted:

- a) Galvanized Surfaces.
- b) Insulation Weatherproofing.
- c) Plastic and Plastic Coated Materials.

B-1.2 Platforms, floor plates and gratings, stairs treads and channel, ladders, safety cages, handrail assemblies, instrument raceways, other small pieces of structures and equipment and their bolting shall be hot dip galvanized in accordance with the ASTM A123 (or EN ISO 1461).

Steel structures will be also hot dip galvanized except where fireproofing protection is required (in this case, steel will be primed with inorganic zinc as shown in Table B-1, System No. 8).

B-1.3 All shop fabricated materials (vessels, heat exchangers, piping prefabricated spools, etc.) requiring painting shall be cleaned and final painted (priming, intermediate and finish coats) at shop by the Fabricator in accordance with the painting systems stated in this standard.

The painting will be touched-up in field after erection at painting Contractor care to restore damages happened during transportation and erection.

B-1.4 Machinery, electric motors, valves, instruments, spring hanger, boards, etc. shall be completely painted in accordance with the Manufacturer painting standards selected on the basis of a refinery ambient exposure and durability of 15 years. The final color of the equipment will be also as per manufacturer's standard.

B-1.5 Requirement for painting of piping includes the entire piping system including fittings, flanges, but excluding all items manufactured in shop such as valves, strainers, traps, etc. (these items shall be painted as per paragraph B-1.6).

B-1.6 Uninsulated portions of insulated/fireproofed equipment on piping (vessel nozzles, manway covers, pipe fittings, flanges, valves, relief valves, strainers, traps, brackets, etc.) which extend beyond the insulation or fireproofing, system shall be painted including the welded joint in accordance with the proper painting system relevant to bare steel surfaces.

B-1.7 The general Contractor shall be responsible for properly handling and storing the painted materials prior to erection to minimize damage to the already applied painting coats.

Damaged areas of the painted surfaces shall be repaired after erection by the painting Contractor to the satisfaction of ORLEN Lietuva Supervisors.

B-1.8 The paint system is to be based on the operating temperature of equipment and piping except:

- a) Supports (skirts, legs, saddles, etc.) shall be considered as operating below 120°C unless otherwise noted.
- b) Higher temperatures required for steam-out, start-up, or other non-operating conditions shall be used where specified in the material requisition of the interested item.

B-1.9 Painting materials shall be delivered to the job site in sealed and labelled containers. They shall be stored in a location that is protected from the elements, well ventilated, and free from excessive heat, open flame, or other sources of ignition.

Paint materials susceptible to freezing shall be stored in a heated area.

B-1.10 Primers and finish coats for any particular system shall be from the same Manufacturer, whenever possible, to assure compatibility.

B-1.11 Paint shall be thoroughly mixed and thinned in accordance with the Manufacturer's instructions immediately prior to application. Only thinners of a type recommended by the paint Manufacturer shall be used.

B-1.12 The equipment listed below shall be shielded to prevent damage during surface preparation and painting operations. All openings, including those that are flanged or threaded, shall be sealed to prevent entry of sand, dust, or coating material.

B-1.13 After completion of painting operations, all materials used for shielding and sealing shall be removed:

- a) Nameplates;
- b) Packing glands;
- c) Packing seals;
- d) Bearings;
- e) Rotating equipment couplings;
- f) Rotating equipment shafts;
- g) Lubrication fittings;
- h) Pressure gauges;
- i) Gauge glasses;
- j) Motor starters;
- k) Instruments dials;
- l) Vents;
- m) Exposed linkages;
- n) Valve stems;
- o) Light bulbs;
- p) Light bulb enclosures;
- q) Light reflectors;
- r) Air intakes;
- s) Rubber and plastic components.

B-2. Paint Applications

B-2.1 Paint Manufacturer's recommendations shall be consulted in each case for possible special temperature requirements. No paints shall be applied to a surface at a temperature that will cause blistering, porosity or otherwise be detrimental to the life of the paint.

B-2.2 Contact surfaces shall be painted as follows:

- a) Contact surfaces of steel members to be joined by high-tensile bolting in friction-type joint shall be left unpainted, except for inorganic zinc primers as approved by AISC (American Institute of Steel Construction).
- b) Steel coated in the shop or in the field before erection shall not be coated within 50 mm of the edges to be welded.
- c) Surfaces not in direct bonded contact, but inaccessible after assembly, shall receive the full specified paint system before assembly.

