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	DEEP WELL AND SHALLOW BED ANODE REPLACEMENT		O-13.7	
	Asset Type: Gas Distribution	Function: Design		
Issued by: [Redacted]	 Original Signed By	Date: 11-13-08		
Rev. #02: This document replaces Revision #01. For a description of the changes, see Page 3.				

Purpose and Scope

This gas numbered document describes the procedures to follow to decide whether it is necessary to replace an anode in a rectified system. Following this numbered document will:

- Facilitate more consistent decisions on replacing anodes.
- Optimize PG&E capital anode replacement expenditures.
- Improve communications between maintenance, engineering, and construction groups.

This numbered document only applies to deep well or shallow bed anodes attached to rectifiers in gas distribution systems.

References

Document

Graphite Anodes Installation and Purchasing Data	O-13
Galvanic Anodes Installation and Purchasing Data	O-13.1
Durichlor Deep Well Anodes Installation and Purchasing Data	O-13.2
Horizontal Anodes Installation and Purchasing Data	O-13.4
Matcor Anodes	O-13.5
Driveable Anodes	O-13.6
Corrosion Control of Gas Facilities	O-16

Procedures

After identifying an anode as a possible candidate for replacement, operations, maintenance and construction personnel shall follow these steps:

1. Field verify that the anode bed’s associated Cathodic Protection Area (CPA) is clear of contacts.
2. Check the anode wire for electrical continuity.
3. Check the rectifier for proper operation (fuses, correct wiring, proper grounding, etc.).
4. Perform an interference test, as described in [Numbered Document O-16](#).
5. Perform an anode bed gas test, as described below.
6. Address all defects detected by the tests required in Steps 1 through 5. If the result of the anode bed gas test is positive, consult corrosion engineering personnel for flushing procedures and criteria.
7. If Steps 1 through 6 do not address the anode problem, consider replacing the anode if it meets one or both the criteria in 7A and 7B.
 - A. The anode/rectifier system is no longer operational (e.g., zero current output)
 - B. The anode/rectifier system can no longer provide effective levels of cathodic protection at maximum output levels as specified in [Numbered Document O-16](#).
8. Develop a “Request for Anode Replacement” package and give it to the responsible gas engineer. The package shall consist of the following:
 - A. A [“Request for Anode Replacement”](#) form (Attachment A).
 - B. An “Interference Test” form ([Numbered Document O-16](#)).

Deep Well and Shallow Bed Anode Replacement

- C. A copy of all CP maintenance forms completed in the time period that the anode operated.
 - D. A copy of the "Cathodic Protection Station Report" showing the anode installation details.
9. The senior gas engineer and/or corrosion engineer will then review the request and determine how the request fits in with any current or future reconstruction plans for the gas facilities in that area. In addition, the engineer should consider the following issues:
- A. Has a 20-Volt rectifier been replaced with a 40-Volt rectifier?
 - B. Is there a nearby rectifier that is not being fully used?
 - C. Should the faulty CPA be tied into another CPA to provide protection?
 - D. Is cathodic protection still needed in the area (i.e., a pipeline replacement job in the near future [within 24 nominal months] going to replace much of the pipe in the area)?
 - E. Should the area become an annual?
 - F. Is a shallow well appropriate for the location (vs. an often more costly deep well anode)? Only install shallow beds in areas where interference is not expected to be encountered (rule of thumb: more than 60' from any other structure). Shallow beds are typically less expensive to install than deep wells (see Table 1 for costs).
10. The engineer should review the records of the voltage and amperage settings of the rectifier as far back as the records have been kept. Use the spreadsheet [Form FO-13.7-B, "Anode Performance Data"](#), to assist in this review. Does it appear that the anode bed is failing?
11. After the engineer has considered other options for the anode replacement, he or she will make a decision about replacing the anode. Anode beds that have not shown signs of failing should normally not be considered for replacement. For deep well anode projects, the engineer will coordinate with the corrosion specialist to review and obtain concurrence for the proposed work.
12. The engineer or Transmission and Regulation supervisor will then coordinate to have a drilling crew perform the work. The procedures for installing anodes are described in Numbered Documents [O-13](#) to [O-13.6](#).

Table 1 Anode Replacement Costs

Item	Installed Costs (Year 2000)
Deep Well (complete replacement – new location – including rectifier)	\$19,000 to \$27,000
Deep Well (drill new well only)	\$5,000 to \$15,000
Shallow Well	\$4,000 to \$8,000

Anode Bed Gas Test

1. Background

- A. When impressed current anode fields are operated at high currents (>3 Amps) in or near brackish water, chlorine gas (Cl₂) or oxygen (O₂) may be produced. These gases can drive out moisture and electrolytes, thereby insulating the anode bed, significantly diminishing its effectiveness. This situation is not normally encountered in properly vented anode beds. However, in unvented anode beds (pre-1971 deep well or any shallow anode beds), particularly those under pavement or in well-consolidated soils (e.g., clay), the insulating gases can build up, severely reducing the effectiveness of the anodes. This is called "gassing."
- B. Although this phenomenon normally only affects shallow bed anodes where the soil does not allow venting of the gas, it can occur on any impressed current anode. Due to the unpredictability of the phenomenon, a gas test must be performed or gassing must be ruled out by other methods before any anode is replaced.
- C. The first sign that gassing may have occurred is a sudden, and otherwise inexplicable, increase of the anode resistance. For example, a rectifier reads 4 Amps at 20 Volts (5 Ohms) in August and suddenly jumps to 1 amp at 20 Volts (20 Ohms) in January for reasons that cannot be explained (contact, removal of pipe, damage, etc.).

2. Procedure

- A. Record voltage and current readings at the affected rectifier, and calculate the effective resistance ($\Omega = V/A$).
- B. Turn the rectifier off for 3 days in well ventilated soil (e.g., sand, loam) or 5 days in clay or under pavement.

Deep Well and Shallow Bed Anode Replacement

- C. Turn the rectifier on and immediately record the voltage and current.
- D. Allow the system to polarize (1/2 hour to 10 days depending on the area).
- E. Record the voltage and current, and calculate the effective resistance.
- F. If the change in resistance between the first and third reads is greater than 20%, gassing has probably occurred.
- G. An alternative to the gas test for shallow bed anode fields is to remove the surface covering, soil, or pavement, above one anode. If gassing has occurred, the spoil will have the distinct odor of chlorine bleach or may be even more rancid.
- H. If anode bed gassing has occurred, to prevent recurrence, install a G-5 valve frame and cover as described in [Numbered Document O-13](#).

Attachments

- [Attachment A](#) . . . [Form FO-13.7-A, "Request for Anode Replacement"](#)
- [Attachment B](#) . . . [Form FO-13.7-B, "Anode Performance Data"](#)

Revision Notes

Revision 02 has the following changes:

1. Added the hyperlinks to the references in entire document.
2. Added the following requirement: "For deep well anode projects, the engineer will coordinate with the corrosion specialist to review and obtain concurrence for the proposed work." to Item 11 on Page 2.
3. Updated the installation costs in Table 1 on Page 2.