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CORROSION CONTROL OF GAS FACILITIES

O-16

Department: Gas Distribution and Technical Services **Section:** Gas Engineering and Planning

Approved by: [REDACTED] **Date:** 10-24-02

Rev. #07: This document replaces Revision #06. For a description of the changes, see Page 10.

This document also appears in the following manuals:

- *Gas Applicant Design Manual*
- *Gas Distribution Maintenance Manual*

Purpose and Scope

This gas standard outlines PG&E's corrosion control program for all gas facilities including PG&E-owned gas gathering lines, gas transmission facilities and gas distribution facilities maintained by GD&TS.

Acronyms

AWG:	American wire gauge
CFR:	<i>Code of Federal Regulations</i>
CGT:	California Gas Transmission (organization within PG&E)
CP:	cathodic protection
CPA:	cathodic protection area
CPUC:	California Public Utilities Commission
dc:	direct current
ETS:	electrolysis test station
E&M:	Estimating and Mapping
GD&TS:	Gas Distribution and Technical Services
HMWPE:	high molecular weight polyethylene
HVac:	high voltage alternating current
kV:	kilovolts
mA:	milliamperes
MSDS:	material safety data sheet
mV:	millivolts
NACE:	National Association of Corrosion Engineers
OM&C:	Operations, Maintenance and Construction
PCM:	Radiodetection pipeline current mapper
P/S:	pipe-to-soil
Vac:	volts alternating current
WRO:	work at the request of others (a budgeting term)

References

	Document
Glass-Epoxy Retainer Gaskets	Gas Standard B-45.1
Cast Iron to Steel Insulated Transition Couplings	Gas Standard B-91.4
Machine Application of Polyethylene Systems (3/4" – 48" Pipe)	Gas Standard E-24
Field Wrapping With Cold-Applied Tape	Gas Standard E-25
Meter Valves	Gas Standard F-80
Electrolysis Test Station Connection to Main	Gas Standard O-10
Connection – Details, Wire Splices	Gas Standard O-12
Galvanic Anodes Installation and Purchasing Data	Gas Standard O-13.1
Flange Insulation	Gas Standard O-22
Leak Survey and Repair of Gas Transmission and Distribution Facilities ...	UO Standard D-S0350/S4110
Cathodic Protection Standards for Cased Pipeline Crossings	UO Standard D-S0354/S4126

Rev. #07: 10-24-02

O-16 Page 1 of 25

Corrosion Control of Gas Facilities

References, continued

	Document
CPA Assessment/Resurvey Procedures	UO Standard D-S0467
NACE	Standard RPO177

General Information

1. Requirements for Protection

Install all new, reconditioned, converted, or replaced buried metallic pipeline facilities with an approved coating and cathodically protect the facilities within 1 year after the installation date. This requirement applies to all gathering lines, transmission lines, distribution mains, and services. This requirement also applies to PG&E-owned, buried, metallic gas houselines maintained and operated by gas distribution.

Based on 49 CFR, generically:

- Metal, gas-carrying facilities installed after July 31, 1971, shall be placed under CP within 1 year of completion of construction. Exceptions are noted in 49 CFR 192.455.
 - Metal, gas-carrying distribution facilities with effective coatings installed before August 1, 1971, with active corrosion, shall be protected.
 - Adequately coated gas transmission facilities other than compressor, regulation, and measuring stations shall be protected.
 - Transmission compressor, regulator, and measuring stations with active corrosion shall be placed under CP.
- A. Attachment A describes cathodic-protection guidelines for steel mains and services.
 - B. Transmission and gathering line cathodic-protection requirements shall be determined either by testing or by investigating the historical current requirements. Galvanic anodes or rectifier stations shall be installed as required.
 - C. Ensure the following adequately coated equipment is cathodically protected: gathering lines, transmission lines, mains, services, PG&E-owned gas houselines, and other buried metallic gas facilities. Bare or poorly coated steel pipe should not be cathodically protected and shall be subject to the appropriate Leak Survey. Known sections of metallic main and services that are not under CP and are deemed as being in a non-corrosive environment shall be verified that they are included in at most a 3-year leak survey. The corrosion department shall provide a record of the aforementioned facilities to the E&M department, which will ensure that these facilities are part of at most a 3-year leak survey. Transmission lines not cathodically protected shall be subject to either an electrical survey every 3 years or an annual flame ionization leak survey.
 - D. When pre-August 1, 1971, previously unprotected services or mains are discovered, the party discovering this condition must report it to the corrosion department. If this piping cannot be cathodically protected or it is not practical to protect it, then this piping shall be included in at most a 3-year leak survey schedule.
 - E. If, in any case, metallic gas carrying facilities that should have been leak surveyed within a given period of time have not been leak surveyed, then the subject facilities shall be surveyed by the end of the following month. If metallic gas-carrying facilities that should have been leak surveyed within a given period of time have been leak surveyed, then the subject facilities shall be appropriately scheduled for future surveys, if they are not appropriately scheduled.

2. Designing and Installing Cathodic Protection Areas (CPAs)

Design CPAs according to the following guidelines:

- A. Use good judgment when engineering CPAs so they are not excessively large or small. Ideally, an area should contain no more than 50,000 square feet of steel pipe. This guideline may not be applicable to some existing systems or to long-line systems.
- B. Design and operate cathodic protection systems to ensure they do not significantly interfere with other underground metallic structures. Select rectifier sites which maintain a minimum distance of separation between the anode bed and any non-PG&E, underground metallic structures, such as water lines, underground electric lines with bare neutral wires, metal-sheathed telephone or television cable, metal fence posts, electric ground rods and guy wire anchors, and similar facilities. A minimum distance of separation is any distance, verifiable through testing, that does not register interference. Employees must maintain a

Corrosion Control of Gas Facilities

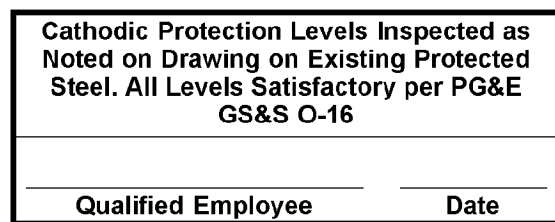
minimum distance of separation between all anodes and protected gas mains or services to prevent coating damage. Document the results on the "Cathodic Protection Station Report" (Attachment C).

