HARPER & ASSOCIATES ENGINEERING, INC.
CONSULTING ENGINEERS

1240 E. Ontario Ave., Ste. 102-312 Corona, CA 92881-8671
Phone (951) 372-9196 Fax (951) 372-9198
www.harpereng.com

2007 CORROSION CONTROL PROGRAM REPORT
(REPORT NO. 2396.00)

Lindsay C.

PREPARED FOR:

Lindsay Cao, P.E.
Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA 91302-1994

CONTENTS

FINAL CATHODIC PROTECTION INSPECTION
WATER STORAGE RESERVOIRS
LAS VIRGENES MUNICIPAL WATER DISTRICT
CALABASAS, CALIFORNIA
JULY-SEPTEMBER, 2006 - 2007

I. INTRODUCTION:

During the months of July through September 2006 through 2007, engineering personnel from Harper & Associates Engineering (HAE) performed a variety of tests and inspections on various water storage reservoirs for the Las Virgenes Municipal Water District (LVMWD) located in Calabasas, California. These tests and inspections were to determine the present operating condition of the internal cathodic protection (CP) systems in thirty (30) reservoirs owned and operated by the LVMWD. These reservoirs supply both drinking (potable) water and recycled (irrigation) water to LVMWD customers throughout the District as well as two reservoirs for water treatment.

The internal cathodic protection systems have been installed at various times on differing reservoirs and consist both of sacrificial anode (magnesium rod) types as well as impressed current (rectifier) systems. The majority of systems are installed on the interior wetted surfaces of coated steel reservoirs; however, two reservoirs were determined to be of underground concrete construction with no cathodic protection, one reservoir was new and had no CP designed or installed and one reservoir was of the open (lake) type with steel "fish screens" located underwater on the intake side of a piping manifold arrangement.

The various systems were electrically and visually inspected and tested for compliance with the design drawings and specifications as well as determining if they were providing adequate cathodic protection to the interior wetted surfaces of each respective reservoir. In addition, each system was inspected for condition of anodes, cabling, splices, conduits, rectifiers (where applicable), test monitoring stations and reference electrodes. These tests and inspections are discussed in the sections following and in the Results and Conclusions sections at the end of this report.

II. TEST PROCEDURES:

A. During the course of the various tests and inspections, the following items were performed at each reservoir (where applicable):

1. Examination of available drawings and specifications for comparison with actual installed components.

2. Visual inspection of all relevant components of the individual cathodic protection system.

3. Photography of system components of interest.

4. Comprehensive electrical testing of system components for proper operation.

5. Measurement of structure-to-water potentials on the respective interior shell and bottom structures for "as found" levels of CP.

6. After system adjustment (where applicable and possible), re-measurement of resultant structure-to-water potentials to establish "as left" or "presently operating" levels of CP. Full cathodic protection is represented by measured "off potentials" (current momentarily interrupted) of at least -850 mV to a $CuSO_4$ reference electrode.

B. Each of these items will be discussed, at length, in the paragraphs following:

1. Where available, each of the CP system Plans and Specifications were reviewed and compared to the actual constructed system. System anomalies were noted where and if found.

2. Each reservoir had all CP components visually inspected where feasible (some reservoirs had special anode "hand hole cover" bolts which required special tools to open which were eventually made available at the time of later testing). Inspections were conducted on anodes, cabling, cable splices, conduit runs, conduit fittings, rectifiers (where utilized), test boxes, meters and interior monitoring reference electrodes. Any system problems were noted.

3. Digital photographs were taken of various systems. Some select photographs of special interest are presented in Appendix C of this report.

4. Rectifiers were tested for DC current and voltage outputs along with the capability to be field adjusted (manually and/or automatically). External monitoring meters were tested for accuracy with a calibrated digital VOM as were the internally installed copper-copper sulfate ($CuSO_4$) reference electrodes. Electrode voltages were compared with a calibrated laboratory grade test $CuSO_4$ reference and any significant differences noted.

5. Structure-to-water potentials were measured on both the interior shell and bottom in their "as found" or unadjusted condition. This was accomplished by lowering a calibrated laboratory grade $CuSO_4$ reference electrode into the reservoir interior (below the water line) and connecting it (by cable) to an electronic DC digital VOM. The voltmeter was then connected directly to the structure (by a separate cable) and the resultant cathodic protection potential was measured and recorded. The reference

electrode was moved down the shell wall and across the bottom in small increments and the data for each stopping point was recorded.

6. After CP systems were adjusted for optimum outputs (rectifiers adjusted, systems connected, connections repaired, anode monitoring test station variable resistors adjusted, etc.), structure-to-water potentials were again obtained (see item 5, above) to verify that proper (or maximum available) levels of cathodic protection had been achieved. Final readings were noted and recorded as "final data".

III. TEST RESULTS:

A. A number of items were observed with respect to the cathodic protection systems on the LVMWD reservoirs. These items, as noted below and in the Appendices to this report, represent the findings by the HAE engineering staff. They will be discussed generally and individually in the following paragraphs:

1. Sacrificial Anode Systems

a. All sacrificial anode systems tested were found to be in good condition with a few exceptions. Some systems that were connected to a "header" cable were found to have corroding splices from the anode lead wire to the header cable. Most anodes were classified as "good" (remaining life of 8-10 years). Some systems that had monitoring test stations on the exterior tank wall were observed to be not connected (not in service). A few of the monitoring test stations have adjustable variable resistors installed to control anode output current. Many of these were improperly adjusted (allowing too little current to the structure) and required field adjustments.

2. Impressed Current (Rectifier) Systems

a. Both rectifier systems were found to be operational; however, these systems required some adjustment of the rectifier DC output voltage and current to bring the CP up to full protection. Additionally, the Cordillera meters were not functioning properly and adjustments of outputs were difficult on the rectifier. The anode lead wire spices to the header cable were in poor condition but the anodes themselves were good.

B. The following paragraphs present individual test results for all Potable and Reclaimed Water Reservoirs (except as noted) tested:

1. Cordillera (Recycled Water) - Impressed current system - poor meters, poor control, poor anode splices, anodes good, poor reference electrode.

2. Parkway (Recycled Water) - Sacrificial anode system - all new condition, system initially connected during this survey, polarizing as expected, all materials good, should be up to full protection in short period of time.

3. Oaks – Upper - Sacrificial anode System - all new condition, system initially connected during this survey, polarizing as expected, all materials good, should be up to full protection in short period of time.

4. Indian Hills (Recycled Water) - Sacrificial anode system - utilizes zinc rather than magnesium anodes, system first energized by HAE at time of inspection, system appears to be polarizing, should be retested at later time.

5. Woolsey - Sacrificial anode system - adjusted at meter box, polarizing as expected, all materials good, should be up to full protection in short period of time.

6. Twin Lakes – Upper - Sacrificial anode system - all new condition, system connected and adjusted, all materials good, full protection achieved.

7. Twin Lakes #1 - Sacrificial anode system - all materials good, reached full protection after adjustment of meter box.

8. Twin Lakes #2 - Sacrificial anode system - all materials good, reached full protection after adjustment of meter box

9. Calabasas - Sacrificial anode system - all materials good, reached full protection after adjustment of meter box (lowered system output).

10. Jed Smith #1 - Sacrificial anode system - all materials good, reached full protection after adjustment of meter box (raised system output slightly).

11. Jed Smith #2 - Sacrificial anode system - all materials good, reached full protection with no adjustment of meter box, left in "as found" condition with no adjustments.

12. Saddle Peak - Sacrificial anode system - found in unprotected condition upon arrival (due to possible lightning strike which apparently destroyed internal meter box shunt), replaced shunt and energized system, left variable resistor in 100% position, tank polarizing, should achieve full protection in short time, should be retested at later time.

13. Oakridge - Sacrificial anode system - found in unprotected condition upon arrival (due to many loose connections on back of meter box board assembly), tightened all connections, left variable resistor in 100% position, tank polarizing, should achieve full protection in short time, should be retested at later time.

14. Mulwood - Sacrificial anode system - all materials good, found with less than full protection, reached full protection after adjustment of meter box (raised system output slightly).

15. Dardenne - Sacrificial anode system - materials good except for digital voltmeter, which has front crystal slightly cracked, found with protective levels too high, adjusted system by reducing output slightly, presently has full protection.

16. McCoy - Sacrificial anode system - all materials good, reached full protection with no adjustments required to meter box, left in "as found" condition.

17. Ranch View - New tank - **no cathodic protection system installed**.

18. Latigo - Sacrificial anode system, materials are good, new (replacement) monitoring test box installed, reached full protection in short time.

19. Seminole #1 - Sacrificial anode system - materials are all good with the exception of the digital voltmeter in the meter box (LCD unreadable). Found with protection too high, adjusted variable resistor to reduce system output slightly, left with full protection

20. Seminole #2 - Sacrificial anode system - materials are all good, found with protection too high, adjusted variable resistor to reduce system output slightly, left with full protection.

21. Kimberly - Sacrificial anode system, materials are all good, found with protection too low, adjusted variable resistor to increase system output slightly, left polarizing and with full protection.

22. Morrison - Sacrificial anode system - materials are all good, found system with variable resistor in "zero" position (no current output from anodes) and no 9V battery for digital voltmeter, adjusted variable resistor to 95% and installed new battery for LCD meter, left polarizing and with time, full protection should be reached, should be retested at later time.

23. Saddletree - Sacrificial anode system - materials are all good, found with full protection, left in "as found" condition with no adjustments.

24. Equestrian - Underground concrete reservoir, no cathodic protection installed, **not inspected.**

25. Oaks – Lower - Underground concrete reservoir, no cathodic protection installed, **not inspected.**

26. Warner #1 - sacrificial anode system, all components in good (new) condition, full protection reached after connecting system.

27. Warner #2 – sacrificial anode system, all components in good (new) condition, full protection reached after connecting system.

28. Las Virgenes Reservoir - Open reservoir with five underwater intake pipes covered with "fish screens" of metallic construction. Screens are provided cathodic protection by an impressed current (rectifier) system and three "sled mounted" underwater anode assemblies. Electric fish "shockers" were previously provided in addition to the screens; however, they are currently reported to be out-of-service. Presently fully protected.

29. Rancho Centrate/Sludge Tank #1 – sacrificial anode system installed on bottom floor (concrete) of reservoir, cable connections to exterior of tank, system not operational at time of test, suspect connection problems, reference electrode defective, **no protection**.

30. Rancho Centrate/Sludge Tank #2 – sacrificial anode system installed on bottom floor (concrete) of reservoir, cable connections to exterior of tank, system fully operational, all components in good condition, full protection.

IV. CONCLUSIONS:

A. After the various tests and inspections were conducted on the respective reservoirs, the following conclusions were reached relevant to the current state of the cathodic protection systems on these facilities:

1. The one tank rectifier system (Cordillera) requires some rework and/or modifications in order to provide full CP to its respective facility.

2. Four reservoirs (Indian Hills, Saddle Peak, Oakridge and Morrison) should be retested in 1-2 months (or at the next annual inspection) due to various anomalies discovered at the time of this test period.

3. The following reservoirs presently are **fully cathodically protected** and require no further action until the next annual inspection:

4. Woolsey, Twin Lakes Upper, Twin Lakes #1, Twin Lakes #2, Calabasas, Jed Smith #1, Jed Smith #2, Mulwood, Dardenne, McCoy, Seminole #1,

Seminole #2, Kimberly, Oaks – Upper, Parkway, Las Virgenes Reservoir, Rancho Centrate #2, Latigo, Warner 1 & 2, and Saddletree.

5. Two reservoirs (Equestrian and Oaks – Lower) were found to be underground concrete reservoirs, no cathodic protection neither installed nor required, were not inspected.

6. The Ranch View reservoir is of new-coated steel construction and does not have a cathodic protection system designed nor installed at this time.

7. Las Virgenes Reservoir presently has all five fish screens fully protected by its impressed current CP system. The installed "permanent" reference electrodes are not totally accurate; however, they can be field calibrated at the time of any future testing to provide useful data.

8. Rancho Centrate/Sludge Tank #1 requires anode cleaning, rework of anode/tank connections, and replacement of reference electrode.

V. RECOMMENDATIONS:

A. Based on the Test Results and Conclusions Sections preceding, the following specific recommendations are offered to the LVMWD for each individual reservoir with regard to the cathodic protection systems:

1. Cordillera – **Replace rectifier, replace all existing anode splices to interior header cable, replace reference electrode**, and have system initialized, adjusted and retested.

2. Indian Hills – retest system at next annual inspection

3. Woolsey – no further action until annual inspection

4. Twin Lakes #1 – no further action until annual inspection.

5. Twin Lakes #2 – no further action until annual inspection.

6. Twin Lakes – Upper – no further action until annual inspection.

7. Calabasas – no further action until annual inspection.

8. Jed Smith #1 – no further action until annual inspection.

9. Jed Smith #2 – no further action until annual inspection.

10. Saddle Peak – repaired meter box, system now in operation, should be retested at next annual inspection.

11. Oakridge – tightened loose connections on meter box, system now in operation, should be retested at next annual inspection

12. Mulwood – no further action until annual inspection

13. Dardenne – no further action until annual inspection

14. McCoy – no further action until annual inspection

15. Ranch View – new tank, no CP designed or installed, have both accomplished as soon as practical

16. Latigo – no further action until annual inspection

17. Seminole #1 – no further action until annual inspection

18. Seminole #2 – no further action until annual inspection

19. Kimberly – no further action until annual inspection

20. Morrison – tank now connected and polarizing, should be retested at later time.

21. Saddletree – no further action until annual inspection

22. Equestrian – underground concrete tank, no further action

23. Oaks (Lower) – underground concrete tank, no further action

24. Warner #1 – no further action until annual inspection

25. Warner #2 – no further action until annual inspection

26. Parkway – no further action until annual inspection

27. Oaks (Upper) – no further action until annual inspection

28. Las Virgenes Reservoir – rectifier and anodes fully operational, system functioning as designed, no further action until annual inspection.

29. Rancho Centrate/Sludge #1 – thoroughly clean the individual anodes by brushing or power washing (do not utilize metallic brushes to clean the anodes as this will contaminate them), replace the $CuSO_4$ reference electrode with a new one (recommended is GMC Electrical Model Cu-2-

FW, manufactured in Ontario, CA), rework all exterior electrical anode connections to the tank shell. Remove all existing lug type connectors and cable and replace with new, crimped or soldered connectors on new AWG #8 (minimum) THWN insulated cables. Cover all exposed connectors with a minimum of 1/8 inch of bituminous mastic to prevent corrosion of the connections.

Thoroughly clean any obvious corroded spots on the tank interior shell and/or piping by power brushing the metal surface to bright metal and cover with at least 1/8 inch of bituminous mastic or other coating compatible with the existing shell interior coating. If the interior coating or lining is determined to be of a glass type material, contact the tank manufacturer for further recommendations.

30. Rancho Centrate/Sludge #2 – no further action until annual inspection

B. In order to maintain full cathodic protection to all reservoirs, it is **highly recommended** that an annual inspection be performed on all protected structures and a full report presented. It is further recommended that only a qualified Corrosion Engineering Firm who specializes in cathodic protection design and maintenance testing on water works facilities conduct these tests and inspections.

VI. COST ESTIMATES:

A. The following engineering budgetary cost **estimates** are provided to the LVMWD for the recommended items contained in the preceding sections:

1. Cordillera Reservoir – replace rectifier, replace interior anode/header cable splices, replace interior monitoring reference electrode $5,400.

2. Ranch View – have sacrificial anode CP designed and installed and tested $10,200.

3. Re-inspect individual reservoirs after repairs/polarization occurs (where required), $650 each.

4. Have annual inspections performed on 30 reservoirs and a full report presented, $15,000.

July 31, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Cordillera
HEATED TANK: YES ____ NO x

Model #TPAYCA 12-16 AEGNZ

ON ARRIVAL, RECTIFIER UNIT # 92A1078, MANUFACTURED BY Good-All (VIP), RATED AT 12 D.C. VOLTS, AND 16 D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☒ AND/OR AUTO CONTROLLED # Part 0084645, WAS FOUND OPERATING AT 0.0 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT 0.0 D.C. VOLTS WITH TAP SETTING N/A AND/OR N/A VOLTS POTENTIAL. (Set Point @ -1.300 Volts)

"UNIT FOUND OFF"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	16	FW	Outer: 1 1/2" ϕ FW - (3) Per String "Good"
RING # 2	8	FW	Center: 1 1/2" ϕ FW - (1) Per String "Good"
RING # 3			
RING # 4			

RECTIFIER — Poor: Meters Not Properly Working, Adjustments Difficult.
WIRING — Splices Poor To Fair Condition.
SUSPENSION — Pin Insulators & Handhole Covers Good (Anodes Good).
OTHER — Cell To Cell Difference: 80 mV.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF -1.050 Volts, WITH .5 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT 2.8 D.C. VOLTS, WITH THE TANK APPROXIMATELY 45 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -1.024 VOLTS ON AND -.922 VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

Coating: Peeling (White) "Poor"

SIGNED:

July 31, 2006

WATER TANK SERVICE REPORT

OR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ______

"SACRIFICIAL ZINC ANODE SYSTEM"

JOB NO. ______
CONTRACT TYPE: ______
ANNIVERSARY DATE: ______
TANK TYPE: Ground Storage
TANK LOCATION: Indian Hills
HEATED TANK: YES ______ NO X

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT N/A AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR N/A VOLTS POTENTIAL.

"SYSTEM NOT HOOKED-UP"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	24	ZINC	Outer: 1 1/2" x 1 1/2" x 3' ft. (x2)
RING # 2	12	ZINC	Middle: 1 1/2" x 1 1/2" x 3' ft. (x2)
RING # 3	4	ZINC	Center: 1 1/2" x 1 1/2" x 3' ft. (x1)
RING # 4			

RECTIFIER — Meter Box With Anode (Current Adjustment)
WIRING — OK, Splices Good.
SUSPENSION — OK, (Anodes Good 95%+)
OTHER — Cell To Cell Difference: 50 mV.

* Hooked-up Meter Box, Set Current Adjustment @ 100%.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH N/A D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 70% FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -.849 VOLTS ON AND ______ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

Coating Appears In Fair Condition.

SIGNED: ______

August 3, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P.O. # ____

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO. ____
CONTRACT TYPE: ____
ANNIVERSARY DATE: ____
TANK TYPE: Ground Storage
TANK LOCATION: Woolsey
HEATED TANK: YES ____ NO x

.5 Million Gallon, 1981 (55'ϕ x 32'H

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .08 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR -.829 VOLTS POTENTIAL.

* Current Control Set @ 95%

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	8	MAG.	1 1/2" ϕ x (10±15' Est.)
RING # 2			"Anodes Couldn't Be Completely Pulled Out"
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.

WIRING — Good, Splices Good.

SUSPENSION — Good, (Anodes Good 98%+).

OTHER — Cell To Cell Reading: Cell #1) 36 mV, Cell #2) 18 mV.
Coating - Coal Tar Epoxy (Fair ?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .14 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 50 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Anode Current Set @ 98%.

SIGNED: ____

August 3, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

JOB NO. ____
CONTRACT TYPE: ____
ANNIVERSARY DATE: ____
TANK TYPE: Ground Storage
TANK LOCATION: Twin Lakes - Upper

CUSTOMER P. O. # ____

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box 031016CAS, MANUFACTURED BY IRT, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT N/A AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR N/A VOLTS POTENTIAL.

"System "OFF" - Meter Box Not Connected, Waiting For Coating Inspection"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	6	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 2			
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes New).
OTHER — Cell To Cell Readings: Cell #1) 11 mV, Cell #2) 5 mV.
Coating - Good.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH N/A D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75% FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

"Needs Coating Inspection Prior To Hook-up"

SIGNED: ____

August 3, 2006

WATER TANK SERVICE REPORT

OR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

USTOMER P. O. # ______

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO. ______
CONTRACT TYPE: ______
ANNIVERSARY DATE: ______
TANK TYPE: Ground Storage
TANK LOCATION: Twin Lakes #1
HEATED TANK: YES ______ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041891, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .02 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. Cell #1) -1.292 Volts * Cell #2) -1.238 Volts *

"Active - Current Set Control @ 88%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access "Handhole Cover Locks"
Had To Visually Inspect Through Hatch.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
	4	MAG	1 1/2" ϕ x 10' ft. (Est.)
RING # 1			
RING # 2			
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 25 mV, Cell #2) 13 mV.
Coating - Coal Tar Epoxy (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .02 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 80 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ______ VOLTS ON AND ______ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

SIGNED: ______

August 3, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ______

JOB NO. ______
CONTRACT TYPE: ______
ANNIVERSARY DATE: ______
TANK TYPE: Ground Storage
TANK LOCATION: Twin Lakes #2
HEATED TANK: YES ______ NO x

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041895, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .07 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -1.268 Volts * #2) -1.328 Volts *

"Active - Current Set Control @ 96%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access "handhole Cover Locks"
Had To Visually Inspect Through Hatch.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	10	MAG.	1 1/2" ϕ x 10'-15' ft. (Est.)
RING # 2			
RING # 3	5	MAG.	1 1/2" ϕ x 10'-15' ft. (Est.)
RING # 4			

RECTIFIER – Meter Box - Good.
WIRING – Good, Splices Good.
SUSPENSION – Good, (Anodes Good 90%+).
OTHER – Cell To Cell Resdings: Cell #1 29 mV, Cell #2 22 mV.
Coating -Coal Tar Epoxy (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .07 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 80 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ______ VOLTS ON AND ______ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

SIGNED: ______

August 3, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Calabasas (8MG)
HEATED TANK: YES ____ NO x

CUSTOMER P. O. #

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041897, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .33 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL.
#1) -1243 Volts *
#2) -1272 Volts *

"Active - Currnet Set Control @98%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access "Handhole Cover Locks"
Had To Visually Inspect Through Hatch.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	20	MAG.	1 1/2" ø x 20' ft. (Est.)
RING # 2	15	MAG.	1 1/2" ø x 20' ft. (Est.)
RING # 3	11	MAG.	1 1/2" ø x 20' ft. (Est.)
RING # 4	4	MAG.	1 1/2" ø x 20' ft. (Est.)

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 31 mV, Cell #2) 12 mV.
Coating - Coal Tar Epoxy (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .15 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 50 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

"Set Anode Current Adjustment To 94%"

SIGNED: ____

August 3, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ____

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO. ____
CONTRACT TYPE: ____
ANNIVERSARY DATE: ____
TANK TYPE: Ground Storage
TANK LOCATION: Jed Smith #1
HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .02 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -.873 Volts * #2) -.903 Volts *

"Anode Current Set @ 60%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	8	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 2	4	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 39 mV, Cell #2)24 mV.
Coating, Beige Type Over Coal Tar Epoxy - (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .05 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 90 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Anode Current Set To 85%.

SIGNED: ____

August 3, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ______

JOB NO. ______
CONTRACT TYPE: ______
ANNIVERSARY DATE: ______
TANK TYPE: Ground Storage
TANK LOCATION: Jed Smith #2

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

HEATED TANK: YES ______ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .03 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -1.080 Volts * #2) -1.101 Volts *

"Anode Current Set @ 82%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES

	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	8	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 2	4	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 28 mV, Cell #2) 17 mV.
Coating, Beige Type Over Coal Tar Epoxy - (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .04 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 90 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ______ VOLTS ON AND ______ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

Anode Current Set To 85%.

SIGNED: ______

August 7, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

JOB NO. ____
CONTRACT TYPE: ____
ANNIVERSARY DATE: ____
TANK TYPE: Ground Storage
TANK LOCATION: Saddle Peak

CUSTOMER P.O. # ____

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT N/A AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -.595 Volts *
"Anode Current Set @ 100%" #2) -.545 Volts *

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	16	MAG.	1 1/2" ϕ x 20' ft. (Est.)
RING # 2	8	MAG.	1 1/2" ϕ x 20' ft. (Est.)
RING # 3	4	MAG.	1 1/2" ϕ x 20' ft. (Est.)
RING # 4			

RECTIFIER – Meter Box OK, Repaired Broken Shunt.
WIRING – Good, Splices Good.
SUSPENSION – Good, (Anodes Good 90%+).
OTHER – Cell To Cell Reading: Cell #1) 32 mV, Cell #2) 48 mV.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .02 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Anode Current Left Set @ 100%.

SIGNED: ____

August 7, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P.O. #

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Oakridge

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

HEATED TANK: YES ______ NO X

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041893, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT 0.0 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL.

#1) -.541 Volts *
#2) -.540 Volts *

"Anode Current Set @ 94%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access "Handhole Cover Locks"
Had To Visually Inspect Through Hatch.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	4	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 2			
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Fair, "Had To Tighten Connection In Back Of Box Board".
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 16 mV, Cell #2) 18 mV.
Coating - Coal Tar Epoxy - (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .04 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 80 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ______ VOLTS ON AND ______ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

Anode Current Set @ 100%.

SIGNED: ______________________

August 8, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ____

JOB NO. ____
CONTRACT TYPE: ____
ANNIVERSARY DATE: ____
TANK TYPE: Ground Storage
TANK LOCATION: Mulwood
HEATED TANK: YES ____ NO X

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .04 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -.874 Volts * #2) -.938 Volts *

"Anode Current Set @ 98%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	10	MAG.	1 1/2" ø x 20' ft. (Est.)
RING # 2	5	MAG.	1 1/2" ø x 20' ft. (Est.)
RING # 3	3	MAG.	1 1/2" ø x 20' ft. (Est.)
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 14 mV, Cell #2) 42 mV.
Coating - Coal Tar Epoxy (Newer).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .09 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 60% FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Anode Current Set To 100%.

SIGNED: ____

August 7, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P.O. # ______

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO. ______
CONTRACT TYPE: ______
ANNIVERSARY DATE: ______
TANK TYPE: Ground Storage
TANK LOCATION: Dardenne
HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041892, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .02 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -1.279 , -1.322 (Fluctuating) #2) -1.443 Volts *

"Anode Current Set @ 96%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access "Handhole Cover Locks"
Had To Visually Inspect Through Hatch.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
	4	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 1			
RING # 2			
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Fair (LED Crystal Slightly Damaged).
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 85%-90%).
OTHER — Cell To Cell Readings: Cell #1) 6 mV, Cell #2) 45 mV.
Coating - Coal Tar Epoxy With Patch Spots - (Fair?).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .01 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75% FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

Anode Current Set To 76%.

SIGNED: ______

August 7, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: McCoy (2.0 MG)
HEATED TANK: YES ____ NO X
106' ϕ x 32' High

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041898, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # ________, WAS FOUND OPERATING AT .04 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -1.156 Volts *
#2) -1.259 Volts *

"Anode Current Set @ 90%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access " Handhole Cover Locks"
Had To Visually Inspect Through Hatch.

ANODES

	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	10	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 2	5	MAG.	1 1/2" ϕ x 10' ft. (Est.)
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 85%).
OTHER — Cell To Cell Readings: Cell #1) 35 mV, Cell #2)46 mV.
Coating - Coal Tar Epoxy - (Fair?)

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .04 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 80 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ______ VOLTS ON AND ______ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

Anode Current Set @ 90%.

SIGNED: ____________________

August 22, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Latigo
HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT 0.0 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR 0.0 VOLTS POTENTIAL.

* Meter Box "Not" Hooked-up, Current Set @ 0.0 "Extensive Water Damage"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	10	MAG.	2" ϕ x 20' ft. (Est.)
RING # 2	5	MAG.	2" ϕ x 20' ft. (Est.)
RING # 3			
RING # 4			

RECTIFIER — Poor: Extensive Water Damage, Meter Box 1/2 Filled With Water.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 95%+).
OTHER — Meter Box & Board Require Repair Or Replacement Prior To Hook-up.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH 0.0 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

"Meter Box Left Without Hook-up."

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

SIGNED: ____________

August 22, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ____

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO. ____
CONTRACT TYPE: ____
ANNIVERSARY DATE: ____
TANK TYPE: Ground Storage
TANK LOCATION: Seminole #1
HEATED TANK: YES ____ NO X

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-041894, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT * AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. Anode Current Set @ 96%

* No Access "Handhole Cover Locks"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	4	MAG.	2" ϕ x 10' ft. (Est.)
RING # 2			
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Fair (LED Unable To Read, Crystal Damaged).
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 16 mV, Cell #2) 38 mV.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .02 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 85 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Coating Appears In Good Condition.

Anode Current Re-Set To 85%.

SIGNED: ____

August 22, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Seminole #2

CUSTOMER P. O. #

"SACRIFICIAL MAGNESIUM ANODE SYSTEM" HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box C041896, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .08 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -1.328 Volts *
"Anode Current Set @ 94%" #2) -1.561 Volts *

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* No Access, Handhole Cover Locks.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	10	MAG.	2" ϕ x 10' ft. (Est.)
RING # 2	5	MAG.	2" ϕ x 10' ft. (Est.)
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 17 mV, Cell #2) 48 mV.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .05 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 80 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Coating Appears In Good Condition.

