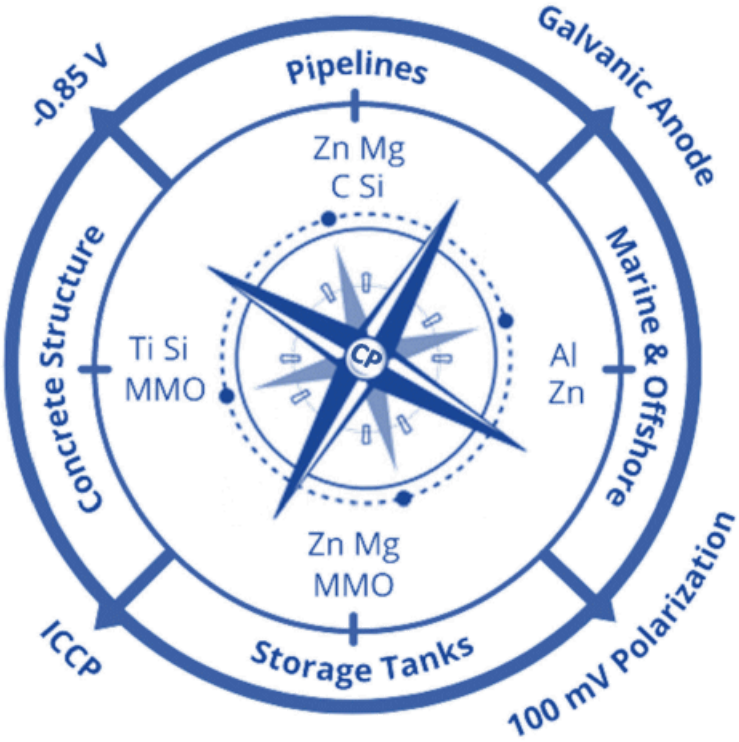


Corrosion Modeling Software and Corrosion Prediction Software Series

CP-Compass®: Cathodic Protection Design, Verification & Assessment

Version 12.4

★ **Performance** ★ **Functionality** ★ **Usability**

Anytime Anywhere Any Device Any OS

No USB dongles No installation No Browser Plug-ins

Contact Us for Licensing Details

CP-Compass has the following standalone modules:

- **CP-Compass-Underground Pipelines**
- **CP-Compass-Submarine Pipelines**
- **CP-Compass-Platforms**
- **CP-Compass-FPSO**
- **CP-Compass-Well Casing**
- **CP-Compass-Jetty Piles**
- **CP-Compass-Storage Tanks**
- **CP-Compass-Concrete Structures**
- **CP-Compass-Condensers & Heat Exchanger**
- **CP-Compass-Customized for Special Needs**

Design calculations in CP-Compass modules are in compliance with internationally accepted codes and standards such as AS 2239, AS 2832, BS EN ISO 12696, BS EN 12473, BS ISO 15589, DNV-RP-B401, DNV-RP-F103, NACE SP0169, and NACE SP0176.

Unparalleled Functionality: CP-Compass is not just for CP design and verification of CP design calculations by 3rd party contractors, it also gives you tools to assess the actual level of cathodic protection achieved (corrosion rate reduction factor) and to predict the corrosion rate of the structure WHEN CP IS ON! Refer to the screen shot below for details.

Unmatched Usability: CP-Compass was designed with the user in mind. Experience the industry's first cross-platform and device-independent Cathodic Protection Design, Verification and Assessment application on your iPads, tablets, smart phones, notebooks and desktops, at any time and anywhere, in the office or in the field. No installation files to download, no browser plug-ins required, no USB dongles to carry around, and no license keys to transfer from one PC to another. **CP-Compass simply works on any device running any OS**. All you need is an internet browser.