- C. To prevent coating damage, the P/S on-potential shall not exceed -1600 mV when measured with a copper-copper sulfate electrode anywhere on the protected, gas-carrying structure. Consider voltage resistance (IR) drop in this measurement. Perform interference response testing or make engineering calculations on rectifier sites that cannot meet the requirements documented in this subheading 2C, as well as in locations where non-PG&E facilities may be affected. Notify non-PG&E facility owners of the new or proposed rectifier sites or of the possibility of increased current outputs. Arrange to conduct testing, if required. Testing should include interrupting the rectifier current and measuring the on and off P/S potentials on nearby non-PG&E facilities. Measure and record hard wire current flows, when necessary. Document the results using the "Interference Test Form" (Attachment E). It is recommended that the highest rectifier reading that does not interfere with other's facilities and does not cause the P/S readings on the gas facilities to exceed -1600 mV be determined and documented on the "Interference Test Form" to identify the maximum setting the rectifier could be adjusted to and not require additional interference tests.
- D. For proposed sites, consider establishing temporary drains to measure potential influences and cathodic protection current necessary to protect the area.
- E. Insulating devices may be used in underground vaults. Take care to prevent possible electrical arcing. Use only approved flanges, gaskets, and insulating sleeves for insulating purposes (as described in Gas Standard O-22 or Gas Standard B-45.1). Design the facility to prevent accidental contact or shorting across the insulating device (i.e., avoid using foil-backed sound insulation on vault lids; it could fall and contact the insulating device).
- F. It may be necessary to provide galvanic grounding or other protection:
- (1) on pipelines which closely parallel HVac electric transmission lines, and
 - (2) on pipelines where the anticipated or measured voltage between the pipeline and ground exceeds 15 Vac open circuit or has a source current capacity of 5 mA. For example, protect pipelines that parallel 230 kV or 500 kV HVac circuits of appreciable distance (over 1 mile) and are within 1,000' of a HVac conductor and any pipeline that parallels a HVac circuit for any distance when the separation is small.
 - (3) on pipelines where the electrical transmission towers are present.
- The need for special precautions is greater when electric loads are higher and when pipelines are well-coated and/or installed in high-resistance soil. These precautions apply to both pipelines under construction and pipelines operated under the conditions described in this section (Item 2F). See the NACE Standard RPO177 for additional guidelines or contact the respective CGT Corrosion Engineering Section, if applicable.
- G. Install wire test leads according to Gas Standard O-10 and at the following locations:
- (1) At new installation transmission/distribution pipeline areas.
 - (2) On both sides of buried, insulated fittings (Type D installation as shown in Gas Standard O-10).
 - (3) On pipeline at new cased crossings (Type B installation as shown in Gas Standard O-10), where the casing cannot be determined to be continuous, or where specified by other standards.
 - (4) Consider installations on crossings with other metallic pipelines.
(Additional test leads should also be attached to major non-PG&E pipelines, if the owners will consent.)
 - (5) In enough additional locations to ensure that the pipeline is accessible at least every block on distribution and every 1 mile on transmission.
 - (6) Install current span test stations at least every 5 miles for gathering and transmission lines (Type E installation).
 - (7) One on each side of a rectifier (Type F installation as shown in Gas Standard O-10).
 - (8) When installing numerous plastic services on a steel main, test leads are required every 500' unless there is sufficient access to the pipeline at existing test leads or existing steel services.
- H. Where stray currents from non-PG&E protection systems, both cathodic and anodic, are detrimentally affecting the cathodic protection of PG&E gas lines, contact non-PG&E facility owners and take corrective measures to limit or eliminate the stray current condition. Non-PG&E protection systems may include pipelines, transit systems, telluric earth currents, etc. When other's facilities are to be installed near existing PG&E gas carrying facilities and these foreign facilities are likely to cause interference to PG&E's gas carrying

Corrosion Control of Gas Facilities

facilities, then the other party should be contacted and before-and-after readings should be taken regarding PG&E's facilities. If interference is encountered, the third party must be informed of the situation and told to correct the situation. This investigative work should be charged to WRO expense.

- I. Clear all CPA contacts before designating the CPA as protected. Before excavation, when practical, confirm the location of underground contacts with current span calculations as well as with a locator (PCM, Tinker, or pipe locator). Cathodic protection systems will be considered adequately protected when the lowest P/S on-potential is a minimum of -850 mV with reference to copper-copper sulfate electrode with protective current applied. Other NACE recognized protection criteria may be used when the -850 mV on-potential criteria is not practical. Obtain baseline current profiles with a PCM unless extenuating circumstances (such as the gas main running in the middle of the street) dictate otherwise. Trace the PCM currents to 15 mA and hard-wire currents to 50 mA. It is typical that the PCM transmitter current is set at one-third of the CP current during "final span down."
- J. When trying to account for current on transmission and gathering lines, employees may use a combination of protective current history, current requirements representative of the age and type of coating, P/S potentials, electrical surveys, or other methods to account for current when spanning is not practical (i.e., too few spans or services off the pipeline). In areas where there is reasonable evidence that other facilities contact the transmission lines, perform electrical surveys such as close interval P/S potential readings, PCM, or tinkering.
- K. The number of final P/S on-potential readings (P/S profile), approximately one per block, if read points are reasonably available, will be considerably greater than the number of locations selected for maintenance readings.
- L. Gathering lines and transmission lines shall use the method described above (Item 2K) except when there are no branch services. Final P/S readings should document approximately one P/S potential reading per mile, unless field conditions warrant otherwise.
- M. Meet cathodic protection requirements for buried, metallic, PG&E-owned gas houselines by ensuring that the gas houseline is insulated from the service line (normally at the service riser valve) and is insulated at the original gas meter location or at the first point that the gas houseline comes above ground. Do this by using an insulating union. Apply cathodic protection with at least one 5-pound zinc or at least one 9-pound magnesium anode that is electrically attached to the buried gas houseline. The coating on the gas houseline will be an approved PG&E coating as listed in Gas Standards E-24 and E-25.
- N. All gas construction jobs installing buried steel, gas-carrying facilities (pipeline, main, or service) or tying plastic mains into existing buried steel, gas-carrying pipelines or mains must ensure that the cathodic protection levels of the affected steel facilities are checked before closing out the job. Note the cathodic protection levels on the as-built construction drawing where the P/S measurements were taken. Each applicable construction job drawing must be stamped with the stamp shown in Figure 1 on Page 4. A corrosion mechanic or other qualified* employee must sign off on the as-built construction drawing before the job is completed. If only full length plastic services are installed, the above requirement does not apply. Report any deficiencies in the cathodic protection levels to the local corrosion supervisor for remedial action. Do not consider a construction job to be complete and ready to be closed out until adequate cathodic protection levels are noted on the installed or affected steel facilities.



**Figure 1
Stamp Used on the Construction Job Drawings**

* A qualified employee is an employee trained to take a P/S cathodic protection measurement.

Corrosion Control of Gas Facilities

3. Cathodic Protection Maintenance and Operation

Maintain cathodic protection systems according to the following procedures:

A. Rectified Areas

In rectified areas, employees shall monitor for cathodic protection effectiveness according to the schedule listed in Table 1 on Page 5.

B. Transmission, Gathering Lines, and Distribution Mains

The test locations selected for monitoring cathodic protection effectiveness shall be representative of locations where the level of protection is the lowest for that CPA or shall be at locations where the loss of effective cathodic protection in the CPA would be detected. For CGT-maintained facilities, this includes at least 1 pipeline and casing test station per casing and 1 test station on both sides of insulating devices.

C. Monitoring Schedule

As documented in a state of California Waiver Resolution, PG&E is exempt from the federal CPA Rectifier Inspection Monitoring Schedule as required in 49 CFR 192.465 (b). Reference: CPUC Resolution SU-39, February 23, 1996, Order Authorizing Pacific Gas and Electric Company to Deviate From General Order 112-D, Section 192.465 (b), to Exempt the Company From the Requirement of Bi-Monthly Rectifier Inspection. (A copy of this waiver is located in the *Gas Distribution Maintenance Manual*, Section II, Part O). The approved monitoring schedule is shown in Table 1 on Page 5.

