

12TH November 1993

**BRISBANE CITY COUNCIL  
DEPARTMENT OF WATER SUPPLY AND SEWERAGE  
MECHANICAL AND ELECTRICAL BRANCH  
EAGLE FARM PUMPING STATION  
ELECTRICAL WORKSHOP**

**OPERATING MANUAL FOR:**

**Luggage Point Waste Water Treatment Plant Final Settling Tanks No.  
9,10,11 & 12. Cathodic Protection System.**

**CLIENT:**

**DEPARTMENT OF WATER SUPPLY AND SEWERAGE  
Sewerage Operations Branch**

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## DRAWINGS

486/7/5-UT2C0331E	Rectifier Wiring Diagram
	Cathodic Protection Details
(No Number)	Monthly Maintenance Program.

## **(1.0) INTRODUCTION**

Steel when immersed or covered in water has a tendency to corrode (or rust) as the oxidized form is more stable than the metal.

Because of this, precaution must be taken to stop or minimize the corrosion reaction to an acceptable level consistent with the design life of the structure. This is normally achieved by the use of protective coatings which control the corrosion reaction by isolating the steel from its surrounding environment.

However, it is not practical to achieve a perfect coating and coating damage will always occur with time. Because of this, corrosion may occur at imperfections in the paint coating, causing further deterioration in the coating as well as loss of metal.

As a result of this, the coating defects must be rectified by periodic maintenance or an additional method of protection used to prevent this deterioration and corrosion occurring. This additional protection is achieved by the cathodic protection system.

## **(2.0) CORROSION AND CATHODIC PROTECTION**

Corrosion is an electrochemical process in that it is accompanied by a flow of electrical current.

Corrosion occurs on the surface of metals at active areas known as anodes, which are electrically continuous with less active or passive areas known as cathodes. The electric current flows from the anode through the electrolyte to the cathode, with the circuit being completed by the electrical continuity between the cathode and anode. In practice anodes and cathodes are generally part of the same metallic surface and individual anodic areas may be small.

In applying cathodic protection and external current is applied to the surface so that the entire surface to be protected acts as a cathode. This involves the use of an auxiliary anode and when the current flow from this anode is sufficient, no part of the structure acts as an anode.

An external source of direct current such as a transformer rectifier is used in conjunction with an anode consisting of material with a very slow corrosion rate.

While it is the flow of current which achieves the cathodic protection of the surface it is impractical to measure these currents over individual anodic areas to determine when cathodic protection has been achieved. However, with the flow of cathodic protection current, the structure becomes more negative with respect to the surrounding electrolyte. Because of this, it is possible to state values of metal/electrolyte potential at which corrosion does not occur. This metal/electrolyte potential is generally measured against a standard reference electrode which allows a reproducible potential at which corrosion does not occur to be quoted.

**(3.0) Structure Details**

**Size:** Final tank bridges no. 9,10,11,&12.

**Coating:** Mild steel galvanised.

**Length:** not applicable.

**Location:** Luggage Point waste water treatment plant. UBD Map No.22 D6

**Construction Drawings:** as per attached sketch.

**(4.0) CATHODIC PROTECTION DETAILS**

- (4.1) Type of Cathodic Protection: Impressed Current & sacrificial.
- (4.2) Rectifier: Each final tank has standard 24V Volt, 10 amp direct current output enclosed in a stainless steel switchboard. Rectifier has a 110V supply from the MCC in the RAS building. The rectifier is located on bridge arm towards the centre.
- (4.3) Cathode: Each cathode point is located inside the rectifier bonding negative to structure. The cathode point is where the cabling from the rectifier is attached to the structure under cathodic protection.
- (4.4) Anodes: There are four strings of anodes with three anodes per string and one string of anodes with two anodes per string per arm, with three arms per final tank. The anode material is silicone iron and anodes measure 230mm long X 40mm diameter. Anode string cable is 16mm<sup>2</sup> cu/pvc/pvc. Total silicone iron anodes per final tank is 42. There are also 10 zinc anodes attached to the centre spider internal structure area.
- (4.5) Test Points: Test points are installed on cathodically protected structures to enable testing to ensure full protection of the structure. There are three permanent zinc reference installed on the structure with cables terminated in the rectifiers with 4mm test plug connection for ease of testing.
- (4.6) Associated Drawings:  
 Cathodic Protection Details - as per sketch.  
 Standard Rectifier Wiring Diagram - 486/7/5-UT2C0331E
- (4.7) Associated Standards:  
 AS 3000 1986 Australia Wiring Rules  
 AS 2832.1 1985 Pipes, Cables, Ducts, Guide to Cathodic Protection,  
 Part One.
- (4.8) Government Regulations:  
 Queensland Electricity Acts and Regulations.