A Brief Overview of CP-Compass-Underground Pipelines

Galvanic Anode CP | ICCP | Corrosion Rate | Tools

Design Calculation for Galvanic Anode Cathodic Protection of Buried Pipelines Version 12.4.8

Client:	Enter client info		PO#201706
Project:	Enter project title for reference		25-Jan-2010
Design Life, year	20	Anode Material	Zn
Steel Grade	API X65	Anode Potential, V(CSE)	-1.100
Pipe OD, mm	273.10	Driving Voltage, V	0.250
Pipe Length, m	30,000	Anode Length (packaged), mm	1,549
Pipe Surface Area, m^2	25,739	Anode Diameter (packaged), mm	152
Coating Breakdown Factor	5%	Anode Weight (Bare), kg	14.500
Soil Resistivity, Ω.cm	1,500	Anode Consumption Rate, kg/A-y	10.76
Design Current Density, mA/m^2	22.0	Current Efficiency	0.90
Protection Potential, V(CSE)	-0.850	Utilization Factor	0.85
CP Current and Anode Weight Requirements			
CP Current Required, A	28.313	Total Anode Weight Required, kg	7,965
		Number of Anode by Weight	549.3
Anode Current Output		Vertical Installation	
Anode to Earth Resistance, Ω	5.242	Single Anode Current Output, mA	47.696
Anode Burial Depth, cm	200	Number of Anodes by Current	593.6
Number of Anodes Selected	**594**	Calculated Anode Life, year	**22**

The number of anodes selected meets the design life requirement.

Figure 1 Galvanic anode cathodic protection design and verification using CP-Compass software

Galvanic Anode CP Design and Verification

Unlike other cathodic protection design software developed by computer programmers that requires users to be trained as an application specialist in order to operate the software, WebCorr's CP-Compass software was developed by corrosion engineers for corrosion engineers with no learning curve required. With CP-Compass, designing a cathodic protection system or verifying a CP design by a 3rd party contractor is as easy as 1-2-3:

1. Enter the design parameters (items in the above screen shot).
2. Choose the anode from the dropdown list.
3. The number of anode required, the the anode life, and system design life are automatically determined and verified.

Impressed Current CP Design and Verification

Advanced features of CP-Compass for impressed current cathodic protection design and verification include:

1. calculation of cathodic protection current requirement based on attenuation,
2. calculation of the number of stations and the spacing between stations,
3. calculation of the CP current requirement per station with plots showings potential attenuation and current attenuation,
4. anode selection and groundbed design,
5. rectifier output rating
6. calculation of the separation distance between the anode groundbed and the pipeline with a plot showing the percent of voltage rise vs. distance from anode groundbed,
7. recommended separation distance between the anode groundbed and the pipeline

Impressed Current CP design and verification are shown in the screen shot below:

Galvanic Anode CP | ICCP | Corrosion Rate | Tools

Design Calculation for Impressed Current Cathodic Protection of Buried Pipelines Version 12.4.8

Client:	Enter client or company info				PO#201706
Project:	Enter project title or reference				25-Jan-10
Design Life, yrs	20.000	Soil Resistivity, Ω.cm	1,500	Natural Corrosion Potential, V(CSE)	-0.500
Pipe Steel Grade	API X65	Coating Type	FBE	Min. Protection Potential, V(CSE)	-0.850
Steel Resistivity, Ω.m	1.850e-007	Coating Resistance, Ω.m^2	4,000	Max. Protection Potential, V(CSE)	-1.500
Pipeline Length, km	1,070.000	Coating Breakdown Factor	1.0%	Attenuation Constant	7.211e-5 /m
Pipe OD, m	0.762	Design Current Density, mA/m^2	0.100	Current from E-Logl Test?	Yes
Pipe Wall Thickness, mm	9.00	Total Surface Area, m^2	2,561,466	Enter the Current (A) if Yes	36.000
Pipe Linear Resistance	8.689e-6 Ω/m	CP Current Required	256.147 A	This option can be used for what-if senarios	

