

# SSPC: The Society for Protective Coatings Technology Guide 15

## Field Methods for Extraction and Analysis of Soluble Salts on Steel and Other Nonporous Substrates

### 1. Scope

**1.1** This Guide describes the most commonly used field methods for the extraction and analysis of soluble salts on steel and other nonporous substrates. Laboratory methods are only included for situations where more complete salt extractions are desired through rigorous laboratory retrieval and analysis protocols.

### 2. Description and Use

**2.1 INTRODUCTION:** Coatings applied on surfaces contaminated with soluble salts exceeding a certain concentration exhibit diminished performance. Likewise, self-passivating metals (not intended for coating such as stainless steel, aluminum and copper) can be compromised from elevated concentrations of residual soluble salts in corrosive environments. Soluble salt testing involves two basic steps: 1) extraction of salts from the surface into a solution and 2) the analysis of the solution. This Guide is intended to assist the user in selecting specific procedures for extracting and performing qualitative and/or quantitative soluble salts from steel and nonporous surfaces. It includes field methods for measuring total conductivity (fully automated or multi-step) and specific ions. It also offers guidance for destructive laboratory soluble salt extraction and testing. An overview of available field and laboratory techniques, methods of salt extraction and surface concentration calculations are provided in Tables 1 and 2 respectively. A discussion and sources on the efficiency of salt removal (also called extraction) from the metal surfaces of interest are provided in Appendix C.

#### 2.1.1 Abbreviations:

Cl <sup>-1</sup>	chloride ion
cm <sup>3</sup>	cubic centimeters
cm <sup>2</sup>	square centimeters
Fe <sup>+2</sup>	ferrous ion
μS	microSiemens
μS/cm	microSiemens per centimeter
mg	milligram
ml	milliliter
ppm	parts per million
NaCl	sodium chloride
NO <sub>3</sub> <sup>-1</sup>	nitrate ion
SO <sub>4</sub> <sup>-2</sup>	sulfate ion

### 2.2 SALT EXTRACTION SOLUTIONS

All of the reagents used to extract salts from metal surfaces in this document fall into two categories: reagent water and proprietary aqueous solutions. They will be designated herein as reagent water or proprietary extraction solution.

**2.2.1 Reagent Water:** Reagent water used for salt extraction should have a maximum conductivity of 5 μS/cm. Distilled water may be purchased at grocery stores but verification of the conductivity is recommended. Alternatively, a portable demineralizer may be used to make reagent water on site. Pour tap water into the plastic bottle, attach the demineralizer cartridge in the direction indicated, invert, and squeeze out the desired amount of water (for many of the tests described below, at least 25 ml will be required). The cartridge can be used until the blue color turns brown, as indicated on the side of the cartridge. Once this occurs, replace the cartridge. Each cartridge should deionize approximately 3000 ml of water.

**2.2.2 Proprietary Solutions:** Proprietary extraction solutions may be included with some commercial test kits. These solutions should only be used for the soluble salts described in the kit instructions. Proprietary solutions are not suitable for measuring conductivity of extracted solutions.

### 3. Referenced Standards

The standards listed below are updated on a periodic basis. The user of this guide should consult the most recent revision.

#### 3.1 SSPC STANDARDS AND JOINT STANDARDS:

**SP 5/NACE No. 1** White Metal Blast Cleaning

#### 3.2 ASTM INTERNATIONAL STANDARDS<sup>1</sup>

<b>ASTM D4327</b>	Standard Test Method for Anions in Water by Chemically Suppressed Ion Chromatography
<b>ASTM D512</b>	Standard Test Methods for Chloride Ion In Water

<sup>1</sup> ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. For referenced ASTM standards, visit the ASTM website, <http://www.astm.org>, or contact ASTM Customer Service at <service@astm.org>. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

**3.2 INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) STANDARDS:<sup>2</sup>**

**ISO 8502 Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness–**

**Part 2** Laboratory determination of chloride on cleaned surfaces (ISO 8502-2)

**Part 5** Measurement of chloride on steel

surfaces prepared for painting–Ion detection tube method (ISO 8502-5)

**Part 6** Extraction of soluble contaminants for analysis–The Bresle method (ISO 8502-6)

**Part 9** Field method for conductometric determination of water-soluble salts (ISO 8502-9)

**Part 12** Field method for the titrimetric determination of water-soluble ferrous ions (ISO 8502-12)

<sup>2</sup> International Organization for Standardization (ISO), Case Postale 56, Geneva CH-1211, Switzerland. ISO standards may be obtained through the American National Standards Institute, 1819 L Street, NW, Suite 600, Washington, DC 20036 (www.ansi.org).