Table 1 Schedule of Monitoring Intervals ¹

	P/S Monitoring	Rectifier Monitoring
UO, CGT ²	Bimonthly ³	Annually ⁴

¹ Record P/S measurements on a PG&E "Cathodic Protection Maintenance Report," Attachment D.

² CGT intervals are the same as UO when maintained by UO.

³ "Bimonthly" means six times each calendar year with intervals not to exceed 2-1/2 months.

⁴ "Annually" means once each calendar year with intervals not to exceed 15 months.

In some distribution rectified CPAs, yearly, routine, P/S on-potential monitoring points can be established in addition to required bimonthly monitoring points. These yearly locations do not have an "anniversary month" but may be read at any time during the calendar year. Each rectified distribution CPA must have at least one bimonthly, routine, P/S on-potential monitoring point.

D. Test Locations

Test locations selected for monitoring cathodic protection effectiveness shall be representative of locations where the level of protection is the lowest for that CPA or shall be at locations where the loss of effective CP in the CPA would be detected.

E. Yearly Reads

Yearly P/S on-potential monitoring points can be established to supplement required bimonthly monitoring points on distribution CPAs. These yearly locations do not have an "anniversary month," but may be read at any time during the calendar year. Yearly monitoring points should be considered at locations where locating wire failure may cause a section of steel main to become unprotected. Additionally, yearly-monitoring points may be established at other points to further verify the effectiveness of CP within the CPA.

F. Rectifier Monitoring and Maintenance

Rectifiers shall be monitored annually, each calendar year, with intervals not to exceed the day of the previous read on the 15th month, to ensure that they are functioning correctly. Include the voltage and amperage measurements when taking rectifier readings. Record the results on the PG&E "Cathodic Protection Maintenance Report," Attachment D.

G. Rectifier Adjustment

If the rectifier output (amperage) needs to be increased to achieve effective levels of cathodic protection, an additional interference test may be required to ensure interference is not occurring on non-PG&E structures. It is recommended that the highest rectifier reading that does not interfere with other facilities and does not cause P/S readings on the gas facilities to exceed -1600 mV be determined and documented on the "Interference Test Form," Attachment E to identify the maximum setting the rectifier could be adjusted to and not require an additional interference test. A previous interference test within 20% of the new higher current

Corrosion Control of Gas Facilities

setting is sufficient to meet this requirement, if this new higher setting does not exceed a level where previous testing identified interference or excessive P/S readings within the CPA. Clear all contacts before raising the rectifier amperage output settings. In addition, document the reason the rectifier output setting had to be adjusted on the back of the "Cathodic Protection Maintenance Report," Attachment D. Acceptable reasons for adjusting the rectifier outputs include:

- (1) Tying another CPA into the area.
- (2) Disconnecting another rectifier in the CPA.
- (3) Adding more steel piping to the CPA.
- (4) Adjusting for summer dryout conditions.
- (5) Deterioration of pipe coating.

H. Casing Monitoring and Maintenance

Casing monitoring requirements are included in UO Standard D-S0354/S4126.

I. Remote Monitoring

Cathodic protection rectifier locations, or P/S locations, can be monitored remotely to meet PG&E requirements. The gas distribution, cathodic protection remote monitoring system will be programmed to take a minimum of one daily reading and report a reading weekly. The gas distribution remote P/S system will initiate an alarm if a reading is out of range or if any other prescribed alarm conditions exist. Any field based system alarm shall be treated the same way as a P/S being found down. Electronic reading data may be kept as official data for the current year and previous years. The minimum electronic P/S on-read data for a CPA that had no down reads is one complete set of reads per month.

J. CPA Restoration

- (1) Schedule CPAs for restoration when the areas show P/S on-potentials to be below adequate levels of protection. Check rectifier readings before restoring a CPA. Restore areas within 30 calendar days from the date they are found to be inadequately protected, as defined by the current version of 49 CFR 192, Subpart I (barring acceptable extenuating circumstances). Document the reason(s) for any delays in the restoration work. Once restored, an area shall have approximately the same P/S on-potentials and rectifier output as existed before the level dropped, unless re-evaluation of the system indicates that different values are more appropriate. After the CPA has been restored and re-polarized, record final P/S on-potential measurements on the PG&E "Cathodic Protection Maintenance Report," Attachment D.
- (2) Extenuating circumstances may cause a CPA's restoration to go beyond the 30-calendar-day timeframe. Examples of acceptable extenuating circumstances may include employee safety, public safety, population density, environmental concerns, climatic conditions, material availability, government permitting processes, land acquisition requirements, and workloads. PG&E employees shall determine if CPA restoration work is being delayed by an acceptable extenuating circumstance.

Some suggested interim or, in some cases, permanent steps that can be taken to resolve or mitigate the down time or the extent of the down area are:

- Bonding the CPA to an adjacent CPA.
- Appropriately adjusting the rectifiers (validate that there is no interference or the excess P/S readings).
- Installing shallow bed anodes.
- Installing galvanic anodes.
- Isolating the suspect problem services and/or mains from the CPA and proceeding to restore CP to isolated facilities.

All of the above mentioned actions, if taken, shall be documented in the respective CPA records.

- (3) If the CPA restoration work is (or is expected to be) over 30 days, an action plan must be developed within 30 days from the date the CPA is found below adequate levels of protection, as defined by the current 49 CFR 192, Subpart I. The action plan shall list and document the extenuating circumstance(s), to the extent known, the cause of the CPA problem (to the extent the cause is known), the desired solution(s), the actions needed to implement the solution, the estimated time to take those actions, and the employees who will perform those actions. The action plan shall be updated in intervals not exceeding 30 days, until

Corrosion Control of Gas Facilities

the CPA restoration work is completed and the CPA shows adequate levels of protection. Updates to the action plan shall document the incremental work that has been completed to date, detailed status updates of needed actions that have not had any significant progress from previous updates, and the work that needs to be completed to achieve adequate protection. (Reference: WIN. DOT - DOT RSPA Interpretation Letter #16 for 49 CFR 192.465 – May 19, 1989.)