**(5.0) PERFORMED TESTING**

- (1) Natural Potential Survey.
- (2) Current Drain Survey.
- (3) Rectifier Loop Resistance.
- (4) Foreign Structure Interference Survey and Mitigation.
- (5) Final Potential Survey and Commissioning.

NOTE: Details of above testing have not been included in this manual but are available upon request.

**(6.0) CONCLUSION**

Full Cathodic protection has been achieved on this final settling tank. The cathodic protection system is registered with the Queensland Electricity Commission and has approval to operate.

**(7.0) MAINTENANCE**

The cathodic protection system is maintained on a monthly basis after commissioning. These checks involve testing rectifier operation and recording of reference potentials.

## **Electrical Workshop Cathodic Protection**

### **CPS Monthly Maintenance Details.**

#### **Required:**

- 1/ Notify plant operator and/or sign entry logs where necessary.
- 2/ Have appropriate keying.

#### **Labour:**

One tradesperson, one vehicle. 20 minutes per site.

#### **Procedure:**

- 1/ Identify installation.
- 2/ Check system for operation.
- 3/ Record voltmeter.
- 4/ Record ammeter.
- 5/ Comments.
- 6/ Log entry.

## Electrical Workshop Cathodic Protection

### CPS 6 Monthly Maintenance Details.

#### Required:

- 1/ Notify plant operator and/or sign entry logs where necessary.
- 2/ Have appropriate keying.
- 3/ Set of tools. (Electricians)
- 4/ Multimeter.
- 5/ DC clampmeter.
- 6/ Copper sulphate reference cell and leads.
- 7/ Cleaning equipment.
- 8/ Gatic cover lifters.

#### Labour:

One tradesperson electrical, one laborer, one vehicle.  
Two hours per site.

#### Procedure:

- 1/ Identify system.
- 2/ Check system for operation.
- 3/ Record voltmeter.
- 4/ Record ammeter.
- 5/ Record "on" potentials for all test points.
- 6/ Record "instant off" potentials for all test points.
- 7/ Record "off" potentials for all test points.
- 8/ Perform loop resistance and record.
- 9/ Check and record anode string currents.
- 10/ Comments.
- 11/ Log entry.



## Electrical Workshop Cathodic Protection

### CPS 60 Monthly Maintenance Details.

#### Required:

- 1/ Notify plant operator and/or sign entry logs where necessary.
- 2/ Have appropriate keying.
- 3/ Set of tools. (Electricians)
- 4/ Multimeter.
- 5/ DC clampmeter.
- 6/ Copper sulphate reference cell and leads.
- 7/ Cleaning equipment.
- 8/ Gatic cover lifters.
- 9/ Rectifier load bank.
- 10/ PCS2000 Detection Equipment.

#### Labour:

One tradesperson electrical, one laborer, one vehicle.  
Eight hours per site.

