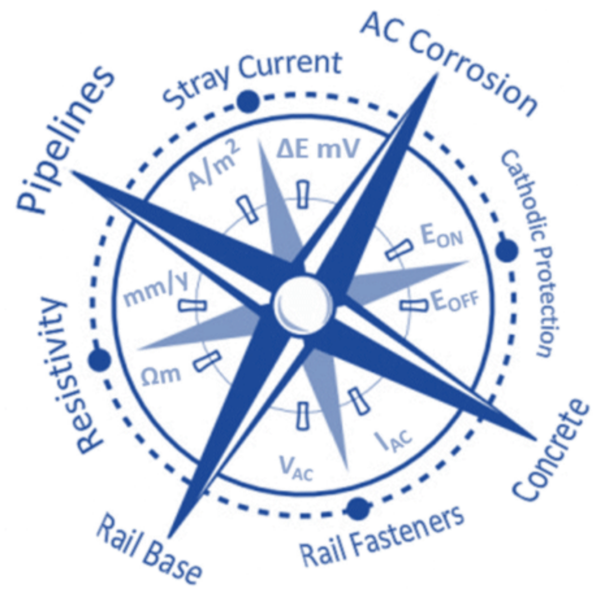


SC-Compass®: Stray Current Corrosion and AC Corrosion
- Identification, Assessment and Prediction

Version 9.18

☆ **Performance** ☆ **Functionality** ☆ **Usability**

Anytime Anywhere Any Device Any OS

No USB dongles No installation No Browser Plug-ins

Features and Functions of SC-Compass

Stray current corrosion refers to corrosion resulting from stray current - the current flowing through paths other than the intended circuit. In the corrosion literature, non-standard terms used by some authors include stray current electrolysis and electrolytic corrosion. Among the many different types of corrosion, stray current corrosion is probably the most misused term by unqualified corrosion consultants worldwide who literally refer to any corrosion phenomenon beyond their comprehension as stray current corrosion. This mis-diagnosis often results in significant financial losses and safety lapses for facility owners and operators.

Accurate identification of stray current corrosion requires a sound understanding of all types of corrosion. A qualified corrosion consultant (NACE certified Corrosion Specialist) can tell the differences among the different types of corrosion. Stray current corrosion is fundamentally different from other (non-stray current) types of corrosion in that stray current corrosion is an electrolysis process. In the electrolysis process, the external current (stray current) alone drives metal atoms into electrolyte as water-soluble ions. The environmental factors such as oxygen concentration, cathode-to-anode area ratio, chloride, and pH that are so critical to natural corrosion processes are no longer relevant. The extent of damage or loss of metal is directly proportional to the magnitude of stray current leaving the structure at the point of discharge. Stray current corrosion will be concentrated at certain location that leads to the lowest electrical resistance in the current circuit.

SC-Compass is developed by NACE certified corrosion specialists with both BEng and PhD degrees in corrosion. It is the only device and OS independent software tool on the market for identification, assessment and prediction of Stray Current Corrosion and AC Corrosion in underground pipelines, rail transit systems, reinforced concrete structures, boats/ships/vessels, and other metallic structures carrying electrical current. Designers, engineers, consultants, maintenance and inspection personnel can quickly identify, assess and quantify the impact of stray current corrosion and AC corrosion on the remaining life of their structures/components anytime, anywhere, on any device running any OS without the need to install or download anything. SC-Compass is developed in full compliance with the latest editions of BS EN and NACE standards relating to stray current corrosion and AC corrosion.

SC-Compass has answers to all the frequently asked questions below and more:

Frequently Asked Questions on Stray Current Corrosion:

- What is stray current corrosion?
- How is stray current corrosion different from other types of corrosion?
- How to tell if my corroded structure is really due to stray current corrosion?
- How to identify stray current corrosion?
- How to predict the level of stray current in my structure?
- How to measure stray current?
- How to assess stray current corrosion risk?
- What international standards are relevant to the assessment of stray current corrosion?
- What is the acceptable level of stray current specified in the latest editions of BS EN and NACE standards?
- How to predict stray current corrosion rate for various metals and alloys?
- How to calculate stray current corrosion rate for various metals and alloys?

Frequently Asked Questions on AC Corrosion:

- What is AC corrosion?
- How is AC corrosion different from stray current corrosion and other types of corrosion?
- How to tell if my corroded structure is really due to AC corrosion or stray current corrosion?
- What are the unique features in AC corrosion?
- How to identify AC corrosion?
- How to measure AC corrosion?
- How to assess AC corrosion risk?
- How does soil resistivity affect the AC corrosion risk?

- What international standards are relevant to the assessment of AC corrosion?
- What is the acceptable level of AC current specified in the latest editions of BS EN and NACE standards?
- What is the acceptable level of AC Voltage to remote earth specified in the latest editions of BS EN and NACE standards?
- What is the acceptable level of AC current to DC current ratio specified in the latest editions of BS EN and NACE standards?
- How to predict AC corrosion?