- (4) Attachment B is a sample "CPA Follow-up Action Plan." When using this action plan, file it with the respective CPA P/S maintenance worksheet. Document routine circumstances using the back of the "Cathodic Protection Maintenance Report," Attachment D.
 - (5) The OM&C office or CGT pipeline department shall provide a monthly status report regarding CP maintenance on CGT gas facilities to CGT. The OM&C office shall provide a monthly status report regarding CP maintenance on gas distribution facilities to Engineering and Planning.
- K. Monitor facilities protected with galvanic anodes by using P/S on-potentials as follows:
- (1) Annual Galvanic: Monitor isolated gas distribution main pipe segments that are over 100' long but less than or equal to eight blocks of steel main or a mile of steel main at least once each calendar year, but with intervals not to exceed 15 months from the day of the previous read. Monitoring includes plastic systems using locating wire to distribute protection to steel service risers, steel pipes, steel valves, etc. Consider monitoring these sections more frequently, as conditions justify.
 - (2) Bimonthly Galvanic: For gas distribution galvanic systems that contain more than eight blocks of steel main or more than one mile of steel main, monitoring shall be conducted bimonthly (not to exceed 2-1/2 months) and read not less than six times per year.
 - (3) 10% Monitoring: Monitor individual isolated services of any length; fittings; individually buried, metallic, PG&E-owned gas houselines; and isolated main segments less than 100' long at least once each 10 years. Monitor at least 10% of all such facilities each year. Each successive year, monitor a different selection of at least 10% of the facilities.
 - (4) Unprotected Pipe: Evaluate non-insulated sections of unprotected metallic main and services at 3-year intervals using repaired and active leak data.
- L. Monitor the cathodic protection on bare transmission line either by performing an electrical survey every 3 years or by performing an annual flamepack ionization leak survey.
- M. Review the gas distribution CPAs and bimonthly galvanics as noted in Item K(2) above, using the "CPA Assessment Worksheet" at 5-year intervals not to exceed the end of the 63rd month, using UO Standard D-S0467. This standard is located in the *Gas Distribution Maintenance Manual*, Section II, Part O, and on the Intranet at http://www/techlib/manuals/uo_standards/all_uo_standards.asp.
- N. Review transmission line CPAs according to methods, schedules, and priorities developed by the CGT Pipeline Re-Evaluation Program. The operating headquarters should use UO Standard D-S0467, located in the *Gas Distribution Maintenance Manual*, Section II, Part O, except when other methods are developed and recommended by the CGT corrosion engineer. CGT will normally use electrical surveys to re-evaluate pipelines, but may also use the Gas Distribution department's method if the CGT corrosion engineer determines it to be appropriate.
- O. Electrically check each reverse current switch, diode, or interference bond that jeopardizes protection for proper performance annually, not to exceed the day of the previous read on the 15th month.
4. Voltage (IR) Drop Considerations
- Always consider the IR drop in the measurement circuit when interpreting the results of P/S on-potential measurements. Elements of the measuring circuit that may cause IR drop include the voltmeter, reference cell placement, reference cell contact resistance, test leads, and pipe and soil resistance.
- A. Voltmeters: Take all P/S on-potential measurements with an approved electronic voltmeter, having an input impedance equal to or greater than 10 megohms.
 - B. Reference Cell Placement: Since it is not always expedient to excavate for the sole purpose of taking P/S on-potential measurements, place the reference cell as close as possible over the pipe. At risers, place the reference cell approximately 6" to 12" from the riser and over the service.
 - C. Reference Cell Contact Resistance: If sufficient moisture is not present, moisten the ground or the conductive surface (sponge) at a location where the P/S on-potential measurement is being taken.

Corrosion Control of Gas Facilities

- D. Test Leads: Since only approved voltmeters are used for making P/S on-potential measurements, IR drop in the test leads is insignificant.
- E. CP Current Flow: Current flow on a pipeline from cathodic protection can cause an IR drop in the pipe and in the soil. When conducting close-interval surveys, refer the data to the corrosion specialist and/or corrosion engineer to determine if and how the IR drop in the pipe should be considered.
- F. Soil: Evaluate the IR drop in the soil using the following considerations:
 - (1) The 850 mV criterion for cathodic protection was developed with an allowance of at least 50 mV for IR drop and other measurement errors.
 - (2) The IR drop from a galvanic anode system is usually insignificant due to the small amount of current flow. Typically, the reference cell is placed over the pipe and away from the galvanic anode.

5. Inspection and Leak Repair

Inspect a pipeline for evidence of external corrosion and take remedial action, as appropriate, any time it is exposed.

- A. Make a written report of each inspection as outlined in UO/CGT Standard D-S0350/S4110. Use Form 62-4060, "Leak Survey, Repair, Inspection, and Gas Quarterly Incident Report," for all distribution and transmission pipeline facilities and services. Do not mark "Corrosion" as the cause of leakage unless it is observed. If in doubt, contact the local headquarters OM&C corrosion group.
- B. Repair, replace, or recoat corrosion-damaged pipe according to the applicable gas standards.
- C. When external corrosion leaks are repaired on steel pipe that is not cathodically protected, regardless of whether the pipe is wrapped or bare, install at least one 9-pound magnesium or one 5-pound zinc anode (preferred) direct buried according to the instructions found in Gas Standard O-13.1. Do not install anodes at leak repairs in cathodically protected areas unless they are part of a cathodic protection improvement plan or approved by the corrosion department. Investigate continuing corrosion leakage in protected areas and take corrective measures, where appropriate.
- D. Where an external corrosion leak occurs on a buried gas steel transmission line, a corrosion mechanic must take a P/S on-potential measurement and a soil resistivity measurement at the leak repair site. If it is safe and practical, immediately take the P/S on-potential reading at the corroded site as the pipe is exposed. If low levels of protection are identified as a possible cause for the leak, take remedial measures.
- E. Where an external corrosion leak occurs on a buried gas steel distribution facility, take a P/S on-potential measurement at the leak site at the time of the repair. If low levels of protection are identified as a possible cause for the leak, take remedial measures.

6. Internal Corrosion

- A. Perform internal corrosion tests where evidence of internal pipeline corrosion is noted and has been verified, or where pipeline liquids are present. Record all information on Form 75-95.
- B. When found, sample and analyze pipeline liquids according to guidelines in the *Corrosion Manual*. If the sample is determined to be corrosive, initiate an internal corrosion control program. If evidence of internal corrosion is found, regardless of the pipeline liquid sample analysis results, initiate an internal corrosion monitoring and/or control program.
- C. The effectiveness of the internal corrosion control program is usually monitored with electrical resistance probes or coupons and data recorded on "Probe Data Sheets" or "Coupon Data Sheets." Also, inhibitor concentrations may be measured by properly sampling liquid and analyzing it at designated liquid collection points. Each pipeline section may have its own internal corrosion control program depending on the operation and environment of that section of the system. Consult the *Internal Corrosion Mitigation Plan* for the specific pipeline sections and for details regarding the internal corrosion control program.
- D. It is recommended to take all electrical resistance probe readings and to log them in at monthly intervals not to exceed a period of 90 days for the life of the system or until the probe is retired from service.
- E. Whenever steel pipe is removed from a pipeline, inspect it for evidence of internal corrosion. Record this inspection as outlined in UO/CGT Standard D-S0350/S4110 using Form 62-4060, "Leak Survey, Repair, Inspection, and Gas Quarterly Incident Report."
- F. Regularly drain drip tubes and bottom tap drains on pipelines to decrease the amount of stagnating liquids and, therefore, the potential for internal corrosion. If liquid is discovered in a pipeline, it is recommended that

Corrosion Control of Gas Facilities

the pipeline be drained monthly until the amount of liquid decreases to a point where monthly draining is not needed. Log the volume of liquids removed and the frequency of their removal. Document the reason for changing the frequency of draining the pipeline. Also, samples of the liquid must be taken and analyzed and the results logged. Repair a damaged or malfunctioning drip tube or drain within 1 year.