#### Procedure:

- 1/ Identify system.
- 2/ Check system for operation.
- 3/ Record voltmeter.
- 4/ Record ammeter.
- 5/ Record "on" potentials for all test points.
- 6/ Record "instant off" potentials for all test points.
- 7/ Record "off" potentials for all test points.
- 8/ Perform loop resistance and record.
- 9/ Check and record anode string currents.
- 10/ Load test rectifier for 10 minutes.
- 11/ Check all switchboard and testpoint terminals for tightness.
- 12/ Check all switchboard and testpoints are labelled and I.D. tags attached.
- 13/ Check plans are correctly drawn and modify if necessary.
- 14/ Remove and inspect anodes.
- 15/ Recheck all interference (CPS) bleeds.
- 16/ Pipecamp structure if applicable.
- 17/ Apply for "continue to operate" permit if applicable.

**LUGGAGE POINT FINAL SETTLING TANK NO. 9**

C.P.S. 109                      SWB 157

42 SIL Fe Anodes              230 X 40mm

10 Zinc Sacrificial Anodes

3 Zinc References

**Natural Potentials****CuSO<sub>4</sub>**

Outer Area of Bridge	-	950 mV
Middle Area of Bridge	-	960 mV
Centre Area of Bridge	-	970 mV
Centre Tank	-	920 mV
Sacrificial Anode Area	-	1100 mV

**Zinc**

REF	9.1	+	182 mV
	9.2	+	188 mV
	9.3	+	188 mV

**Loop Resistance**

2 Volts at 1.0 amps

3 Volts at 3.0 amps

4 Volts at 5.5 amps

5 Volts at 7.5 amps

6 Volts at 10.0 amps

7 Volts at 13.0 amps

Unit Reading 4.0 V at 4.6 amps

**CuSO<sub>4</sub> to Structure**

Average	F.S.T. (Main)	On	-	1010 mV
		Off	-	960 mV
	Centre	On	-	1180 mV
		Off	-	980 mV

**Anode Current**

15 Anodes	Centre	1.56 amps
27 Anodes	Main	2.71 amps

**Interference Test on Outer Ring** (At top of stairs)

Before Arm	Off	-	105 mV	On	-	76 mV	Swing + 29 mV
After Arm	Off	-	34 mV	On	-	49 mV	Swing - 15 mV

**Brisbane City Council**  
**Dept. W.S. & S.**  
**Metropolitan Division**  
**Eagle Farm Pump Station**

### Cathodic Protection System Loop Resistance

Date: 12th November 1993

Cathodic Protection System:

Luggage Point Waste Water T/P Final Tank #9

System Operating Volts:

4

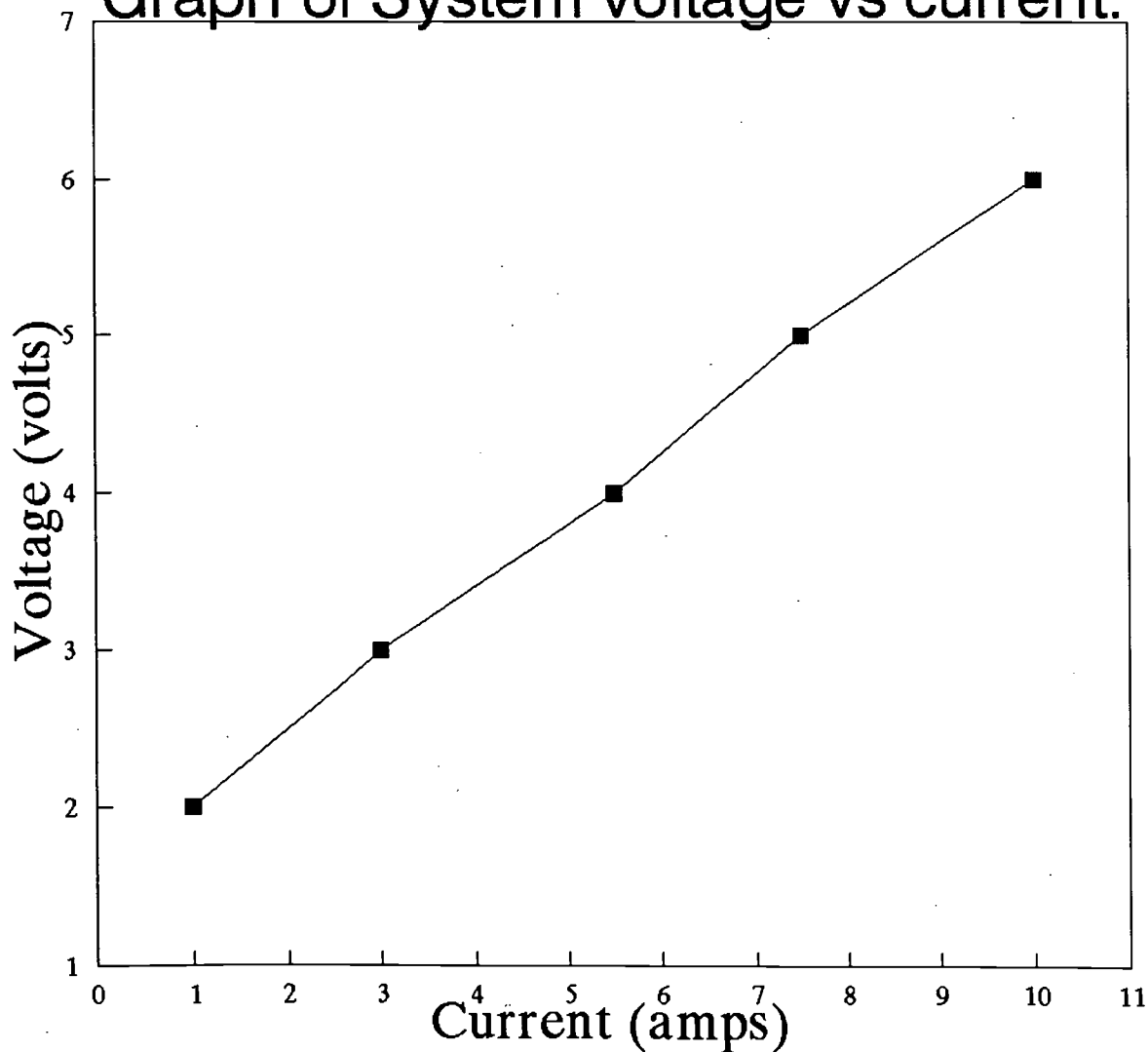
System Operating amps

4.6

Test Voltage:		Test Current:	
(volts)		(amps)	
2		1	
3		3	
4		5.5	
5		7.5	
6		10	

Loop Resistance (ohms)
0.444444

**Graph of System voltage vs current.**



**LUGGAGE POINT FINAL SETTLING TANK NO. 10**

C.P.S. 110                      SWB 158

42 SIL Fe Anodes              230 X 40mm

10 Zinc Sacrificial Anodes

3 Zinc References

**Natural Potentials****CuSO<sub>4</sub>**

Outer Area of Bridge	-	960 mV
Middle Area of Bridge	-	970 mV
Centre Area of Bridge	-	980 mV
Centre Tank	-	945 mV
Sacrificial Anode Area	-	1045 mV

**Zinc**

REF	10.1	+	140 mV
	10.2	+	139 mV
	10.3	+	150 mV

**Loop Resistance**

2 Volts at 1.4 amps

3 Volts at 3.5 amps

4 Volts at 6.0 amps

5 Volts at 8.5 amps

6 Volts at 11.0 amps

7 Volts at 13.7 amps

Unit Reading 4.0 V at 5.5 amps

**CuSO<sub>4</sub> to Structure**

Average	F.S.T. (Main)	On	-	1100 mV
		Off	-	1010 mV
	Centre	On	-	1400 mV
		Off	-	1100 mV

**Anode Current**

15 Anodes	Centre	2.05 amps
27 Anodes	Main	3.51 amps

**Interference Test on Outer Ring** (At top of stairs)

Before Arm	Off	-	229 mV	On	-	1.95 mV	Swing +	34 mV
After Arm	Off	-	76 mV	On	-	38 mV	Swing +	38 mV

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**Metropolitan Division**  
**Eagle Farm Pump Station**

