

Cathodic protection of underground storage tank systems

What is cathodic protection?

Cathodic protection (CP) is a method of protecting metal structures from corrosion, commonly called rust, which is the degradation of a metal material caused by a reaction with its environment. If the metal components of underground storage tank (UST) systems are not protected, they will eventually corrode and leak, causing contamination of soil, groundwater, and surface water by petroleum and other hazardous substances.

There are two main types of CP systems. **Sacrificial anode CP** (also called galvanic CP) consists of magnesium or zinc anodes connected to the metal tank or piping. With this arrangement, the anodes will corrode over time instead of the tank or piping.

Impressed current CP also uses anodes to prevent tanks or piping from corroding by applying a weak electrical current to strengthen the protective effect. A rectifier converts alternating current (AC) from a power source to direct current (DC) and sends it to the anodes. Impressed current CP is typically used at older sites, and sites with soil conditions where more current is needed than the anodes themselves can produce.

Tank owners need to know their CP type in order to provide proper notification to the MPCA and because the operating requirements differ. Sacrificial anode CP systems are added by the manufacturer to new steel tanks built to the sti-P3 design, or by the installation contractor to new steel piping, and this should be indicated on the purchase documents. Impressed current systems by contrast will always have an electrical box, called a rectifier, indicating power on/off and voltage and amperage readings.

When is cathodic protection required?

In general, any metal tanks and metal appurtenances such as piping, valves, and connectors that are in contact with soil and routinely contain a regulated substance must have CP. Stainless steel components such as stainless steel-encased flex connectors can still be subject to corrosion and do require CP if they are in contact with soil. Tanks and piping that are double-walled require CP when the outer wall is made of metal.

There are a few exceptions. Steel tanks, which have a properly installed and maintained internal lining, and steel tanks and piping, which have a fiberglass-reinforced plastic jacket, are not required to have CP. An example of a metal tank component that does not routinely contain liquid, and does not need CP would be a vent pipe. If a metal pipe section is not in contact with soil, such as when a boot is added, or soil is cleared away, CP is not required.

What are the installation requirements?

Cathodic protection systems must be designed and installed according to applicable industry codes of practice for external CP of buried metal structures. Tanks with sacrificial anode CP systems must be manufactured to the sti-P3 standard. A person certified by the National Association of Corrosion Engineers (NACE) as a corrosion expert must design impressed current tank and piping CP systems.

All CP systems of either type must be tested for proper function within six months after initial installation.

How do I maintain effective cathodic protection on my tank?

Cathodically protected UST systems must be operated to provide continuous protection to all metal components. For impressed current CP, the electricity to the rectifier must be kept on at all times. If a rectifier indicates zero amperage, zero voltage, or both, effective CP is not occurring. Sacrificial anode CP operates without electricity. For both types of systems, over time the anodes will corrode and become ineffective.

To maintain effective CP, all CP systems must continue to be tested for proper function at regular intervals and repaired as necessary.

How often is cathodic protection testing required?

Periodic testing is required for each type of system as follows:

- Sacrificial anode: Every three years
- Impressed current: Every year

In addition to annual testing, the rectifier of an impressed current CP system must be checked **every two months** to ensure that current is being delivered to the system. Document this in writing by recording the date, the voltage and amperage displayed on the gauges, and the initials of the person reading the gauges. If the rectifier has an hour meter, record the hours as well. Rectifier readings of impressed current CP systems may be taken by the owner or another person.

Who can perform cathodic protection testing?

Cathodic protection systems must be tested by a person certified by either the Steel Tank Institute (STI) as a CP tester, or NACE as a CP tester or higher certification.

What procedures are used for cathodic protection testing?

Advance notification to the MPCA of CP testing is not required. The CP tester must evaluate the CP system according to NACE RP0285, "Corrosion Control of Underground Storage Tank Systems by Cathodic Protection." At least three test points per tank and per piping run must be utilized. Of the three test points, one must be a **local** test point, and one must be a **remote** test point. The third test point can be either **local** or **remote**.

In order to pass, a sacrificial anode CP system must show structure-to-soil potentials of at least -850 mV for all metal system components. For an impressed current CP system to pass, all components must meet the -850 mV (Instant Off) criteria. In the alternative, the difference between the depolarization voltage and the Instant Off voltage must be at least 100 mV. If one or more components do not show this level of structure-to-soil potential, the system fails and must be repaired or replaced.

Structure continuity testing must also be performed. For sacrificial anode CP systems, the continuity tests must demonstrate each protected structures (tank or pipe) are electrically isolated from other protected structures and non-protected structures (electrical conduits, risers, vent lines). For impressed current systems, continuity tests must demonstrate all protected structures are electrically continuous with each other.

Can cathodic protection systems be tested during the winter?

Cathodic protection tests conducted when the ground is frozen will not be accepted by the MPCA. According to numerous studies, frozen ground will cause inaccurate CP test results.

What if the system needs repair?

If a tank component fails a CP test, the system can usually be repaired. One common repair is to add new anodes or replace old ones. Repairs must be completed within 60 days after a failing test or as otherwise required by an MPCA enforcement action.

Sacrificial anode or impressed current systems may be repaired by a CP tester who is qualified to repair CP systems according to industry standards, or by a corrosion expert. Impressed current systems are inherently more complex than sacrificial anode CP systems, and the MPCA highly recommends repairs to impressed current systems be performed by a corrosion expert. Impressed current CP system repairs must be designed by a corrosion expert and certified by the corrosion expert that the repair was done properly. Addition or replacement of anodes or the rectifier is considered a repair.

The system must be re-tested within six months after any repairs.

Do cathodic protection test results need to be reported to the MPCA?

Cathodic protection test results must be submitted to the MPCA within 30 days of testing, using the appropriate form: "Cathodic Protection System Evaluation – Sacrificial Anode Type" or "Cathodic Protection System Evaluation – Impressed Current Type." The forms ask for general information about the site, owner, and tester; reason for evaluation; test results; and any follow-up actions required. Forms must be completed and signed by the cathodic protection tester, and may be submitted by either the tester or the tank owner. The tank owner should always make a copy of the test results form or obtain it from the tester for the owner's records. The forms may be obtained from the UST Program website, or by calling the MPCA; see "Need more information?" below.

Rectifier readings taken every two months need not be submitted, but must be retained by the owner operator for MPCA inspections.

What records must be kept on file?

Tank owners are required to maintain certain written records. These records must be kept at the facility where the tanks are located or at a readily available alternative site. In either case, the records must be immediately submitted to the MPCA upon request. Testing contractors may also ask to see previous test reports and maintenance reports to determine the effectiveness of the system and troubleshooting any problems that may be occurring.

For **sacrificial anode** CP systems, the following records must be kept:

- Test results form for the previous three system tests

For **impressed current** CP systems, the following records must be kept:

- Test results form for the previous three system tests
- Rectifier readings for the previous three years

Records must also be retained for the life of the tank system involving repairs to CP systems. Repair information includes design criteria, materials installed, and as-built drawings of the repair.

Need more information?

Visit the UST Program at <https://www.pca.state.mn.us/waste/underground-storage-tank-systems>. The site has forms, fact sheets, and other information about USTs and UST requirements.

You can also call the MPCA at 651-296-6300 or 1-800-657-3864 and ask for the UST Program.