- G. It is strongly recommended to swiftly retire idle pipelines that could potentially be wet. This action significantly reduces the risk of internal corrosion and, therefore, the need to eventually treat these idle pipelines with other methods (i.e., installing probes and inhibitor injection sites).
- H. Evaluate well sites upstream of PG&E-owned lines that are in potentially internally wet areas of operation (i.e., downstream of a wet well but upstream of dehydration facilities) as described in the *Corrosion Manual*. Log the result of these evaluations.
- I. Locate all inhibitor-injection sites on a map. Include information on the type of chemical found, the volume of the chemical tank, and county where the site is located. Send the information to the operating headquarters' environmental coordinator. Update these maps as necessary. They are used to track and determine county permitting and spill plan requirements. Log all information regarding the type of inhibitor and the delivery rates. If possible, set the delivery rates off of the total flow to ensure that chemicals are not delivered to the pipeline when the gas flow is zero. Ensure that all inhibitor injection sites have an MSDS displayed and a placard indicating whether the inhibitor is flammable, since it is considered to be a hazardous material.

7. Records

- A. Maintain records to show the location details of all protected structures. Ensure that the records contain sufficient test data to demonstrate the adequacy of installed corrosion control measures. Maintain a file folder containing location maps illustrating the protected piping system for each cathodic protection system. The file folder should also contain information on the number, kind, and location of rectifiers and anodes; a complete history of monitoring information; bond data; pipe square footage; final saturation P/S on-potentials; final current (PCM/hardwire) spans; gas facility maps; and any other pertinent information. Maintain these records for the life of the facility.

This is a list of the records that shall be part of the CPA file folder:

- Maps of all protected facilities.
- CP station reports for each rectifier.
- Interference test reports for each rectifier.
- CP maintenance reports including a complete history of P/S monitoring records and maintenance work.
- CPA follow-up action plans.
- PCM or CP hardwire baseline data.
- Interference and other bond data.
- CPA current requirement worksheet (all historical sheets and the current sheet).
- Initial CPA assessment worksheets.
- A copy of the most current saturation surveys (to verify that the proper P/S locations are being monitored).
- CPA field resurvey checklist.
- CPA file review checklist.
- Other pertinent information.

- B. Use an approved computer software database management system to maintain part or all of the records and information required in Item 7A.

8. Atmospheric Corrosion Control

A. General

This section outlines requirements for lessening the damage caused by corrosive environments to aboveground PG&E gas facilities in compliance with current CPUC General Order 112 and 49 CFR 192.

- (1) Atmospheric corrosion is present on aboveground or exposed piping by corrosion pitting or substantial wall thickness loss. Surface rust or passive surface oxidation does not constitute atmospheric corrosion.

Corrosion Control of Gas Facilities

- (2) Coat all new pipe installed aboveground with a PG&E-approved product (Section E, "Coating and Wrapping," in *Gas Standards and Specifications*). It is strongly recommended to use an approved petrolatum wax tape on manifolds and meter sets in highly corrosive environments.
- (3) Operating organizations are responsible for designating areas subject to atmospheric corrosion. Use Electric Engineering Document 032911, which defines atmospheric corrosion areas. Maps of the atmospheric corrosion areas shall be prepared and maintained by the operating organizations. Areas affected by atmospheric corrosion monitoring are made up of all the areas bordering the ocean, including North Coast, North Bay, San Francisco, Peninsula, Central Coast, and Los Padres divisions.

B. Monitoring

- (1) In atmospheric corrosion areas, inspect all aboveground gas facilities at intervals not greater than 3 years.
- (2) During inspection, analyze all piping or metersets with active corrosion to determine whether the damaged facility may be repaired by removing the corrosion and recoating it, or whether it must be replaced.

C. Maintenance

Complete all repairs or replacements according to the appropriate gas design standards.

D. Coatings

Galvanized piping does not require coating. Take care to minimize the number of scratches on galvanized pipe.

E. Records

Each operating organization shall maintain a file that includes the following information:

- (1) A map of the atmospheric corrosion area(s).
- (2) Documentation from each survey indicating the following information: dates the surveys were taken, physical locations of the pipe requiring remedial attention, the type of action required, and dates of remedial actions taken.

Revision Notes

Revision 07 has the following changes:

1. Clarified code requirements.
2. Added recommendation to identify and record the highest rectifier settings that do not cause the interference or excess pipe-to-soil readings.
3. Added a per-block P/S saturation for resurvey activity.
4. Clarified the yearly reads.
5. Clarified the 15-month time interval requirement.
6. Added the remote-monitoring recording requirements.
7. Defined the maximum size of an annual galvanic system.
8. Defined the records required in the CPA folder.
9. Modified the "CPA Follow-Up Action Plan" form, "Cathodic Protection Station Report," "Rectifier Service History Sheet," "Cathodic Protection Maintenance Report," and "CPA Current Requirement Worksheet."
10. This document is part of Change 51.

Corrosion Control of Gas Facilities

Attachment A

Cathodic Protection Guidelines for Installing New, Replaced, or Transferred Steel Mains, and Steel or Plastic Services

Proposed New or Replaced Gas Facility Existing Main Piping System	Mains	Services			
	Steel Main	Direct Burial Plastic Service (See Note 5) or Plastic Service Insert (See Note 6) With Noncorrodible Riser	Plastic Service Insert with Noncorrodible Riser Where Plastic Service Locating Wire Cannot Be Inserted Through Service Case Pipe	Plastic Service Insert Through Existing Steel Riser (See Note 7)	New or Transferred Steel Services or Steel Risers
Cathodically Protected Steel Main or Plastic Main With a Locating Wire That is Part of a Cathodic Protection System	<ol style="list-style-type: none"> 1. Tie new steel main into existing steel main. 2. Bond existing plastic main locating wire to installed steel main, if doing so does not cross CPA boundaries. 3. Ensure adequate P/S readings on installation. 4. Contact a corrosion mechanic to ensure proper cathodic protection requirements are met. 	<ol style="list-style-type: none"> 1. Bond installed plastic service wire to existing steel main or existing plastic main locating wire. 2. Insulate plastic service locating wire from the riser by wrapping it around the service riser. 3. Insulate at the riser valve. 4. Insulate plastic service locating wire from the inserted steel casings. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing steel main or existing plastic main locating wire. 2. If plastic service locating wire is needed (see Note 7), bond plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Bond another plastic service locating wire to the plastic service case pipe at the riser end of the service case pipe and insulate the plastic service locating wire from the riser by wrapping it around the service riser. 4. Insulate at the riser valve. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing steel main or plastic main locating wire. 2. If the plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Insulate at the riser valve. 	<ol style="list-style-type: none"> 1. Tie steel service at the steel main. 2. Bond steel service to the plastic main wire. 3. Insulate at the riser.
Wrapped, Unprotected Steel Main	<p>100' or Less Replacement Repair, or Relocation</p> <ol style="list-style-type: none"> 1. Tie new steel main to existing steel main. 2. Install at least one 17-pound magnesium or one 15-pound zinc anode on each end of the new pipe. 3. Monitor in accordance with applicable leak survey requirements. <p>Over 100' and All Main Extensions</p> <ol style="list-style-type: none"> 1. Insulate at each end of main-to-main connections. 2. Install the appropriate number of galvanic anodes. 3. Monitor P/S annually. 4. Ensure P/S readings are adequate. 	<ol style="list-style-type: none"> 1. Bond installed plastic service wire to existing steel main. 2. Insulate plastic service locating wire from the riser by wrapping it around the service riser. 3. Insulate at the riser valve. 4. Insulate plastic service locating wire from inserted steel casings. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing steel main. 2. If plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Bond another plastic service locating wire to the plastic service case pipe at the riser end of the service case pipe and insulate the plastic service locating wire from the riser by wrapping it around the service riser. 4. Insulate at the riser valve. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing steel main. 2. If the plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Insulate at the riser valve. 	<p>Any Length:</p> <ol style="list-style-type: none"> 1. Tie to existing steel main. 2. Use an insulated valve stop riser (Gas Standard F-80). 3. Install at least one 9-pound magnesium or one 5-pound zinc anode on the service pipe. 4. Monitor in accordance with applicable leak survey requirements.