- d) Steel surfaces in contact with aluminum surfaces shall be coated with a coal tar epoxy paint.
- e) Steel to be embedded in brick or other masonry shall be given at least one prime coat.

B-2.3 Surfaces shall not be recoated until the previous coat has properly dried or cured. The surface may be considered ready for recoating when the next coat can be applied without the development of paint film irregularities, such as lifting or loss of adhesion of the undercoat. However, the minimum or maximum drying or curing time specified by the paint Manufacturer shall be acceptable recoat period. Paint shall not be force-dried under conditions which will cause cracking, wrinkling, blistering, formation of pores, or which will be detrimental to its condition of appearance. Newly painted surfaces shall be protected to the fullest extent practicable from rain, condensation, contamination, snow and freezing until the coating has dried.

B-2.4 Sprayed coatings shall be cross-spray-applied to insure uniform coverage, free of runs and sags.

B-2.5 Where the required thickness is not achieved, additional coats shall be applied until the proper thickness is obtained. Application shall be such that the film thickness will not affect appearance or service life of the paint.

B-2.6 The type of paint to be used and the number of coats to be applied shall be in accordance with Tables B-1 and B-2 of this specification.

B-3. Selection of Paint

B-3.1 Following Table B-1 shows the required paint systems.

Painting for system No. 1 is based on standard EN ISO 12944.

Additional paint systems n°.2 to 8 are included for cases not defined in EN ISO 12944, considering product resistance to high temperatures and protection against humidity corrosion.

B-3.2 A list of some paint products acceptable is shown in Table B-2. Alternative equivalent products will be allowed (if previously approved in writing by OL).

B-3.3 The color system to be adopted in the plant will be in accordance with Table B-3.

Table B-1. Paint Systems

System No.	Oper. Temp.	Surf. Prep.	System Description		DFT (3)	Paint Type
Surface to Be Painted: Carbon Steel and Low Alloy Steel (Piping, Vessels, Tanks, Exchangers, Heaters, Stacks, etc.) Bare - Uninsulated						
1	below 120°C	Sa 2.5	Primer: ZINC-RICH EPOXY PRIMER (4) Intermediate: EPOXY POLYAMIDE Finish: ALIPHATIC POLYURETHANE		80 110 50	103 201 204
2	121°C to 200°C	Sa 2.5	Primer: INORGANIC ZINC SILICATE (4) Intermediate: SILICONE ACRYLIC Finish: SILICONE ACRYLIC		75 25 25	101 202 202
3	200°C to 400°C	Sa 2.5	Primer: INORGANIC ZINC SILICATE (4) Intermediate: SILICONE ALUMINUM Finish: SILICONE ALUMINUM		75 25 25	101 203 203
4	401°C to 540°C	Sa 2.5 (1)	Primer: SILICONE PRIMER Intermediate: ----- Finish: SILICONE ALUMINUM		25 -- 25	102 --- 203
Surface to Be Painted: Carbon Steel and Low Alloy Steel (Piping, Vessels, Tanks, Exchangers, Operating Continuously) Insulated						
5	below 120°C	Sa 2.5	Primer: EPOXY POLYAMIDE PRIMER Intermediate: ----- Finish: -----		75 -- --	104 -- --
6	above 120°C	Sa 2.5	Primer: TWO-PACK MOISTURE-CURING ZINC (ETHYL) SILICATE PRIMER Intermediate: ----- Finish: -----		80 -- --	101 -- --
Surface to Be Painted: Carbon Steel and Low Alloy Steel (Piping, Vessels, Tanks, Exchangers, Operating Discontinuously) (2) Insulated						
7	120°C to 540°C	Sa 2.5 (1)	Primer: SILICONE PRIMER Intermediate: ----- Finish: SILICONE ALUMINUM		25 -- 25	102 --- 203
Surface to Be Painted: Carbon Steel Fireproofed Structure						
8	below 120°C	Sa 2.5	Primer: INORGANIC ZINC SILICATE Intermediate: ----- Finish: -----		75 -- --	101 --- ---

Notes:

- (1) For Silicone Primer, check paint manufacturer's recommendation for Anchor Profile of Surface Preparation (about 20 ÷ 30 µm).
- (2) This system shall be used on components operating between a minimum temperature lower than 120°C and a maximum temperature in the range 120°C ÷ 540°C.
- (3) Minimum dry film thickness (min. DFT), in microns.
- (4) Zinc-rich primers (products no. 101 and 103) must have a minimum zinc pigment content in dry film of 80% by weight (required by standard EN ISO 12944-5), measured by Standard ASTM D2371.
- (5) Paint system is usable only if temperature will not drop below 120°C.