Anode Current Re-Set To 90%.

SIGNED: ____

August 22, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #
"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Kimberly
HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-024647, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR . AUTO CONTROLLED # N/A , WAS FOUND OPERATING AT .04 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -.842 Volts * #2) -.940 Volts *
"Anode Current Set @ 90%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
	5	MAG.	2" ø x 10' ft. (Est.)
RING # 1			
RING # 2			
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 41 mV, Cell #2) 45 mV.
Coating - Coal Tar Epoxy.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A , WITH .06 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Anode Current Re-Set To 98%.

SIGNED: ____

August 22, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Morrison
HEATED TANK: YES ____ NO X

ON ARRIVAL, RECTIFIER UNIT # Meter Box C041899 MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT 0.0 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL.

"Current Control Set @ Zero"

#1) -.562 Volts
#2) -.615 Volts

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

* System Hooked-up, But Control Set @ Zero.
* No Access, Handhole Cover Locks.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
	16	MAG.	2" ϕ x 10' ft. (Est.)
RING # 1			
RING # 2	10	MAG.	2" ϕ x 10' ft. (Est.)
RING # 3	4	MAG.	2" ϕ x 10' ft. (Est.)
RING # 4			

RECTIFIER — Meter Box - Good (Had No Battery, Installed New 9 Volt).
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 95%+).
OTHER — Cell To Cell Readings: Cell #1) 35 mV, Cell #2) 14 mV.
Coating - Coal Tar Epoxy.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .17 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 90 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

Current Control Set To 95%.

SIGNED: ____________________

August 22, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Saddle Tree
HEATED TANK: YES ____ NO x

ON ARRIVAL, RECTIFIER UNIT # Meter Box C-022728JB, MANUFACTURED BY Corrpro, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR . AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT .11 AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR * VOLTS POTENTIAL. #1) -1.205 Volts *
"Current Control Set @ 100%" #2) -1.290 Volts *

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	16	MAG.	2" ϕ ("D") x 5' ft. (Calcium Deposits On Anodes
RING # 2	4	MAG.	2" ϕ ("D") x 5' ft.
RING # 3			
RING # 4			

RECTIFIER — Meter Box - Good.
WIRING — Good, Splices Good.
SUSPENSION — Good, (Anodes Good 90%+).
OTHER — Cell To Cell Readings: Cell #1) 31 mV, Cell #2) 39 mV.
Coating - Coal Tar Epoxy.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .11 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

"Current Set @ 100%"

SIGNED: ____

September 21, 2006 **WATER TANK SERVICE REPORT**

OR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

USTOMER P. O. #

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Parkway
HEATED TANK: YES ___ NO x
40' ϕ x 17' High

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

ON ARRIVAL, RECTIFIER UNIT # Meter Box N/A, MANUFACTURED BY IRT, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT N/A AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR N/A VOLTS POTENTIAL.

* Recently Passed Coating Waiting Period, Meter Box Unhooked.

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	4	MAG.	2" ϕ x 10' ft. (Est.)
RING # 2			"Anodes Couldn't Be Completely Pulled Out"
RING # 3			
RING # 4			

RECTIFIER – Meter Box - New (Current Adjustable).
WIRING – Good, Splices Good.
SUSPENSION – Good, Anodes Good.
OTHER – Cell To Cell Readings Good (Cell #1) -2mV, Cell #2) -5 mV).
*Energized System 9/21/06, Hooked-Up & Tested Meter Box System.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .04 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 60 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

* Current Adjustment
Set @ 96%
(.04 Amps)

Meter Box Readings: Cell #1 -1.076 Volts
Cell #2 -1.092 Volts
(Tank @ Same Location As Oaks-Upper)

SIGNED:

September 21, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. #

"SACRIFICIAL MAGNESIUM ANODE SYSTEM"

JOB NO.
CONTRACT TYPE:
ANNIVERSARY DATE:
TANK TYPE: Ground Storage
TANK LOCATION: Oaks - Upper
HEATED TANK: YES ____ NO X
55' ϕ x 17.5" High

ON ARRIVAL, Meter Box RECTIFIER UNIT # N/A, MANUFACTURED BY IRT, RATED AT -- D.C. VOLTS, AND --- D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT N/A AMPS TO THE BOWL AND --- AMPS TO THE RISER AT N/A D.C. VOLTS WITH TAP SETTING N/A AND/OR N/A VOLTS POTENTIAL.

* Recently Passed Coating Waiting Period, Meter Box Unhooked.

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1	6	MAG.	2" ϕ x 10' ft. (Est.)
RING # 2			"Anodes Couldn't Be Completely Pulled Out"
RING # 3			
RING # 4			

RECTIFIER — Meter Box - New (Current Adjustable).
WIRING — Good, Splices Good.
SUSPENSION — Good, Anodes Good.
OTHER — Cell To Cell Readings Good (Cell #1 -8 mV, Cell #2 -6 mV).

* Energized System 9/21/06, Hooked-Up & Tested Meter Box System.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A, WITH .02 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 75 % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ____ VOLTS ON AND ____ VOLTS OFF.

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ____ AND ____ AMPS AND THE RISER CURRENT BETWEEN ____ AND ____ AMPS WHEN THE TANK IS FULL.

* Current Adjustment
Set @ 100%
(.02 Amps)

Meter Box Readings: Cell #1 -.809 Volts
Cell #2 -.820 Volts
(Tank @ Same Location As Parkway)

SIGNED:

September 21, 2006

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

CUSTOMER P. O. # ______

JOB NO. ______
CONTRACT TYPE: ______
ANNIVERSARY DATE: ______
TANK TYPE: Ground Storage
TANK LOCATION: Las Virgenes Reservoir
"RESERVOIR"
HEATED TANK: YES ______ NO x

Model # MASYSA 80-42 ABM

ON ARRIVAL, RECTIFIER UNIT # 521R0795, MANUFACTURED BY Matcor, Inc., RATED AT 80 D.C. VOLTS, AND 42 D.C. AMPS, TYPE: MANUAL ☒ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A, WAS FOUND OPERATING AT 11.3 AMPS TO THE BOWL AND ---- AMPS TO THE RISER AT 45.5 D.C. VOLTS WITH TAP SETTING C-2 AND/OR -1.150 VOLTS POTENTIAL.
@ Test Box

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO	TYPE	PLATINIZED NIOBIUM HOOP DIAMETER, DIAMETER AND LENGTH OF ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON).
RING # 1		TA	(4) Cast-Iron 84" Tubular
RING # 2		TA	(4) Cast-Iron 84" Tubular
RING # 3		TA	(4) Cast-Iron 84" Tubular
RING # 4			

RECTIFIER — Fair Condition
WIRING — Fair Condition
SUSPENSION — Unknown
OTHER — Permanent Reference Electrodes (Poor To Fair Condition).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF C-2 AND/OR REFERENCE CELL SETTING OF N/A, WITH 11.5 D.C. AMPS TO THE BOWL AND --- D.C. AMPS TO THE RISER AT 45.5 D.C. VOLTS, WITH THE TANK APPROXIMATELY Reservoir % FULL OF WATER. THE TANK-TO-WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -1.122 VOLTS ON AND -.966 VOLTS OFF.
@ Fish Cage Location

TO INSURE CONTINUOUS CATHODIC PROTECTION, OF MANUALLY OPERATED SYSTEMS, THE RECTIFIER OUTPUT SHOULD BE READ ONCE A MONTH AND ADJUSTMENTS MADE TO MAINTAIN THE BOWL CURRENT BETWEEN ______ AND ______ AMPS AND THE RISER CURRENT BETWEEN ______ AND ______ AMPS WHEN THE TANK IS FULL.

SIGNED: ______

POTENTIAL FIELD DATA SHEET
LAS VIRGENES RESERVOIR
SEPTEMBER 21, 2006

"AS FOUND" READINGS

Structure	Permanent CuSO4 Electrode	
	"ON"	"OFF"
Cage #1	Out of Water	Out of Water
Cage #2 *	-996	-923
Cage #3 *	-793	-761
Cage #4 *	-965	-948
Cage #5 *	-927	-917

* Structure Leads White In Test Box.

Structure	Portable CuSO4 Electrode Directly Over Cage	
	"ON"	"OFF"
Cage #1	Out of Water	Out of Water
Cage #2	-1122	-966
Cage #3	-1279	-1020
Cage #4	-1140	-1018
Cage #5	-1200	-1010

Portable Electrode To Permanent Electrode (Calibration Test)

Rectifier "OFF"

Cell No.	Potential (mV) **
Cage #2	35
Cage #3	270
Cage #4	86
Cage #5	96

** These are Readings to a Laboratory Calibrated Portable CuSO4 Field Electrode.

"CONTINUED"
POTENTIAL FIELD DATA SHEET
LAS VIRGENES RESERVOIR
SEPTEMBER 21, 2006

"AS FOUND READINGS"

Anode Current Output
(3) Skids w/(4) High Silicone
Cast Iron Anodes 84" Long (Tubular Type).

Anode No. - Skid No.	Amps
#1	2.4
#2	1.9
#3	4.5

HARPER & ASSOCIATES ENGINEERING, INC.

1240 E. Ontario Ave., Ste. 102-312, Corona, CA. 92881-8671
Phone: (951) 372-9196 Fax: (951) 372-9198
e-Mail: HAETanks@aol.com

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

Customer P.O. #

JOB NO.:
CONTRACT TYPE:
TYPE OF SYSTEM: Sacrificial Magnesium Anode System
TANK TYPE: Ground Storage
TANK LOCATION: Latigo

HEATED TANK YES ___ NO X

ON ARRIVAL METER BOX # C-051932, MANUFACTURED BY Corrpro, RATED AT ------ D.C. VOLTS AND —— , D.C. AMPS, TYPE: MANUAL☐ AUTOMATIC POTENTIAL CONTROL☐ AND/OR AUTO CONTROLLED # N/A FOUND OPERATING AT .02 AMPS TO THE BOWL AND ------ AMPS TO RISER AT ------ D.C. VOLTS WITH TAP SETTING ------ AND/OR #1 .937 #2 .947 VOLTS POTENTIAL. "Anode Current Set @ 55%"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO.	TYPE	LENGTH OF TITANIUM OXIDE WIRE, ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON) ANODES.
RING # 1	10	MAG.	2" Diameter x 20' ft. (Estimate)
RING # 2	5	MAG.	2" Diameter x 20' ft. (Estimate)
RING # 3			
RING # 4			

RECTIFIER - Meter Recent Replacement - Cell #1 Reading -.937 Volts, Cell #2 Reading -.947 Volts.
WIRING - Good Condition – Splices Good Condition.
SUSPENSION - Good Condition – Anodes Good Condition.
OTHER - Reference Electrodes Good Condition. Coating Appears In Good Condition.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A WITH, .02 D.C. AMPS TO THE BOWL AND TANK-TO-WATER D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 85 % FULL OF WATER , THE TANK TO WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -.969 VOLTS ON AND -.897 * VOLTS OFF. * And Polarizing

- Anode Current Set @ 62%.
- Performed Inspection of Replacement of Meter Box, And Testing – All OK After Adjustment.

SIGNED: ____________________

FOR YOUR CONVENIENCE IN MAINTAINING RECORDS OF THE MONTHLY READINGS ON THIS CATHODIC PROTECTION SYSTEM THE FOLLOWING FORM IS PROVIDED:

	TAP/ POTENTIAL SETTING	UNIT D.C. VOLTAGE	BOWL CURRENT	RISER CURRENT	WATER LEVEL
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY	N/A	N/A	.02	------	85%
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

STRUCTURE – TO – WATER POTENTIALS (MV)

"AS FOUND POTENTIALS"

	"ON"	"OFF"
Top	-963	-849
3'	-936	-848
6'	-934	-846
9'	-933	-845
12'	-935	-843
15'	-937	-851
18'	-940	-855
21'	-940	-869
Bottom	-940	-880

"AFTER ADJUSTMENTS"

	"ON"	"OFF"
Top	-975	-887
Middle	-969	-875
Bottom	-965	-901

HARPER & ASSOCIATES ENGINEERING, INC.

1240 E. Ontario Ave., Ste. 102-312, Corona, CA. 92881-8671
Phone: (951) 372-9196 Fax: (951) 372-9198
e-Mail: HAETanks@aol.com

WATER TANK SERVICE REPORT

FOR Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

Customer P.O. # ______

JOB NO.: ______
CONTRACT TYPE: ______
TYPE OF SYSTEM: Sacrificial Magnesium Anode System
TANK TYPE: Ground Storage
TANK LOCATION Centrate / Sludge Tank #1
HEATED TANK YES ______ NO X

ON ARRIVAL METER BOX # N/A, MANUFACTURED BY ------, RATED AT ------ D.C. VOLTS AND ------, D.C. AMPS, TYPE: MANUAL☐ AUTOMATIC POTENTIAL CONTROL☐ AND/OR AUTO CONTROLLED # N/A FOUND OPERATING AT ------ AMPS TO THE BOWL AND ------ AMPS TO RISER AT ------ D.C. VOLTS WITH TAP SETTING ------ AND/OR ------ VOLTS POTENTIAL.

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO.	TYPE	LENGTH OF TITANIUM OXIDE WIRE, ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON) ANODES.
RING # 1	N/A	MAG.	"Unknown" – Unable To See @ Bottom Of Tank.
RING # 2			
RING # 3			
RING # 4			

RECTIFIER - None
WIRING - N/A
SUSPENSION - N/A
OTHER - Reference Electrodes Lead Found, No Reading Reference Electrode Bad.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A WITH, N/A D.C. AMPS TO THE BOWL AND TANK-TO-WATER D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 50 % FULL OF WATER, THE TANK TO WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ------ VOLTS ON AND ------ VOLTS OFF.

- Random Coil Lead Tested At .882 Volts (Possible Anode).
- Performed Initial Testing Only.

Note: (15) Coiled Lead Bonds Located Around Base Of Tank. Potentials Jumped To -.545 Volts When Shorted. Other Random One's Showed No Change. Anode Inspection Needed, Possible Bonding Problem.

SIGNED: ______

FOR YOUR CONVENIENCE IN MAINTAINING RECORDS OF THE MONTHLY READINGS ON THIS CATHODIC PROTECTION SYSTEM THE FOLLOWING FORM IS PROVIDED:

	TAP/ POTENTIAL SETTING	UNIT D.C. VOLTAGE	BOWL CURRENT	RISER CURRENT	WATER LEVEL
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY	N/A	N/A	N/A	-------	50%
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

STRUCTURE – TO – WATER POTENTIALS (MV)

"AS FOUND POTENTIALS"		"AFTER ADJUSTMENTS"	
"Upon Arrival"	"OFF"	"ON"	"OFF"
Top -532			
-529			
-519			
Bottom -504			

HARPER & ASSOCIATES ENGINEERING, INC.

1240 E. Ontario Ave., Ste. 102-312, Corona, CA. 92881-8671
Phone: (951) 372-9196 Fax: (951) 372-9198
e-Mail: HAETanks@aol.com

WATER TANK SERVICE REPORT

FOR Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

Customer P.O. # ____

JOB NO.: ____
CONTRACT TYPE: ____
TYPE OF SYSTEM: Sacrificial Magnesium Anode System
TANK TYPE: Ground Storage
TANK LOCATION Centrate / Sludge Tank #2
HEATED TANK YES ____ NO X

ON ARRIVAL METER BOX # N/A, MANUFACTURED BY ------, RATED AT ------ D.C. VOLTS AND ------, D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A FOUND OPERATING AT ------ AMPS TO THE BOWL AND ------ AMPS TO RISER AT ------ D.C. VOLTS WITH TAP SETTING ------ AND/OR ------ VOLTS POTENTIAL.

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO.	TYPE	LENGTH OF TITANIUM OXIDE WIRE, ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON) ANODES.
RING # 1	N/A	MAG.	"Unknown" – Unable To See @ Bottom Of Tank.
RING # 2			
RING # 3			
RING # 4			

RECTIFIER - None
WIRING - N/A
SUSPENSION - N/A
OTHER - Reference Electrodes Lead Found, Potential -1.065 Volts (Cell To Cell Reading 47 mV).

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A WITH, N/A D.C. AMPS TO THE BOWL AND TANK-TO-WATER D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 50 % FULL OF WATER, THE TANK TO WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS ------ VOLTS ON AND ------ VOLTS OFF.

- Random Coil Lead Tested At 1.262 Volts (Possible Anode).
- Performed Initial Testing Only.

SIGNED: ____

FOR YOUR CONVENIENCE IN MAINTAINING RECORDS OF THE MONTHLY READINGS ON THIS CATHODIC PROTECTION SYSTEM THE FOLLOWING FORM IS PROVIDED:

	TAP/ POTENTIAL SETTING	UNIT D.C. VOLTAGE	BOWL CURRENT	RISER CURRENT	WATER LEVEL
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY	N/A	N/A	N/A	------	50%
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

STRUCTURE – TO – WATER POTENTIALS (MV)

"AS FOUND POTENTIALS"		"AFTER ADJUSTMENTS"	
"Upon Arrival"	"OFF"	"ON"	"OFF"
Top -1139			
-1128			
-1124			
Bottom -1117			

HARPER & ASSOCIATES ENGINEERING, INC.

1240 E. Ontario Ave., Ste. 102-312, Corona, CA. 92881-8671
Phone: (951) 372-9196 Fax: (951) 372-9198
e-Mail: HAETanks@aol.com

WATER TANK SERVICE REPORT

FOR: Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

Customer P.O. #

JOB NO.:
CONTRACT TYPE:
TYPE OF SYSTEM: Sacrificial Magnesium Anode System
TANK TYPE: Ground Storage
TANK LOCATION: Twin Lakes - Upper
HEATED TANK YES ____ NO X

ON ARRIVAL METER BOX # 031016CAS, MANUFACTURED BY IRT, RATED AT ------ D.C. VOLTS AND ---- , D.C. AMPS, TYPE: MANUAL ☐ AUTOMATIC POTENTIAL CONTROL ☐ AND/OR AUTO CONTROLLED # N/A FOUND OPERATING AT 0 AMPS TO THE BOWL AND ------ AMPS TO RISER AT ------ D.C. VOLTS WITH TAP SETTING ------ AND/OR N/A VOLTS POTENTIAL. "System / Meter Box Not Connected"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO.	TYPE	LENGTH OF TITANIUM OXIDE WIRE, ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON) ANODES.
RING # 1	6	MAG.	1 1/2" Diameter x 10' ft. (Estimate)
RING # 2			
RING # 3			
RING # 4			

RECTIFIER - Meter Box Good Condition– Cell #1 Reading -1.020 Volts, Cell #2 Reading -1.040 Volts (After Hook-Up).
WIRING - Good Condition – Splices Good Condition.
SUSPENSION - Good Condition – Anodes Good Condition.
OTHER - Reference Electrodes Good Condition. Coating Appears In Good Condition.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A WITH, .0 D.C. AMPS TO THE BOWL AND TANK-TO-WATER D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 50 % FULL OF WATER, THE TANK TO WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -1.025 VOLTS ON AND -.849 * VOLTS OFF. * And Polarizing

- Anode Current Set @ 95%.
- NATIVE -.428 Volts
- Performed Initial Hook-Up, Energized, And Testing – All OK.

SIGNED: ____________________

FOR YOUR CONVENIENCE IN MAINTAINING RECORDS OF THE MONTHLY READINGS ON THIS CATHODIC PROTECTION SYSTEM THE FOLLOWING FORM IS PROVIDED:

	TAP/ POTENTIAL SETTING	UNIT D.C. VOLTAGE	BOWL CURRENT	RISER CURRENT	WATER LEVEL
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY	N/A	N/A	.01	-------	50%
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

STRUCTURE – TO – WATER POTENTIALS (MV)

"AS FOUND – NATIVE POTENTIAL"

"ON"	"OFF"
-428	

"AFTER HOOK-UP / ENERGIZING"

	"ON"	"OFF"
Top	-1035	-850
Middle	-1025	-849
Bottom	-1015	-848

* After 20 Minutes And Polarizing

HARPER & ASSOCIATES ENGINEERING, INC.

1240 E. Ontario Ave., Ste. 102-312, Corona, CA. 92881-8671
Phone: (951) 372-9196 Fax: (951) 372-9198
e-Mail: HAETanks@aol.com

WATER TANK SERVICE REPORT

FOR Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

Customer P.O. # ______

JOB NO.: ______
CONTRACT TYPE: ______
TYPE OF SYSTEM: Sacrificial Magnesium Anode System
TANK TYPE: Ground Storage
TANK LOCATION Warner #1

HEATED TANK YES ______ NO X

ON ARRIVAL METER BOX # C-060662, MANUFACTURED BY Corrpro, RATED AT ------ D.C. VOLTS AND ----- , D.C. AMPS, TYPE: MANUAL☐ AUTOMATIC POTENTIAL CONTROL☐ AND/OR AUTO CONTROLLED # N/A FOUND OPERATING AT 0 AMPS TO THE BOWL AND ------ AMPS TO RISER AT ------ D.C. VOLTS WITH TAP SETTING ------ AND/OR N/A VOLTS POTENTIAL. "System / Meter Box Not Connected"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO.	TYPE	LENGTH OF TITANIUM OXIDE WIRE, ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON) ANODES.
RING # 1	6	MAG.	2" Diameter x 20' ft. (Estimate)
RING # 2			
RING # 3			
RING # 4			

RECTIFIER - Meter Box Good Condition – Cell #1 Reading -.986 Volts, Cell #2 Reading -.997 Volts (After Hook-Up).
WIRING - Good Condition – Splices Good Condition.
SUSPENSION - Good Condition – Anodes Good Condition.
OTHER - Reference Electrodes Good Condition. Coating Appears In Good Condition.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A WITH, .01 D.C. AMPS TO THE BOWL AND TANK-TO-WATER D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 60 % FULL OF WATER , THE TANK TO WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -1.004 VOLTS ON AND -.846 * VOLTS OFF. * And Polarizing

- Anode Current Set @ 50%.
- NATIVE -.674 Volts
- Performed Initial Hook-Up, Energized, And Testing – All OK.

SIGNED: ______

FOR YOUR CONVENIENCE IN MAINTAINING RECORDS OF THE MONTHLY READINGS ON THIS CATHODIC PROTECTION SYSTEM THE FOLLOWING FORM IS PROVIDED:

	TAP/ POTENTIAL SETTING	UNIT D.C. VOLTAGE	BOWL CURRENT	RISER CURRENT	WATER LEVEL
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY	N/A	N/A	.01	-------	60%
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

STRUCTURE – TO – WATER POTENTIALS (MV)

"AS FOUND – NATIVE POTENTIAL"		"AFTER HOOK-UP / ENERGIZING"	
"ON"	"OFF"	"ON"	"OFF"
-674		Top -1013	-886
		Middle -1004	-846
		Bottom -1006	-834
		* After 20 Minutes And Polarizing	

HARPER & ASSOCIATES ENGINEERING, INC.

1240 E. Ontario Ave., Ste. 102-312, Corona, CA. 92881-8671
Phone: (951) 372-9196 Fax: (951) 372-9198
e-Mail: HAETanks@aol.com

WATER TANK SERVICE REPORT

FOR Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA. 91302

Customer P.O. # ______

JOB NO.: ______
CONTRACT TYPE: ______
TYPE OF SYSTEM: Sacrificial Magnesium Anode System
TANK TYPE: Ground Storage
TANK LOCATION Warner #2

HEATED TANK YES ______ NO X

ON ARRIVAL METER BOX # C-051931, MANUFACTURED BY Corrpro, RATED AT ------ D.C. VOLTS AND ----- , D.C. AMPS, TYPE: MANUAL☐ AUTOMATIC POTENTIAL CONTROL☐ AND/OR AUTO CONTROLLED # N/A FOUND OPERATING AT 0 AMPS TO THE BOWL AND ------ AMPS TO RISER AT ------ D.C. VOLTS WITH TAP SETTING ------ AND/OR N/A VOLTS POTENTIAL. "System / Meter Box Not Connected"

ALL ANODES, SUSPENSION, WIRING, ETC., WERE INSPECTED AND THE FOLLOWING REPAIRS OR REPLACEMENTS WERE MADE.

ANODES	NO.	TYPE	LENGTH OF TITANIUM OXIDE WIRE, ALUMINUM, OR NO. SECTIONS AND SPACING (HISILICON CAST IRON) ANODES.
RING # 1	10	MAG.	2" Diameter x 20' ft. (Estimate)
RING # 2	5	MAG.	2" Diameter x 20' ft. (Estimate)
RING # 3			
RING # 4			

RECTIFIER - Meter Box Good Condition – Cell #1 Reading -.971 Volts, Cell #2 Reading -.980 Volts (After Hook-Up).
WIRING - Good Condition – Splices Good Condition.
SUSPENSION - Good Condition – Anodes Good Condition.
OTHER - Reference Electrodes Good Condition. Coating Appears In Good Condition.

THE SYSTEM WAS LEFT OPERATING AT A TAP SETTING OF N/A AND/OR REFERENCE CELL SETTING OF N/A WITH, .02 D.C. AMPS TO THE BOWL AND TANK-TO-WATER D.C. AMPS TO THE RISER AT N/A D.C. VOLTS, WITH THE TANK APPROXIMATELY 60 % FULL OF WATER , THE TANK TO WATER POTENTIAL PROVIDED AT THESE SETTINGS WAS -.985 VOLTS ON AND -.845 * VOLTS OFF. * And Polarizing

- Anode Current Set @ 63%.
- NATIVE -.680 Volts
- Performed Initial Hook-Up, Energized, And Testing – All OK.

SIGNED: ______

FOR YOUR CONVENIENCE IN MAINTAINING RECORDS OF THE MONTHLY READINGS ON THIS CATHODIC PROTECTION SYSTEM THE FOLLOWING FORM IS PROVIDED:

	TAP/ POTENTIAL SETTING	UNIT D.C. VOLTAGE	BOWL CURRENT	RISER CURRENT	WATER LEVEL
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY	N/A	N/A	.02	-------	60%
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

STRUCTURE – TO – WATER POTENTIALS (MV)

"AS FOUND – NATIVE POTENTIAL"

"ON"	"OFF"
-680	

"AFTER HOOK-UP / ENERGIZING"

"ON"		"OFF"
Top	-997	-839
Middle	-985	-845
Bottom	-983	-840

* After 20 Minutes And Polarizing

I. SUMMATION OF RESULTS

A. Cordillera reservoir requires a new rectifier, repair of anode splices and a new reference electrode installed. System will require adjustment and re-testing after items installed.

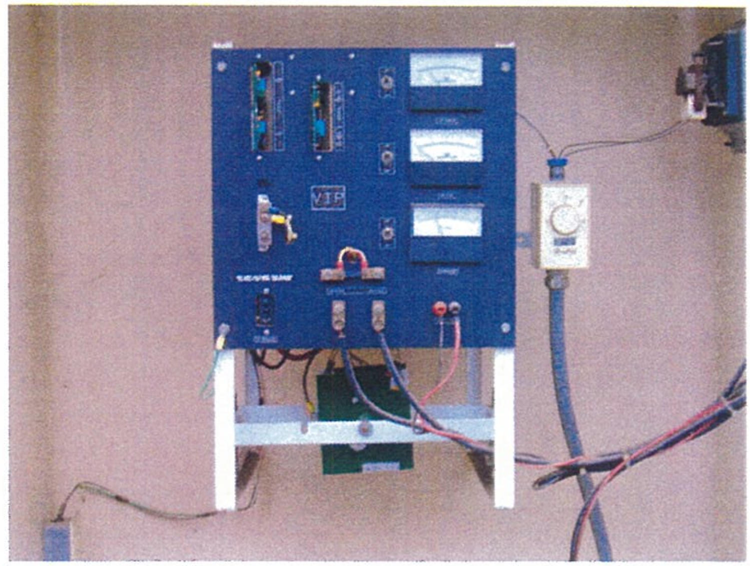
B. Four reservoirs should be re-tested in 1-2 months **or** at the annual inspection due to various anomalies discovered during this test phase (Indian Hills, Saddle Peak, Oakridge and Morrison).