Corrosion Control of Gas Facilities

Attachment A, continued

Cathodic Protection Guidelines for Installing New, Replaced, or Transferred Steel Mains, and Steel or Plastic Services

Proposed New or Replaced Gas Facility Existing Main Piping System	Mains		Services		
	Steel Main	Direct Burial Plastic Service (See Note 5) or Plastic Service Insert (See Note 6) With Noncorrodible Riser	Plastic Service Insert with Noncorrodible Riser Where Plastic Service Locating Wire Cannot Be Inserted Through Service Case Pipe	Plastic Service Insert Through Existing Steel Riser (See Note 7)	New or Transferred Steel Services or Steel Risers
Unwrapped, Unprotected Steel Main	<p>10' or Less Replacement Repair, or Relocation</p> <ol style="list-style-type: none"> 1. Tie new main to existing main. 2. Install at least one 9-pound magnesium or one 5-pound zinc anode. 3. Monitor in accordance with applicable leak survey requirements. <p>Over 10' and All Main Extensions</p> <ol style="list-style-type: none"> 1. Insulate at each end of main-to-main connections. 2. Install the appropriate number of galvanic anodes. 3. Ensure P/S readings are adequate. 4. Monitor P/S yearly on 10% of those pipe sections which are 100' long or less. Monitor annually if pipe length is over 100'. 	<ol style="list-style-type: none"> 1. Bond installed plastic service wire to existing steel main. 2. Insulate plastic service locating wire from the riser by wrapping it around the service riser. 3. Insulate at the riser valve. 4. Insulate plastic service locating wire from the inserted steel casings. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing steel main. 2. If plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Bond another plastic service locating wire to the plastic service case pipe at the riser end of the service case pipe and insulate the plastic service locating wire from the riser by wrapping it around the service riser. 4. Insulate at the riser valve. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing steel main. 2. If the plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Insulate at the riser valve. 	<p>Any Length</p> <ol style="list-style-type: none"> 1. Insulate steel service at both the main and the riser. 2. Install at least one 9-pound magnesium or one 5-pound zinc anode on the service pipe or a driveable anode per Gas Standard O-13.6. 3. Ensure P/S readings are adequate. 4. Monitor P/S yearly on 10% of these installations.
Cast Iron Main	<p>Any Length</p> <ol style="list-style-type: none"> 1. Insulate cast iron-to-steel transition with an approved insulating coupling (per Gas Standard B-91.4). 2. Install the appropriate number of galvanic anodes. 3. Ensure there are adequate P/S readings on the installation. 4. Monitor P/S yearly on 10% of those pipe sections which are 100' long or less. Monitor annually if pipe length is over 100'. 	<ol style="list-style-type: none"> 1. Insulate installed plastic service wire from existing cast iron main by wrapping around tee. 2. Insulate plastic service locating wire from the riser by wrapping it around the service riser. 3. Insulate at the riser valve. 4. Insulate plastic service locating wire from inserted steel casings. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing cast iron main. 2. If plastic service locating wire is needed (see Note 7), bond plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Bond another plastic service locating wire to the plastic service case pipe at the riser end of the service case pipe and insulate the plastic service locating wire from the riser by wrapping it around the service riser. 4. Insulate at the riser valve. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing cast iron main. 2. If the plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Insulate at the riser valve. 	<p>Any Length</p> <ol style="list-style-type: none"> 1. Install malleable iron saddle, Universal 90. Install a small section of plastic pipe to isolate the service from the cast iron main. 2. Wrap the saddle and tee according to Section E of the <i>Gas Standards and Specifications</i>. 3. Install at least one 9-pound magnesium or one 5-pound zinc anode on the service pipe or a driveable anode per Gas Standard O-13.6. 4. Ensure P/S readings are adequate. 5. Monitor P/S yearly on 10% of these installations.

Corrosion Control of Gas Facilities

Attachment A, continued**Cathodic Protection Guidelines for Installing New, Replaced, or Transferred Steel Mains, and Steel or Plastic Services**

Proposed New or Replaced Gas Facility Existing Main Piping System	Mains	Services			
	Steel Main	Direct Burial Plastic Service (See Note 5) or Plastic Service Insert (See Note 6) With Noncorrodible Riser	Plastic Service Insert with Noncorrodible Riser Where Plastic Service Locating Wire Cannot Be Inserted Through Service Case Pipe	Plastic Service Insert Through Existing Steel Riser (See Note 7)	New or Transferred Steel Services or Steel Risers
Plastic Main (Insert or Direct Buried) With Locating Wire That is Not Part of a Cathodic Protection System	<ol style="list-style-type: none"> 1. Insulate at each end of main-to-main connection. 2. Do not bond existing plastic main locating wire to steel main. 3. Install the appropriate number of galvanic anodes. 4. Ensure P/S readings are adequate. 5. Monitor P/S yearly on 10% of those pipe sections which are 100' long or less. Monitor annually if pipe length is over 100'. 	<ol style="list-style-type: none"> 1. Insulate installed plastic service wire from existing plastic main by wrapping it around the tee. 2. Insulate plastic service locating wire from the riser by wrapping it around the service riser. 3. Insulate at the riser valve. 4. Insulate plastic service locating wire from inserted steel casings. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing plastic main locating wire. 2. If plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Bond another plastic service locating wire to the plastic service case pipe at the riser end of the service case pipe and insulate the plastic service locating wire from the riser by wrapping it around the service riser. 4. Insulate at the riser valve. 	<ol style="list-style-type: none"> 1. Insulate plastic service locating wire from existing cast iron main. 2. If plastic service locating wire is needed (see Note 7), bond the plastic service locating wire to the inserted steel casing and wrap it around the tee. 3. Insulate at riser valve. 	Any Length <ol style="list-style-type: none"> 1. Insulate steel service at both the main and the riser. 2. Install at least one 9-pound magnesium or one 5-pound zinc anode on the service pipe or a driveable anode per Gas Standard O-13.6. 3. Ensure P/S readings are adequate. 4. Monitor P/S yearly on 10% of these installations.