**TABLE 1  
OVERVIEW OF FIELD METHODS FOR RETRIEVAL AND ANALYSIS OF SOLUBLE SALTS FROM STEEL AND OTHER NONPOROUS SURFACES**

Methodology (see section number for more detail)	Surface Sampling via Extraction Medium (Applicable ISO Standard)	Analysis of Extracted Sample	Calculating Surface Concentrations of Ions (also refer to Appendix A or B)
<b>4. Field Methods Measuring Conductivity</b>			
<b>4.1 Fully Automated Conductivity Measurement Techniques</b>			
4.1.1 Soluble Salt Meter	Employs Reagent Water for Extraction Manufacturer Calibration Magnetic Surface Attachment	Integrated Conductivity Sensor	Reported as conductivity $\mu\text{S}/\text{cm}$ $\text{mg}/\text{m}^2$ (ISO 8502-9) $\text{mg}/\text{m}^2$ as NaCl (IMO PSPC)
4.1.2 Surface Salinity Meter	Employs Reagent Water for Extraction Manufacturer Calibration Magnetic Surface Attachment	Integrated Conductivity Sensor	Reported as conductivity $\mu\text{S}/\text{cm}$ $\text{mg}/\text{m}^2$ (ISO 8502-9) $\mu\text{g}/\text{cm}^2$ as chlorides
4.1.3 Continuous Flow Extraction Fiber Strip	Employs Reagent Water for Extraction Manufacturer Calibration. User accuracy check provided. No-Residue Tape Surface Attachment	Integrated Conductivity Sensor	Reported as conductivity $\mu\text{S}/\text{cm}$ $\text{mg}/\text{m}^2$ (ISO 8502-9) $\mu\text{g}/\text{cm}^2$ total salts per ISO 8502-9
<b>4.2 Multi Step Conductivity Measurement Techniques</b>			
4.2.1 Surface Swab or Wash	Employs Reagent Water for Extraction (ISO 8502-2, Sections 5 and 6)	Probe-Type Conductivity Meter	Conductivity reported as $\mu\text{S}/\text{cm}$ (ISO 8502-9).
4.2.2 Adhesively Bonded Latex Patch or Cell	Employs Reagent Water for Extraction (ISO 8502-6)	Probe-Type Conductivity Meter	Conductivity reported as $\mu\text{S}/\text{cm}$ (ISO 8502-9).
4.2.3 Saturated Special Filter Paper With Concentric Ring Conductivity Meter	Employs Reagent Water for Extraction	Concentric Ring Conductivity Meter	Conductivity reported as $\mu\text{g}/\text{cm}^2$ , $\text{mg}/\text{cm}^2$ , $\mu\text{S}/\text{cm}$ , ppm, % salinity.

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<b>5. Field Methods Measuring Specific Ions</b>			
<b>5.1 Fully Automated Methods</b> <i>No automated or single-step specific-ion extraction/analyses are currently available.</i>			
<b>5.2 Multi-Step Ion-Specific Methods</b>			
5.2.1 Chloride Ion Paper Strip Test of Swab/Wash or Latex Patch/Cell Extracts	Employs Reagent Water for Extraction Swab: ISO 8502-2, Sections 5 and 6) (Latex Patch/Cell: ISO 8502-6)	Commercially Available Kit. Convert "QuanTab Units" to ppm per manufacture instructions. Convert solution concentration as ppm to surface concentration ( $\mu\text{g}/\text{cm}^2$ ) per Appendix A.	Calculation of surface $\text{Cl}^{-1}$ from swab as $\mu\text{g}/\text{cm}^2$ ( $\text{Cl}^{-1}$ as ppm $\times$ quantity of water used in ml) $\div$ area sampled in $\text{cm}^2$
5.2.2 Chloride Ion Detection Tube Test of Swab/Wash or Latex Patch/Cell Extracts	Employs Reagent Water for Extraction Swab: ISO 8502-2, Sections 5 and 6) (Latex Patch/Cell: ISO 8502-6)	Commercially Available Kit. Convert solution concentration as PPM to surface concentration ( $\mu\text{g}/\text{cm}^2$ ) per Appendix A.	Calculation of surface $\text{Cl}^{-1}$ from swab as $\mu\text{g}/\text{cm}^2$ : ( $\text{Cl}^{-1}$ as ppm $\times$ quantity of water used in ml) $\div$ area sampled in $\text{cm}^2$
5.2.3 Ferrous Ion Paper Strip Test of Swab/Wash or Latex Patch/Cell Extracts	Employs Reagent Water for Extraction (Swab: ISO 8502-2, Sections 5 and 6) (Latex Patch/Cell: ISO 8502-6)	Commercially Available Kits. Ferrous solution concentration is measured visually. Color comparison to charts on ferrous ion strip bottle (units in ppm or ( $\mu\text{g}/\text{cm}^2$ ). Convert solution concentration as ppm to surface concentration ( $\mu\text{g}/\text{cm}^2$ ) per Appendix A.	$\text{Fe}^{+2}$ from swab as $\mu\text{g}/\text{cm}^2$ : (ppm $\times$ ml of water) $\div$ area sampled in $\text{cm}^2$
5.2.4 Field Drop Titration for Chloride of Swab/Wash or Latex Patch/Cell Extracts	Employs Reagent Water for Extraction (Swab: ISO 8502-2, Sections 5 and 6) (Latex Patch/Cell: ISO 8502-6)	Commercially Available Test Kit used to analyze aqueous extracted solutions. Chloride ion concentration is determined by "drop titration."	$\text{Cl}^{-1}$ concentration is calculated as follows: Convert number of drops to cause color change from surface area tested to determine concentration of chloride as $\mu\text{g}/\text{cm}^2$
5.2.5 Latex Sleeve Methodology	Proprietary Extraction Solution	Single ion or multi-ion prepackaged commercial kits are available.	-----
5.2.5.1 Sleeve Extract for Chloride Only	Proprietary Extraction Solution	Chloride Ion Detection Tube.  Units reported in ppm.	Calculation of Surface $\text{Cl}^{-1}$ same as $\mu\text{g}/\text{cm}^2$ ( $\text{Cl}^{-1}$ as ppm 10 ml Proprietary Extraction Solution with sleeve. Area sampled of 10 $\text{cm}^2$ yields 1:1 equivalence to $\mu\text{g}/\text{cm}^2$ ) (ISO 8502-5)