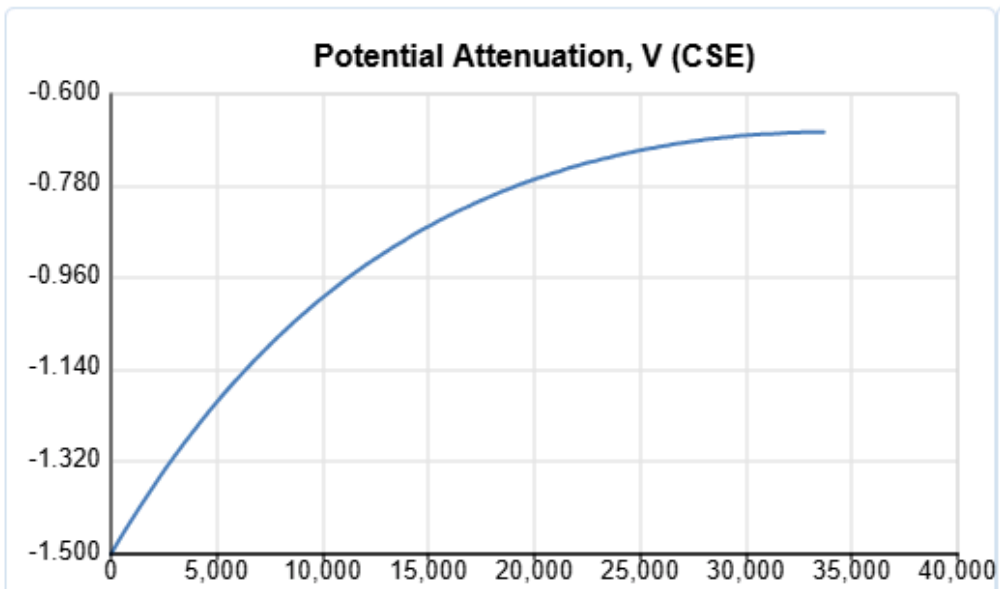
1. Total CP Current Based on the Specified Design Current Density 256 A — CP Current per Station 15 A

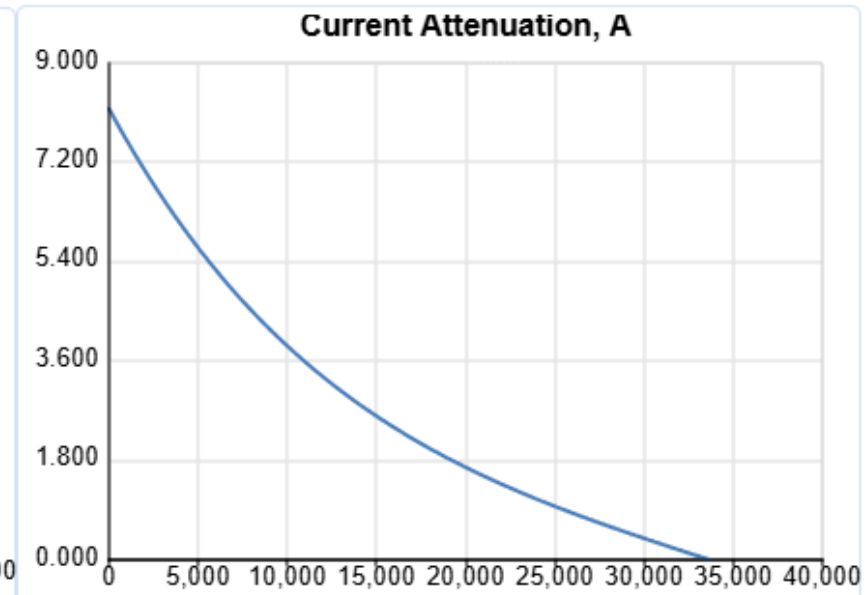
2. Calculation of Protection Current Requirement Based on Attenuation

One Way of An Infinite Pipeline			One Way To A Mid-Point Between 2 Drain Points		
Protected Length One Side	m	23,724	Protected Length One Side	m	33,674
Protection Current One Side	A	7.774	Protection Current One Side	A	8.171
Resulting Current Density	mA/m^2	0.137	Resulting Current Density	mA/m^2	0.101

3. Number of Stations and Spacing Between Stations

No of Stations Required	2	Located at	23,700 m	from each pipe end	Current per Station 16 A
No of Stations Required	15	Spaced at	63,700 m	along the pipeline	Current per Station 16 A
Total No of Stations	17	One Way To Mid-Point Between 2 Drain Points			Total Current Required 272 A