Overview and Application Examples of SC-Compass

Figures below show the screen shots of SC-Compass. There are 6 modules in SC-Compass for 6 groups of structures:

- Underground Pipelines,
- Rails,
- Rail Fasteners,
- Reinforced Concrete Structures,
- Boats/Ships/Vessels,
- Other Metallic Structures.

The main screen in SC-Compass has 5 zones:

- Zone 1: **Identification** of Stray Current Corrosion and AC Corrosion
- Zone 2: Image Representing the **Corroded Morphology**
- Zone 3: **Assessment and Prediction** of Stray Current Corrosion (BS EN 50162)
- Zone 4: Prediction of Stray Current **Corrosion Rate**
- Zone 5: Assessment and Prediction of **AC Corrosion** (BS EN 15280 / NACE SP21424)

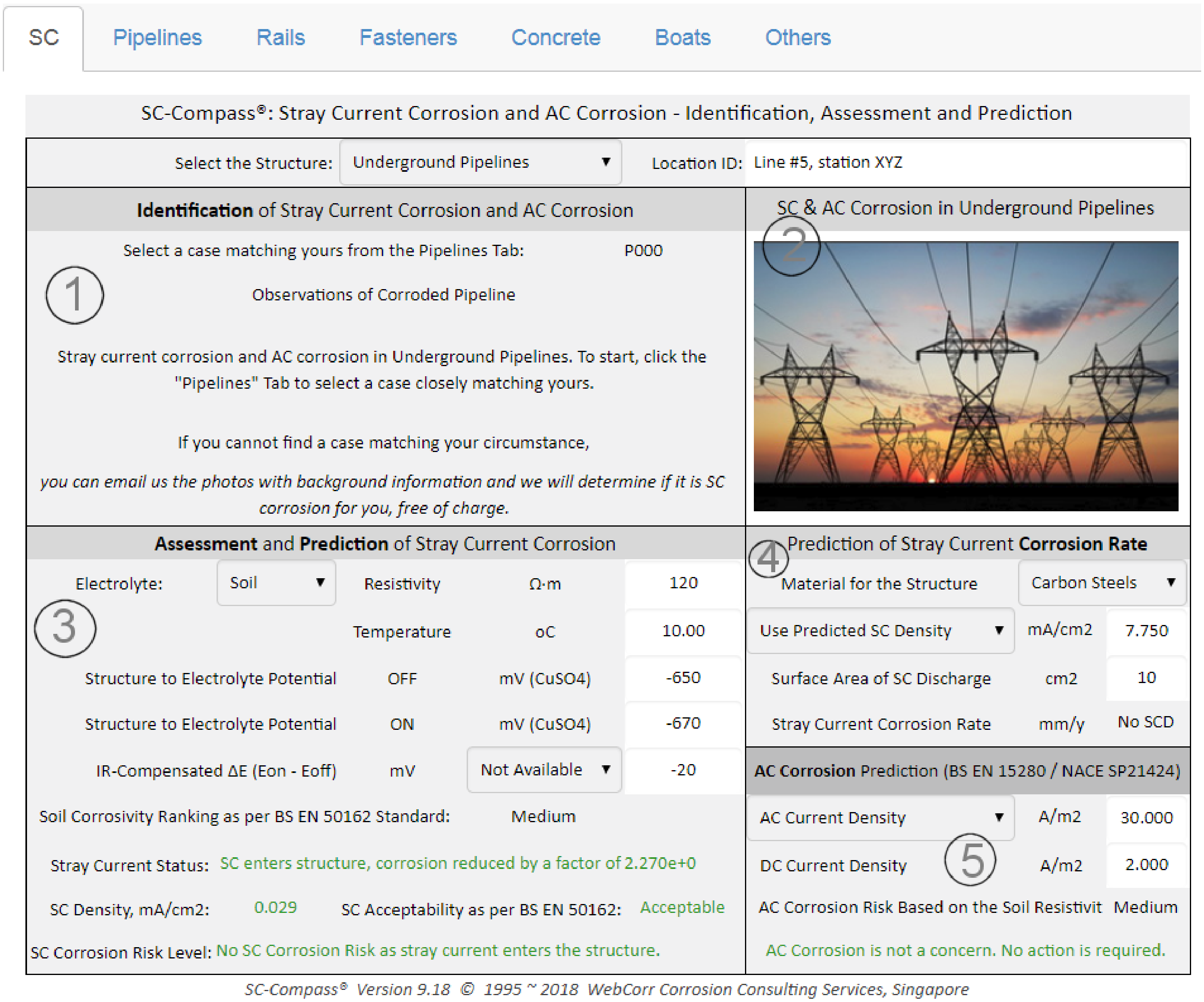


Figure 1 Overview of SC-Compass

Users of SC-Compass start by selecting the type of structure from the dropdown list:

Rails

Rail Fasteners

Reinforced Concrete Structures

Underground Pipelines

Boats, Ships and Vessels

Other Metallic Structures

After selecting the structure, users simply click the corresponding Tab and select a case from the built-in database that closely matches the users' circumstance based on the description and morphology of the corroded structure as demonstrated below.