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5.2.5.2 Sleeve Extract for Ferrous Ion	Proprietary Extraction Solution	Ferrous Ion Test Strip immersed in sleeve solution to develop color. Color comparison to chart on ferrous test strip bottle. Units reported in ppm.	Calculation of Surface Fe <sup>+2</sup> same as $\mu\text{g}/\text{cm}^2$ (Fe <sup>+2</sup> as ppm; 10 ml proprietary extraction solution with sleeve. Area sampled of 10 cm <sup>2</sup> yields 1:1 equivalence to $\mu\text{g}/\text{cm}^2$ )
5.2.5.3 Sleeve Extract for Chloride, Nitrate, and Sulfate (CNS)	Proprietary Extraction Solution	Nitrate Test Strip immersed in sleeve solution to develop color. color comparison to chart on nitrate test strip bottle.* Units reported in ppm. *See 5.2.5.1 for summary of analysis procedure for chloride and 5.2.5.4 for summary of analysis procedure for sulfate.	Calculation of Surface NO <sub>3</sub> <sup>-1</sup> same as $\mu\text{g}/\text{cm}^2$ (NO <sub>3</sub> <sup>-1</sup> as ppm; 10 ml proprietary extraction solution with sleeve. Area sampled of 10 cm <sup>2</sup> yields 1:1 equivalence to $\mu\text{g}/\text{cm}^2$ )
5.2.5.4 Sleeve Extract for Sulfate	Proprietary Extraction Solution	Sulfate Analysis by Colorimetric Methods. Concentration reported in ppm.	Calculation of Surface SO <sub>4</sub> <sup>-2</sup> same as $\mu\text{g}/\text{cm}^2$ (SO <sub>4</sub> <sup>-2</sup> as ppm; 10 ml proprietary extraction solution with sleeve. Area sampled of 10 cm <sup>2</sup> yields 1:1 equivalence to $\mu\text{g}/\text{cm}^2$ )
5.2.6 Field Detection Sulfate Ion	Employs Reagent Water for Extraction ( Swab: ISO 8502-2, Sections 5 and 6) (Latex Patch/Cell: ISO 8502-6)	Sulfate Analysis by Optical Comparative Method. Concentration reported in ppm	Calculation of Surface SO <sub>4</sub> <sup>-2</sup> same as $\mu\text{g}/\text{cm}^2$ SO <sub>4</sub> <sup>-2</sup> as ppm to surface concentration ( $\mu\text{g}/\text{cm}^2$ ) per Appendix A [or: ISO 8502-11, Sections 6 and 7]
5.2.7 Qualitative Field Detection of Ferrous Ions	----	Blotting paper is treated with potassium ferricyanide solutions and wetted with reagent water. On contact with ferrous ions, the paper shows blue spots.	Not a quantitative technique. (ISO 8502-12)

### 3.3 NACE INTERNATIONAL STANDARD<sup>3</sup>

**NACE SP0508-2010** Methods of Validating Equivalence to ISO 8502-9 on Measurement of the Levels of Soluble Salts

## 4. Field Methods Measuring Total Soluble Salts by Conductivity

**4.1 Fully Automated Conductivity Measurement Techniques:** Recent innovations in salinity testing devices have

resulted in direct, real-time automated integrated systems that comply with ISO 8502-9. These devices are alternatives to patch cells and measure solution salinity from conductance. All of these devices attach to metal surfaces (magnetically or with non-residue tape). A fixed volume of pure extraction water is automatically dispensed and agitated against the metal surface to remove (extract or retrieve) soluble salts and conductance measurements are taken in real-time. The devices process conductance data to generate surface concentration and store data and results internally. The commercially available devices are summarized in Table 1, Sections 4.1.1 Soluble Salt Meter; 4.1.2 Surface Salinity Meter; and 4.1.3 Continuous Flow

<sup>3</sup> NACE International, 1440 South Creek, Houston, TX 77084. NACE standards are available online at <http://www.nace.org>.

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