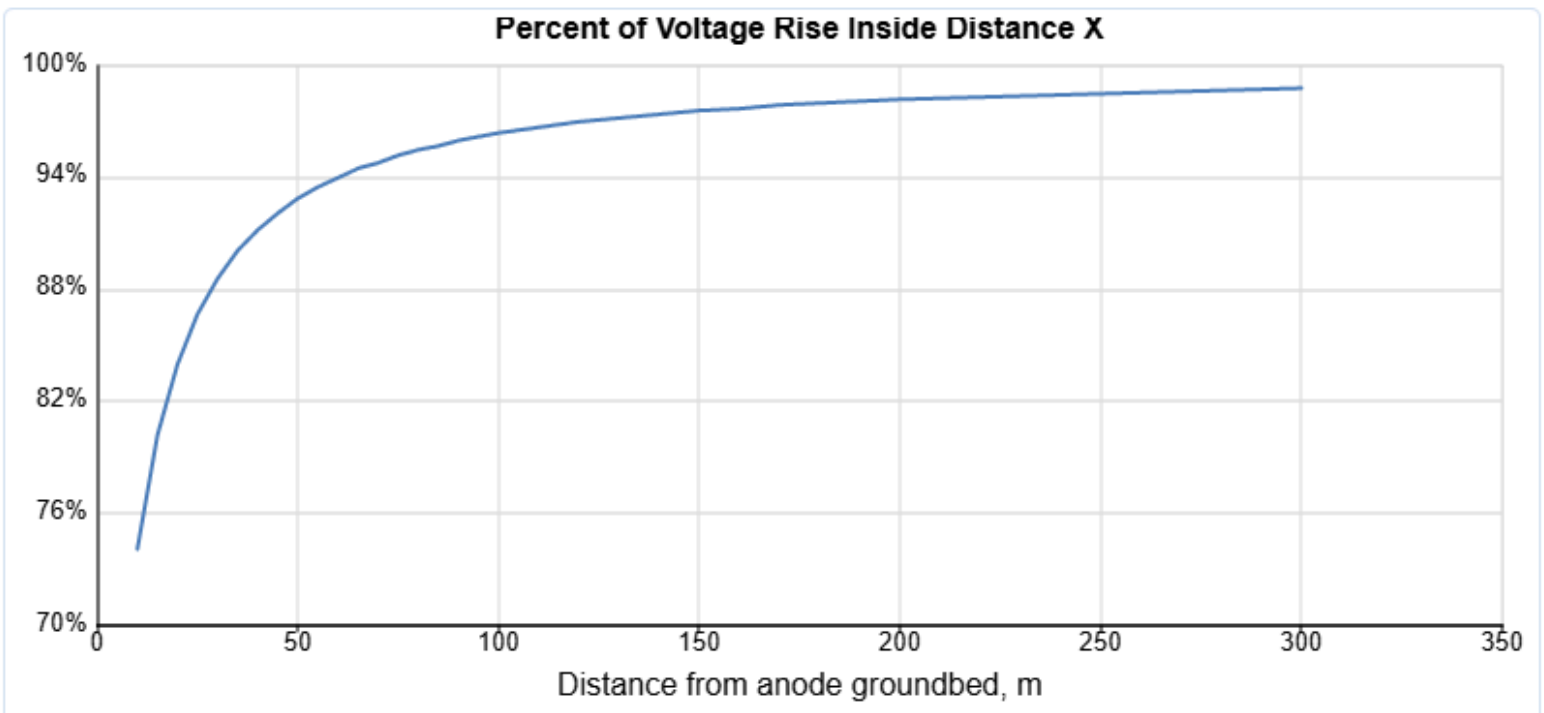
4. Selection of CP Current (per station) Based on: Attenuation — 16 A — Extra Capacity (%): 0%