Figure 2 shows the database under "Others" Tab for "Other Metallic Structures". An user selected a case closely matching his/her circumstance. Identification of stray current corrosion and AC corrosion, and relevant comments on the user selected case are displayed in Zone 1, with the representative image showing the corroded morphology displayed in Zone 2, as shown in Figure 3.

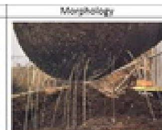
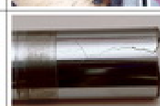
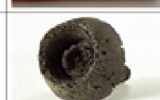
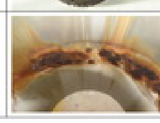
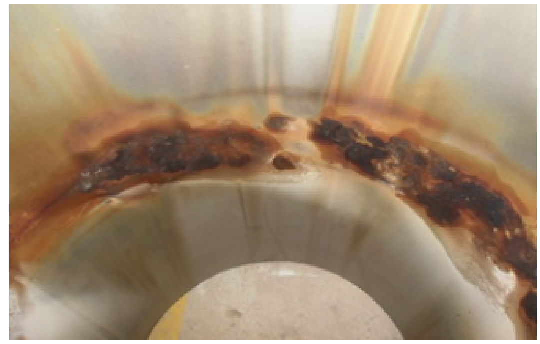
S/N	Description	Morphology	Additional Information
O001	Underground storage tank with multiple perforation. Visible rust all over the surface.		Not available
O002	Aluminium pump casing. Severe metal loss with smooth surface. No deposits at corroded site.		Not available
O003	Stainless steel pump shaft. Crack line visible. No rust or deposit on surface.		Not available
O004	Stainless steel (316) impeller cap in an electrolyte pump. Severe pitting over entire surface after only 3 months in service. No rust or deposit on surface.		Not available
O005	Duplex stainless steel pump casing. A cluster of pits covered with black deposit. Rust streaks visible.		Not available

Figure 2 Stray Current Corrosion and AC Corrosion Identification

SC | Pipelines | Rails | Fasteners | Concrete | Boats | Others

SC-Compass®: Stray Current Corrosion and AC Corrosion - Identification, Assessment and Prediction

Select the Structure: Other Metallic Structures ▼ Location ID: Line #5, station XYZ

Identification of Stray Current Corrosion and AC Corrosion	Morphology of Corroded Structure
Select a case matching yours from Others Tab: O005 Observations of Corroded Structure Duplex stainless steel pump casing. A cluster of pits covered with black deposit. Rust streaks visible. This is not Stray Current Corrosion. *Stray current corrosion is an electrolysis process and as such, it will not produce heavy rust scales, pinhole type pitting, or any form of cracking.*	

Assessment and **Prediction** of Stray Current Corrosion

Electrolyte:	Soil ▼	Resistivity	Ω·m	120
		Temperature	oC	10.00
Structure to Electrolyte Potential	OFF		mV (CuSO4)	-650
Structure to Electrolyte Potential	ON		mV (CuSO4)	-670
IR-Compensated ΔE (Eon - Eoff)	mV		Not Available ▼	-20

Soil Corrosivity Ranking as per BS EN 50162 Standard: Medium

Stray Current Status: SC enters structure, corrosion reduced by a factor of 2.270e+0

SC Density, mA/cm2: 0.029 SC Acceptability as per BS EN 50162: Acceptable

SC Corrosion Risk Level: No SC Corrosion Risk as stray current enters the structure.

Prediction of Stray Current **Corrosion Rate**

Material for the Structure		Carbon Steels ▼
Use Predicted SC Density ▼	mA/cm2	7.750
Surface Area of SC Discharge	cm2	10
Stray Current Corrosion Rate	mm/y	No SCD

AC Corrosion Prediction (BS EN 15280 / NACE SP21424)

AC Current Density ▼	A/m2	30.000
DC Current Density	A/m2	2.000
AC Corrosion Risk Based on the Soil Resistivit		Medium

AC Corrosion is not a concern. No action is required.

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Figure 3 Identification of Stray Current Corrosion and AC Corrosion for User Selected Case

SC-Compass determines that the selected case is NOT stray current corrosion and displays comment on this case:

"Stray current corrosion is an electrolysis process and as such, it will not produce heavy rust scales, pinhole type pitting, or any form of cracking."

If an user cannot find a case closely matching his/her own situation in the database, the user can email the photos with background information to WebCorr. Our NACE certified Corrosion Specialists will then examine the photos and analyze the information to determine if it is stray current corrosion or AC corrosion. This consulting service is free of charge to licensed users of SC-Compass during the entire licensing period. The savings in consulting fee can be worth many times of the license fee.

Assessment and prediction of stray current corrosion in SC-Compass are carried out in accordance with relevant international standards such as BS EN 50162 for DC stray current corrosion, and BS EN 15280/NACE SP21424 standards for AC corrosion.

In Zone 3, users need to select the electrolyte from the dropdown list: Soil, Water, Concrete.
The electrical resistivity (in the unit of Ω.m) of the selected electrolyte is then entered.
The structure to electrolyte potentials with respect to a copper sulphate reference electrode are required to assess the stray current status, stray current corrosion risk level and stray current acceptability as per BS EN 50162 standard.