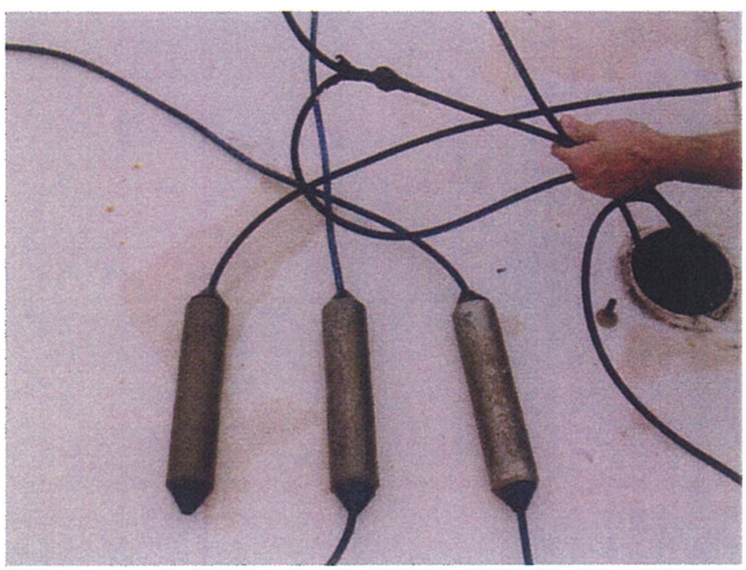
C. Twenty-two (22) reservoirs are currently fully cathodically protected and require no further action until next annual inspection (see Conclusions Section, Item #3 for list).

D. Equestrian and Oaks – Lower reservoirs were found to be concrete construction.

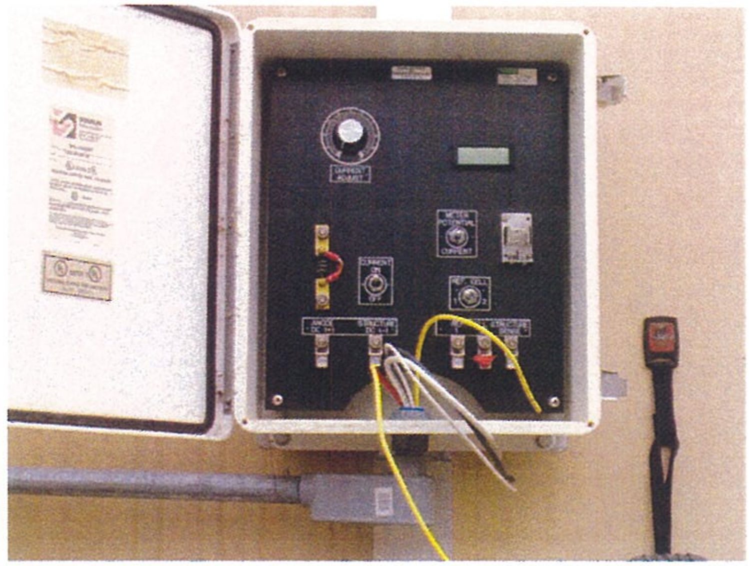
E. Ranch View reservoir is new, has no CP installed, has no protection, needs new design and CP system.