Table B-2. Example of Acceptable Paint Materials

Paint Code	Paint Type	Supplier	Paint Identification
101	Inorganic Zinc Rich Solvent Base (3)	BARIL INTERNATIONAL AMERON HEMPEL	19511 Zinc-Sil S-HB Interzinc 22 Dimetcote 9 Galvosil 1570 or 1578
102	Silicone Primer	BARIL INTERNATIONAL AMERON HEMPEL	15711 Baritherm Zimox Intertherm 50 Amercoat 878 HS Silicone Aluminium 56910
103	Zinc-rich Epoxy Primer (3)	BARIL INTERNATIONAL AMERON HEMPEL	16515 UniBar ZN HS Hempadur Zinc 17360 Amercoat 68G Interzinc 52 or 72
104	Epoxy Polyamide Primer	BARIL INTERNATIONAL AMERON HEMPEL	644 UniMax RC Intergard 251 or 563 Amercoat 71 Primer Hempadur Primer 15300
201	Epoxy Polyamide	BARIL INTERNATIONAL AMERON HEMPEL	16442 UniBar ZFC Intergard 410 or 563 or 475 HS Amercoat 385 Hempadur HB 4520
202	Silicone Acrylic	BARIL INTERNATIONAL AMERON HEMPEL	15841 Baritherm HR Intertherm 875 Amercoat 878 HS Silicone Acrylic 5694 or 565E1
203	Silicone Aluminum	BARIL INTERNATIONAL AMERON HEMPEL	15841AL Baritherm HR Silver Intertherm 50 Amercoat 878 HS Silicone Aluminium 56910
204	Aliphatic Polyurethane	BARIL INTERNATIONAL AMERON HEMPEL	154 PoluRan TC Express HB Interthane 990 or 990 SG Amercoat 450S Hempathane Topcoat 55210

Notes:

- (1) A paint product shall not be used at operating temperatures higher than the max. temperature specified by the Supplier of the paint product.
- (2) The list of painting product identified as acceptable does not relieve Vendor to check that the paint product actually used meet the required type of paint.
- (3) Zinc-rich primers (products no. 101 and 103) must have a minimum zinc pigment content in dry film of 80% by weight (required by Standard EN ISO 12944-5), measured by Standard ASTM D2371.

Table B-3. Color Coding

Items		Color	RAL
Vessels, Exchangers, Tanks, etc.		Light Grey	7035
Steel Structure		Galvanized or Fireproofed	----
Rotating Equipment, Motors, Valves, Instruments, Boards, etc.		Manufacturers' Standard	----
Piping	Hydrocarbons - Liquids	Light Grey	7035
	Hydrocarbons – Vapors and Gases	Light Yellow	1016
	Hydrogen	Light Yellow	1016
	Amine (MEA)	Purple	4006
	LP and MP Steam	Dark Red with Yellow Strips	3004 1021
	HP Steam	Dark Red	3004
	Condensate	Green with Blue Strips	6032 5012
	Cooling Water	Green	6032
	Nitrogen	Yellow	1021
	Instrument and Plant (Technical) Air	Blue	5012
	Firefighting Water	Signal Red	3001

Notes:

- (1) The colors are defined according the following code: "RAL 840 HR" issued by "DEUTSCHER NORMEN AUSSCHUSS".
- (2) Equipment and piping without insulation must be painted following this color code for the top coat.
- (3) Equipment and piping with insulation can be painted of any color, this table is not mandatory for them. Nevertheless, piping with insulation must have strips (painted or taped) acc. to Table B-4.

Table B-4. Strip Width

Pipe with Insulation Diameter	Strip Width
up to 149 mm	50 mm
from 150 mm to 300 mm	70 mm
over 301 mm	100 mm

Note:

Strips must be applied not less than 5 m and on both sided of valves and when pipe changes direction or splits.