**Cathodic Protection System Loop Resistance**

Date: 12th November 1993

Cathodic Protection System:

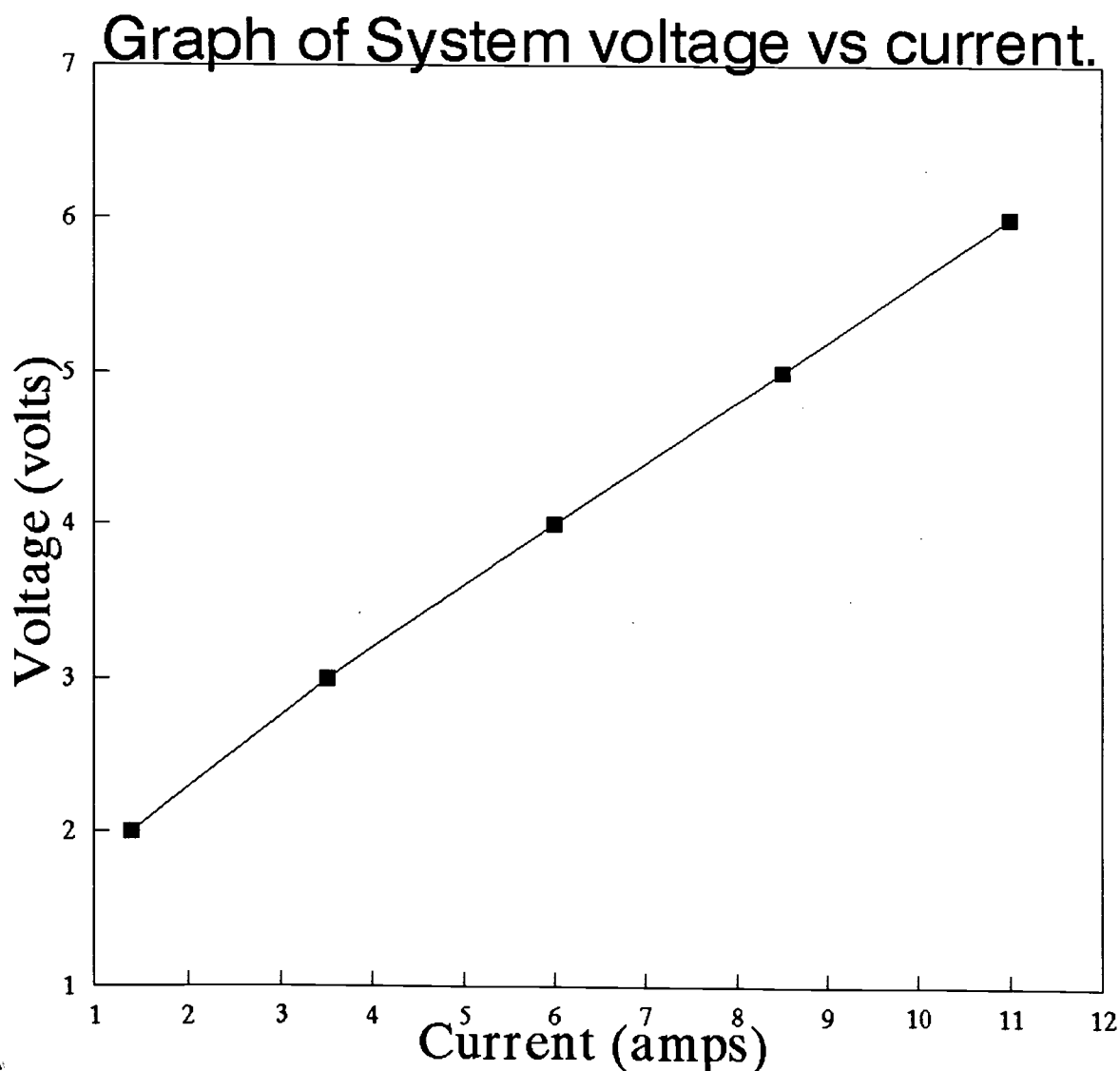
Luggage Point Waste Water T/P Final Tank #10