1. Cordillera Reservoir

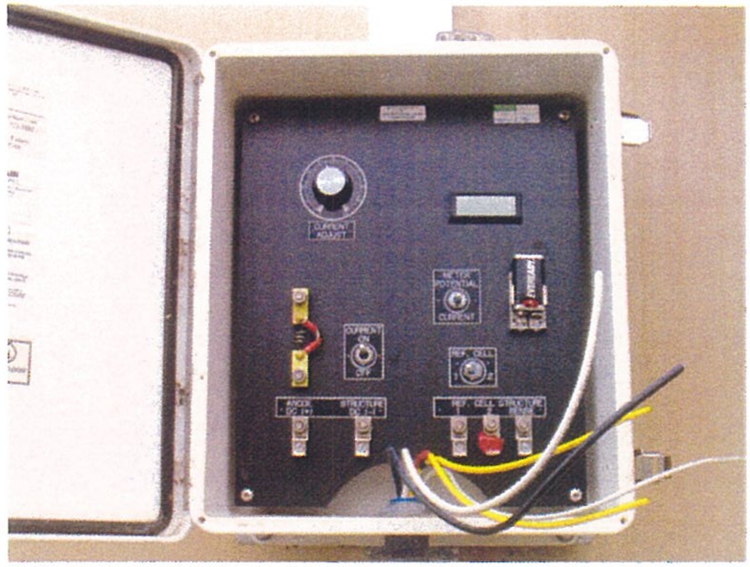


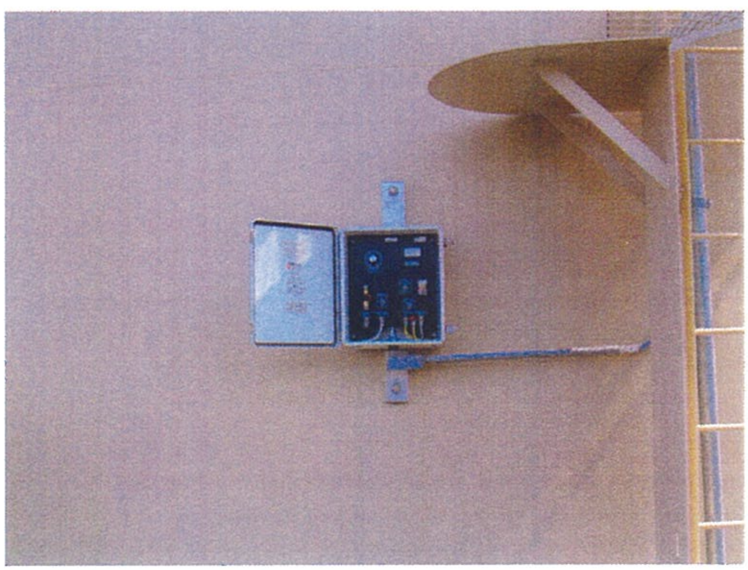


2. Parkway Reservoir

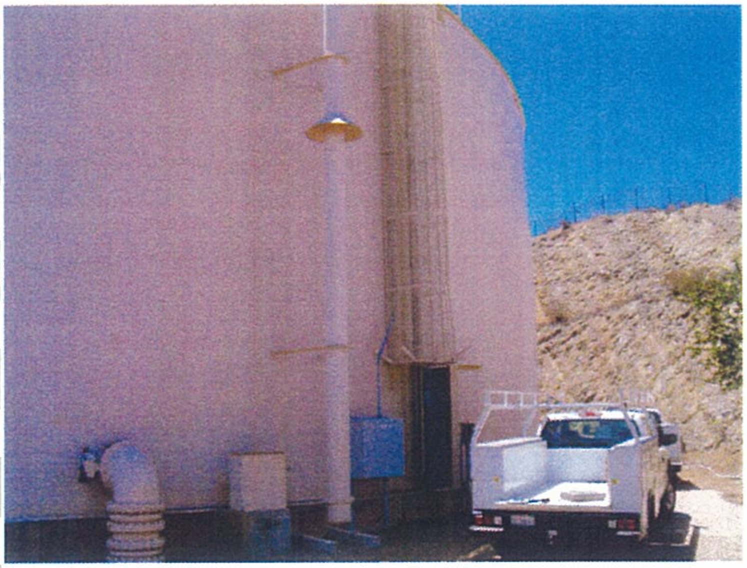


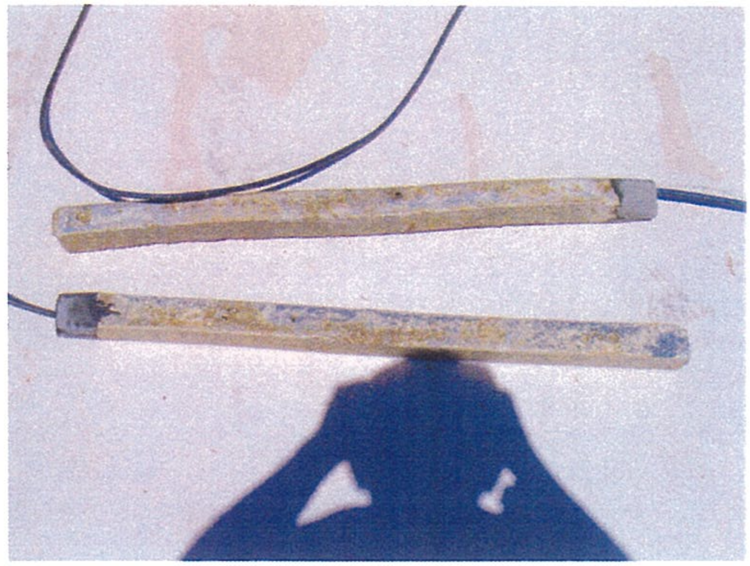
3. Oaks – Upper Reservoir

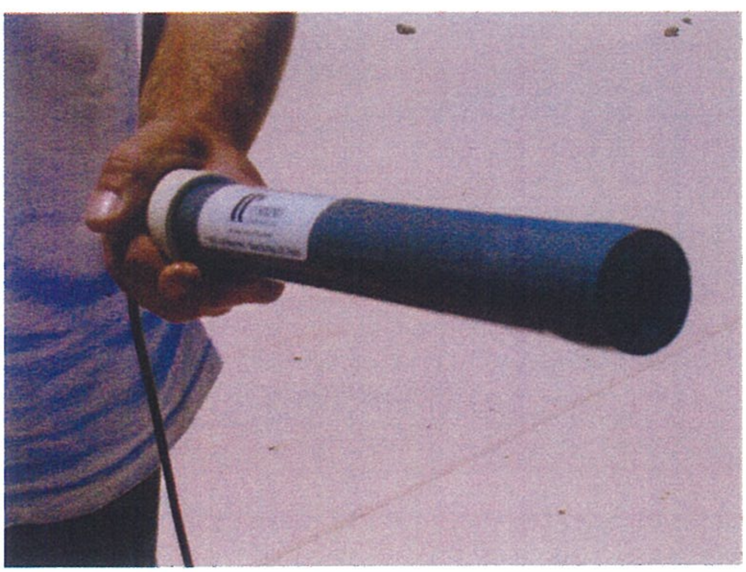




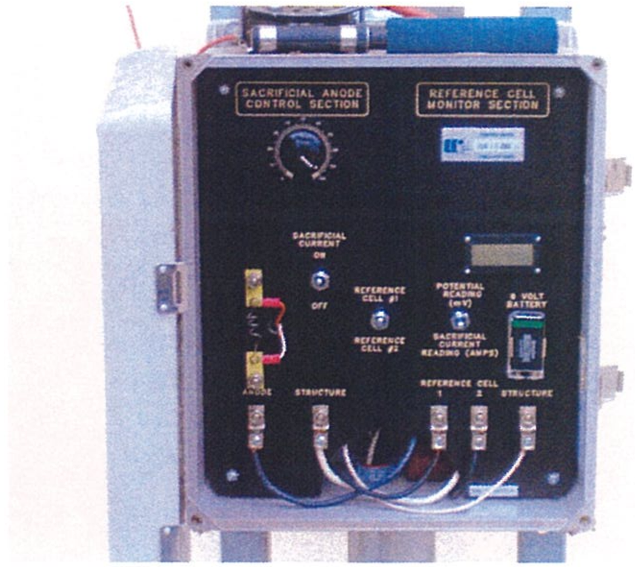
4. Indian Hills Reservoir



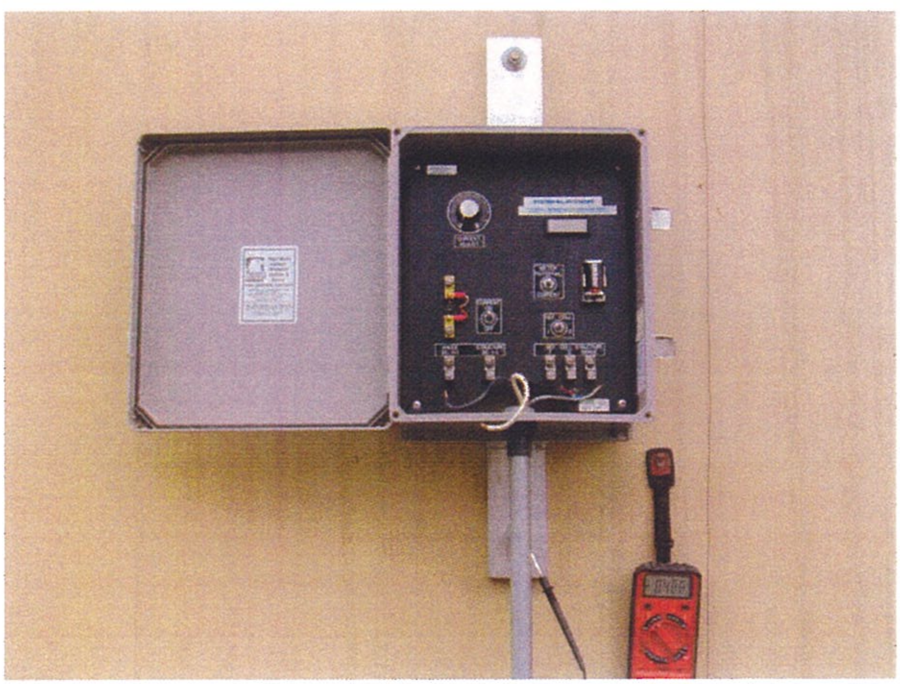




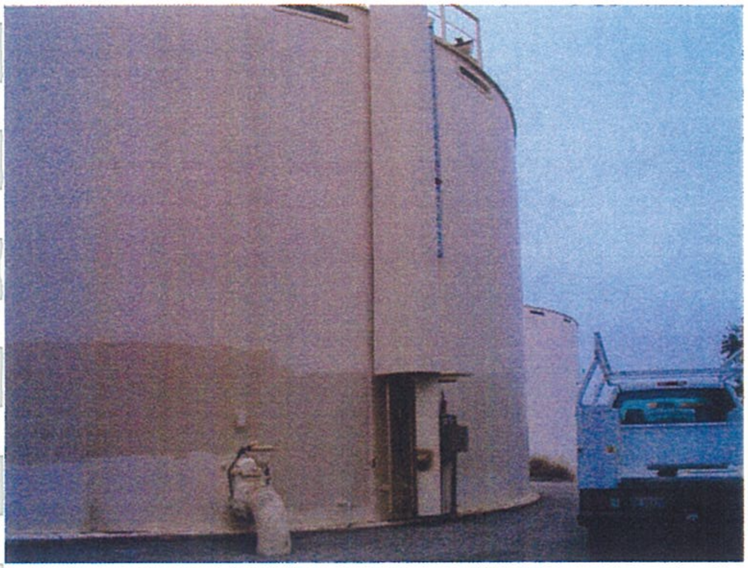
5. Woolsey Reservoir

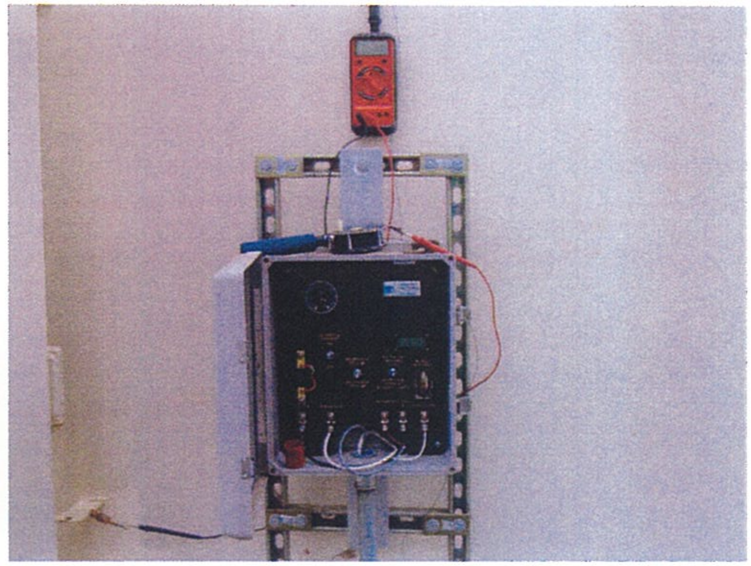


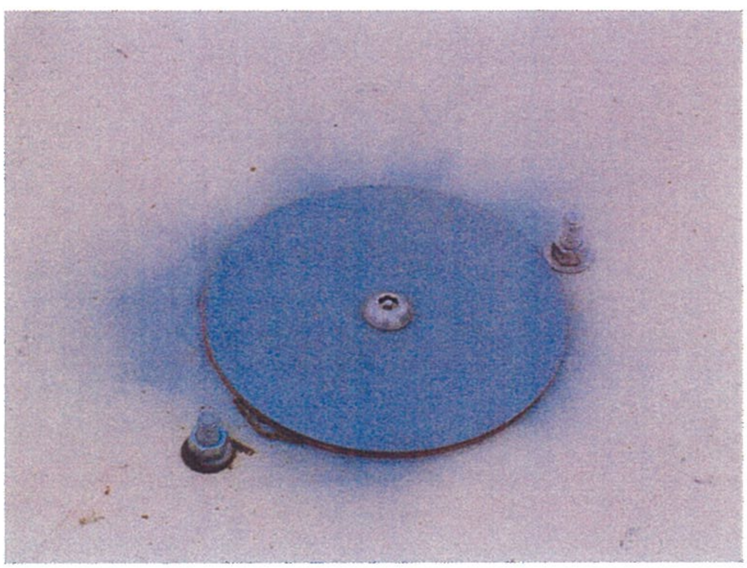
6. Twin Lakes – Upper Reservoir



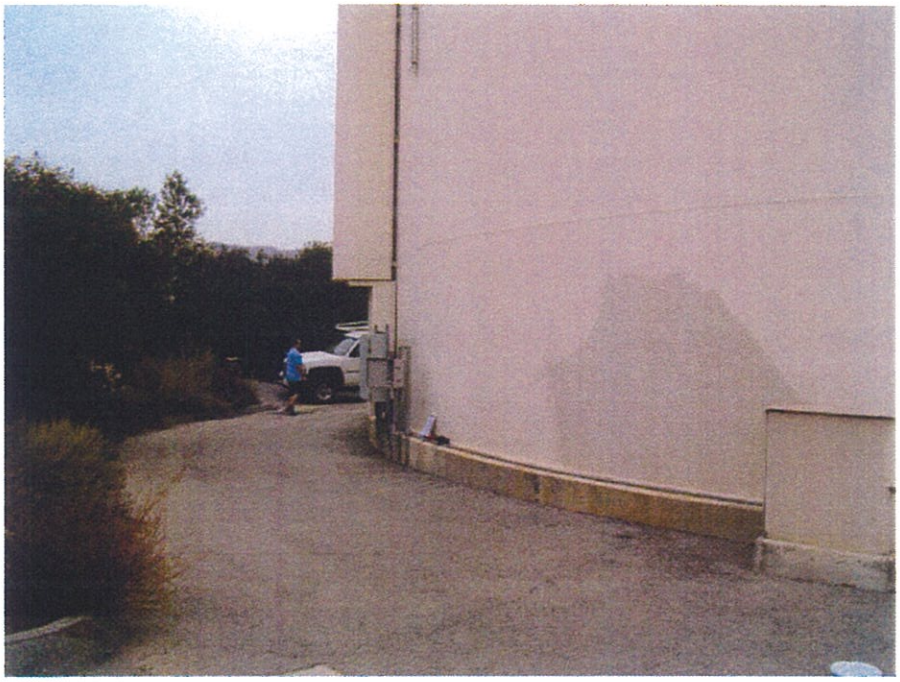
7. Twin Lakes #1 Reservoir

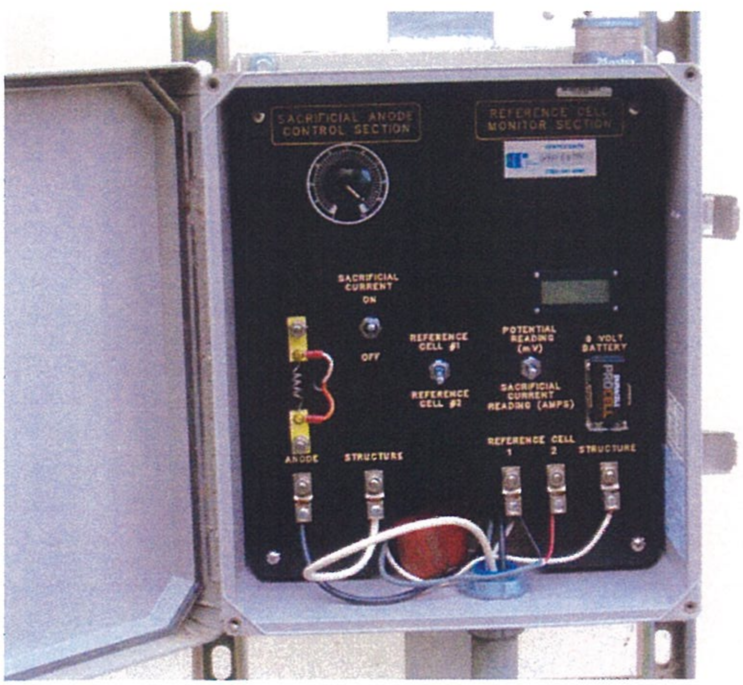




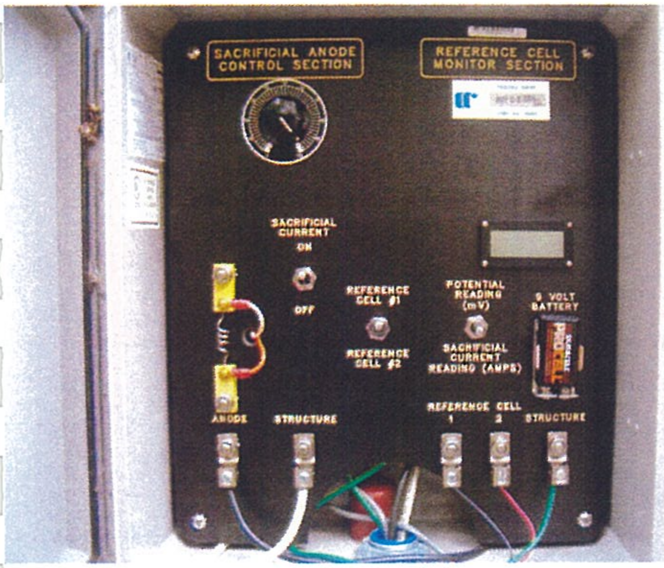


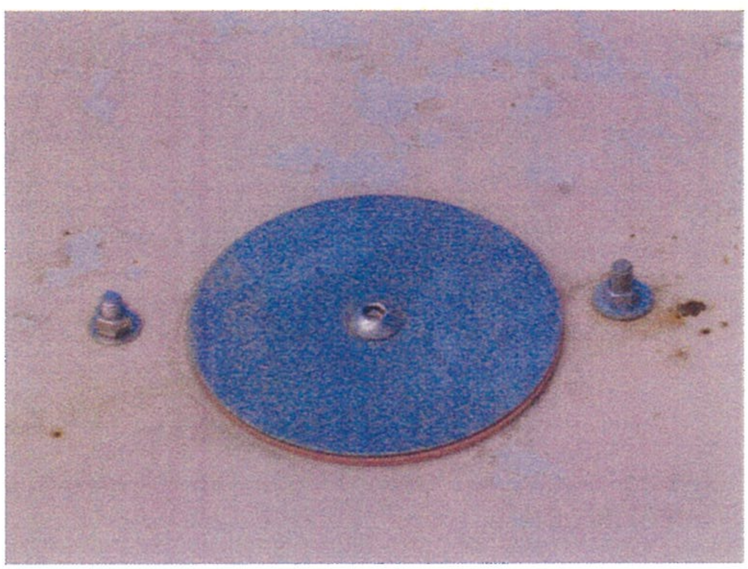
8. Twin Lakes #2 Reservoir



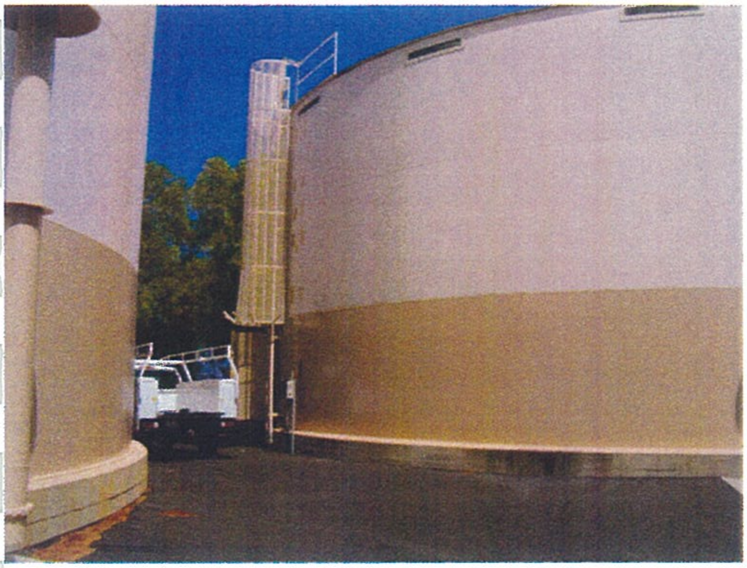


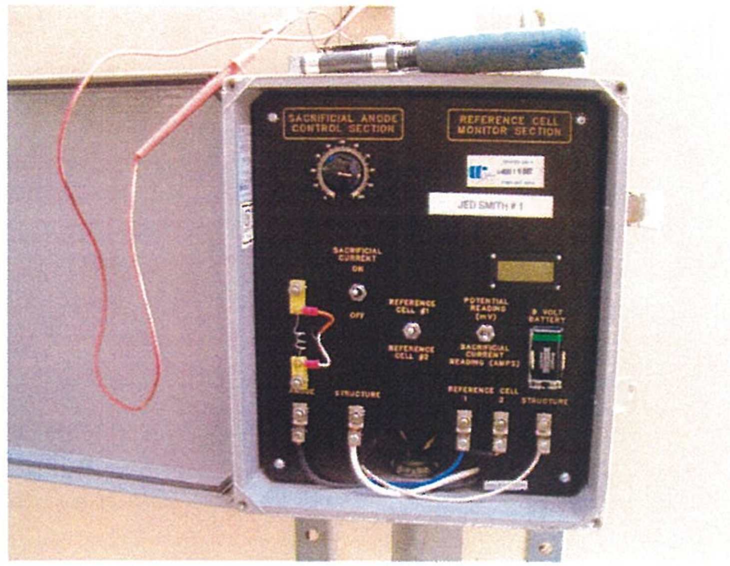
9. Calabasas Reservoir

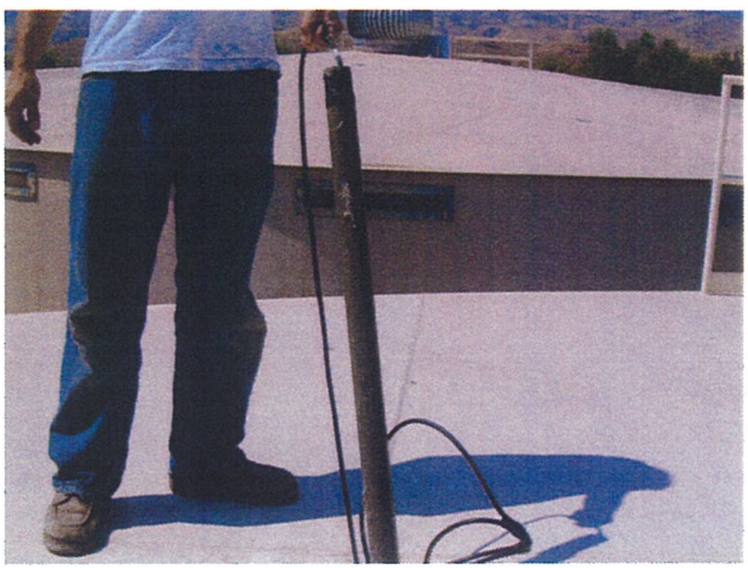




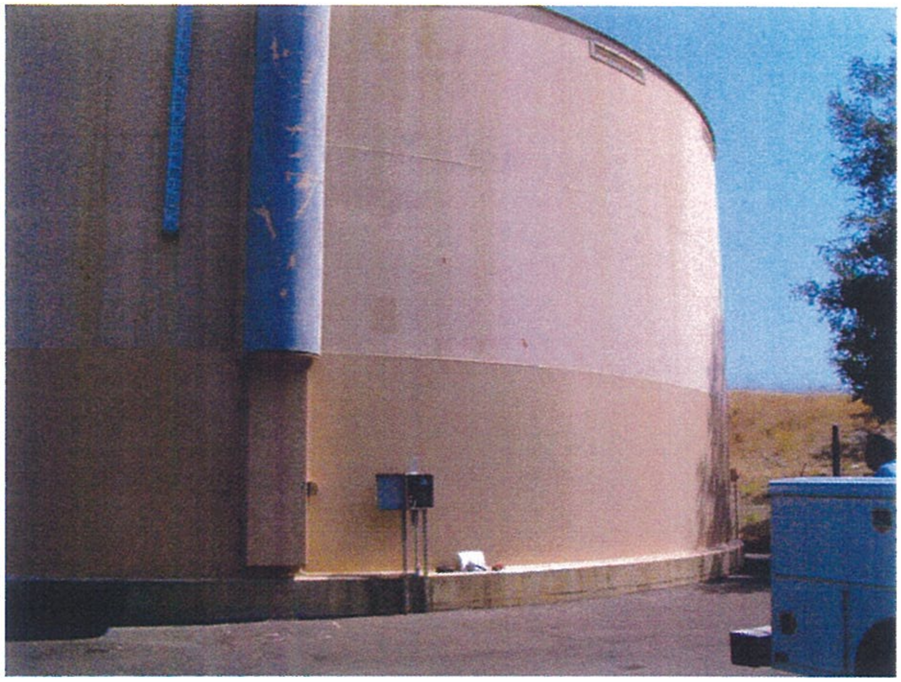
10. Jed Smith #1 Reservoir



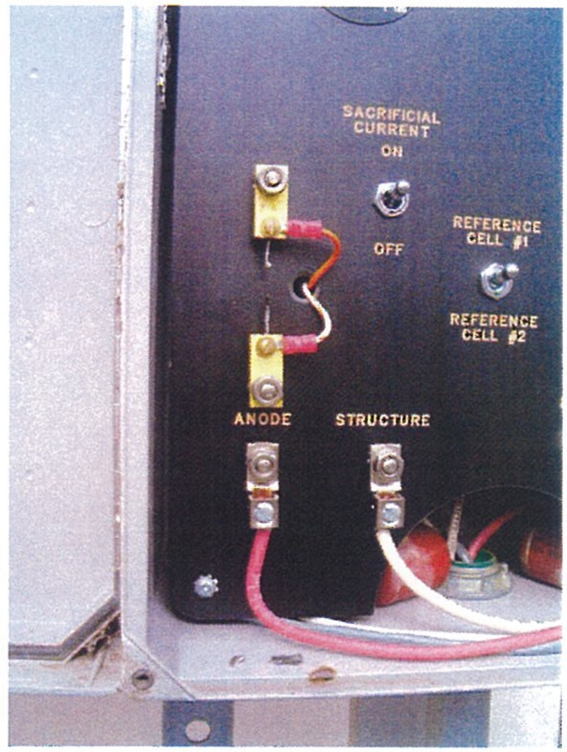


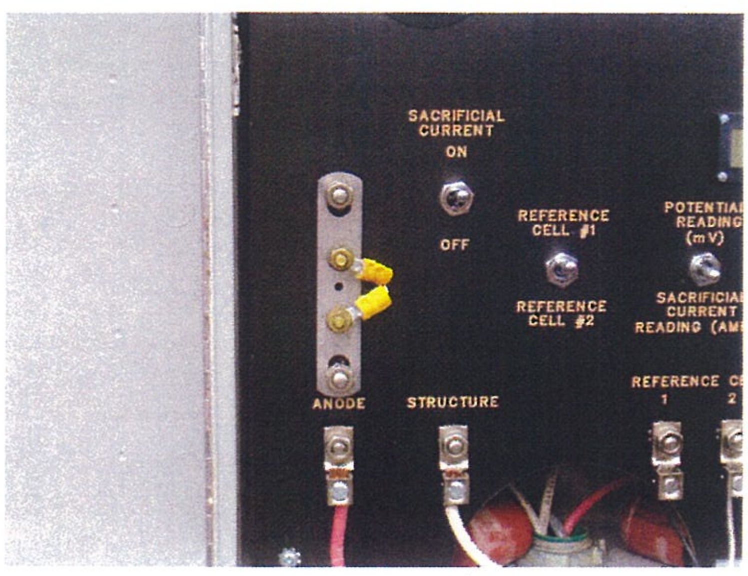


11. Jed Smith #2 Reservoir

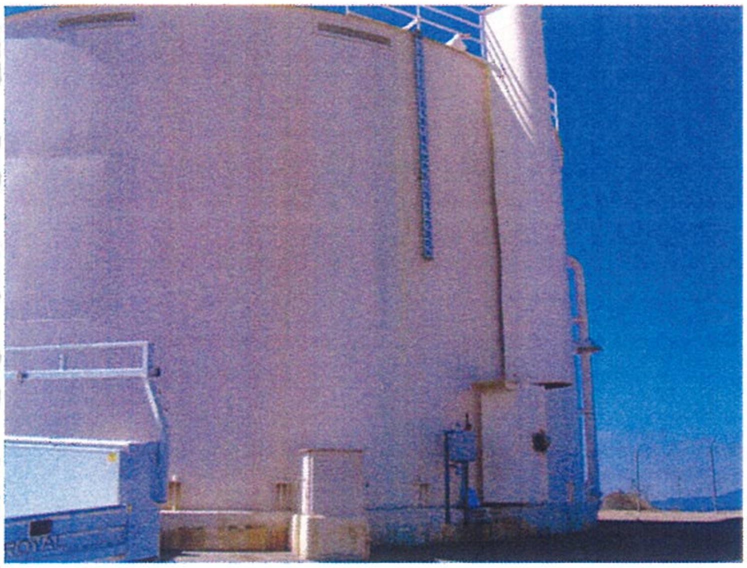


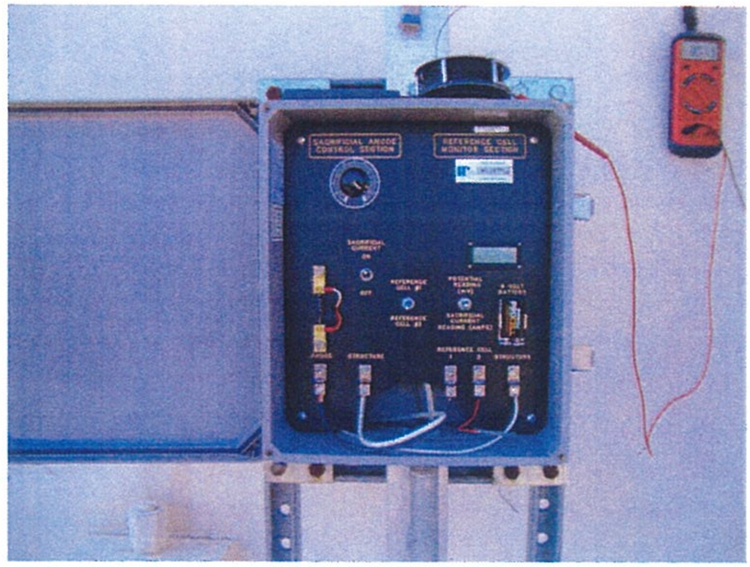
12. Saddle Peak Reservoir

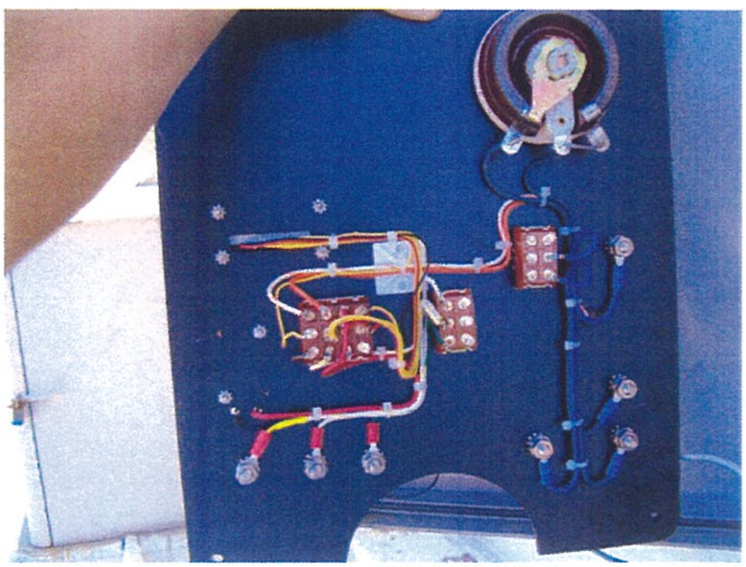




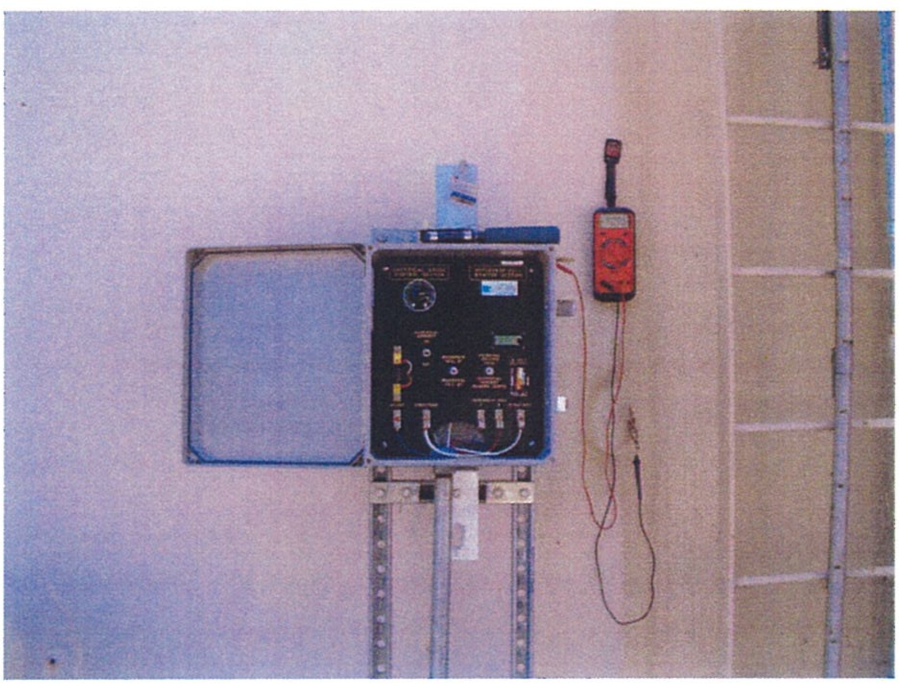
13. Oakridge Reservoir



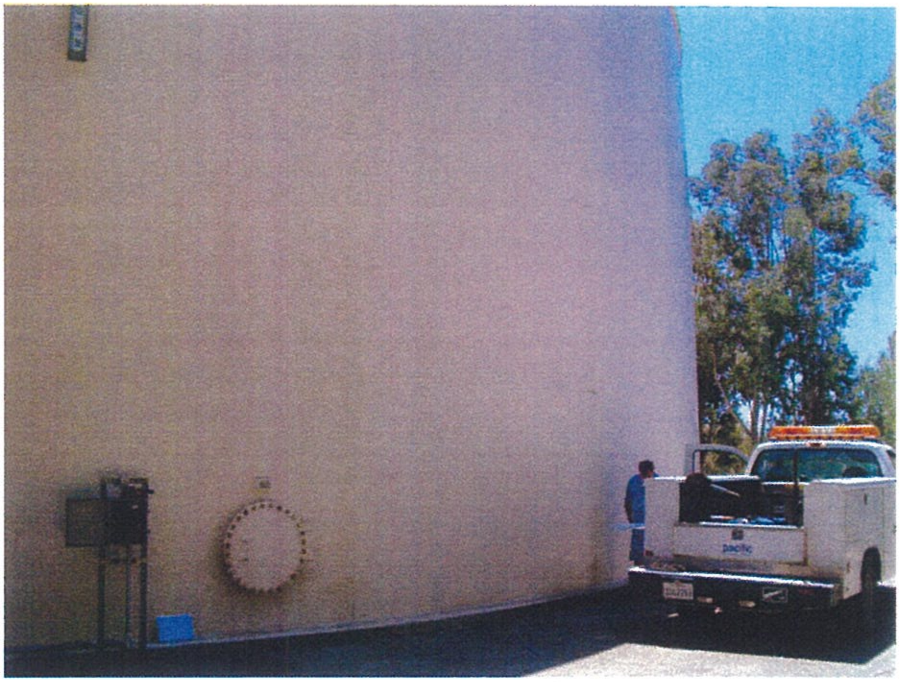


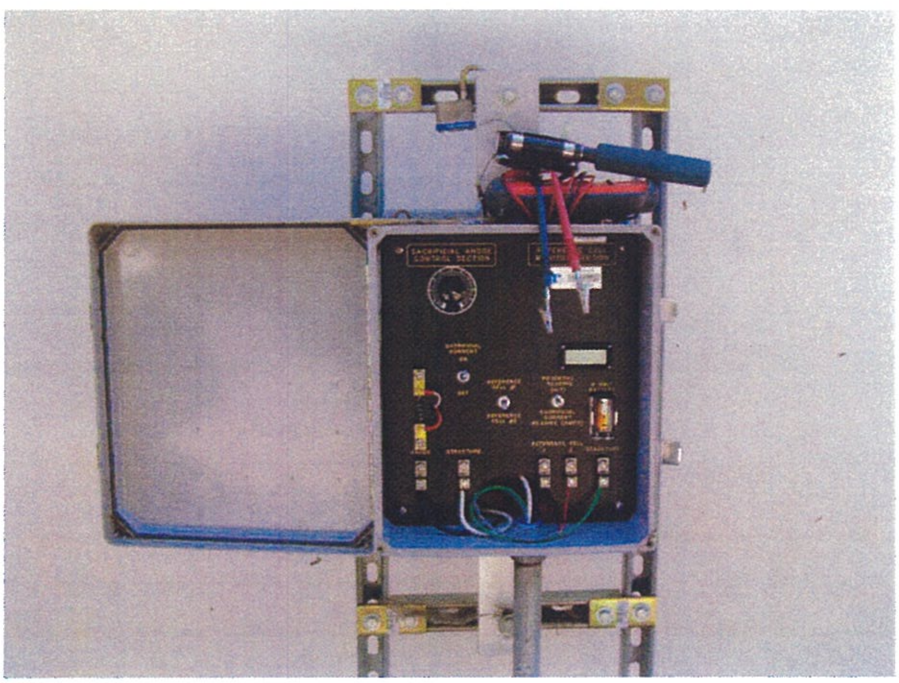


15. Dardenne Reservoir



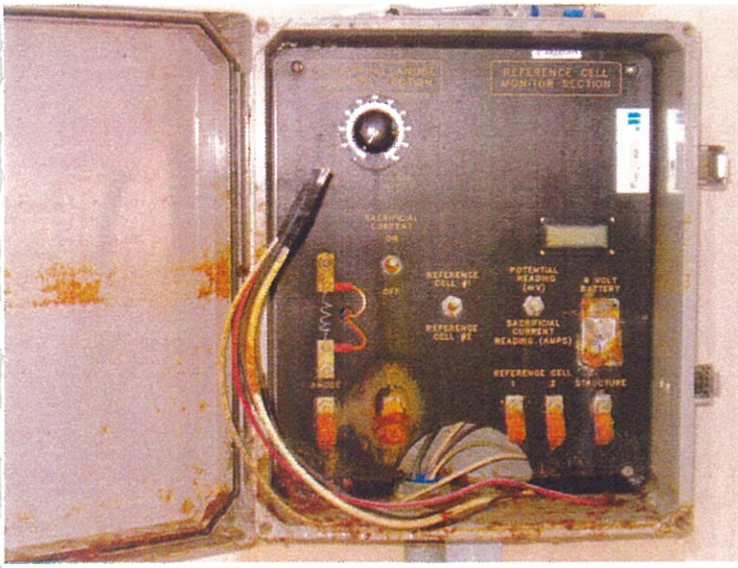
16. McCoy Reservoir

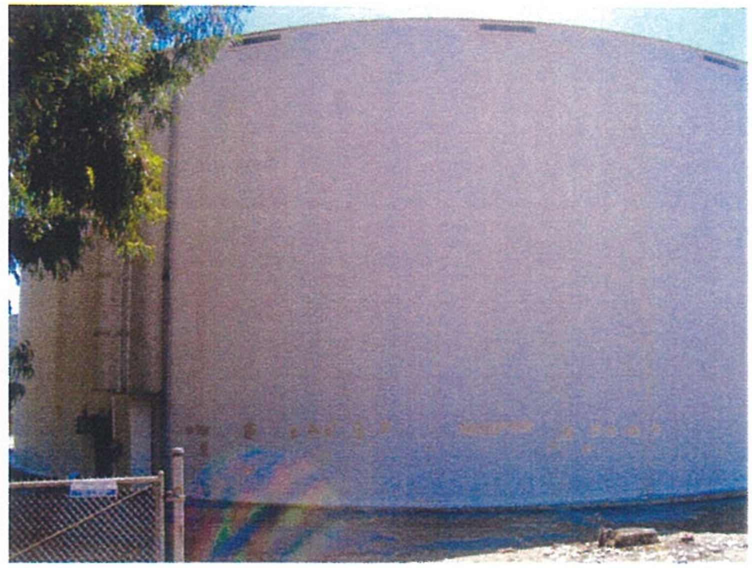


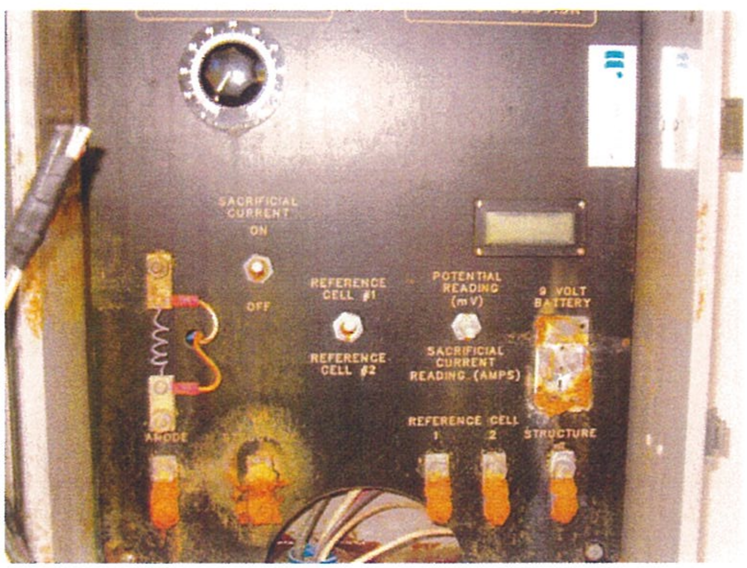


17. Ranch View Reservoir

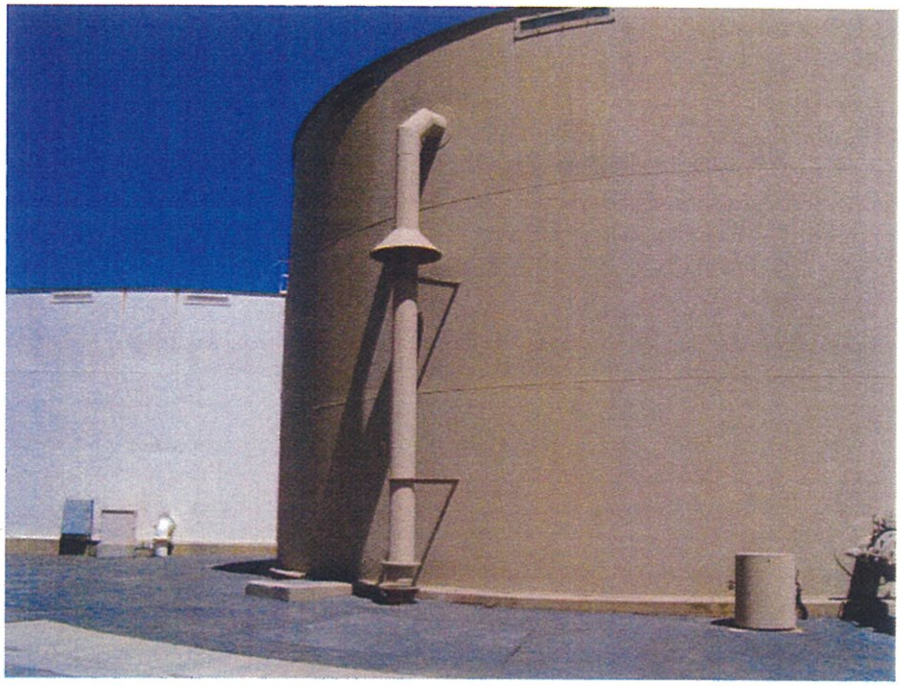
18. Latigo Reservoir

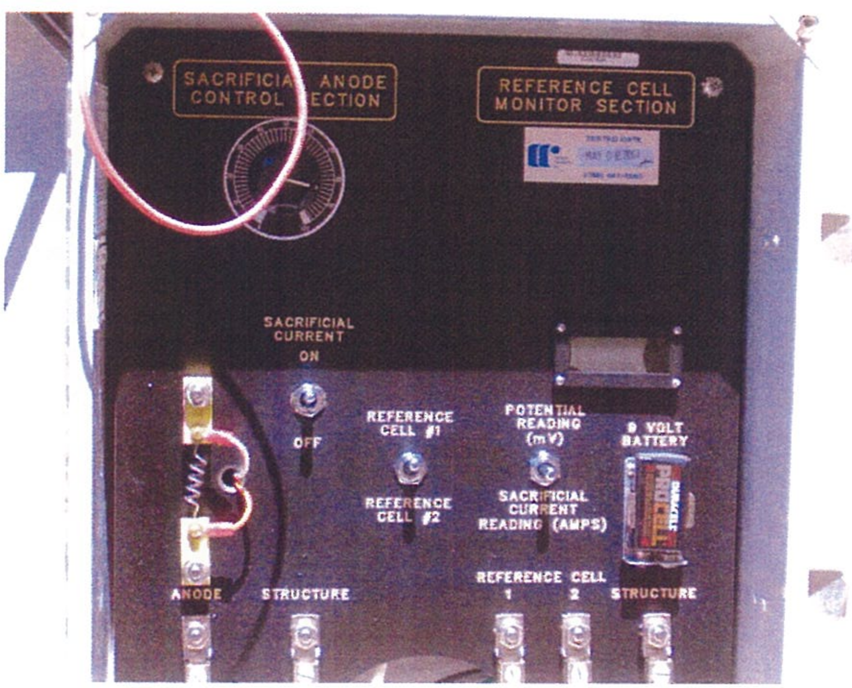






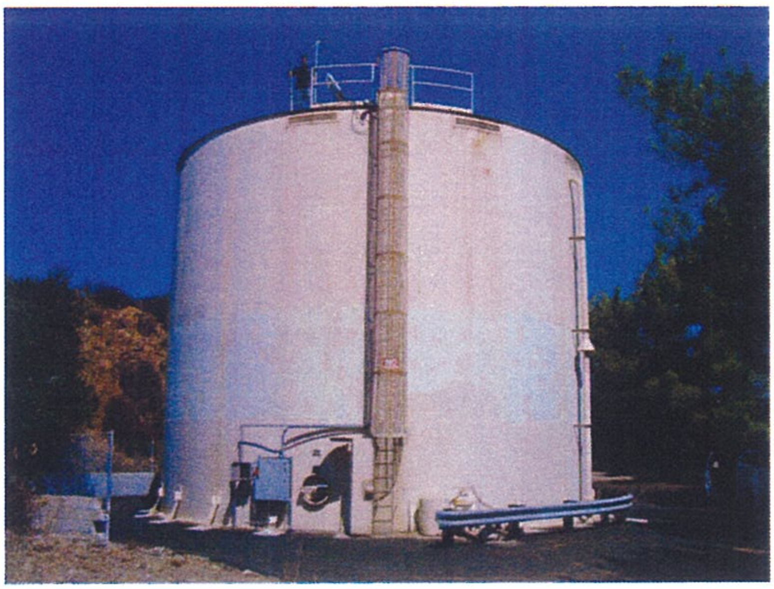
19. Seminole #1 Reservoir



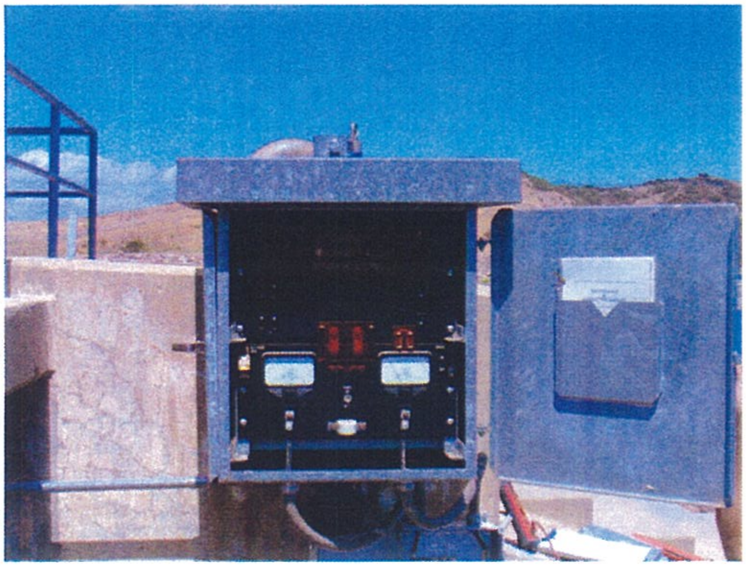


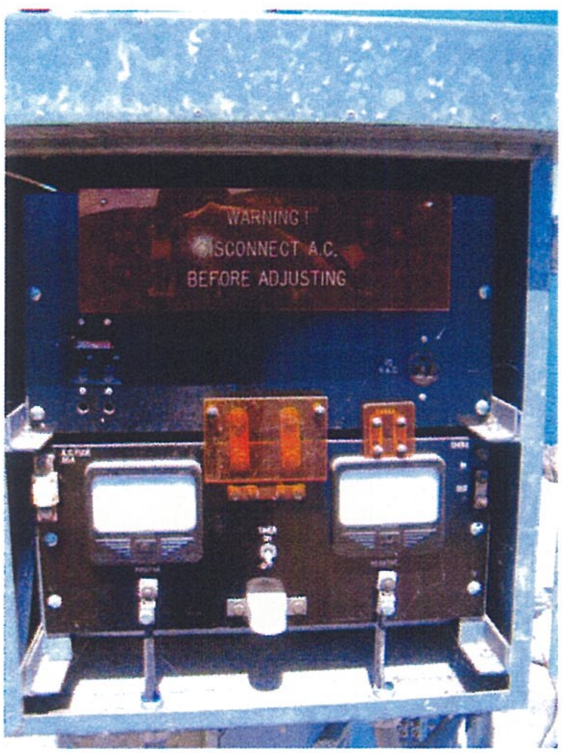
21. Kimberly Reservoir

23. Saddletree Reservoir

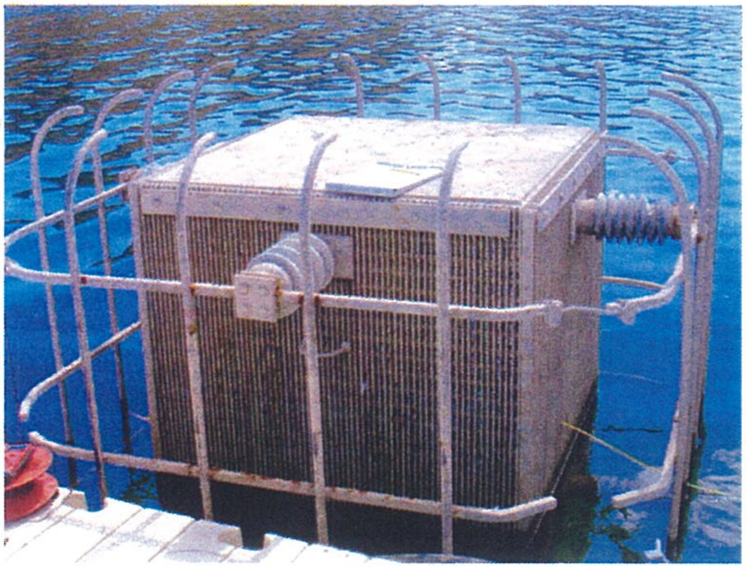


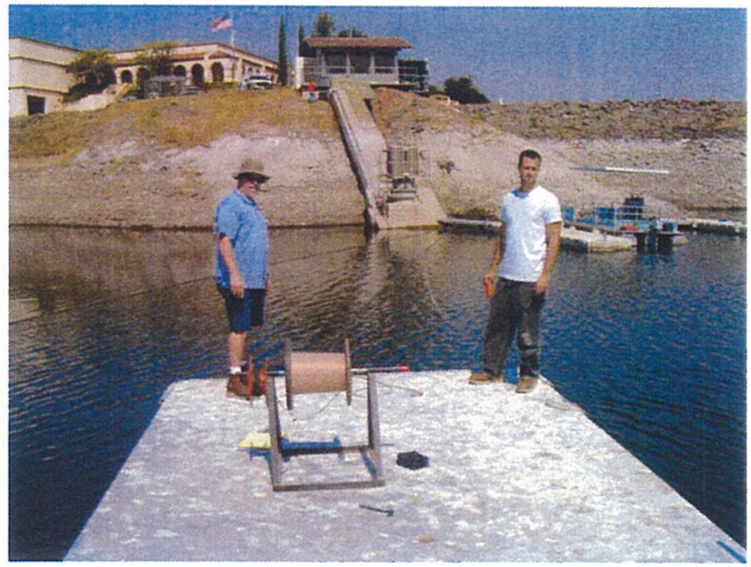
28. Las Virgenes Reservoir

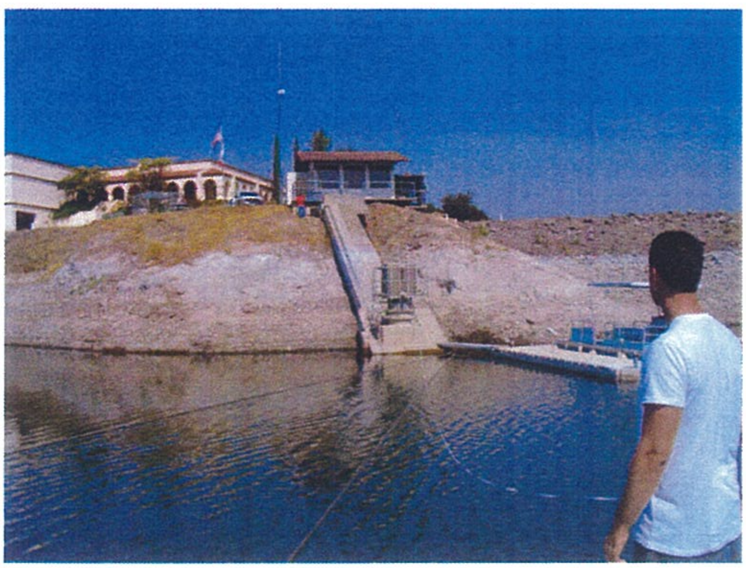




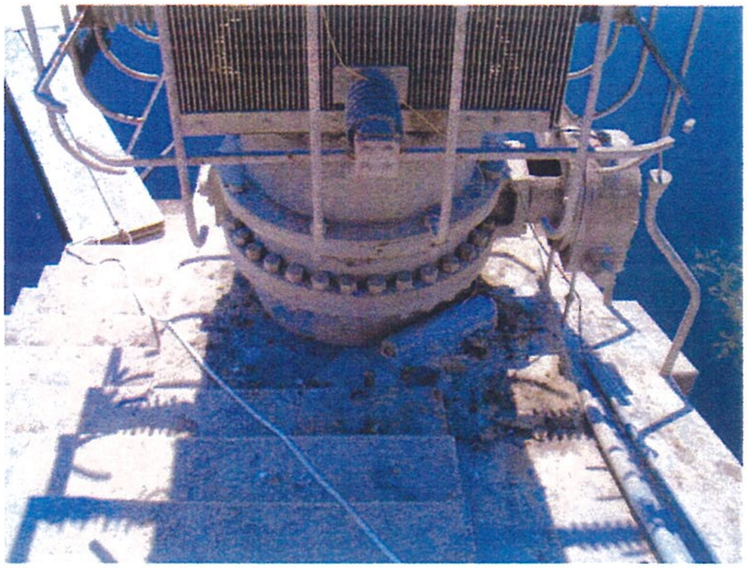
Las Virgenes Reservoir

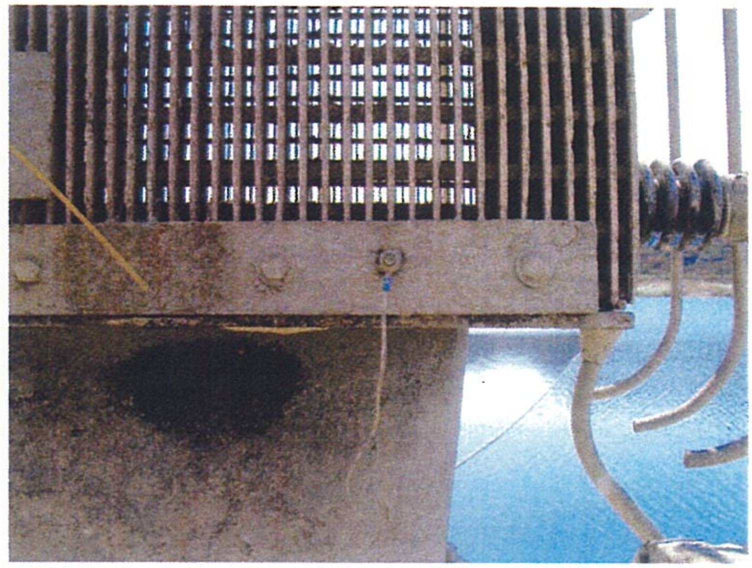






Las Virgenes Reservoir





CATHODIC PROTECTION INSPECTION
30" WATER TRANSMISSION PIPELINE
OCTOBER-NOVEMBER, 2006

I. INTRODUCTION:

During the months of October through November, 2006, engineering personnel from Harper & Associates Engineering (HAE) performed a variety of tests and inspections on a 30" diameter mortar coated and lined steel water transmission pipeline owned and operated by the Las Virgenes Municipal Water District (the District) located in Calabasas, California. The purpose of these tests and inspections were to determine several items as noted below:

A. Locate all existing cathodic protection monitoring test stations that had been provided during original pipeline construction and subsequently thereafter.

B. Test and inspect each of these test stations to verify that they were still electrically continuous with the transmission pipeline.

C. Inspect all existing cathodic protection impressed current rectifiers located on the pipeline to verify that they were turned "off" (inoperative) at the time of this inspection. It should be noted that these units were reported to have been turned "off" approximately 2 years ago at the recommendation of another corrosion engineering firm and MWD engineers, due to numerous electrical "discontinuities" across pipe joints, which had been discovered during previous testing of this line.

D. Monitor pipe-to-soil potentials at each respective test station to determine the line's present status from a corrosion standpoint. Measure "native" or unprotected potentials at each test station (see item C above).

E. If required, from the results of item D above, energize all CP rectifiers, adjust their output voltage and current, and re-measure pipe-to-soil potentials at all located test stations until full cathodic protection has been achieved throughout the system.

F. If necessary, from the results of item E above, using specialized testing techniques, determine where the electrical discontinuities exist within the pipeline system.

G. From the results of all these tests and inspections, provide engineering recommendations to the District as to how to proceed with the operation of the line and its various cathodic protection systems.

II. PIPE MATERIAL AND COATINGS:

A. Two types of pipe material are utilized for the 30" transmission main. The primary pipe utilized is cement mortar lined and coated steel cylinder pipe (CML&C). This type of pipe utilizes a thin gage steel cylinder both internally lined and externally coated with cement mortar in varying thickness depending upon pipe diameters and pressure ratings.

For water transmission service, the cement mortar serves primarily for corrosion protection to the internal and external surfaces of the steel cylinder and to give some degree of strength to the pipe. As the pH of the mortar is high (in the range of 12-13) indicating high alkalinity, this property raises the pH of the surface of the steel and provides "passivation" or a substantial reduction in the natural potential of the steel. This reduction in potential effectively makes the steel more "noble" or corrosion resistant. As long as the mortar remains intact, and the lime in the cement is not leached out of the mortar, this passivation effect will remain on the steel surfaces and will provide extended life to the pipeline cylinder.

The majority of pipeline leaks on mortar coated pipe take place due to damage to the mortar coating, which allows corrosive ground water or soil to make contact with the steel cylinder. A pitting attack usually occurs which, over time, will penetrate the steel cylinder and cause loss of product. This damage is usually caused by poor initial construction practices such as mishandling the pipe over the ditch or by improper mortaring of the pipe joints after they have been made in the field.

All pipe manufacturers of CML&C pipe agree that maintaining the mortar coating integrity is essential to a long life of the product. Along with this, field experience and laboratory testing have shown that as long as the native (unprotected) pipe-to-soil potentials do not rise substantially above (become more negative numerically than) –350 mV, that mortar coated pipe will experience little or no corrosion effects.

B. The second type of pipe used on this project (albeit only 988 LF) is ductile-iron or DIP. This pipe is usually of heavy-wall construction, which provides extended life from corrosion related effects but still corrodes when located in a corrosive environment. In order to provide additional corrosion protection, DIP is usually field wrapped with 8-10 mil polyethylene "sleeves" or "baggies" (ANSI/AWWA C105/A21.5) prior to placing in the ditch. Field joints are also covered with the sleeves and taped with polyethylene compatible tape to prevent water or soil ingress. Unless the sleeves are compromised by improper construction methods or are penetrated by rocks and/or soil movement, the DIP is essentially protected from corrosion by water and soils.

III. TEST PROCEDURES:

During the course of the tests and inspections, the following items and procedures were utilized:

A. Assist District personnel in inspecting drawings, specifications, original and revised construction prints and any other relevant documents to locate all existing cathodic protection test stations, which had been provided during original and subsequent construction of the 30" pipeline. Follow the ROW of the pipeline and note locations of test stations including those that have been lost or abandoned over time and any fairly recent additions.

B. Utilizing electrical measurements, determine that all located test stations were or were not electrically continuous, as designed, with the pipeline.

C. At each located and electrically continuous test station, measure native pipe-to-soil potentials utilizing the following procedure:

1. With one lead of a calibrated electronic DC voltmeter connected to the insulated copper cable(s) located in each test station, and the other lead connected to a laboratory grade copper-copper sulphate ($CuSO_4$) test reference electrode placed at grade over the pipeline, measure "native" or unprotected potentials at each test station location. Native potentials (those where cathodic protection has never been provided or where rectifier systems have been "off" for extended periods) are useful in determining corrosion activity on a buried pipeline. Measured potentials less negative (lower numerically) than –350 mV (to the $CuSO_4$ reference) are considered to be essentially "non-corroding" (for mortar coated steel pipe) while potentials more negative (higher numerically) could be indicative of increasing corrosion activity.

D. Visually inspect all cathodic protection rectifier units reported to be a part of the CP system on the 30" pipeline. Verify that they are indeed turned "off" as reported (unit circuit breaker in OFF position), and verify this by measuring the output DC voltage at the rectifier ANODE terminals. The voltage should be "zero" indicating that the unit is off.

E. **If required**, energize individual rectifier units and adjust outputs until the required voltage and current are available to provide complete cathodic protection to the line.

F. **If required**, utilizing specialized field-testing techniques known variously as 50/50 over-the-line potential measurements and/or "splitting the difference" measurements, locate missing or broken electrical joint bonding locations. Assist the District in restoring these broken bonds and retest the line after these deficient locations have been corrected.

V. TEST RESULTS:

The following information was determined during the course of the tests and inspection of the 30" transmission pipeline:

A. <u>PIPELINE INFORMATION</u>:

1.. The majority of the pipeline is constructed of cement mortar lined and coated steel cylinder pipe (CML&C).

2. A small portion (approximately 988 LF) is constructed of poly-wrapped and bonded ductile-iron pipe (DIP).

3. The transmission main does not appear to be totally electrically isolated from connections to other facilities.

4. The transmission main was attempted to be cathodically protected at one time with a distributed system of impressed current (rectifier) semi-deep anode beds. These systems were turned "off" approximately two years ago (at the recommendation of another corrosion engineering firm and by MWD engineers) due to observed problems with electrical continuity between select pipe joints.

5. Over-the-line distributed monitoring test stations were provided at various times to monitor the cathodic protection systems and/or corrosion potentials on the transmission main. These consisted both of at grade "valve box" type test stations and pole mounted "above grade" types with copper cable connections to the buried main.

B. <u>CATHODIC PROTECTION SYSTEM INFORMATION</u>:

1. The provided cathodic protection system on the transmission line consists primarily of impressed current rectifiers (AC to DC transformer/rectifiers) energizing underground anode beds which "impress" a current onto the pipeline with the intention of arresting corrosion activity. These systems covert conventional alternating-current 60 Hz power (usually 120/240 VAC) into low voltage direct-current DC voltages and currents, which can be utilized to power various types of anode bed materials (graphite, high-silicon cast-iron and/or platinized anodes). The DC current discharges off these

anodes, travels through the soil and onto the pipeline, which raises (makes more negative) the pipe potential. The intention is to sacrifice the anode material instead of the steel pipe cylinder by creating this new corrosion "cell". Thus, the term "cathodic protection" is derived from the new anode/cathode corrosion cell where the **anode** (current discharge point) is sacrificed and the **cathode** (pipe) or current receptor is protected.

2. Monitoring test stations are installed all along the ROW and consist of insulated copper wires which are connected to the steel cylinder of the line by exothermic weld and are run underground in direct burial up to a grade or pole mounted box. By attaching a DC voltmeter to the respective test leads (in the box) and utilizing a $CuSO_4$ reference electrode placed at grade directly over the line, pipe-to-soil potentials can be measured at each test station.

3. Turning the individual cathodic protection systems off over two years ago meant that the potentials measured during this inspection were essentially "native" or totally unprotected readings and reflect the present condition of the line "as is" with no protection. In this fashion, HAE could exactly determine areas where more active corrosion is occurring without the necessity of having the line completely electrically continuous.

4. Test data obtained during this survey indicates that the majority of the 30" cement mortar coated transmission main is presently experiencing only minimal corrosion activity (as evidenced by measured "native" potentials of –350 mV (to the $CuSO_4$ reference) or less (lower numerically). A potential of –350 mV has been both empirically and by practical field experience determined to be a level where cement mortar coated pipe is not corroding and does not require cathodic protection to maintain this level. Only more negative (larger numerically) potentials are of concern, from a corrosion standpoint, on pipe of this type (see Appendix A, Potential Data).

5. In areas where the measured native potentials were greater than –350 mV, such as near so-called (by LVMWD personnel) "protected structures" (assumed to mean those where manholes, culverts, large steel reinforced concrete drainage structures, etc. exist) and at locations where DIP pipe was utilized, it can be assumed that some degree of active corrosion may be occurring at these locations. It is also possible that the protected structure itself is responsible for the higher than expected potentials due to the presence of reinforcing steels, etc. It is these specific areas where

HAE will make recommendations for future corrosion mitigation procedures.

6. Measured native potentials on the majority of the CML&C main are less than –350 mV, which are indicative of "normal" or essentially "non-corroding" pipe.