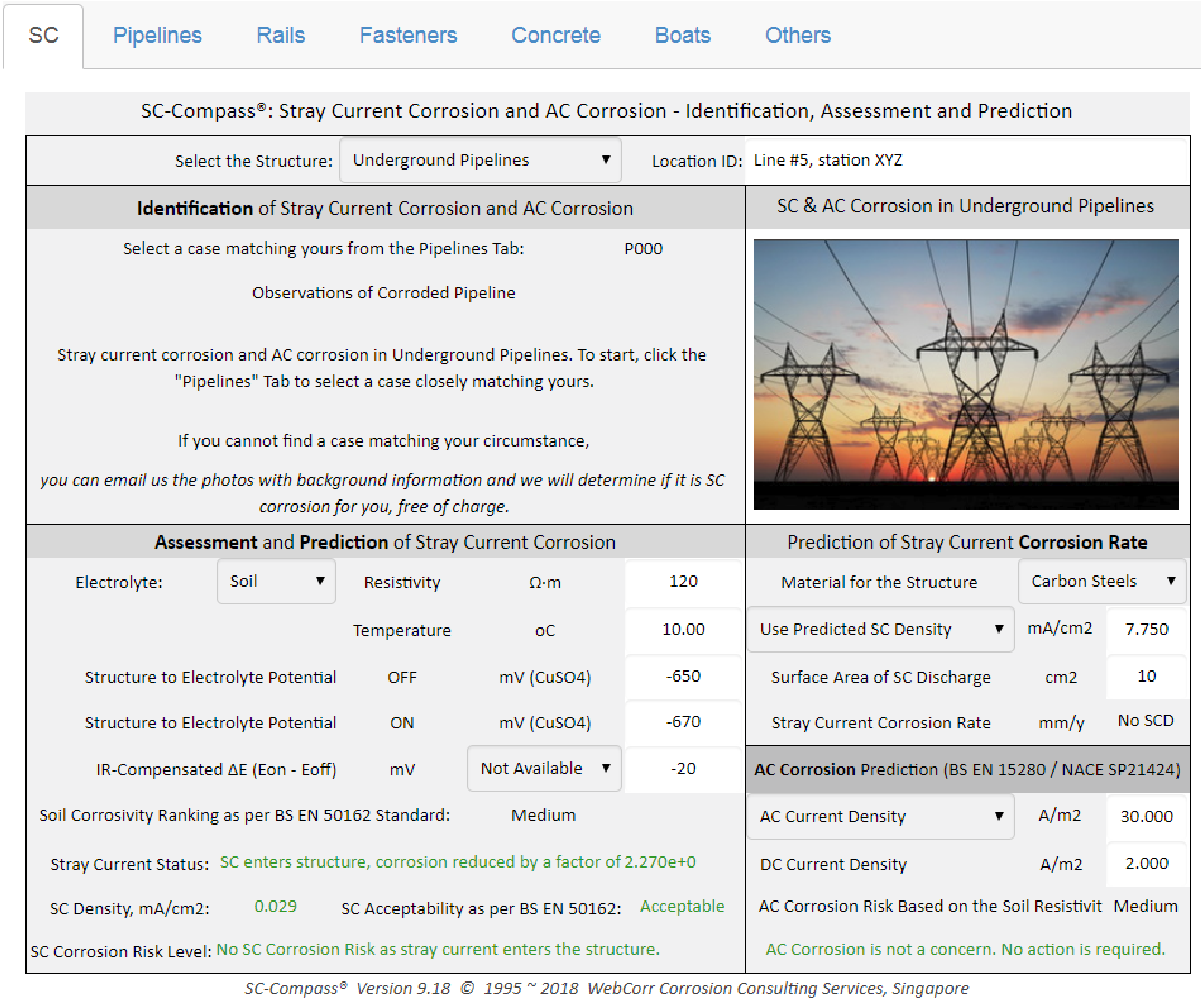

Figure 3 Stray Current Corrosion and Assessment and Prediction

In Figure 3 above, an user entered the following values as inputs:

Soil resistivity: 120 Ω.m

Temperature: 10oC

Structure to electrolyte potential (OFF): -650 mV

Structure to electrolyte potential (ON): -550 mV

IR-compensated potential shift ΔE: Not Available (if set to "Available", the entered value will be used for the assessment)

Based on the user inputs, SC-Compass predicts that stray current is entering the structure and reducing the corrosion rate by a factor of 2.27. SC-Compass also computes the amount of stray current in the structure and this is determined to be 0.029 mA/cm2.

The stray current acceptability as per BS EN 50162 is determined to be "Acceptable" and the stray current corrosion risk level is determined to be "No SC Corrosion Risk as stray current enters the structure".

In Zone 4, the stray current corrosion rate prediction shows "No SCD", - meaning "No Stray Current Discharge" and therefore no stray current corrosion. Stray current corrosion ONLY occurs at the point of discharge. At the point of entry, there is no corrosion.