Notes:

1. For new mains or services, or when reconstructing plastic services by insertion, use AWG No.14 copper HMWPE wire (Code 294378). Use AWG No.10 copper HMWPE wire (Code 294414) for mains.
2. Use compression fittings and wrap them with Tac-Tape (Code 507036). Then wrap splices with electrical tape. Soldered splices may be used instead of compression fittings (refer to Gas Standard O-12).
3. Thermite weld all wire connections to steel pipe. Strap locating wire to the service line with electrical tape or Tie-Locks (Code 399093) to ensure close proximity. Tape other than electrical tape is not permitted for strapping unless approved by the corrosion supervisor.
4. Ensure that anodes are a minimum of 12" from other underground metallic facilities.
5. Strap a locating wire to the service riser aboveground, but below an insulated service valve. Use Tie-Locks (Code 399093). Do not bond the wire to the riser.
6. Do not bond plastic service locating wire to existing service case pipe or to a new, noncorrodible, prefabricated riser. If plastic service locating wire can be inserted successfully, strap it to the service riser aboveground, but below an insulated service valve. Use Tie-Locks (Code 399093).
7. Do not bond plastic service locating wire to steel main or plastic main locating wire. For distances less than 3' from the metallic service case pipe to the main, a plastic service locating wire is not required. For longer distances, bond a plastic service locating wire to a metallic service case pipe, but never to steel main or the plastic main locating wire.
8. Driveable anodes can be thermite welded or clamped.

Corrosion Control of Gas Facilities



Attachment B

Gas Distribution and Technical Services
Rev. 10/02

CPA FOLLOW-UP ACTION PLAN

CPA # _____ CPA Description _____

Corrosion Mechanic _____ Office _____ Date _____ Page # _____

OBJECTIVE: This follow-up action plan facilitates completing actions needed to restore a CPA to adequate levels of cathodic protection and to meet the requirements for documenting extenuating circumstances as required in Gas Standard O-16, Section 3, Item A.

Date CPA Was Found Below Adequate Levels of Cathodic Protection: _____

Date of Action Plan: _____

Date Next Action Plan Update Needed: _____ Date CPA Restored: _____

Cause of CPA Problem: _____

Desired Solution: _____

Description of Extenuating Circumstances: _____

	Recommended Action / Work Completed	Assigned Person	Estimated Completion Date	Actual Completion Date	Supervisor's Review (Required at Least Every 30 Days)
1					
2					
3					
4					
5					
6					

Final Reviewed by _____ / _____ Date _____

Corrosion Control of Gas Facilities



Attachment C

Gas Distribution and Technical Services
Rev. 10/02

- Transmission
- Distribution
- Both

CATHODIC PROTECTION STATION REPORT

PREVENTATIVE MAINTENANCE NO. (FM or PLM)	CP. SYSTEM NO.	AREA	DIVISION/DISTRICT	LOCAL OFFICE
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RECTIFIER

LOCATION		CITY		
MANUFACTURER	TYPE	MODEL	SERIAL NO.	
PRIMARY RATING		ACTUAL PRIMARY VOLTAGE		
	VOLTS		VOLTS	
SECONDARY RATING	INITIAL SETTING	DATE PLACED IN OPERATION		
AMPS	VOLTS	AMPS	VOLTS	

ANODE

NUMBER OF ANODES	WEIGHT AND/OR SIZE
TYPE OF ANODE	BACKFILL USED AND THE AMOUNT USED

SOIL RESISTIVITY (For Shallow Bed Anodes Only)

PIN SPACING - Feet	Ohms	MULTIPLIER	Ohm-Cm
2.5	_____	500	_____
5.0	_____	1,000	_____
7.5	_____	1,500	_____
10.0	_____	2,000	_____
15.0	_____	3,000	_____

STRUCTURE PROTECTED _____ WALL MAP _____ PLAT _____ BLOCK _____

SHOW LOCATION OF RECTIFIER AND ANODE(S) AND PERTINENT DIMENSIONS

PREPARED BY _____ DATE _____ CALIFORNIA GRID COORDINATE NUMBER _____

Corrosion Control of Gas Facilities

Attachment C, continued

“Cathodic Protection Station Report” Instructions

RECORD

- Transmission/Distribution/Both: Check the appropriate box for the type of gas facility that the rectifier is protecting.
- Preventative Maintenance No.: Record the rectifier’s preventative maintenance number, FM or PLM.
- CP System No.: Record the cathodic protection system number for the rectifier.
- Area/Division/District/Local Office: Record the names of the area, division, district, and local office where the rectifier is located.

RECTIFIER

- Location: Provide details of the rectifier’s location.
- City: Record the name of the city.
- Manufacturer/Type/Model/Serial No.: Complete the rectifier manufacturer’s information.
- Primary Rating: Record the unit’s input voltage rating per manufacturer’s specifications.
- Actual Primary Voltage: Complete the unit’s input actual primary voltage rating as measured in the field.
- Secondary Rating: Record the unit’s maximum secondary amperage and voltage ratings per the manufacturer.
- Initial Setting: Record the rectifier’s initial setting (amperage and voltage).
- Date Placed in Operation: Record the month, day, and year when the rectifier was placed in operation.

ANODE

- Number, Weight and/or Size: Record the number of anodes, weight (or size) in pounds, type (material), backfill used, and the amount of backfill used.

SOIL RESISTIVITY

- Soil Resistivity: Record soil resistivity readings based on ohm readings and pin spacing.
- Location Sketch: Include a detailed sketch of the location of the rectifier and the anodes. Ensure the sketch is precise enough to enable a person to locate those structures in the field.

RECTIFIER SERVICE HISTORY

- Date, By, Man-hrs: Record the date, person, and time (in hours) used for the maintenance.
- Inspection: Verify that all actions specified in Note were taken.
- Rectifier Cleaned: Verify that this action was taken.
- Output: Record both, an amperage and a voltage readings.
- Ground Resistance: Record the ground resistance reading in ohms.
- Repairs /Action Taken: Specify any needed repairs. Record any corrective actions taken.
- Repaired by/Date: Record the initials of the person performing the repair and the date of the repair.
- Reviewed by/Date: Supervisor’s initials and the date of review.



CATHODIC PROTECTION MAINTENANCE REPORT

Gas Distribution and Technical Services
Rev. 10/02

A. RECORD INFORMATION

LOCATION	CITY	CP SYSTEM NO.	FM/PLM#
AREA	DIVISION	DISTRICT	YEAR

B. PIPE-TO-SOIL POTENTIAL MEASUREMENTS (MILLIVOLTS)

TEST LOCATION	INITIAL OR REVIEW																		
1.																			
2.																			
3.																			
4.																			
5.																			
6.																			
7.																			
8.																			
DATA RECORDED BY																			
DATE (MONTH/DAY)																			

C. GALVANIC ANODE/RECTIFIER MEASUREMENTS

GALVANIC ANODE LOCATION OR RECTIFIER LOCATION	PRIOR YR.	(VOLTS/AMPS)																		
1.																				
2.																				
3.																				
4.																				
5.																				
DATA RECORDED BY																				
DATE (MONTH/DAY)																				
REVIEWED BY (REQUIRED BIMONTHLY)																				
DATE (MONTH/DAY)																				



Attachment D, continued

Gas Distribution and Technical Services
Rev. 11/00

“Cathodic Protection Maintenance Report” Instructions

A. RECORD INFORMATION

- Location: Record the location of the cathodic protection area.
- City: Record the city where the cathodic protection area is located.
- CP System No.: Record the cathodic protection system number.
- FM/PLM#: Record the facility maintenance system or work management system number for the cathodic protection area.
- Area: Record the neighborhood or area description of the cathodic protection area.
- Division: Record the division or operating headquarters.
- District: Record the local district office.
- Year: Record the year that is being monitored.