System Operating Volts: 4

System Operating amps 5.5

Test Voltage:		Test Current:	
(volts)		(amps)	
2		1.4	
3		3.5	
4		6	
5		8.5	
6		11	

Loop Resistance (ohms)
0.4



**LUGGAGE POINT FINAL SETTLING TANK NO. 11**

C.P.S. 111                      SWB 232

42 SIL Fe Anodes              230 X 40mm

10 Zinc Sacrificial Anodes

3 Zinc References

**Natural Potentials****CuSO<sub>4</sub>**

Outer Area of Bridge	-	925 mV
Middle Area of Bridge	-	960 mV
Centre Area of Bridge	-	950 mV
Centre Tank	-	936 mV
Sacrificial Anode Area	-	1052 mV

**Zinc**

REF	11.1	+	135 mV
	11.2	+	144 mV
	11.3	+	159 mV

**Loop Resistance**

2 Volts at 1.0 amps

3 Volts at 3.9 amps

4 Volts at 5.6 amps

5 Volts at 8.5 amps

6 Volts at 11.0 amps

7 Volts at 13.5 amps

Unit Reading 4.0 V at 5.5 amps



**CuSO<sub>4</sub> to Structure**

Average	F.S.T. (Main)	On	-	1140 mV
		Off	-	1010 mV
	Centre	On	-	1300 mV
		Off	-	1012 mV

**Anode Current**

15 Anodes	Centre	1.70 amps
27 Anodes	Main	2.83 amps

**Interference Test on Outer Ring** (At top of stairs)

Before Arm	Off	-	202 mV	On	-	181 mV	Swing + 21 mV
After Arm	Off	-	34 mV	On	-	66 mV	Swing + 62 mV

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**Metropolitan Division**  
**Eagle Farm Pump Station**

Cathodic Protection System Loop Resistance

Date: 12th November 1993

Cathodic Protection System:

Luggage Point Waste Water T/P Final Tank #11

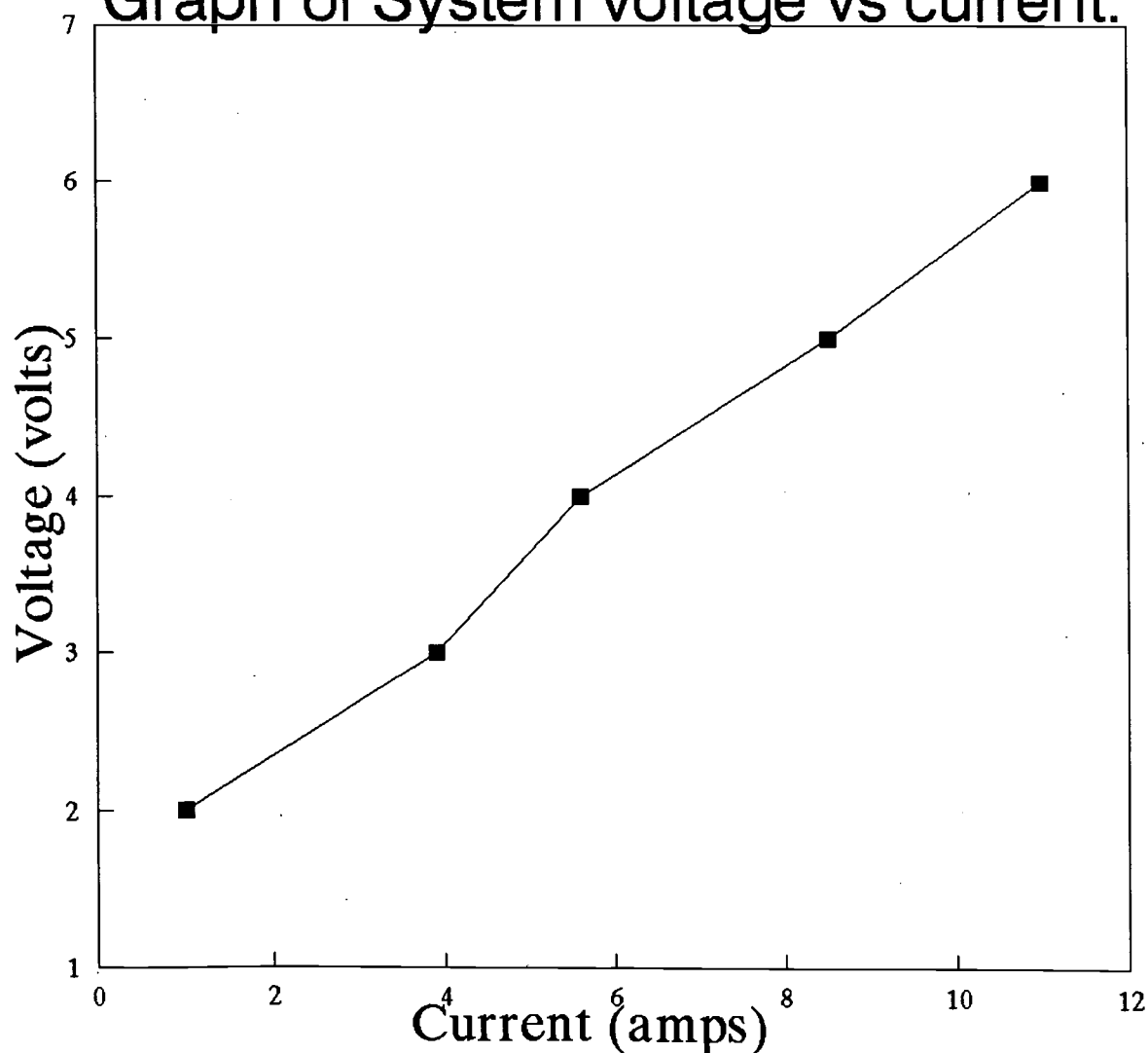
System Operating Volts: 4

System Operating amps 5.5

Test Voltage:		Test Current:	
(volts)		(amps)	
2		1	
3		3.9	
4		5.6	
5		8.5	
6		11	

Loop Resistance (ohms)
0.37037

**Graph of System voltage vs current.**



**LUGGAGE POINT FINAL SETTLING TANK NO. 12**

C.P.S. 112                      SWB 230

42 SIL Fe Anodes              230 X 40mm

10 Zinc Sacrificial Anodes

3 Zinc References

**Natural Potentials****CuSO<sub>4</sub>**

Outer Area of Bridge	-	950 mV
Middle Area of Bridge	-	940 mV
Centre Area of Bridge	-	950 mV
Centre Tank	-	930 mV
Sacrificial Anode Area	-	1054 mV

**Zinc**

REF	12.1	+	188 mV
	12.2	+	182 mV
	12.3	+	181 mV

**Loop Resistance**

2 Volts at 1.0 amps

3 Volts at 2.9 amps

4 Volts at 5.6 amps

5 Volts at 8.1 amps

6 Volts at 10.9 amps

7 Volts at 13.5 amps

Unit Reading 4.0 V at 5.5 amps

**CuSO<sub>4</sub> to Structure**

Average	F.S.T. (Main)	On	-	1050 mV
		Off	-	980 mV
	Centre	On	-	1320 mV
		Off	-	1030 mV

**Anode Current**

15 Anodes	Centre	1.95 amps
27 Anodes	Main	3.34 amps

**Interference Test on Outer Ring (At top of stairs)**

Before Arm	Off	-	240 mV	On	-	207 mV	Swing + 33 mV
After Arm	Off	-	216 mV	On	-	155 mV	Swing + 61 mV

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**Metropolitan Division**  
**Eagle Farm Pump Station**