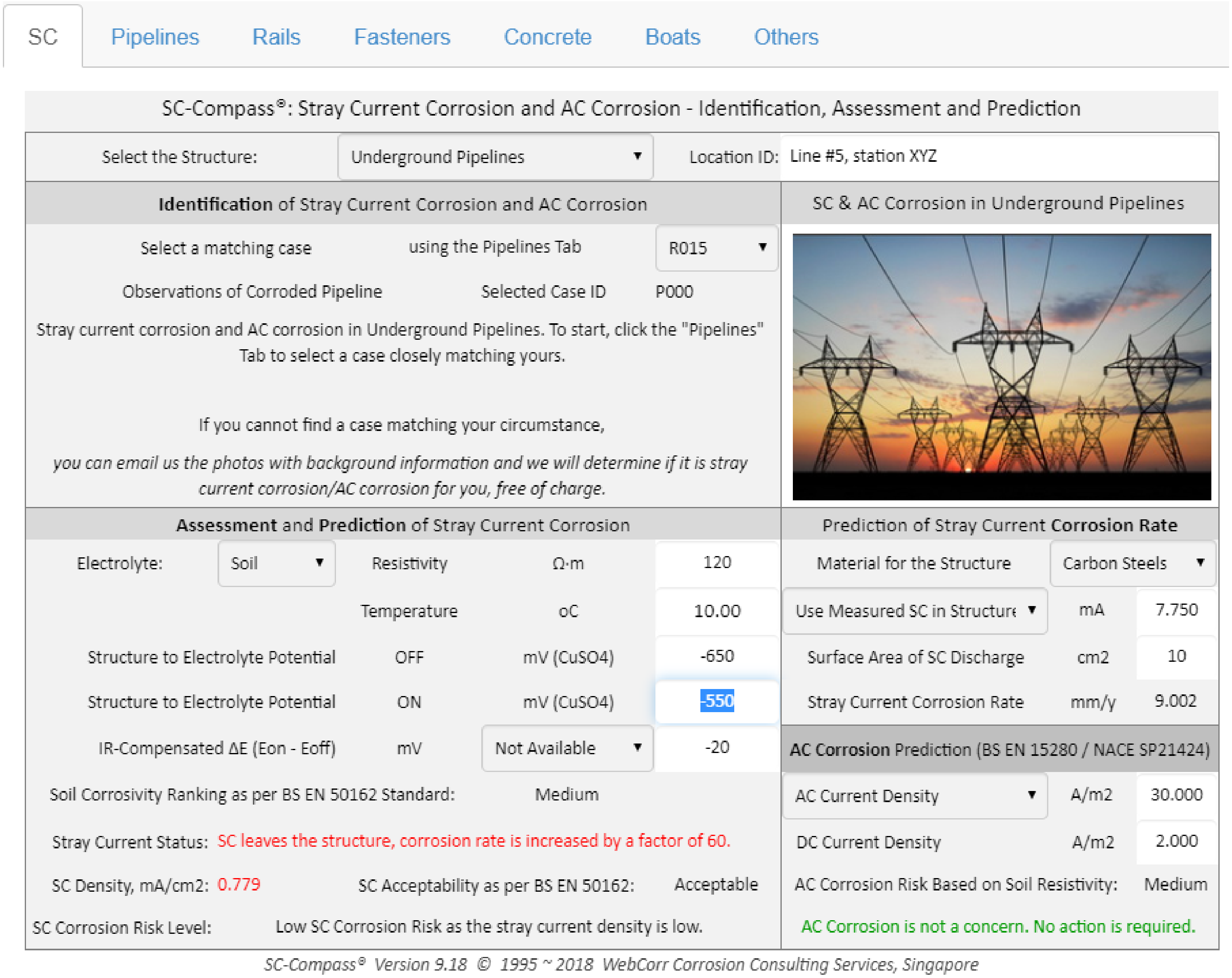

Figure 4a Stray Current Corrosion Rate Calculation from Predicted SC Density

Note that in Zone 3 of Figure 4a above, the input for Structure to Electrolyte potential (ON) has changed to "-550", as a result, SC-Compass predicts that stray current is leaving the structure and increasing the corrosion rate by a factor of 60.29. The amount of stray current is predicted to be 0.779 mA/cm2.

Zone 4 is for the prediction of stray current **Corrosion Rate**.

For the inputs parameters shown in Figure 4a, the stray current corrosion rate predicted by SC-Compass is 9.044 mm per year for carbon steels. If an user measured the stray current in the structure and the surface area over which the stray current discharges, the measured data can be entered for the calculation of the stray current corrosion rate by selecting "Use Measured SC in Structure" from the dropdown list, as shown in Figure 4b below. Here, the user enter "7.750" mA as measured stray current in the structure and "10" cm2 as the surface area over which the stray current discharges. The calculated corrosion rate based on the measured data is 9.002 mm per year.