7. In a location east of Liberty Canyon Road and west of Los Virgenes Road, at an area where the 30" transmission main "B" had been previously relocated, approximately 988 LF of pipe has been replaced with poly-wrapped and bonded ductile-iron pipe (DIP). At the only test station provided (#76, pipe station number 204 + 05), measured potentials were -419 mV (native), which is indicative of only mildly corroding DIP. Additionally, the potential shifted more negatively with the application of test current to the adjacent CML&C pipe, which indicates that the DIP is both electrically continuous (not isolated from) the CML&C pipe and that its joints are bonded for continuity as reported.

V. CONCLUSIONS:

Based on the results of both observation and test data obtained during the course of this investigation, the following conclusions are reached regarding the LVMWD 30" transmission main:

A. The majority of CML&C pipe within the transmission system is currently experiencing only "very mild" corrosion activity (by virtue of measured "native" potentials of -350 mV or less). As such, cathodic protection is **not required nor recommended** on the sections noted.

B. The approximate 988 LF of DIP is presently experiencing only "very mild" corrosion activity (based on one potential measurement at the only available test station) and, as such, cathodic protection is presently **not required nor recommended** on the DIP section. It should be noted however, that this type of pipe should be electrically isolated from any connections to CML&C pipe. DIP piping is "anodic" to the CML&C pipe and will ultimately corrode sacrificially if it remains electrically connected to the mortar-coated main.

C. There are many "missing" or lost test stations on the CML&C main which could have provided additional, and possibly valuable, data had they been available. These lost or missing test stations should be replaced as soon as possible.

D. Additional test stations should be provided on the section of DIP pipe to further evaluate its condition. This would include points of connection to

CML&C pipe (and the installation of dielectric insulating fittings at both ends) as well as 1-2 additional test stations along the 988' of pipe.

E. All but two test stations investigated during this survey were determined to be electrically continuous with the main and fully operational.

F. Areas on the CML&C main where measured "native" potentials exceeded –350 mV should be re-evaluated at the next annual inspection to determine if the corrosion activity currently being experienced has increased or remained the same over the intervening twelve months. Should these potentials increase (become substantially more negative) over time, additional corrosion mitigation procedures should be implemented.

G. At this point in time, considering that it is not currently recommended to cathodically protect the 30" main, **continuity testing** is not required nor recommended. Therefore, it is **not** considered necessary to locate and excavate discontinuous pipe joint areas. Future annual testing may locate areas where active corrosion is occurring, and if this occurs, consideration should be made with regard to pipeline continuity and/or additional cathodic protection requirements.

H. All existing cathodic protection rectifiers should remain **"off"** as currently found. Most rectifier systems are very old and in need of either repair or replacement. As such, it is concluded that leaving them in their present state and location is preferable to making them operable.

VI. RECOMMENDATIONS:

Based on the Conclusions Section preceding, the following specific recommendations are offered for the 30" water transmission main at the LVMWD:

A. Have the entire main tested and inspected **annually** and a full report presented. In this fashion, any changes in the line with regard to corrosion can be addressed <u>as soon as they occur</u> and the proper mitigation procedures implemented before any damage occurs. It is **specifically recommended** that any areas located during <u>this</u> survey where native potentials were greater than (more negative than) –350 mV (on CML&C pipe) are thoroughly retested for changes.

B. Locate any and all missing or lost test stations as soon as practical and repair/replace as required. Note locations of replaced test stations in records.

C. Electrically isolate the DIP section of piping from its connections to CML&C pipe. Provide test stations at each insulating fitting to monitor the effectiveness of the insulators. Add two additional test stations on the 988' of DIP at approximately 1/4 the distance (250') from each POC to CML&C pipe.

D. Electrically isolate any "laterals" or other appurtenances off the 30" CML&C main if they are determined to be of pipe material <u>other than</u> CML&C.

E. Leave all existing cathodic protection rectifiers "off" unless <u>future</u> annual testing indicates the necessity to turn them on. Do not repair or replace any rectifier systems at this time.

F. The District should revise LVMWD record keeping such that all <u>future</u> annual monitoring data obtained on the line is organized in a fashion to easily compare readings year-to-year. This can be a spreadsheet or other format as desired. Existing data in archives of the District can be held or discarded as desired; however, current 2006 data should be the basis for any future decisions regarding the operation of the cathodic protection systems on the line.

G. It is further recommended that the District revise their pipe repair standards to include specific data on the cause of leaks (where applicable). This revision should include data on whether the leak was caused by interior or exterior corrosion, the exact location of the leak (top, bottom, springline, etc.), the condition of the mortar and/or poly wrap, any old damage to the coatings, exact station number of leak location, etc. Furthermore, <u>anytime</u> a leak or <u>any</u> pipeline excavation is undertaken, a **new monitoring test station** should be installed and data entered of its location for future use.

H. Any new monitoring test stations installed by the District, or by others, should have at least a pair of AWG #8 THWN wires thermite welded to the steel cylinder or DIP and brought to grade in a clearly marked valve box or 4" x 4" wooden post mounted test box similar to existing post mounted boxes. Note all new test station locations on records.

POTENTIAL DATA
LAS VIRGENES MWD
30" TRANSMISSION LINE

START OF "A" LINE

TEST POINT	STATION NO.	POTENTIAL	COMMENTS
1	3+50	340	Andora @ TC
2	14+95	326	Post
3	32+50	391	Before Devonshire
4 & 5	36+50	374	Rect lead, #4 miss
6	46+87	387	Valve can, 30' SS
7	67+00	470	Baden @ StopSign
7A	Unknown	1126 (foreign line) 253 (30")	Bond, Past 9711
8	87+00	226	Opp 9600 Baden
9	93+32	278	Rect, Baden/Plum
10	107+00	214	Opp Reserv Ent
11	126+76	247	Reservoir, Post
12	136+50	288	Fence, 200' Road
13	147+00	245	Uphill, away road
14	170+50	255	Road right,rk pile
15	173+25	140* (broken lead)	Gully, by BO
16	185+28	277	Last tall tree in burn area
17	206+50	216	Outside fence on mailbox, 8583 VC
18	226+00	226	PP along VC
19	230+00	260	Rect, green/pole
20	235+00	277	SW corner,A/V
21	253+75	259	March/Justice med in bushes
22	272+00	299	Ingomar, W March
23	282+00	326	Ingomar, sidewalk
24	???	410	Manhole, @ VC
25 & 26	N/A	N/A	Not located
27	297+45	N/A	Lost - 1994
28 & 29	N/A	N/A	Abandoned
30	330+95	252	High. @ VC, side
31	???	249	Abandoned – Old
32	???	228	Meter box, ball flg
33-34	???	N/A	Paved Over
35	344+38	240	Test Station

36	344+38	N/A	Rect.
37	351+20	258	SW corner, Vano
38-39	???	N/A	Abandoned
40	363 +00	220	Conc. Box, slope
41	364+00	248	Pump Sta w/anode but no rect., conc. Box, right of gate
42	369+75	440 (586)	Valve box, adj A/V
42A	375	470	FW BO,SW of 42
43 – 47	**N/A**	**N/A**	**PVC pipe section**
48	432+35	N/A	Rect.
49	437 +54	508	Conc box (bond?)
50	???	N/A	Lost, 1981
51	442+11	333	A/V w/wire
52	456+00	621*(prot struct)	Post w/mult wires
52A		107 (broken lead)	24508 Winfield
52B		101 (broken lead)	50' from 52A
52C		N/A	Not located
53	466+60	406	White post w/sign "Equestrian Trail" 5697 Hoback Glen
53A	475+87	457	Adj to post & A/V Hoback @ Equest. Trail
54	486+65	374	E of Robertson, N of R View, inside corral near Equest. Trail sign
54A	491+50	387	Conc box @ A/V

BREAK IN STATION NUMBERING HERE

START OF "B" LINE

55	00 + 33	342	Conc. box, in slope down from tank
56	520 + 97	N/A	Not Located
57	524 + 20	N/A	Never Installed
58	531 +50	316	In structure, Round

59	23 +50	N/A	Meadow Rd, 100' From intersection Lost, 2001
60	28 +95	304	T/S along Mureau
61	33 +58	410	Rectifier
62 – 66	???	N/A	All lost or buried
67	67 +00	304	On pole, in box, w/5 other leads, bond not conn.
68	80 +00	323	Uphill, past El Camino, trail W/Anza monument
69	109 +50	320	Test box, LV road next to prot. Strut.
70	21 +80	317	Back corner, pk lot planter, bell sys bx on post
71	???	N/A	Lost
72	???	410	Conc box sidewalk
73	???	410	Conc box, A/V
74	???	405	Conc box,sidewalk
75	203 + 44	432	Conc box,sidewalk
76	204 + 05	418	Conc box, struct A/V, S. Liberty
77	223 +08	417	T&R blue,wht post
77A	???	620 (foreign line)	T&R blue,wht post
78	239 +30	422	T&R blue,wht post
79	15 +25,lateral	384	Conc box, Dorothy lateral, behind bldg
80	253 +96	365	T&R blue,wht post
81	15 +00	N/A	In prot structure

CATHODIC PROTECTION INSPECTION
TAPIA AERATION BASINS
APRIL 2007

I. INTRODUCTION:

During the month of April 2007, engineering personnel from Harper & Associates Engineering (HAE) performed a variety of tests and inspections on the various aeration basin air injection arms located at the Tapia Reclamation Facility for LVMWD (the District). The purpose of these tests and inspections were to determine several items as noted below:

A. Visually inspect a select number of air injection arms for the presence and condition of existing sacrificial magnesium anodes.

B. Obtain structure-to-water potentials on six (6) basins, each containing eight (8) air injection arms, for a total of 48 data points.

C. Determine if the existing sacrificial anode system is adequate and, if not, recommend a replacement system.

II. TEST PROCEEDURES:

A. Each of the six basins were examined visually and, where feasible, a select number of injection arms were raised by LVMWD personnel for photography and inspection for corrosion. Sacrificial anodes were inspected for overall size, condition, attachment method and an estimate of remaining life (based on size and condition).

B. Structure-to-water potentials were measured at 48 locations in the six basins. This was accomplished by lowering a laboratory grade copper-copper sulphate ($CuSO_4$) reference electrode into the respective operating basin, and adjacent to the particular injection arm of interest, by its own insulated lead wire. The reference lead wire was then connected to a calibrated electronic DC voltmeter while the other lead of the voltmeter was connected directly to the injection arm. In this fashion, structure-to-water potentials could be measured and recorded for each individual injection arm.

C. Each anode on each raised available injection arm was examined for attachment method and remaining life. Overall condition of the anode was noted. Anodes were also noted by LVMWD personnel to require replacement, on average, every 1-2 years.

III. TEST RESULTS:

The following test results were obtained at the Tapia facility.

A. At each location where injection arms were raised, it was observed that overall, the condition of the arms (from a corrosion standpoint) was good and very little corrosion was evidenced. There was a notable degree of "product" in evidence on each arm; however, there was almost no corrosion activity under this product. Individual sacrificial magnesium anodes were observed on each of the raised arms, and it was noted that many of the anodes were consumed by anywhere from 50-80% of their original size and mass.

B. Measured potentials on all 48-injection arms are included in the Appendix to this report. Test results indicate that the majority of arms are **fully cathodically protected** by measured potentials in excess of (more negative than) –0.850 volts (with respect to the $CuSO_4$ reference). In six (6) locations (see Appendix), potentials were either below the criteria for full protection or the anodes were missing. (had been previously removed by LVMWD personnel).

C. The anodes, which were available for inspection, were noted to be consumed (reduced in size and mass) by from 50-80%. This would indicate that their remaining life was probably in the range of 4-6 months. Additionally, the method of attachment of the individual anodes to the injection arms was by a "U-bolt" arrangement, which is considered inadequate for this project.

IV. CONCLUSIONS:

Based on the Test Results section preceding, the following specific conclusions have been reached for the injection facilities at Tapia:

A. The existing method of cathodically protecting the injection arms at Tapia is proving to be adequate for corrosion control of these facilities. The sacrificial magnesium anodes will provide protection as long as they have sufficient mass and good electrical connections to the respective structures. If either the anode size is reduced or the electrical connections are compromised, the anodes will not provide adequate protection to these facilities and corrosion of the structures is anticipated.

B. Measured potentials indicate that the majority of injection arms are presently fully cathodically protected. Exceptions are noted for six arms (see Test Results section preceding). As long as the potentials remain above (more negative than) –0.850 volts DC, the structures should remain fully protected. Should the anodes become significantly reduced in size or the electrical connections become degraded, the potentials will be reduced accordingly with accompanying corrosion activity expected on the facilities.

C. The existing magnesium anode mounting method and selection of anode type is deemed **inadequate** for this application as the anode life is too short and the present connection method could be improved for greater reliability.

V. RECOMMENDATIONS:

Based on the Conclusions section preceding, the following recommendations are offered for the Tapia Reclamation Facility:

A. Immediately change the type and method of anode attachment to the individual injection arms to the new recommended anode (see Appendix, Recommended Anode Replacement drawings). The new anode should have the model number **GA-MG-T-36** and should be a "high-potential" cast magnesium anode with a centrally cast steel strap core. The anode weight should be 36 pounds each and be attached to the individual injection arm with a bolted connection as shown on the details in the drawing. These anodes are available from the local distributor, **GMC ELECTRICAL**, Ontario, California, phone (909) 947-6016.

B. Following the installation of these new recommended anodes, the Tapia facility should be tested and inspected at least annually by a qualified Corrosion Engineering firm and a full report presented.

