



AMERICAN PETROLEUM INSTITUTE

---

# API Recommended Practice 651

## Cathodic Protection of Aboveground Petroleum Storage Tanks

FOURTH EDITION | SEPTEMBER 2014 | 46 PAGES | \$125.00 | PRODUCT NO. C65104

---

The purpose of this recommended practice (RP) is to present procedures and practices for achieving effective corrosion control on aboveground storage tank bottoms through the use of cathodic protection. This RP contains provisions for the application of cathodic protection to existing and new aboveground storage tanks. Corrosion control methods based on chemical control of the environment or the use of protective coatings are not covered in detail.

When cathodic protection is used for aboveground storage tank applications, it is the intent of this RP to provide information and guidance specific to aboveground metallic storage tanks in hydrocarbon service. Certain practices recommended herein may also be applicable to tanks in other services. It is intended to serve only as a guide to persons interested in cathodic protection. Specific cathodic protection designs are not provided. Such designs should be developed by a person thoroughly familiar with cathodic protection practices for aboveground petroleum storage tanks.

This RP does not designate specific practices for every situation because the varied conditions in which tank bottoms are installed preclude standardization of cathodic protection practices.

For ordering information:

Online: [www.api.org/pubs](http://www.api.org/pubs)

Phone: 1-800-854-7179  
(Toll-free in the U.S. and Canada)

(+1) 303-397-7056  
(Local and International)

Fax: (+1) 303-397-2740

API members receive a 30% discount where applicable.

# Contents

	Page
<b>1</b>	<b>Scope . . . . . 1</b>
<b>2</b>	<b>Normative References. . . . . 1</b>
<b>2.1</b>	<b>Standards, Codes, Publications, and Specifications . . . . . 1</b>
<b>2.2</b>	<b>Other References. . . . . 3</b>
<b>3</b>	<b>Terms and Definitions. . . . . 3</b>
<b>4</b>	<b>Corrosion of Aboveground Steel Storage Tanks. . . . . 8</b>
<b>4.1</b>	<b>Introduction . . . . . 8</b>
<b>4.2</b>	<b>Corrosion Mechanisms. . . . . 9</b>
<b>4.3</b>	<b>Internal Corrosion . . . . . 11</b>
<b>5</b>	<b>Determination of Need for Cathodic Protection. . . . . 11</b>
<b>5.1</b>	<b>Introduction . . . . . 11</b>
<b>5.2</b>	<b>Tank History . . . . . 12</b>
<b>5.3</b>	<b>Tank Pad and Soil Conditions . . . . . 14</b>
<b>5.4</b>	<b>Other Factors Affecting Cathodic Protection. . . . . 18</b>
<b>6</b>	<b>Methods of Cathodic Protection for Corrosion Control . . . . . 19</b>
<b>6.1</b>	<b>Introduction . . . . . 19</b>
<b>6.2</b>	<b>Galvanic Systems . . . . . 19</b>
<b>6.3</b>	<b>Impressed Current Systems. . . . . 21</b>
<b>7</b>	<b>Design of Cathodic Protection Systems. . . . . 23</b>
<b>7.1</b>	<b>Introduction . . . . . 23</b>
<b>7.2</b>	<b>Influence of Replacement Bottoms, External Liners (Release Prevention Barriers), and Secondary Containment on Cathodic Protection System Design . . . . . 24</b>
<b>7.3</b>	<b>External Cathodic Protection. . . . . 27</b>
<b>7.4</b>	<b>Internal Cathodic Protection . . . . . 32</b>
<b>8</b>	<b>Criteria for Cathodic Protection. . . . . 33</b>
<b>8.1</b>	<b>Introduction . . . . . 33</b>
<b>8.2</b>	<b>Protection Criteria . . . . . 33</b>
<b>8.3</b>	<b>Measurement Techniques . . . . . 34</b>
<b>8.4</b>	<b>Alternative Reference Electrodes . . . . . 35</b>
<b>9</b>	<b>Installation of Cathodic Protection Systems . . . . . 35</b>
<b>9.1</b>	<b>Introduction . . . . . 35</b>
<b>9.2</b>	<b>Galvanic Anode Systems . . . . . 35</b>
<b>9.3</b>	<b>Impressed Current Systems. . . . . 36</b>
<b>9.4</b>	<b>Corrosion Control Test Stations, Undertank Monitoring Methods, and Bonds . . . . . 39</b>
<b>10</b>	<b>Interference Currents . . . . . 42</b>
<b>10.1</b>	<b>Introduction . . . . . 42</b>
<b>10.2</b>	<b>Sources of Interference Currents . . . . . 42</b>
<b>10.3</b>	<b>Detection of Interference Currents . . . . . 42</b>
<b>10.4</b>	<b>Control of Interference Currents . . . . . 42</b>
<b>11</b>	<b>Operation and Maintenance of Cathodic Protection Systems. . . . . 43</b>
<b>11.1</b>	<b>Introduction . . . . . 43</b>
<b>11.2</b>	<b>Safety . . . . . 43</b>
<b>11.3</b>	<b>Cathodic Protection Surveys . . . . . 44</b>
<b>11.4</b>	<b>Cathodic Protection Records. . . . . 45</b>

# Contents

Page

## Figures

1	Electrochemical Corrosion Cell . . . . .	8
2	Oxygen Concentration Cell Caused by Rocks or Clay in Tank Pad . . . . .	9
3	Example of Stray Current Corrosion of an Unprotected Tank Bottom . . . . .	10
4	Galvanic Corrosion . . . . .	11
5	Cathodic Protection with Galvanic Anodes . . . . .	20
6	Impressed Current Cathodic Protection . . . . .	22
7	Impervious External Liner Beneath Aboveground Storage Tank . . . . .	24
8	New Steel Bottom on Top of Old Bottom . . . . .	26
9	Current Requirement Test Setup . . . . .	31
10	Potential Measurement Schematic . . . . .	34
11	Typical Galvanic Anode Installation . . . . .	36
12	Typical Shallow Anode Bed Installation . . . . .	37
13	Commonly Installed Deep Anode Bed . . . . .	38
14	Permanently Installed Reference Electrode and Test Station . . . . .	40
15	Perforated Pipe Installed for Reference Electrode . . . . .	41

## Tables

1	General Classification of Resistivity . . . . .	15
2	Partial Galvanic Series . . . . .	20
3	Commonly Used Reference Electrodes . . . . .	35
4	Permanently Reference Electrodes . . . . .	40