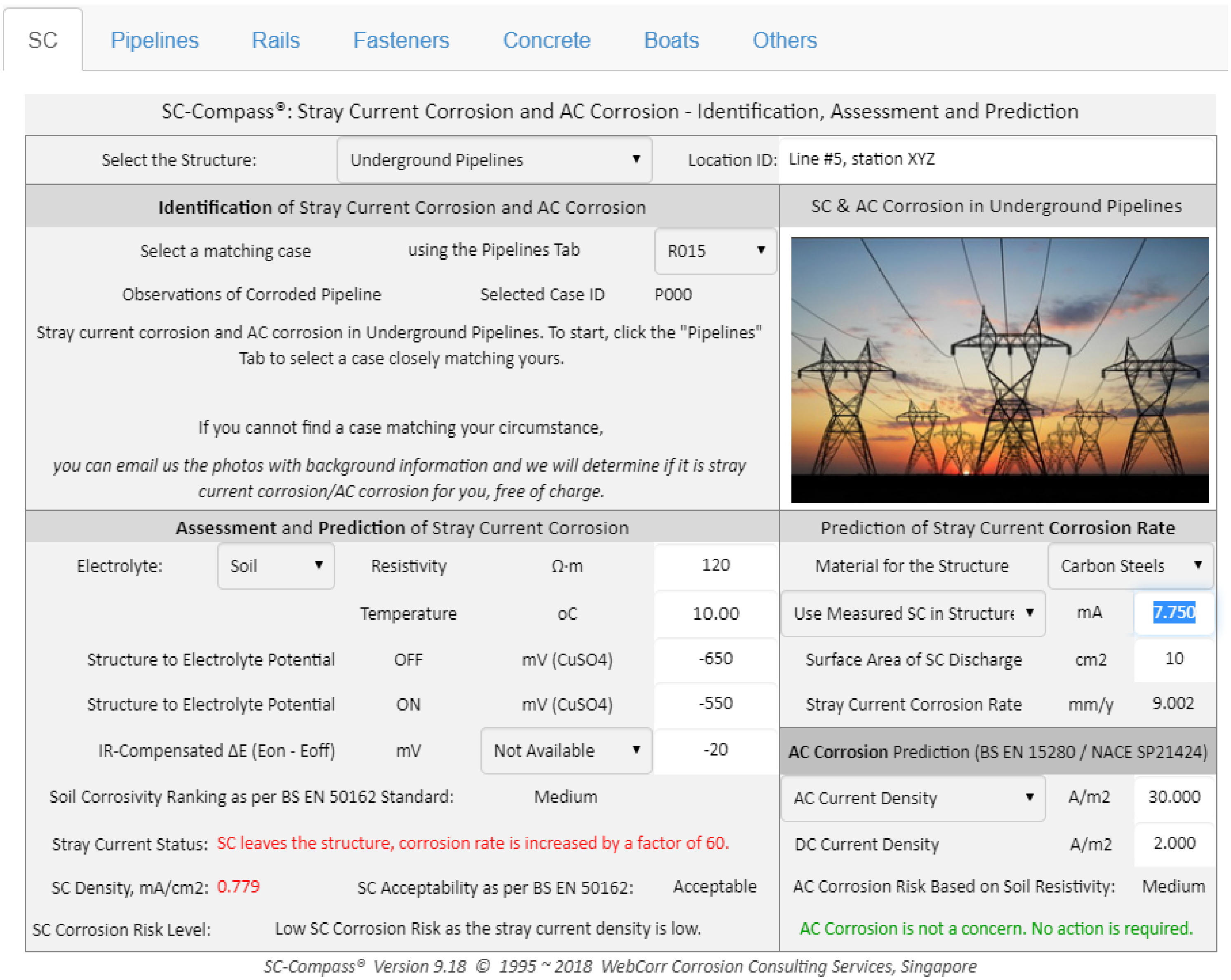

Figure 4b Stray Current Corrosion Rate Calculation from Measured Stray Current

The stray current corrosion rate in mm per year is computed for about 200 metals and alloys (Figure 4c). If you cannot find the metal or alloy in the database, email us the grade of your alloy and we will update the database within 24 hours after receiving your request.