Tapia Water Reclamation Facility

"Aeration Tanks"
Structure-To-Electrolyte Potential Measurements (mV)

Tank #1

1) -.975
2) -.945
3) -.997
4) -.939
5) -.948
6) -.939
7) -.952
8) -.962

Tank #2

1) -.995
2) -1.034
3) -.975
4) -.959
5) -.964
6) -.980
7) -.975
8) -1.030

Tank #3

1) "Removed" N/A
2) -.962
3) -.971
4) -.945
5) -.945
6) -.946
7) -.918
8) -.938

Tank #4

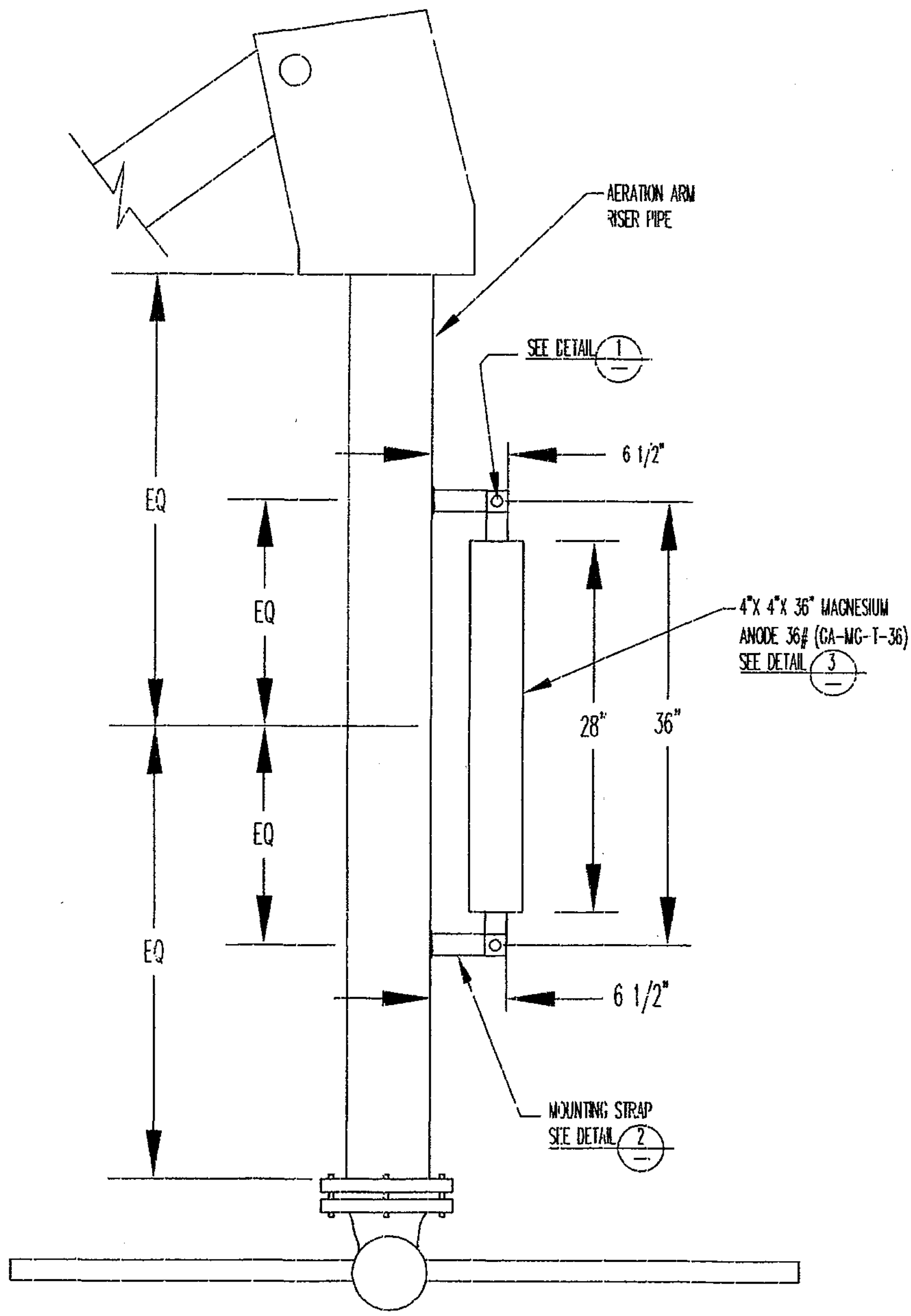
1) -1.316
2) -1.074
3) -1.282
4) -1.236
5) -1.216
6) -1.138
7) -1.139
8) -1.187

Tank #5

1) "Removed" N/A
2) -.586
3) -1.389
4) -1.389
5) -.604
6) -1.432
7) -.967
8) -1.260

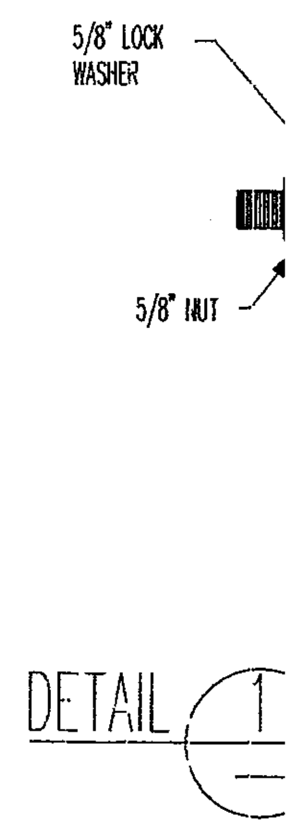
Tank #6

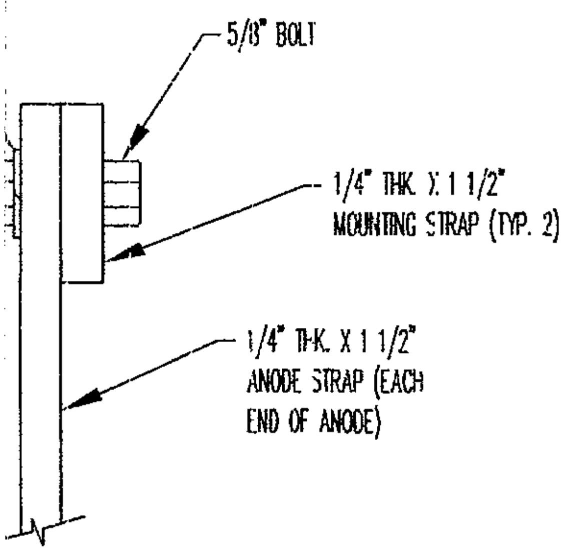
1) -.996
2) -1.108
3) -1.360
4) -1.340
5) -.649
6) -.630
7) -1.270
8) -.981



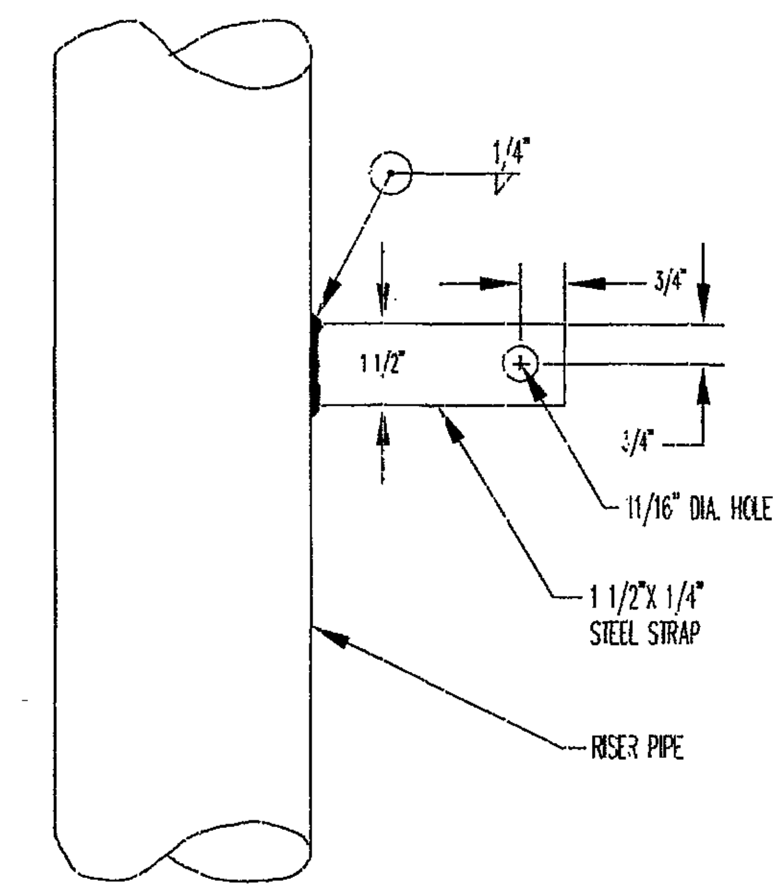
TYPICAL ANODE MOUNT FOR 36# MAGNESIUM ANODE

N.T.S.

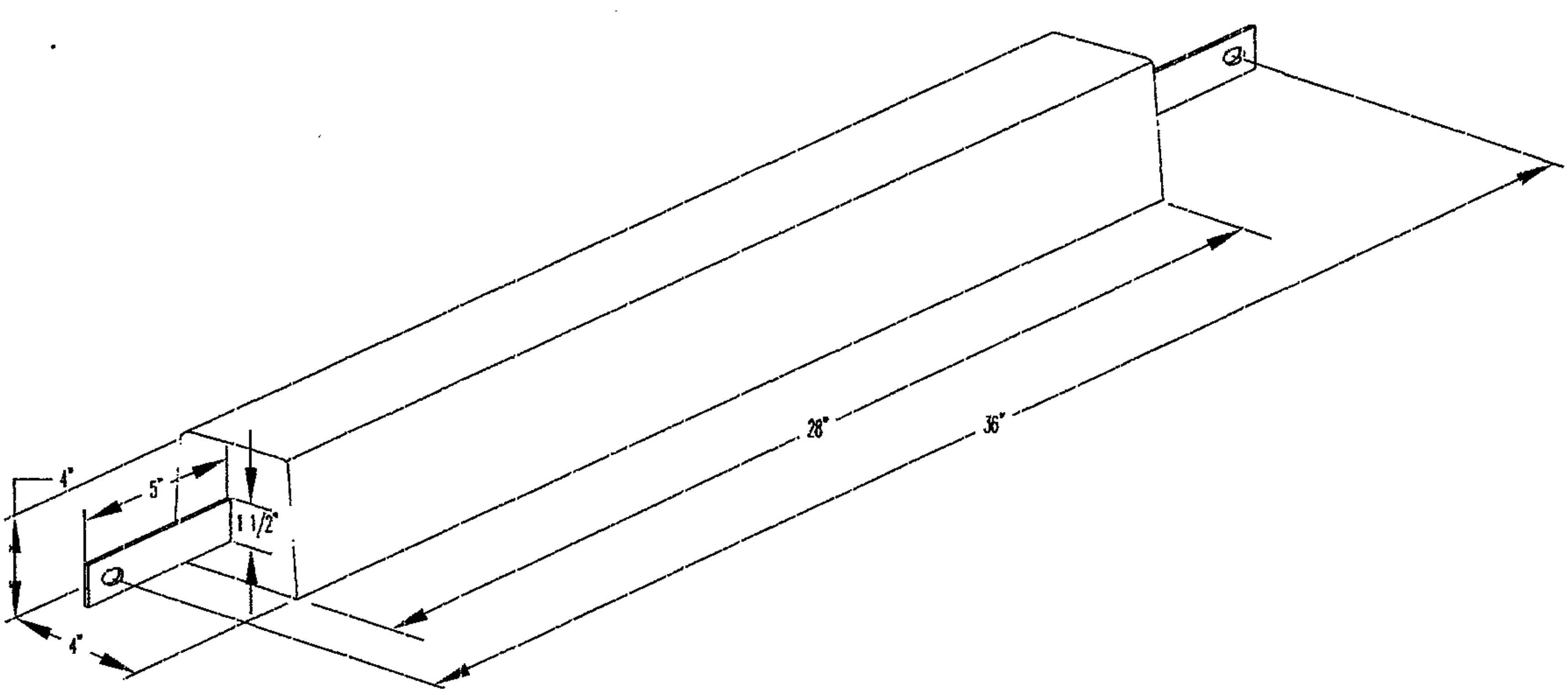




TYPICAL BOLT CONNECTION
N.T.S.



DETAIL 2 TYPICAL MOUNTING STRAP
N.T.S.



DETAIL 3 TYPICAL 36# MAGNESIUM TANK ANODE
N.T.S.

GMC ELECTRICAL INC.
2[illegible]2 S. GROVE AVE. UNIT "F" ONTARIO CA. 917[illegible]
PHONE# (909) 947-6016 FAX# (909) 947-9430

CATHODIC PROTECTION SYSTEM
FOR AERATION UNITS
LAS VIRGENES WATER DISTRICT

SCALE N.T.S. SHEET 1 OF 1
SPECIFICATION NUMBER NONE
DRAWING NUMBER NONE

OPERATION AND MAINTENANCE MANUAL
IMPRESSED CURRENT CATHODIC PROTECTION SYSTEMS

INDEX

OPERATION AND MAINTENANCE MANUAL
IMPRESSED CURRENT CATHODIC PROTECTION SYSTEMS

I. <u>DESCRIPTION OF THE SYSTEM:</u>

A. The purpose of an impressed current (rectifier) cathodic protection (ICCP) system is to prevent corrosion on any buried or underwater metallic pipeline surface. This is accomplished by a passage of DC (direct) current from metallic anodes, which are buried alongside the structure of interest, through the electrolyte (soil) and onto the structure. The anode system is energized by connecting the anodes to the positive terminal of the rectifier units (by a cable) and connecting the structure (pipeline) to the negative terminal of the units (also by cable). The rectifier is typically an air-cooled, silicon diode bridge connected unit. The anodes used in typical ICCP systems are titanium oxide, high-silicon cast-iron or graphite.

B. When the systems are set for final operation, the rectifier units are field adjusted, by engineering personnel to operate at the voltage and current outputs shown on the typical Rectifier System Maintenance Data Sheets.

II. <u>OPERATION OF THE SYSTEMS:</u>

A. A cathodic protection system, which makes use of buried metallic anodes and which is energized by silicon diode rectifier units, is capable of many years of continued operation with very little maintenance. In order for the system to function effectively, it is important that it be kept in continuous operation (24 hours/day). It is further recommended that the <u>panel meters</u> of all rectifier units be read at least <u>once every month</u> and that a logged record of these readings is kept. A typical Cathodic Protection Maintenance Record Sheet for each rectifier unit is enclosed in the Appendix Part III. The output parameters at which each rectifier unit was set to operate during the final adjustment of the system are recorded on this sheet. It is mandatory that each unit be maintained to operate so as not to exceed either the rated voltage or rated current capacity stamped on the face of the unit. Each rectifier unit is provided with fine and course adjustment taps for the purpose of adjusting the current output. These adjustments should only be accomplished by trained Corrosion Engineering personnel.

B. The anodes used in these systems are capable of a life in excess of 20 years at nominal current settings. As long as the rectifier unit continues to operate at or near the recommended (preset) current outputs, the anodes will require no attention. A fault in the connecting cables between the rectifier unit and the anodes can be determined from observation of the panel meters on the rectifier units. This will be more fully discussed in the section entitled "Maintenance of Rectifier Units" and the "Maintenance of Anode Circuits" following.

C. Although a cathodic protection system using a silicon rectifier and metallic anodes is capable of many years of trouble-free operation, it is recommended that the system be tested thoroughly each year by a Corrosion Engineering firm in order to determine that all parts of this system are operating properly and that an adequate level of cathodic protection is being maintained. It is possible that changes in the environment or structure may require adjustment in the current delivered by the existing cathodic protection system. It is essential that the system be periodically tested and readjusted as required and a report prepared with findings and recommendations.

III. <u>MAINTENANCE OF RECTIFIER UNIT:</u>

A. Inspection:

Inspection of each rectifier unit and reading of the panel meters should be done once each month (at a minimum) and incorporated in a routine documentation and inspection procedure for these facilities. The meter readings should be placed in a log or format similar to the Rectifier Maintenance sheets. If any appreciable <u>decrease</u> in voltage or current is noted, the trouble should be located as outlined in the Appendix. No other routine inspection work is typically required except visual inspection to determine the need for cleaning and cabinet painting, to determine that all electrical connections are secure and that AC power is continuously applied to the unit.

B. Cleaning:

Although the openings of the cooling vents of each rectifier unit are screened, it is possible for dirt, debris and some insects to accumulate in these openings. In order to achieve proper cooling of each unit, it is important that these openings remain clear and unobstructed; therefore, any accumulation of dirt or debris should be removed.

C. Painting: (On cabinets other than anodized aluminum or hot-dipped galvanized)

The finish originally provided the cabinet of each rectifier unit is baked enamel and should be capable of many years of service. However, when painting is required, it should be done in accordance with regular procedures established for painting of outdoor equipment of this type. Care should be taken in the painting of any screened openings of the air-cooled units so that it does not obscure the required air circulation.

D. Servicing Procedure:

If, upon visual inspection of the unit, it is found that both the ammeter and voltmeter are at or near zero (it is possible for the voltmeter to read as much as 2 volts even though the rectifier unit is turned "off" due to the galvanic voltage which exists between the anode and the underground structures), and A.C. power in "on" at the input terminals of the rectifier unit, the fault is in the rectifier unit. Continuity tests should be made in the rectifier unit (with AC power turned "off"). The unit ammeter should be checked for proper operation and the rectifier stack (bridge) should be checked to determine that it is operating correctly. In order to check the rectifier stacks (rectifying bridge), an ohmmeter can be used at the bridge output terminals. The output cables should be disconnected from the unit and the ohmmeter connected across the bridge terminals, first in one direction, and then with the leads reversed. If the resistance reading on the ohmmeter is appreciably greater when connected in one direction from that which is obtained when the leads are reversed, the rectifier stack is operable. The ammeter should be checked with a portable meter to verify accuracy.

If it is found that the ammeter reads zero but the voltmeter indicates voltage (above 2.0V), and changing the adjustment taps can vary this voltage, the rectifier unit is operating correctly but there is an "open" in the anode circuit. If the circuit breaker trips and this condition can be corrected by disconnecting the positive (+) output leads, a "short" is indicated in the anode circuit. Maintenance of the anode circuit is necessary and is described below.

E. Maintenance of Anode Circuit:

Circuit breaker "trips" are usually attributed to shorts (faults) to ground in a circuit. This can be in the unit itself, in the anode (+) "header" cable to the anodes or the anode itself contacting the structure to be protected. It will be necessary to eliminate this short to ground in order for the system to function properly. If the rectifier unit pre-set DC output current decreases considerably or drops to zero at a given voltage, and if the decrease cannot be attributed to the operation of the rectifier unit or to a decrease in the ground moisture level (increased soil resistance), an "open" in the anode circuit is indicated. When this occurs, the anode cable must be electrically traced to find the defect. This may be due to loose connections in the rectifier unit, construction in the area of the anode cable or possibly rodent activity underground. If the header cable to the anodes proves to be electrically continuous, an "open" in the internal rectifier positive or negative lead is indicated.

F. Problems Beyond Those Mentioned Above:

Problems with the rectifier systems not mentioned above are generally too complex for normal maintenance procedures. Should these occur, contact a Corrosion Engineering firm for assistance. Should the maintenance staff desire additional trouble-shooting, consult the Appendix to this manual. Parts I and II of the Appendix provide information on the typical rectifier circuitry and components along with trouble-shooting recommendations. Part III shows a typical Rectifier Maintenance Record Sheet which should be utilized for monthly rectifier panel meter readings.

APPENDICES

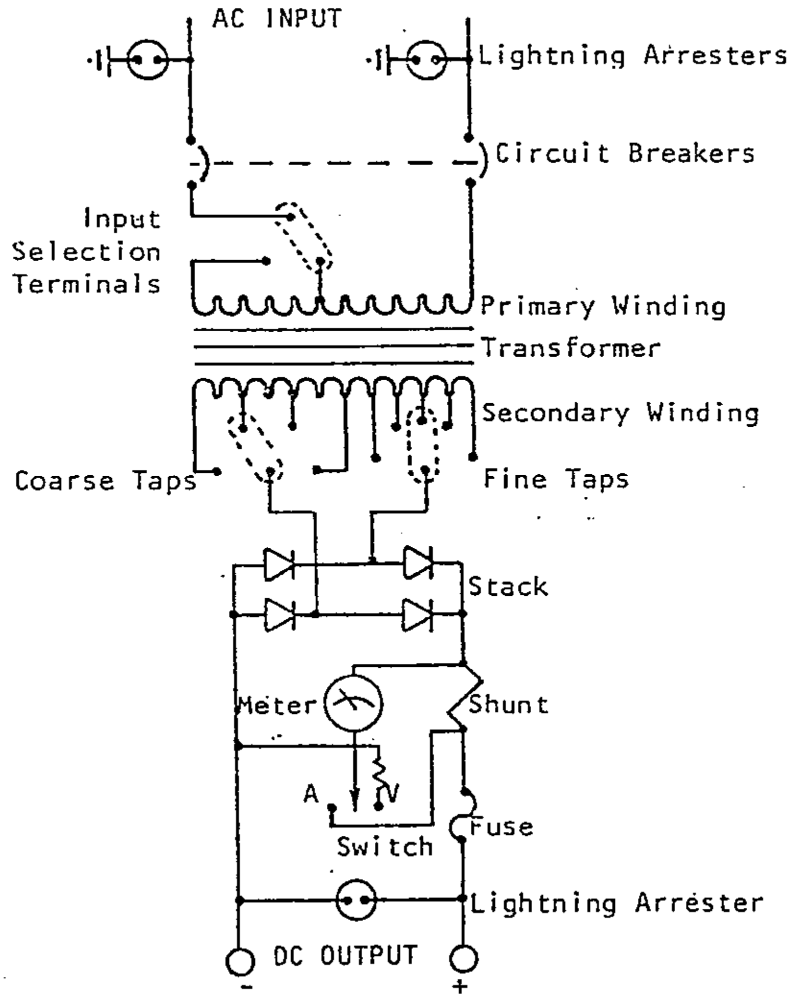
PART I
TYPICAL RECTIFIER CIRCUIT AND COMPONENTS

PART I
TYPICAL RECTIFIER CIRCUIT AND COMPONENTS

A standard cathodic protection rectifier is basically a simple device, although, upon first glance at its schematic or the rectifier itself, it may appear quite complicated. However, if the components that make up the rectifier are individually examined, and an understanding is gained of these, the unit as a whole will likewise be simplified.

The main "power train" of a rectifier is the transformer and the rectifier stack. These two components alone could provide the DC power for the cathodic protection system, but the other components found within the cabinet perform useful functions also.

Lightning arresters are used on the input and output to protect the rectifier from component failure. Circuit breakers are on the input to turn the rectifier on and off, and to provide overload protection. The transformer changes the input line voltage to a useable level. The stack converts AC to DC. The meter, shunt, and switch provide a means to monitor the output of the rectifier. Fuses serve as overload protection devices.



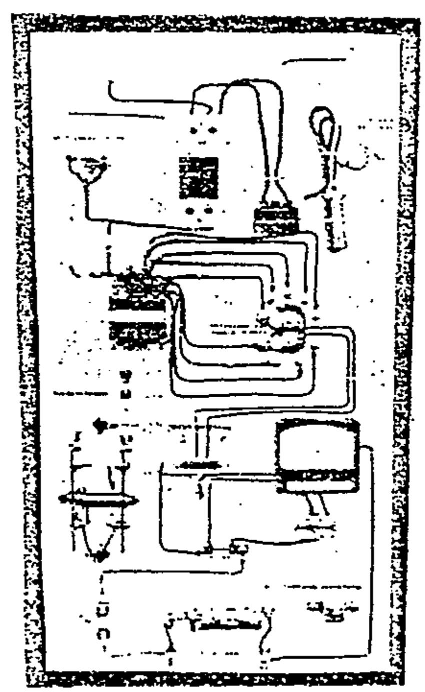


Figure 1-1

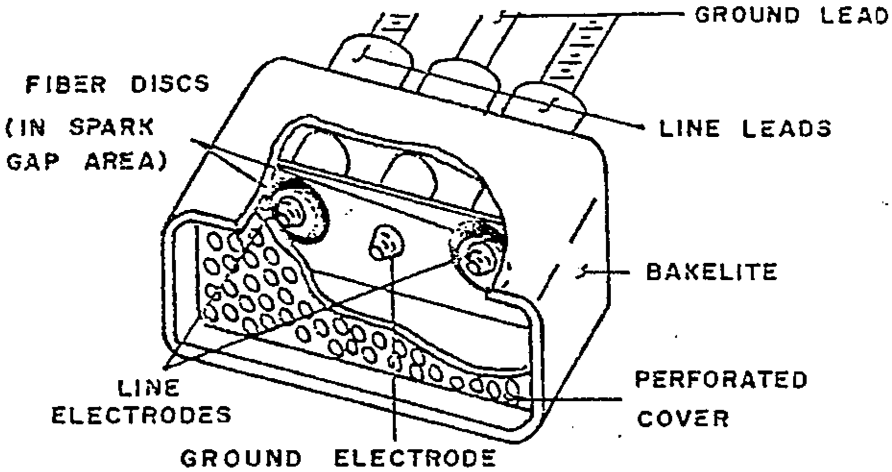
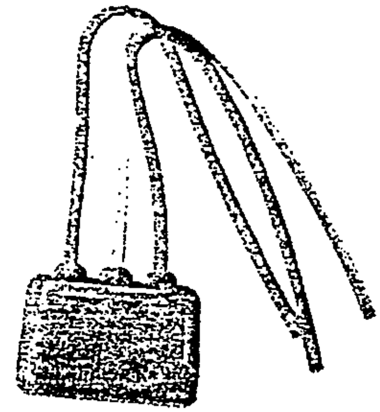


FIGURE 3-2A



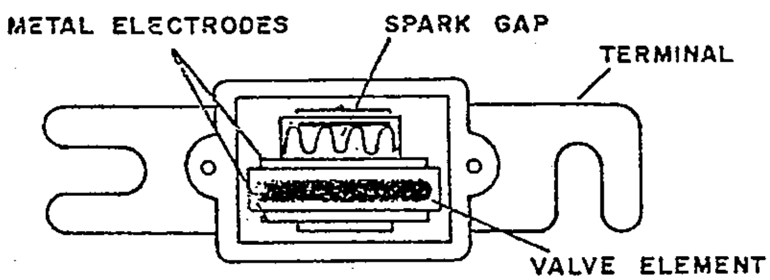
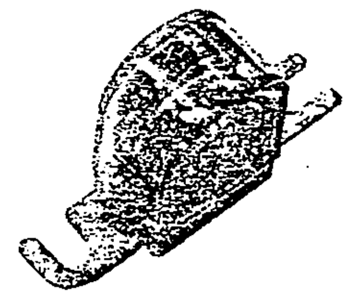


FIGURE 3-2B



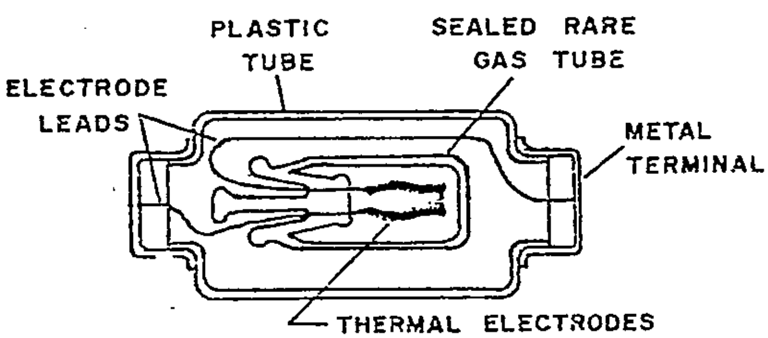
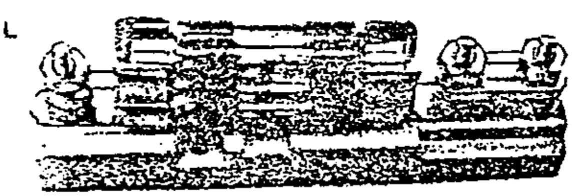
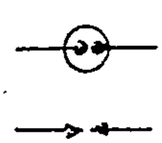


FIGURE 1-2C



SYMBOLS FOR
LIGHTNING ARRESTER



LIGHTNING ARRESTERS

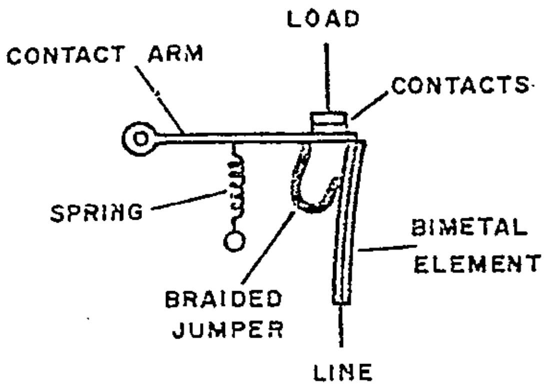
The simplest form of lightning arrester is the arc-gap. A high voltage surge ionizes the air between two electrodes, and conducts current across the gap until the voltage drops below the ionization level.

There are various types of arresters designed for many applications. Among these are explusion, valve and rare gas types. Each type may have a number of designs or configurations.

One type of expulsion arrester has a pair of line electrodes that are separated from the ground electrode by air gaps which contain fiber discs. (Figure 3-2A) The disc breaks the arc up into a multitude of smaller arcs and spreads it over a larger area. This causes the arc to extinguish more quickly and at the same time limits or prevents damage to the arrester itself.

A typical valve arrester utilizes a resistive element, called the valve element, which is held between two metal fingers by an air gap. (Figure 3-2B) In this type of arrester, a surge of sufficient force causes an arc to jump from the fingers to the nearest metal electrode. The valve element, which conducts current from one electrode to the other, acts as a very low impedance to the extremely high voltage of lightning, but becomes a high resistance to normal line voltage. This prevents the line voltage from sustaining the arc current.