B. PIPE-TO-SOIL POTENTIAL MEASUREMENTS

- Test Location: Record the exact address or location of the P/S monitoring point.
- Initial or Review: Indicate whether the measurements are initial P/S in newly created CPA or the latest CP resurvey/review readings.
- Measurement: Record the exact P/S reading in millivolts for the date and test location.
- Data Recorded by: Record the initials of the person taking the P/S reading.
- Date (Month/Day): Record the exact month and day that a P/S reading was taken at the test location.

C. GALVANIC ANODE/RECTIFIER MEASUREMENTS

- Galvanic Anode Location or Rectifier No. and Location: Record the location of the galvanic anode or the rectifier number and location.
- Prior Yr.: Record previous year’s rectifier output amperage and voltage.
- Voltage/Amperage: Record two measurements at each location: the voltage in volts and the amperage in either milliamperes or amperes.
- Remarks: Record any remarks for the test location.
- Data Recorded by: Record the initials of the person taking the volt/ampere readings.
- Date (Month/Day): Record the exact month and day that the volt/ampere readings were taken at the test location.
- Reviewed by: Record the initials of the person reviewing the maintenance sheet for completeness and accuracy.
- Date (Month/Day): Record the exact month and day that the maintenance sheet was reviewed, if reviewed.

Corrosion Control of Gas Facilities



Attachment D, continued

Gas Distribution and Technical Services
Rev. 11/00

D. LOG OF CATHODIC PROTECTION MAINTENANCE WORK

- CP System No.: Record the cathodic protection system number.
- Date/Initials: Record the date that work was performed and the initials of the person performing it.
- Work Description: Describe the exact work task completed on the date (e.g., Checked with engineering, who submitted a permit to the city on 09/09/99, expect to receive by 10/01/99).

Corrosion Control of Gas Facilities

Attachment E Gas Distribution and Technical Services Rev. 11/00				
INTERFERENCE TEST FORM				
PG&E NO.	CP SYSTEM NO.	DIVISION	OPERATING HQ	CITY
RECTIFIER				
LOCATION				
DC RATING		DC SETTING		
Amperes	Volts	Amperes	Volts	
SOIL RESISTIVITY				
AVERAGE SOIL RESISTIVITY FOR SHALLOW WELL ANODES _____ Ohm/Cm				
TOTAL SOIL RESISTIVITY FOR DEEP WELL ANODES _____ Ohms				
PIPE-TO-SOIL POTENTIAL				
PROTECTED STRUCTURE	ON		OFF	
NON-PG&E STRUCTURE	ON		OFF	
NON-PG&E STRUCTURE	ON		OFF	
NON-PG&E STRUCTURE OWNER		TELEPHONE		
DRAWING				
CORRECTIVE ACTION TAKEN:				
DATE:			PREPARED BY:	

Corrosion Control of Gas Facilities

**Attachment E, continued**

Gas Distribution and Technical Services
Rev. 11/00

“Interference Test Form” Instructions**RECORD**

- PG&E Number: Record the rectifier’s PG&E identification number.
- CP System Number: Record the cathodic protection system number for the area.
- Division/Operating Headquarters/City: Record those elements for the tested rectifier.

RECTIFIER

- Location: Record the exact location of the rectifier.
- DC Rating: Record the manufacturer’s rating for the rectifier (amperes and volts).
- DC Setting: Record the maximum amperes and volts at the time of the interference test.

SOIL RESISTIVITY

Average Soil Resistivity for Shallow
Well Anodes/Total Soil Resistivity for

- Deep Well Anodes: Record soil resistivity for the shallow or deep well anodes as applicable to the test.

PIPE-TO-SOIL POTENTIALS

- Pipe-to-Soil Potentials on Protected
and Non-PG&E Structure: After setting up an interrupter, record “ON” and “OFF” P/S potentials on the protected facility (e.g., PG&E Gas Main) and any non-PG&E structures that could be affected by the rectifier.
- Non-PG&E Structure Owner and
Telephone: Record the name of the owner of non-PG&E structure and a local telephone number.
- Drawing: Include a drawing of the rectifier, anode bed, and the location of any non-PG&E structure.
- Corrective Action Taken: Record the corrective action taken, if any, needed to mitigate any interference situations.
- Date/Prepared by: Record the date and the name of the person who conducted the interference test.

Corrosion Control of Gas Facilities



Attachment F

Gas Distribution and Technical Services
Rev. 4/00

CATHODIC PROTECTION AREA CURRENT REQUIREMENTS WORKSHEET

CPA _____ Job No. _____ Date _____

Soil Resistivity (Ohms Cm) _____ Calculated By _____

1. Cathodic Protection Current Formula

Total Current Requirements (Amperes) = Pipe Length (Feet) x Pipe Outside Wall/Running Foot (Square Feet per Foot) x Current Requirements per Square Feet (Milliamperes per Square Feet)/1000

Steel Mains

Nominal Pipe Size (Inches)	Length of Pipe (Feet)	Circumferential Area per Feet of Pipe (Square Ft. / Ft.)	Total Outside Pipe Area (Square Feet)	Current Requirements (Milliamperes per Sq. Ft.)	Total Current Requirements (Amperes)	Comments
3/4		0.27		0.05		
1		0.34		0.05		
1-3/4		0.43		0.05		
1-1/2		0.50		0.05		
2		0.62		0.05		
3		0.92		0.05		
4		1.18		0.05		
6		1.73		0.05		
8		2.26		0.05		
10		2.81		0.05		
12		3.34		0.05		
16		4.19		0.05		
20		5.24		0.05		
Totals						

Gas Services

Number of Services	Nominal Pipe Size (Inches)	Average Length of Pipe (Feet) ¹	Total Length of Pipe (Feet)	Circumferential Area per Feet of Pipe (Square Ft. / Ft.)	Total Outside Pipe Area (Square Feet)	Current Requirements (Milliamperes per Sq. Ft.)	Total Current Requirements (Amperes)
	3/4 STL			0.27		0.05	
	1 STL			0.34		0.05	
	1-1/4 STL			0.43		0.05	
	1-1/2 STL			0.50		0.05	
	2 STL			0.62		0.05	
	1/2 CU			0.16		7.8	
	PL	N/A					
Total Current Requirement							

¹ Use the division average length.

Corrosion Control of Gas Facilities



Attachment F, continued

Gas Distribution and Technical Services
Rev. 4/00

Total Cathodic Protection Current (Design)

Total Calculated Current (Mains and Services)	
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2. Total Number of Rectifiers Needed:

$$\frac{\text{Total Current}}{3.5 \text{ (Amperes)}} = \text{Number of Rectifiers}$$

3. Actual Current in CPA:

$$\frac{\text{Total Current}}{\text{Square Feet}} = \text{mA/sq ft}$$

Notes

1. After completing this form, attach it as part of the job. Ensure that this form is filed in the CPA's permanent record.
2. Check with the local corrosion department for any special local current requirements.
3. Update this form as required by UO Standard D-S0467, "CPA Assessment/Resurvey Guidelines."
4. Computerized "Current Calculation Sheet" may also be used.