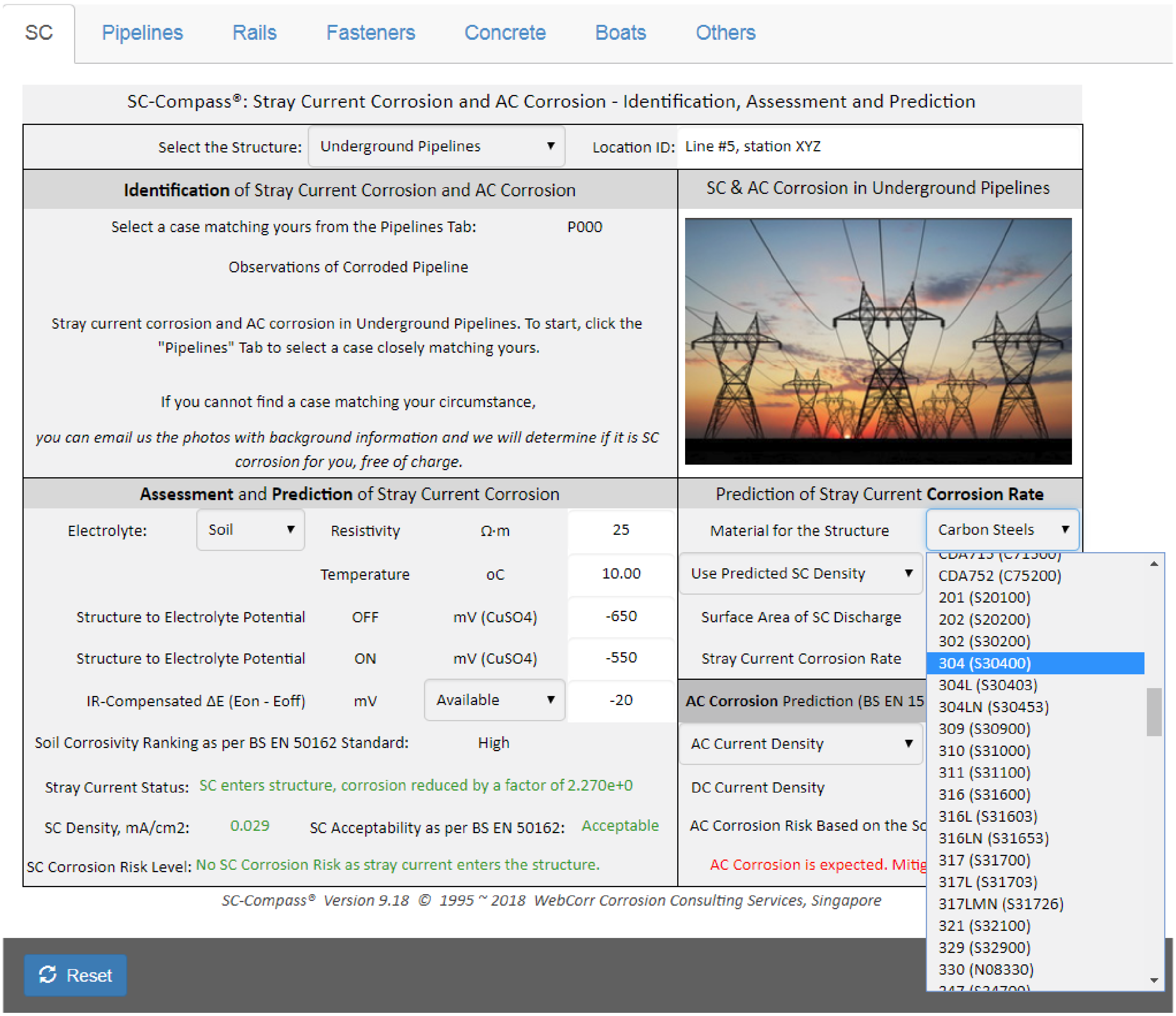

Figure 4b Stray Current Corrosion Rate Calculation from Measured Stray Current

Zone 5 is for **AC Corrosion** Prediction and Assessment

For underground pipelines under the influence of induced AC current, the risk of AC corrosion is assessed in accordance with the latest editions of BS EN 15280 and NACE SP 21424 standards. In

Zone 5, users can select either AC current density or AC voltage with respect to remote earth from the dropdown list (Figure 5a) for assessment and prediction of AC corrosion. The DC current density is required only if users selected "AC current density" from the dropdown list as the assessment criteria (Figure 5b). SC-Compass takes into consideration of the AC current density to DC current density ratio as per BS EN and NACE standards.