In the rare gas arrester, inert gases argon and neon are used to conduct current from one electrode to the other. (Figure 3-2C) These gases are normally insulators unless acted upon by a high voltage. This causes the gases to ionize and conduct current. As the surge voltage subsides, the gases, at some specific point, will deionize, again becoming an insulator. Some types of rare gas arresters contain a pair of thermal electrodes to assist in carrying the surge current. The rare gas tubes are also generally connected in parallel with an open type arc gap to carry surges that exceed the rating of the tube.



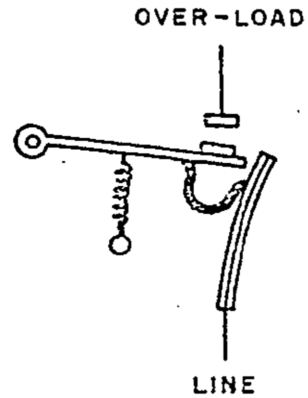
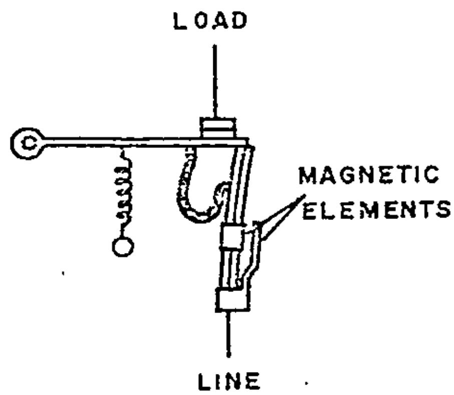


FIGURE 3-3A



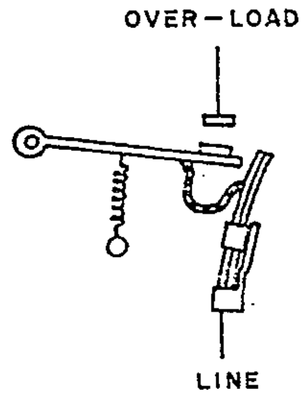
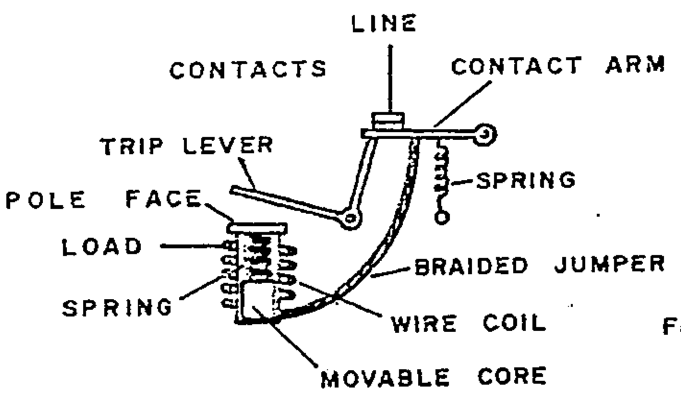


FIGURE 3-3B



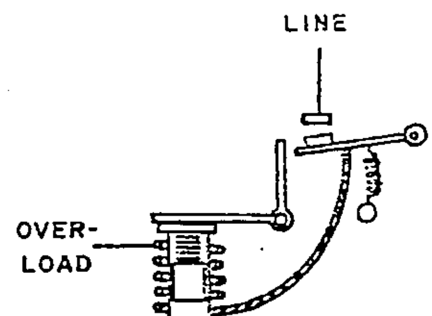
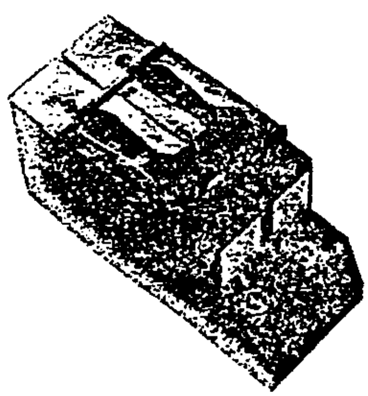


FIGURE 3-3C



CIRCUIT BREAKER
SYMBOL

CIRCUIT BREAKERS

The primary function of a circuit breaker is to provide overload protection to the circuit it is in. It also serves as an on-off switch.

There are three basic types of circuit breakers. These three types are thermal, thermal-magnetic, and fully magnetic.

In the thermal breaker, there is a bi-metallic element, through which current flows when the breaker is in the "on" position. (Figure 3-3A) If more current flows through the element than it is rated for, heat caused by the excessive current will cause the two metals to expand. Because it is the property of two dissimilar metals to expand at different rates, the two strips bonded together will bend to one side. This will release the moveable contact, and the circuit will be opened.

Since heat is the determining factor in the operation of the thermal breaker, outside ambient temperatures will have an effect on it also. This is generally a disadvantage in cathodic protection, as the rectifier is going to be, in nearly all cases, mounted outside on a pole or platform, where it can be affected by extreme temperature variations. The outside temperature could, in some cases, trip the thermally operated breaker without an overload on the rectifier. Also, it might be necessary to wait until the temperature drops before the breaker can be re-set.

Operation of the thermal-magnetic breaker is identical to the thermal breaker, with one exception. Attached to the bi-metal element is a magnetic plate. (Figure 3-3B) The purpose of this plate is to speed up the opening of the contacts during short circuit or other extremely heavy current surges. A heavy surge sets up a magnetic field around the plate, causing it to be attracted to another plate located near it, which results in immediate opening of the contacts. Under normal load or light overloads, the magnetic plate performs no function whatsoever.

A breaker that is more suitable for cathodic protection is the fully magnetic breaker. (Figure 3-3C) This type of breaker responds only to overloads in current. The current rating of this breaker is determined by the number of turns and wire size of the magnetic coil which is wound around a sealed tube in the circuit breaker. This tube contains an iron core immersed in silicone fluid and retained by a compression spring.

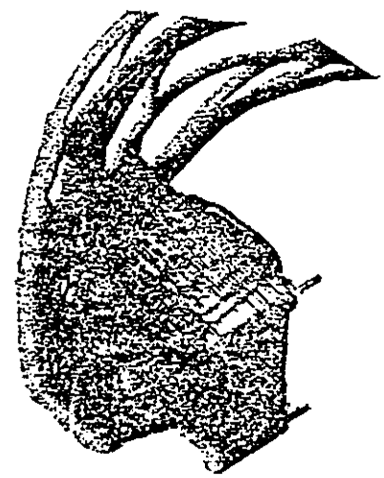
As long as the breaker is operating within the rating, the iron core will remain stationary; but if there is an overload on the breaker, the core will be drawn towards the pole-face on the end of the tube by the magnetic action of the coil. The closer the core comes to the pole-face, the stronger the magnetic pull is on the arm that holds the contacts closed. When the pull is great enough, the lever will trip and the contact will open.

Under short circuit conditions, the magnetic action of the coil itself will trip the arm instantaneously. This type of action is entirely independent of temperature, making it much more suitable for rectifier application.

Circuit breakers should be placed in every "hot" input line. This means that with 115 volts single phase, one breaker would be placed in the "hot" line, while the ground or neutral lead would not need one.

On higher single phase input voltages, such as 230, 460, etc., both input lines should be protected with a breaker. Three phase units should have breakers in all three input lines.

Circuit breakers should always be ganged so that all input lines will be opened, thus preventing personal injury or circuit damage.



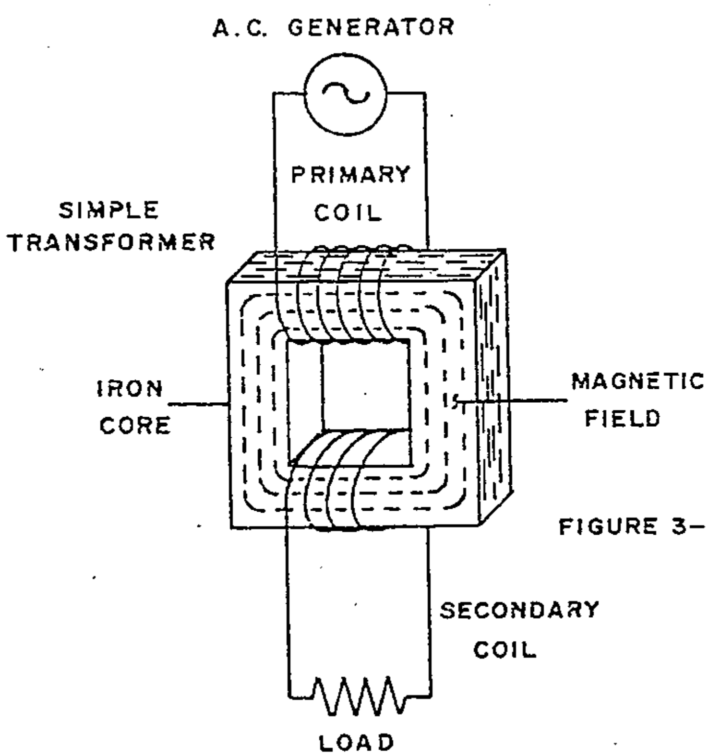
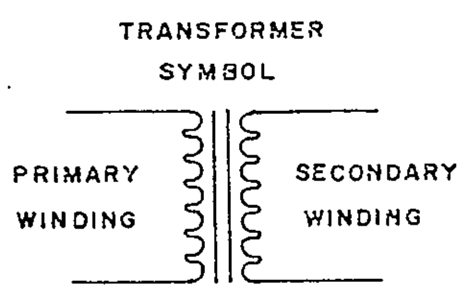


FIGURE 3-4 A



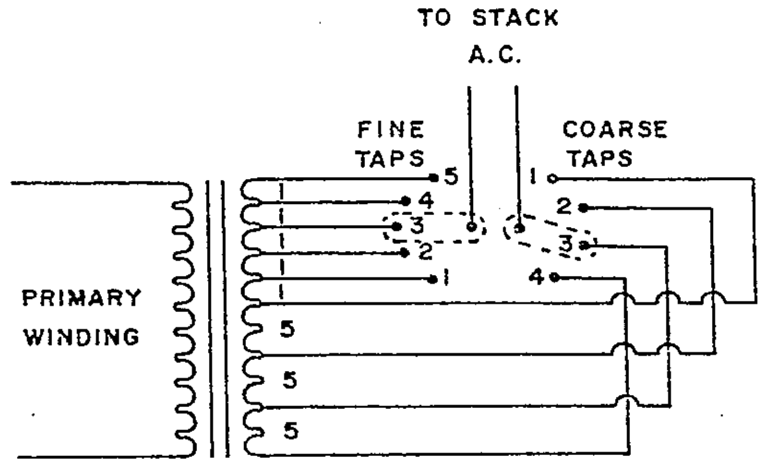


FIGURE 3-4B

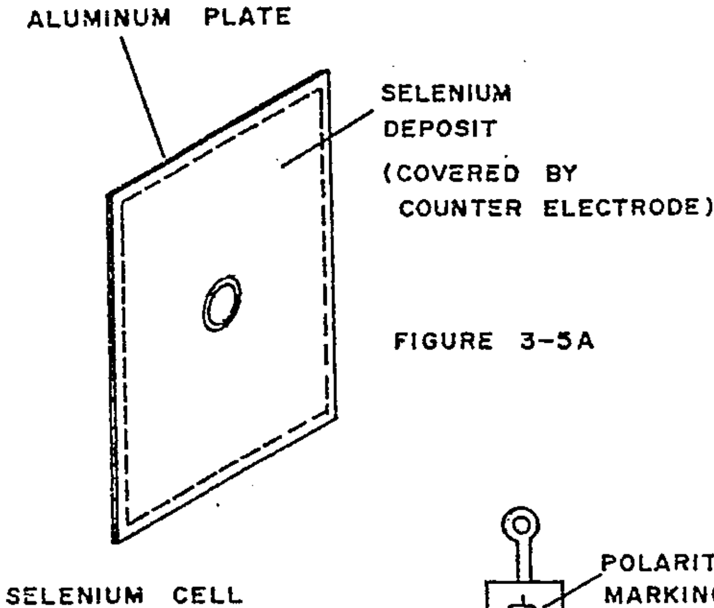
TRANSFORMERS

A transformer is one or more coils of wire wound around a laminated iron core. (Figure 3-4A) Its purpose is to step voltage up, step it down, or to isolate a voltage from its source.

The primary winding of a transformer receives voltage from a source, such as a generator. The secondary winding receives voltage from the primary through magnetic coupling. When an AC voltage is applied to the primary winding, an alternating magnetic field, called flux, is set up in the core. This flux induces a voltage into the secondary winding at the same volts per turn ratio as that of the primary. Therefore, the ratio of secondary volts to secondary turns is the same as the ratio of primary volts to primary turns.

This is true only under no-load conditions, however. When a load is connected to the secondary, current flow in the primary and secondary causes a reduced voltage across the secondary winding. This is due to resistance in the wire and other losses that appear in the wire and in the lamination.

Taps placed at intervals along the secondary winding produce voltages corresponding to the number of turns at which they are connected. (Figure 3-4B) By locating the taps in "coarse" and "fine" arrangements, relatively few taps can produce a considerable number of evenly spaced voltage adjustments.



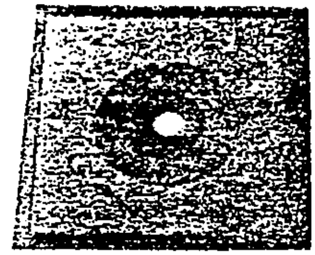
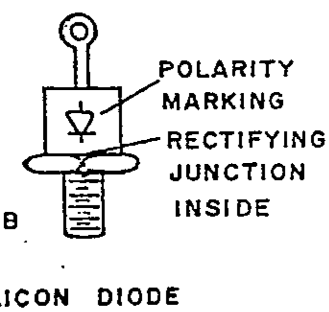


FIGURE 3-5A



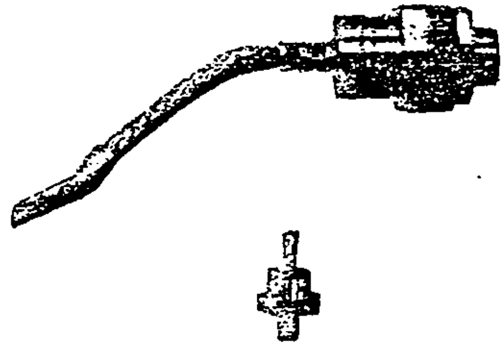
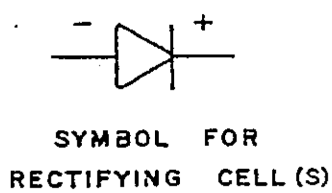


FIGURE 3-5B



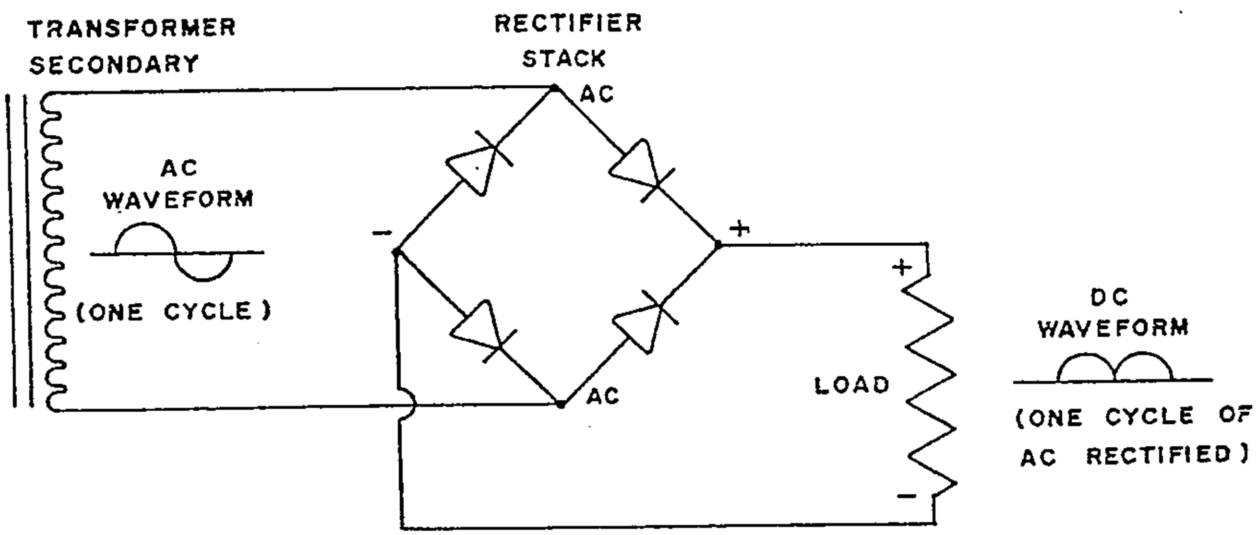


FIGURE 3-5C

RECTIFYING CELLS AND SINGLE PHASE BRIDGE CIRCUIT

The function of a rectifying cell or element is to pass current in one direction and to block it in the opposite direction. There are a number of materials that will accomplish this, but the most common types used in cathodic protection are selenium and silicon.

The selenium cell is generally made up of an aluminum plate with a deposit of selenium crystals on one side of the plate, then covered with a metal film to provide a contact area on that side. (Figure 3-5A) Special processing creates a barrier layer on the selenium side of the plate which prevents current from passing from the selenium to the aluminum.

Unlike the selenium plate, the silicon diode has a single crystalline rectifying junction. By comparison, the rectifying area of the diode is many times smaller than that of the selenium plate, so the diode is manufactured in a physical configuration which permits it to be mounted on a heat sink, which serves in drawing the heat away from the junction area. (Figure 3-5B)

An assembly of selenium plates or silicon diodes arranged to rectify AC current and produce DC output is commonly referred to as a "stack." Each stack is made up of one or more "arms" or "legs," which are one-way paths for electrical current. An arm or leg may be made up of one or more rectifying cells or elements. The schematic symbol for a rectifying cell is an arrow-shaped figure with a short line across the point. This indicates current flow in the direction of the arrow and current blockage in the opposite direction.

By tracing alternating current flow from the secondary winding of a transformer through a single phase bridge stack, it can be demonstrated how rectification is achieved. (Figure 3-5C)

Current leaving one end of the transformer secondary will pass first through one leg of the stack in the direction of the arrow (from an AC stack connection to the positive stack connection), flow through the load, then return to the other end of the secondary winding through a second stack leg in the direction of the arrow (from the negative stack connection to the other AC stack direction). This completes one-hold cycle of AC rectification. During the second half of the AC cycle, current will flow in the opposite direction in the transformer secondary and through the remaining two legs of the stack in the direction of the arrows, with the current passing through the load in the same direction as before, resulting in two pulses of DC current in the load for each cycle of alternating current in the transformer.

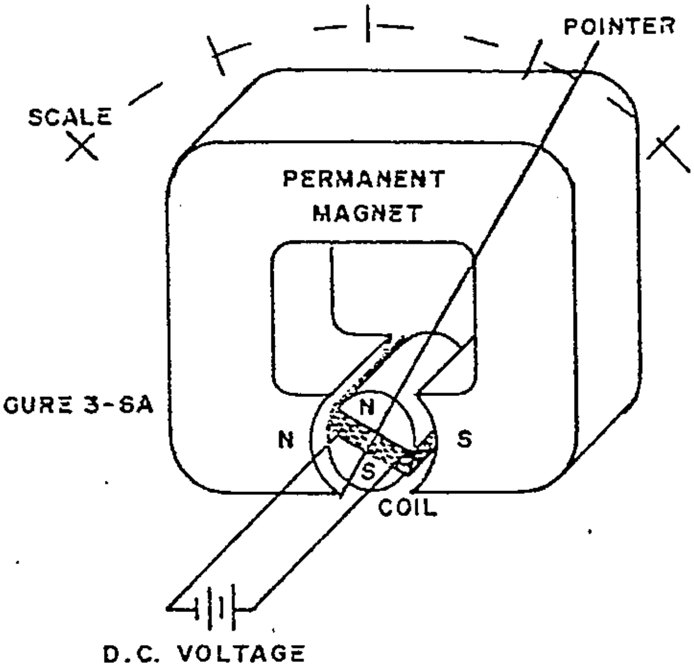
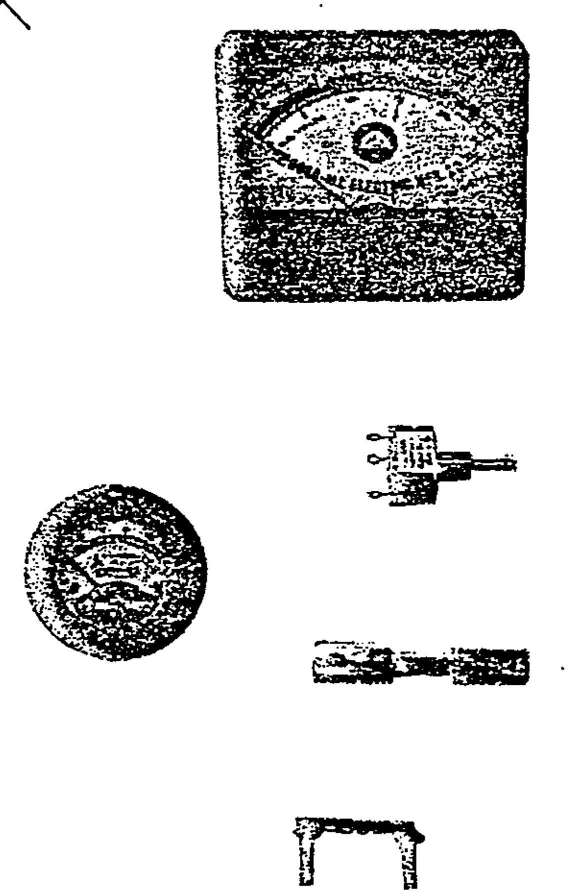


FIGURE 3-6A



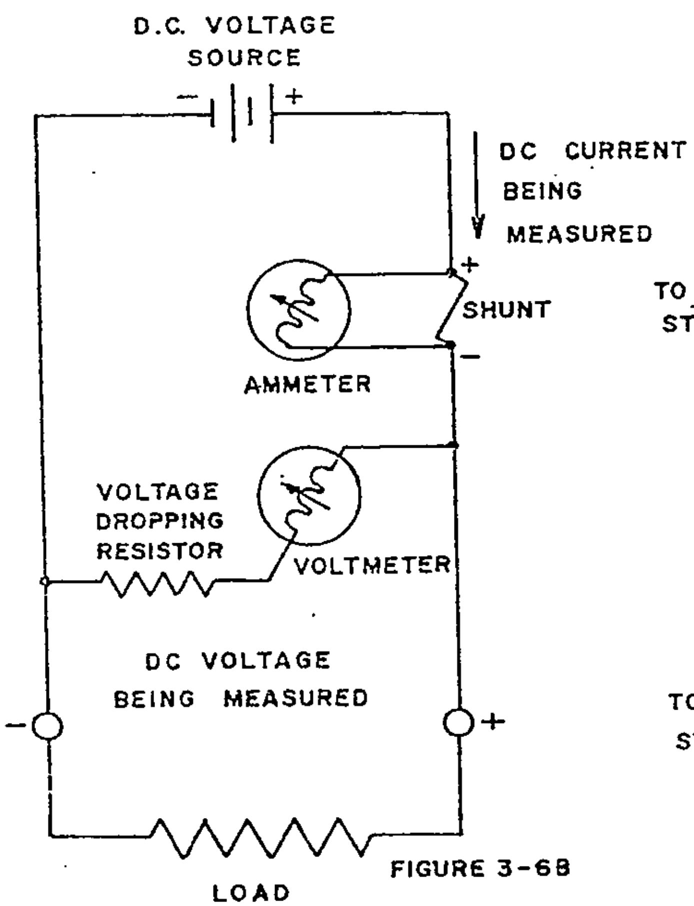


FIGURE 3-6B

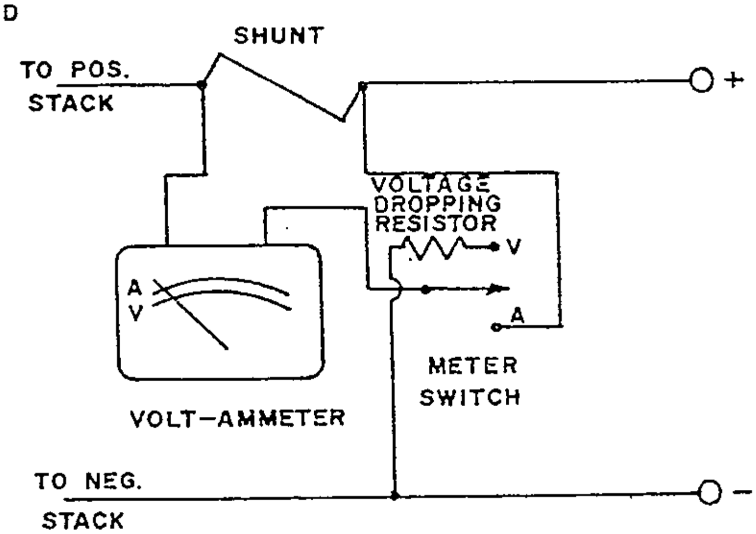


FIGURE 3-6C

METERS

The purpose of a meter in a cathodic protection rectifier is to indicate the amount of DC voltage or current in the output. These meters are generally of the D' Arsonval type, that is, a meter which employs a movable coil inside a permanent magnet field. (Figure 3-6A) Current flowing through the coil, or meter movement, sets up north and south poles on opposite faces of the coil. These poles are attracted by the poles of the permanent magnet. The power of the magnet field of the coil and the amount of its deflection is in proportion to the amount of current flowing through the coil. A pointer attached to the movement indicates on a stationary dial whether current is flowing in the meter. The amount of deflection is regulated by springs attached to either end of the movement. These springs also serve the purpose of conveying the current to and from the coil, and to return the pointer back to zero when there is no current flow in the meter.

When it is used as a voltmeter, resistance is placed in series with the movement to limit the voltage applied to the meter to protect it from damage since it takes only 50mv to deflect the meter full scale. (Figure 3-6B) With this resistance in series with the meter movement, the meter is connected across the output to obtain the voltage readings.

When a meter is used as an ammeter, it is connected in series with either the negative or positive DC line of the rectifier. The full amount of DC current must be kept from passing through the meter itself, so another type of limiting device called a shunt is used to carry the main flow of current, leaving only a small fraction of current to pass through the meter. The shunt provides a 50mv drop across it when the amount of current flowing through it is equal to the current rating of the shunt. The 50mv movement of the ammeter will then be deflected full scale. The shunt is generally mounted externally from the meter, but in some cases it may be mounted internally.

By employing a single meter to act as both voltmeter and ammeter advantages may be gained. (Figure 3-6C) One advantage is that a larger, easier to read meter may be used that will take up the same or less panel space than two separate meters. Another advantage of a single combination volt-ammeter is that the meter must be out of the circuit except when the meter switch is thrown in the volt or amp position. This serves to protect the meter from lightning and other voltage or current surges.

Temperature-compensating devices are generally a standard feature in meters used for cathodic protection, due to the wide range of temperatures to which a rectifier may be exposed.

PART II

TROUBLE-SHOOTING RECTIFIER SYSTEM PROBLEMS

PART 2
TROUBLE SHOOTING (BASIC)

An adequate inspection and maintenance program will greatly reduce the possibility of rectifier failure. Rectifier failures do occur, however, and the field technician must know how to find and repair troubles quickly to reduce rectifier down time.

TROUBLE SHOOTING EQUIPMENT

Equipment required for trouble shooting need not be elaborate, but must be adequate to do the job. A multimeter, such as the Simpson 260 or Triplett 630, is relatively inexpensive and is valuable for reading AC and DC voltages and DC current up to 10 amperes. This meter may also be used to measure resistance and to determine whether short circuits or open circuits exist (other than ground bed resistance). A millivoltmeter may be used for checking rectifier DC current by measuring the millivolt drop across the shunt on the rectifier panel. In addition to necessary small tools, every technician's kit should include a heavy shorting cable and several jumper cables about three feet long with booted alligator clips.

PRECAUTIONS

The following precautions should be observed when trouble shooting rectifiers:

1. Turn the rectifier off when handling components within the rectifier. Open the disconnect switch ahead of the rectifier as well as internal circuit breakers.

2. Be careful when testing a rectifier which is in operation. Most rectifiers are located in isolated areas and an injured technician may be far from help. Some companies insist that their technicians stand on a rubber mat and wear rubber gloves when working on electrical equipment.