5. Anode Selection and Groundbed Design

Design Life	yrs	20	**Anode Material Selected**		HSCI
Total Capacity Required	A-y	320.000	*Net Weight of Single Anode*	*kg*	14.300
Single Anode Output	A	5.000	*Anodes Consumption Rate*	*kg/A-y*	0.227
Single Anode Capacity	A-y	47.247	*Anode Utilization Factor*		0.75
If not known, enter data on the right to calculate =>			*Single Anode Capacity*	*A-y*	47.247
Number of Anodes Required		6.77	The number of anodes selected meets the design life requirement.		
Number of Anodes Selected:		7	Current Output: 16.536 A		System Life: 21 yrs

Shallow Anode Groundbed Design		Vertical	Deep Well Anode Groundbed Design		
Anode Length (incl. backfill)	cm	243.84	**Groundbed Diameter**	cm	20.00
Anode Diameter (incl. backfill)	cm	30.48	**Coke Consumption Rate**	kg/A-y	0.9988
Anode Spacing	cm	500.00	**Coke Utilization Factor**		0.50
Anode Burial Depth	cm	200.00	Coke Length by Consumption	m	20.35
Single Anode Resistance	Ω	3.093	Coke Length by Current Limit	m	16.45
Groundbed Resistance	Ω	0.650	Coke Column Length Selected	m	21
Pipe Resistance to Earth	Ω	0.061	Anode Spacing	cm	300
Cable Resistance per km	Ω/km	0.833	Groundbed Drilling Depth	m	41
Cable Length	m	150	Pipe Resistance to Earth	Ω	0.061
Cable Resistance	Ω	0.125	Groundbed Resistance	Ω	0.652
Total Circuit Resistance	Ω	0.836	Total Circuit Resistance	Ω	0.838
Rectifier Output Rating			Rectifier Output Rating		
Back Voltage	V	2.000	Back Voltage	V	2.000
TR Voltage Output Rating	V	16	TR Voltage Output Rating	V	16
TR Current Output Rating	A	17	TR Current Output Rating	A	17

6. Separation Distance of Anode Groundbed from Pipeline



Distance from the Anode Groundbed	X	m	50
Voltage Drop at Distance X from anode	V_X	V	0.238
Voltage drop over 1 m at X_{min} from anode	V_d	mV	5.000
Min Distance of Anode to Pipeline	X_{min}	m	87.404
Recommended Separation Distance of Anode Groundbed from Pipeline		m	90

Figure 2 Impressed current cathodic protection design and verification using CP-Compass software

Current and potential attenuation are calculated automatically to give you the most realistic estimation of the number of anode groundbeds required (see plots under Section 3 in Figure 2).

The separation distance between the anode groundbed and the structure is automatically optimized based on the user specified acceptable voltage drop (see plot under Section 6 in Figure 2).

The corrosion rate of the structure when CP is on can be calculated based on the polarization measurements, as shown in the screen shot below:

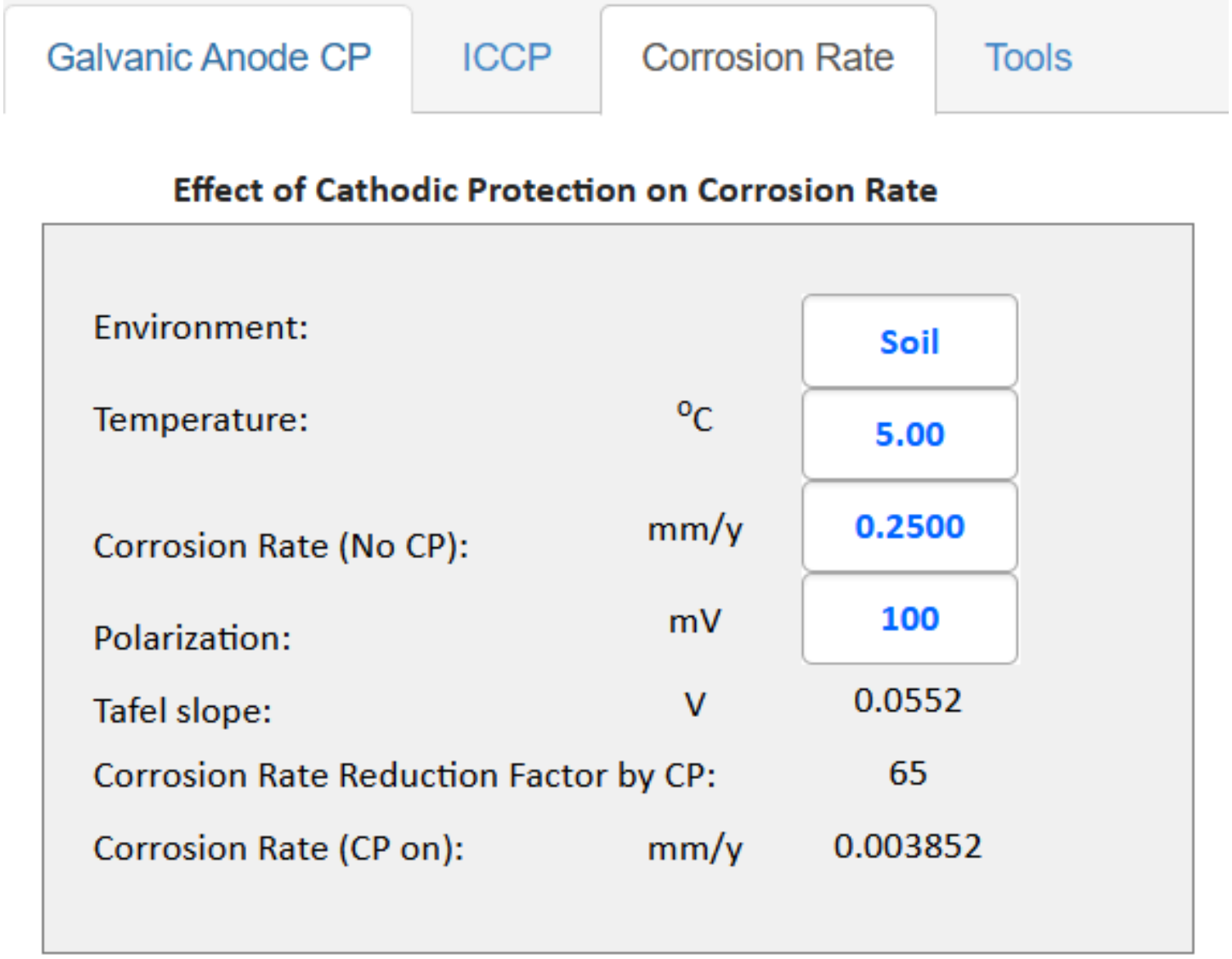


Figure 3 Assessing the degree of CP protection using CP-Compass software

This unique function not found in any other CP design software allows users of CP-Compass to assess the degree of CP protection on an existing structure based on the CP survey results (the polarization data). It also allows the designer to set the CP criteria (e.g., 100 mV or 150 mV) to meet the corrosion rate target when CP is on.

The "Tools" menu in CP-Compass allows users to perform design calculations for any CP system for any structure.

Relative Values of Typical Reference Electrodes to Copper-Copper Sulfate Reference Electrode

Electrode (Half - Cell)	Name	Potential (Volts)
Copper - Copper Sulfate (Cu-Cu SO4)	CSE	0
Silver - Silver Chloride (Saturated)	Ag-AgCl	-0.05
Saturated Calomel	SCE	-0.07
Zinc (Pure Zinc)	Zn	-1.1

Sacrificial Anode Efficiency and Utilization Factor

Magnesium :

$$L_M = \frac{C_a * W * E * U_F}{I}$$

Ca = Electrochemical Capacity (A-y/kg)	Ca =	0.250
W = Weight of Anode (kg)	W =	109.000
E = Current Efficiency	E =	0.5
U_F = Utilization Factor	U_F =	0.85
I = Total Protection Current (amps)	I =	2.000
L_M = Life of Magnesium Anode (yrs)	L_M =	**5.791 yrs**

Figure 4 CP-Compass software has tools for users to perform design calculations for any CP system for any structure.

Click here to contact us for licensing details and experience the power of CP-Compass.

CP-Compass, giving you the right directions in the design and operation of cathodic protection.