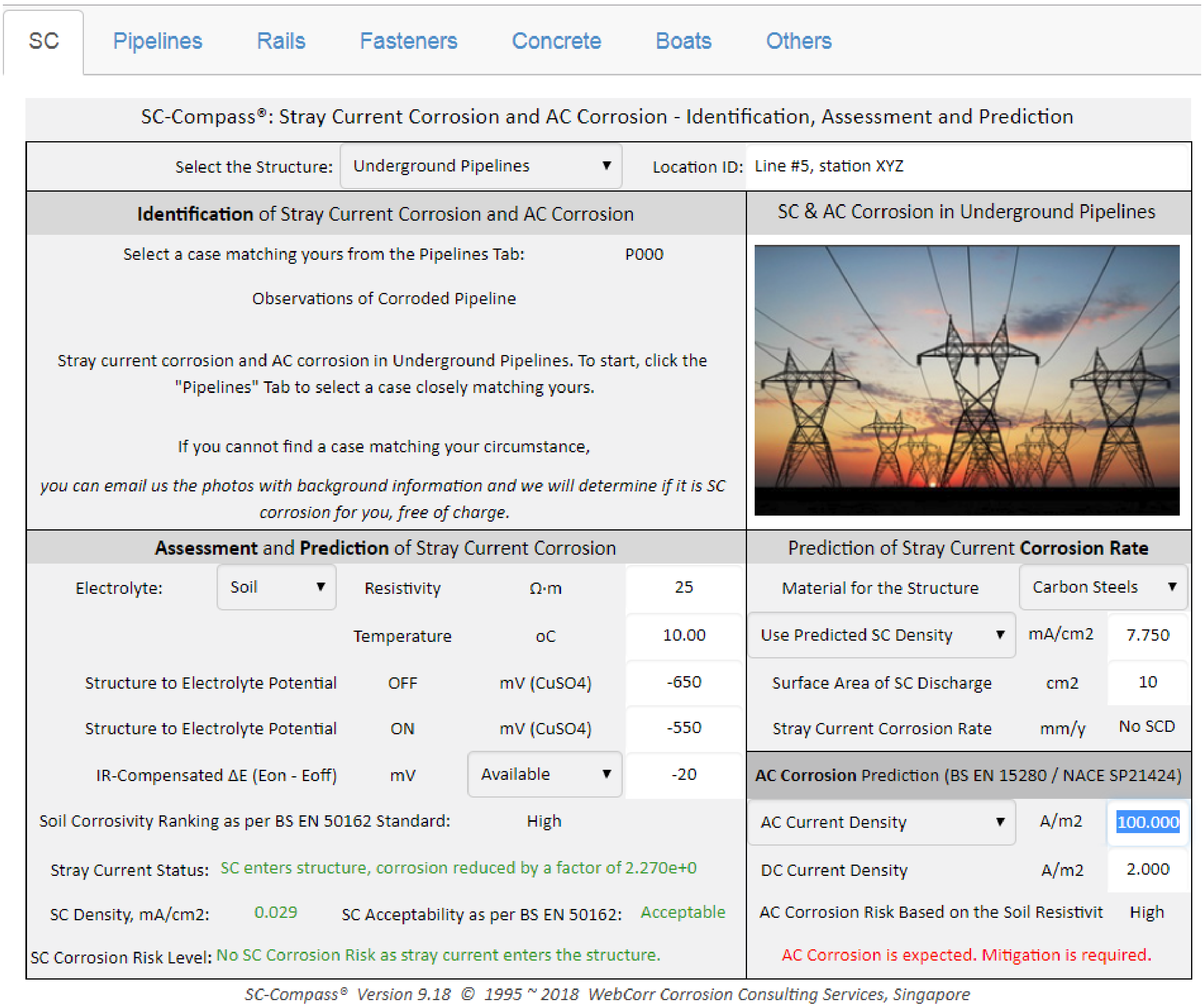

Figure 5a Assessment and Prediction of AC Corrosion Using AC Current Density and DC Current Density

SC | Pipelines | Rails | Fasteners | Concrete | Boats | Others

SC-Compass®: Stray Current Corrosion and AC Corrosion - Identification, Assessment and Prediction

Select the Structure: Underground Pipelines ▼ Location ID: Line #5, station XYZ

Identification of Stray Current Corrosion and AC Corrosion	SC & AC Corrosion in Underground Pipelines
Select a case matching yours from the Pipelines Tab: P000 Observations of Corroded Pipeline Stray current corrosion and AC corrosion in Underground Pipelines. To start, click the "Pipelines" Tab to select a case closely matching yours. If you cannot find a case matching your circumstance, *you can email us the photos with background information and we will determine if it is SC corrosion for you, free of charge.*	

Assessment and **Prediction** of Stray Current Corrosion

Electrolyte: Soil ▼	Resistivity	Ω·m	120
	Temperature	oC	10.00
Structure to Electrolyte Potential	OFF	mV (CuSO4)	-650
Structure to Electrolyte Potential	ON	mV (CuSO4)	-550
IR-Compensated ΔE (Eon - Eoff)	mV	Available ▼	-20

Soil Corrosivity Ranking as per BS EN 50162 Standard: Medium

Stray Current Status: SC enters structure, corrosion reduced by a factor of 2.270e+0

SC Density, mA/cm2: 0.029 SC Acceptability as per BS EN 50162: Acceptable

SC Corrosion Risk Level: No SC Corrosion Risk as stray current enters the structure.

Prediction of Stray Current **Corrosion Rate**

Material for the Structure		Carbon Steels ▼
Use Predicted SC Density ▼	mA/cm2	7.750
Surface Area of SC Discharge	cm2	10
Stray Current Corrosion Rate	mm/y	No SCD

AC Corrosion Prediction (BS EN 15280 / NACE SP21424)

AC Voltage to Remote Earth ▼	Volt	20.000
AC Current Density AC Voltage to Remote Earth	A/m2	2.000
AC Corrosion Risk Based on the Soil Resistivit		Medium

AC Corrosion is possible but uncertain.

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Figure 5b Assessment and Prediction of AC Corrosion Using AC Voltage to Remote Earth

The powerful applications of SC-Compass in rail transit systems, civil structures, underground pipelines, boats, ships and vessels are truly unlimited in engineering design, materials evaluation and selection, remaining life prediction, trouble-shooting and failure analysis. Contact us for licensing details.

SC-Compass, giving you the right directions in Managing Stray Current Corrosion