3. Consult the rectifier wiring diagram before starting to trouble shoot.

4. Make certain that meters used in trouble shooting are properly connected. The voltmeter should be connected across the points where the voltage is to be measured, while the ammeter should be placed in series with the circuit being tested. A millivoltmeter should be connected across the terminals on the rectifier shunt. Correct polarity must be observed when using DC instruments. Turn the rectifier off before using an ohmmeter to avoid harming the instrument.

TYPICAL RECTIFIER CIRCUIT

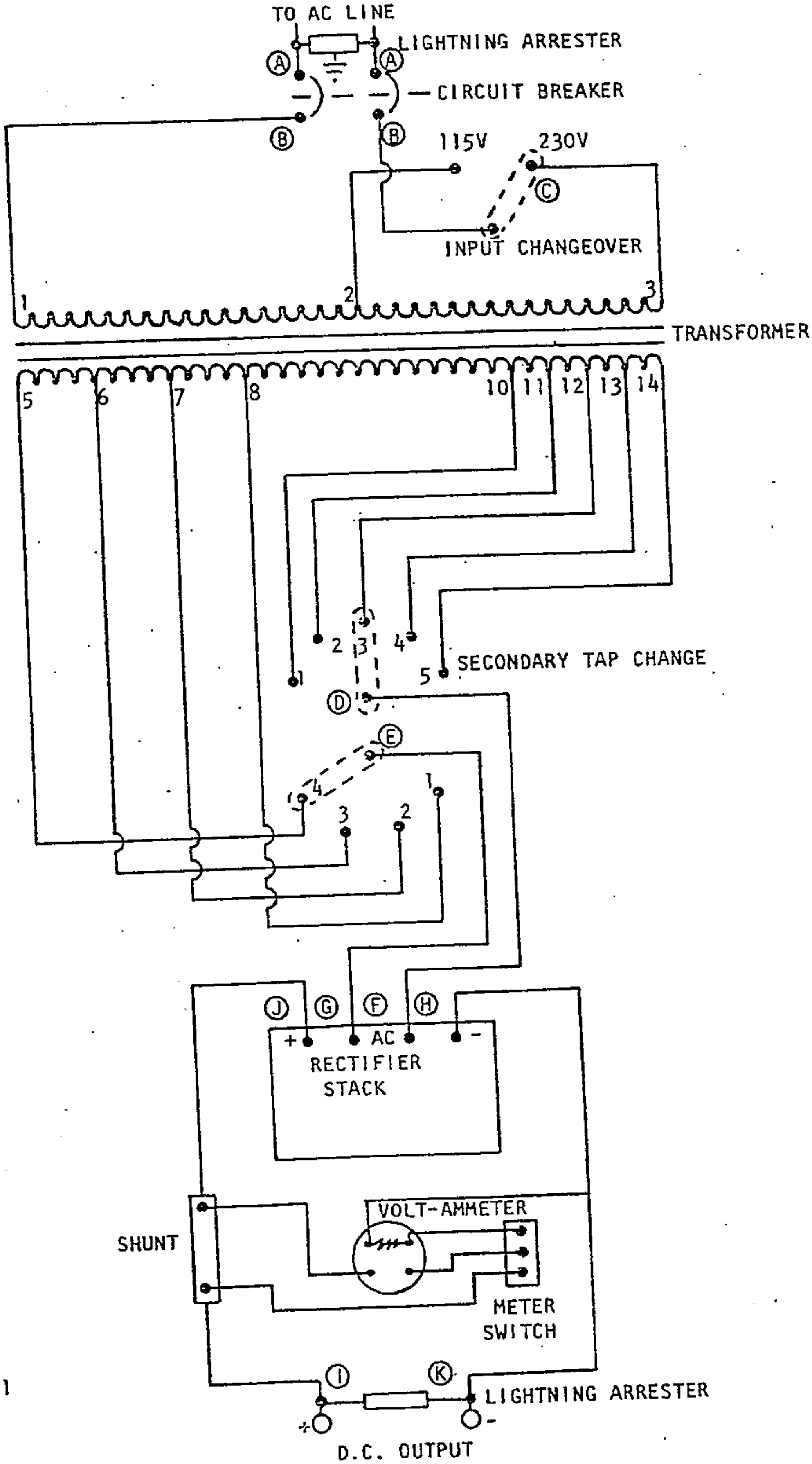


FIGURE 9-1

T Y P I C A L   R E C T I F I E R   C I R C U I T

(Mechanical Layout)

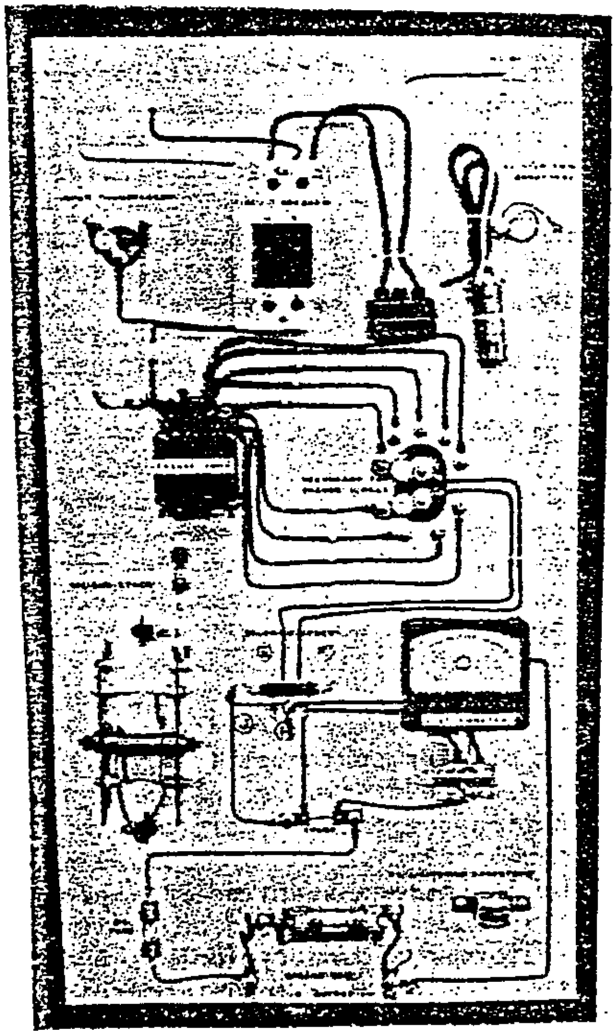


FIGURE 9-2

TROUBLE SHOOTING THEORY

Most rectifier troubles are simple and do not require extensive detailed trouble shooting procedures. Most common problems are: blown fuses, faulty meters, loose terminals, open ground-bed leads and lightning damage. These troubles are usually found by a simple visual examination of the rectifier.

For more difficult troubles, however, it is usually better to systematically isolate the rectifier components until the defective part is found. This amounts to trading a difficult problem for several simpler ones. This may be done as follows (please refer to Figure 9-1):

1. Check to see whether voltage is being supplied to the rectifier by placing the leads from an AC voltmeter or the light across the line side of the circuit breaker at points A.

2. Check across the load side of the circuit breaker at points B to determine whether it is defective. The voltage should be the same as that at points A.

3. Check the input change taps (point C) for loose connections and to verify that the tap change bar (or lead) is adjusted for the correct input voltage.

4. With an AC voltmeter or light check the transformer secondary windings (at points D and E) to determine whether voltage is present. Voltage may be measured between any of the secondary taps. The entire secondary winding may be measured between the number 4 coarse tap/and the number 5 fine tap. If the circuit breaker trips, indicating a short circuit, the transformer may be isolated from the DC circuit by removing the secondary tap changing link bars (D and E). If the circuit breaker continues to trip, look for visible shorts between the transformer leads. If it holds, the short is not in the transformer, but in the DC circuit.

5. Measure the AC voltage supplied to the rectifier stack (points F and G). This voltage should be the same as that measured at the transformer secondary (points D and E). If AC voltage is present at the transformer secondary, but not at the stack AC terminals, check the leads from the transformer between point D on the transformer secondary and point G on the stack. If no voltage is present, the lead between points E and G is probably open. Verify by measuring the AC voltage between points E and F. If voltage is present between these points the open is between points E and G. Replace the defective lead.

6. If the circuit breaker trips, the stack may be isolated from the rest of the DC circuit by removing one of the DC leads at either point H or J. If the breaker continues to trip the stack is defective and should be replaced.

7. If AC voltage is supplied to the stack, check the DC output voltage with a DC voltmeter. If DC voltage is present but is much less than expected, the stack testing procedures of Section 5 may be used to determine whether the stack is aged. If the DC voltage is about half that expected, turn the unit off and feel the individual plates in the stack (or stacks). If part of the plates are warm and part are cold, the stack has an open circuit and is half waving. If the stack assembly consists of more than one stack, check the connecting leads for opens. This may be done readily by paralleling the suspected lead with a jumper cable.

8. If the circuit breaker does not trip when a DC lead on the stack is removed, but does trip when it is connected, the short circuit is probably in the external ground-bed or structure leads. This may be verified by removing one of the external DC leads from the rectifier and turning the rectifier on again.

9. If DC voltage is present at the stack, but not at the rectifier output terminals, check for loose connections or open leads between points J and L or between points H and K. This may be done by measuring the DC voltage between points J and K or between H and L.

10. If DC voltage is present at the rectifier output terminals, but no current is flowing, there is an open in one of the external DC leads.

11. Faulty meters may cause the rectifier to appear defective when it is actually all right. The meters may be checked with portable meters known to be accurate.

12. The meter switches may be checked with an ohmmeter or, after consulting the wiring diagram, jumper wires may be placed across the switch terminals. (Care must be taken not to short across both switch terminals at the same time on units equipped with combination volt-ammeters.)

13. Some rectifiers are equipped with a filter for noise interference or to improve conversion efficiency. If it is suspected that the choke is defective, it may be effectively taken from the circuit by placing a heavy jumper lead across the choke leads.

    The capacitors in an interference filter are individually fused. Capacitors usually fail by shorting. If the capacitor fuse is blown, replace with a new fuse and turn the unit on again. If the fuse blows again, the capacitor is defective and should be replaced. The unit may be safely operated without the capacitor. When the fuse is open or removed the defective capacitor is not in the circuit.

14. Lightning arresters in rectifiers may be isolated by removing them from the circuit. The rectifier will operate without them.

TYPICAL RECTIFIER CIRCUIT

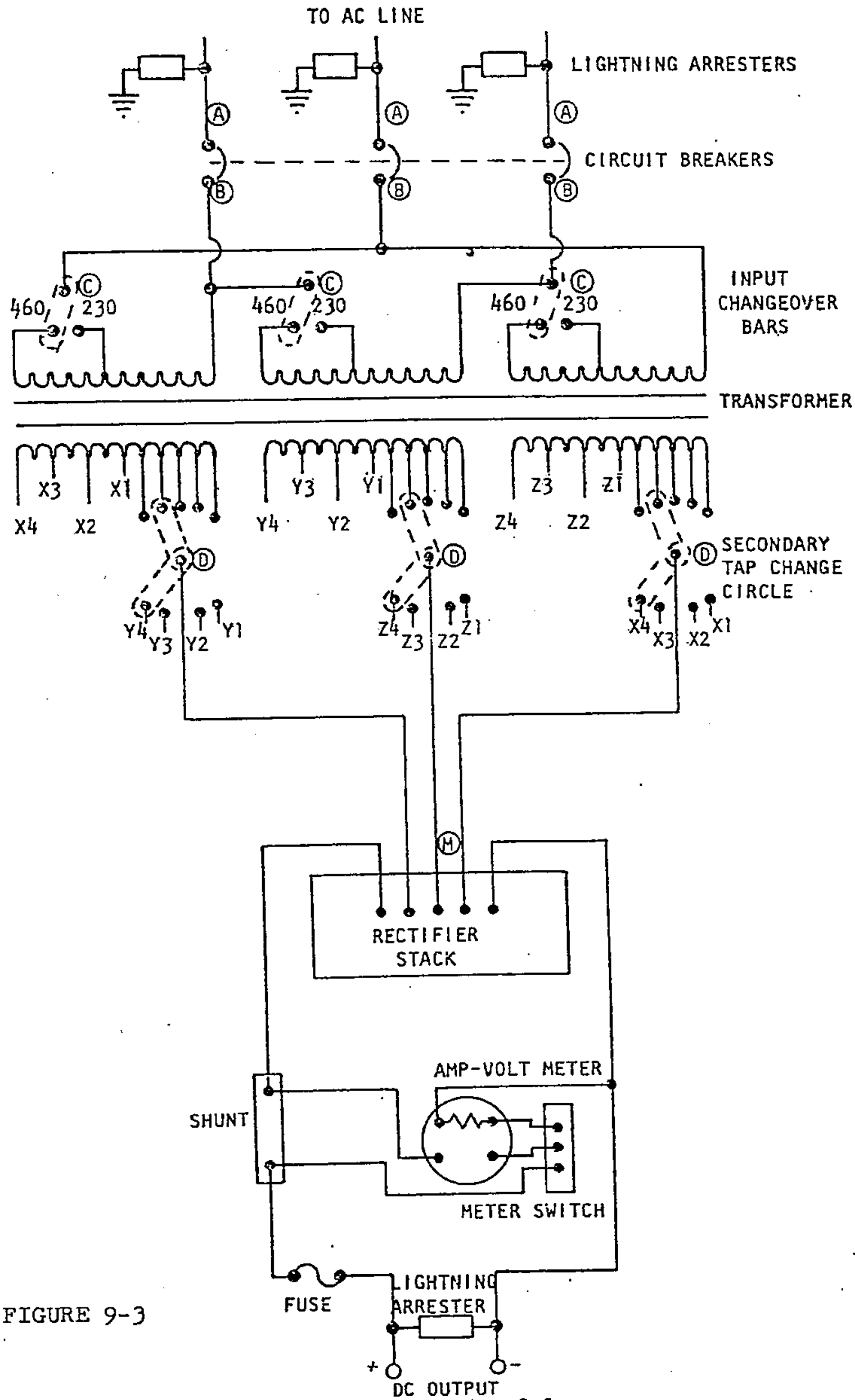


FIGURE 9-3

TROUBLE SHOOTING TIPS

Many rectifier problems are relatively obvious to the experienced tehcnicians upon physical examination. The obvious should never be overlooked! Loose connections, signs of arcing, strange odors, etc., indicate troubles which do not require elaborate test procedure to uncover. Some helpful trouble shooting tips to follow:

1. If no output voltage or current is present, the trouble and remedy may be:

   A. Breaker tripped (or fuse blown).

      (a) If apparently due to steady overload, reduce the output slightly.
      (b) If the breaker trips repeatedly even with the output reduced, the cause may be a short circuit in some component. Isolate the component as described before and repair or replace.
      (c) If the breaker trips occasionally for no obvious reason, the cause may be:

         (1) Temporary overload due to soil moisture changes.
         (2) Line voltage surges, or wrong line voltage connections. Adjust the rectifier for operation at the proper line voltage for the location.
         (3) Intermittent short circuits. Isolate the component as described before. Check for loose brackets or connections. Check with ohmmeter while moving leads, etc. (Make certain power is turned off when using the ohmmeter.)
         (4) Thermal breaker may be affected by sun heat. Install a shield or shade.

   B. No AC line voltage. Check with light or AC voltmeter. Do not overlook the possibility that service to the rectifier may have been interrupted.

   C. Open circuit in some component or connection.

      (a) Check all connections, especially the AC voltage selector (dual input units only), fine and coarse transformer tap adjustments and stack connections.
      (b) Rectifier stacks. Use an AC voltmeter to see if voltage is applied to the stacks. If so, they may be open circuited and should be checked with an ohmmeter and possibly replaced. (Note: An ohmmeter check is not a valid test for determining whether selenium stacks are aged). If multiple stack arrangements are used, check leads between stacks for opens. On silicon stacks, disconnect each silicon diode and check individually with an ohmmeter for forward and reverse resistance. A bad silicon diode is either shorted or open, so the ohmmeter check is valid here.

D. Defective meters or meter switches.

(a) Follow the procedure of Paragraph 11, Page 2-5 of the Trouble Shooting section.

E. Defective transformer. If AC line voltage is applied to the primary, but none is present at the secondary, check to see whether there is an audible hum coming from the transformer.

(a) If so, the primary is operating, but the secondary is probably open.
(b) Check the above conclusions by isolating the transformer and checking the DC resistance of the windings with an ohmmeter.

(1) Primary should have perhaps 1-10 ohms resistance.
(2) If either is quite high, that winding is effectively an open circuit and the transformer will have to be replaced. (It is difficult to make internal repairs on a defective transformer). Make certain that the high resistance is in the winding and no in some connection lug.

F. Circuit breaker (or thermal overload protector).

If the contacts do not close, they should be repaired or the breaker replaced.

2. If maximum DC output voltage at rated DC current is only about half what it should be, the trouble may be:

A. Rectifier may be connected for higher input voltage than that being used.

B. Half the stacks or plates open-circuited, making the unit operate as a half-wave, rather than full-wave rectifier.

C. Badly aged stacks.

D. In a three-phase unit, in addition to the above, one phase may:

(a) Be open circuited, in which case the current in one AC line will be considerable less than that in the other two.
(b) Have stacks that are more aged than the other two.

E. Low line voltage.

TROUBLE SHOOTING THE SATURABLE REACTOR CONSTANT CURRENT RECTIFIER

Much of the maintenance and trouble-shooting is similar to that of an ordinary rectifier; the Manufacturer's Service Manuals should be consulted for this part of servicing.

Isolate the control portion of the unit before going to the usual servicing, unless the trouble is obvious. Without control current, the reactor withholds voltage from the stack. Connect a jumper lead from the transformer secondary (where it connects to the saturable reactor) to the stack, thus shorting out the saturable reactor. The output will go to maximum voltage if everything else is alright.

After removing the jumper cable, if the output is low and cannot be adjusted with a control knob or tap switch, the AC voltage to the control stack should be checked to see that it increases and decreases with the tap switch setting; the DC voltage from the control stack should do the same. The DC voltage to the control winding should then be checked, and it would be best to measure the control current if possible; the control current on recent units will be less than 4 amps, and on most units will be about one amp maximum. If these checks are alright, the trouble is in the reactor; if they are not alright, the trouble can be isolated by noting the point where the control voltage or current, or both, were lost.

If the output is high and cannot be controlled, disconnect one of the control winding leads. If the output then drops to low level, check the control circuit as in the preceding paragraph. If the output does not drop, the trouble is in the reactor or its connections.

If the output can be set from low to medium but no high, the control circuit is not supplying enough power. Of the control circuit checks alright, the reactor should be jumpered-out of the circuit. The output should increase to maximum. If it does, the trouble is in the reactor or its connections.

If the output can be set from medium to high, but no low, the control circuit may not be reducing the control current enough. If this is not the case, the trouble is in the reactor or its connections.

The troubles in the saturable reactor can only be an open winding or its connections, a shorted winding or its connections, or a mix-connection of the winding leads.

An open gate winding when series connected will result in no output. A shorted series or parallel winding, or one open parallel connected winding, will result in high output with little or no control. A shorted control winding will result in no control and low output if completely shorted, or partial control if partially shorted. An open control winding would show low output and no control. The opens or shorts can also be in the connections, and not necessarily in the windings themselves.

If series gate windings are mis-connected in parallel, the output cannot be reduced below about half rated. If parallel windings are mis-connected in series, the output will not reach rated output and the gate windings may overheat. If a gate winding is reversed, a very high AC voltage is induced in the control winding and will most likely damage the control stack.

PART III

RECTIFIER SYSTEM MAINTENANCE RECORD DATA SHEETS

CATHODIC PROTECTION SYSTEM MAINTENANCE RECORD SHEET

Location of Rectifier Unit: ______________________________

Type of Rectifier Unit: ______________________________

Type of Anodes: ____________ Number ________ Size _____Ø x ______Long

Rectifier Manufactured By: ______________________________

Rectifier AC input: ____________ Volts ______ Phase ____________ Cycles

Rectifier DC Output: ____________ Volts ______ Amperes

Date turned on: ________________

RECTIFIER READINGS

Rectifier Setting Coarse	Fine	DC Output Volts	Amps	By	Date	Remarks

OPERATION AND MAINTENANCE MANUAL
SACRIFICIAL ANODE CATHODIC PROTECTION SYSTEMS

INDEX

OPERATION AND MAINTENANCE MANUAL
SACRIFICIAL ANODE CATHODIC PROTECTION SYSTEMS

I. DESCRIPTION OF THE SYSTEM:

A. The purpose of a sacrificial anode cathodic protection (CP) system, as utilized by the District, is to protect the interior wetted surfaces of coated steel water reservoirs from corrosion. This is accomplished by a passage of DC (direct) current from sacrificial magnesium anodes, which are suspended from the roof plates of the reservoir, through the water (electrolyte) and onto the submerged portions of the structure. This type of system requires no outside source of power as the anode, water and steel structure act as a type of "battery", whereby the anode, at a higher natural voltage than the steel, consumes itself by generating DC current.

B. These sacrificial or "galvanic" systems do not generally require any adjustment of output current as the current delivered from the anodes depends upon the electrolyte resistivity, size and operating voltage of the anode and the overall coating condition. An exception to this general rule is when a "monitoring and control" test station has been provided on the exterior of the reservoir. These test stations contain, among other components, a "variable resistor" in series with the interior anode lead wires. Adjusting this resistor upwards (increasing its resistance) decreases the current output of the anode circuit while conversely; reducing its resistance increases the anode current. This has the effect of making the system adjustable (within limits) and allows the Engineer to custom tailor the system to the respective reservoir demands. Additionally, an analog (or digital) DC voltmeter is usually provided, along with an internally submerged, long-life, copper-copper sulphate ($CuSO_4$) reference electrode, to monitor the "structure-to-water" potential of the steel structure.

II. OPERATION OF THE SYSTEM:

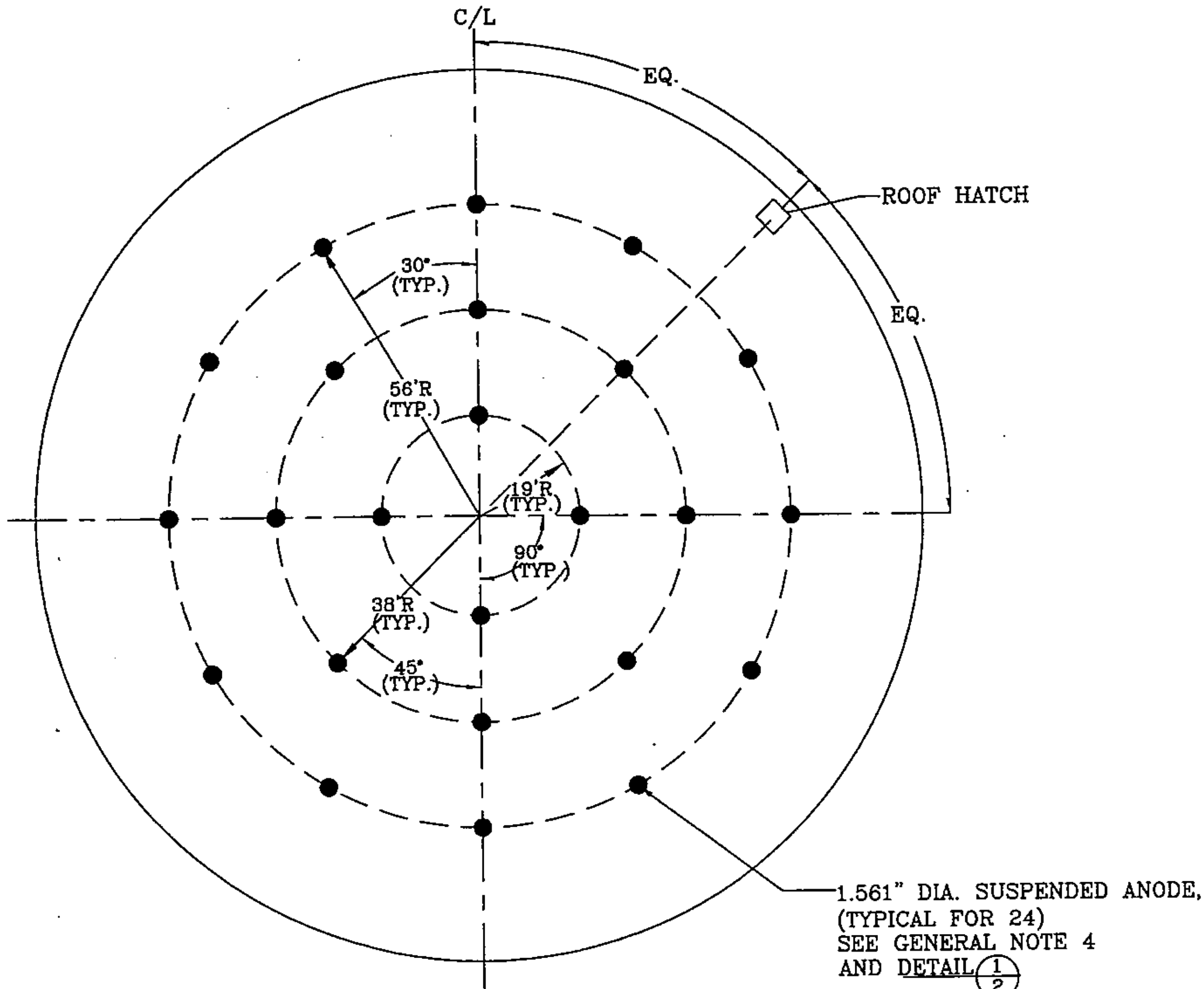
A. A sacrificial anode CP system for water storage reservoirs is designed to be essentially maintenance free for its entire life. The typical design life for these systems is from 15-20 years assuming the interior coating system remains in good condition for this period.

B. If a monitoring test station has been provided, the included DC voltmeter should be read and recorded at least monthly in order that the reservoir interior "structure-to-water" potential is maintained at fully protective levels. Should the measured potential fall below the "green arc" area (which would be indicative of potentials lower than –0.850 V with a digital voltmeter), the system should be inspected by a Corrosion Engineering firm for trouble-shooting and/or adjustment of the anode output current.

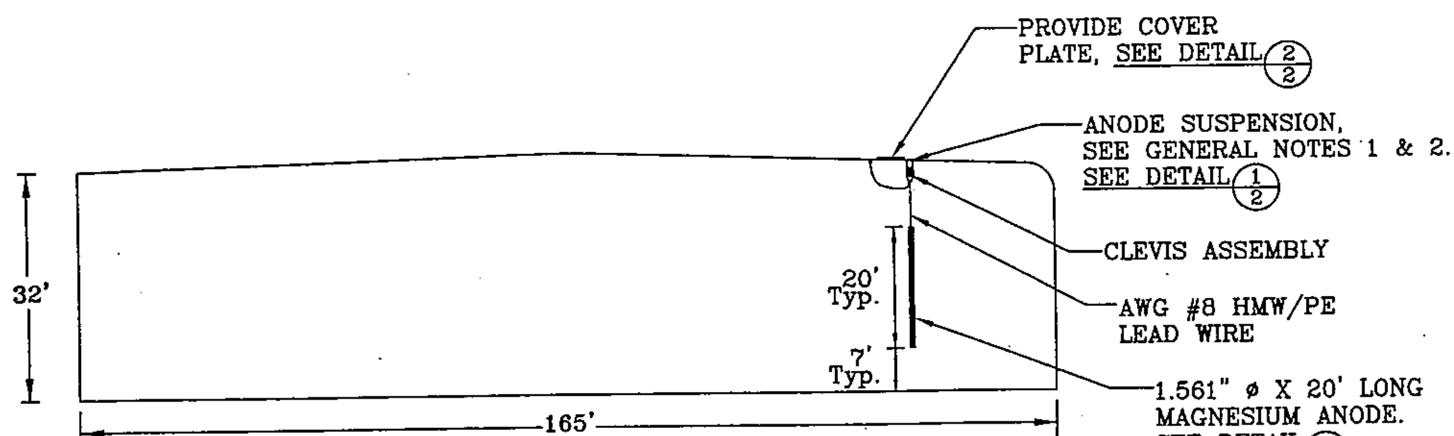
III. MAINTENANCE OF THE SYSTEM:

A. As previously mentioned, sacrificial anode CP systems do not ordinarily require maintenance other than a monthly reading and recording of the monitoring test box DC voltmeter. It is specifically **not recommended** for maintenance personnel to adjust the variable resistor circuit as this is preset by field test engineers and should not be changed unless major problems occur within the system.

B. It is highly recommended that the CP system be inspected and tested **annually** by a Corrosion Engineering firm and a full report presented with Results, Conclusions and Recommendations. Should the voltmeter readings decrease substantially during any monthly reading interval (greater than 10% of the previous month's reading), a Corrosion Engineering firm should be contacted for assistance.



PLAN VIEW
NTS



ELEVATION
NTS