**Cathodic Protection System Loop Resistance**

Date: 12th November 1993

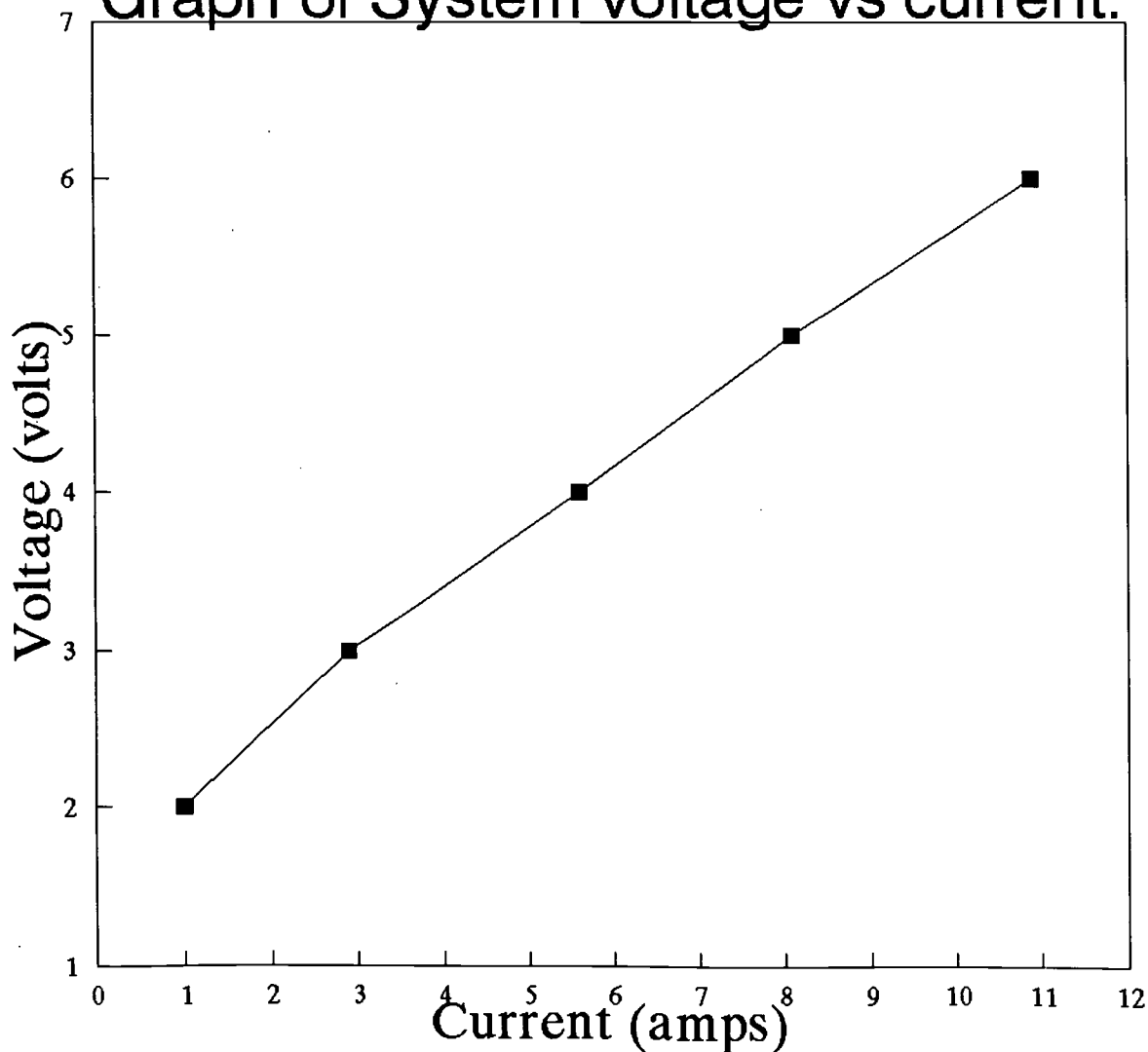
Cathodic Protection System: Luggage Point Waste Water T/P Final Tank #12

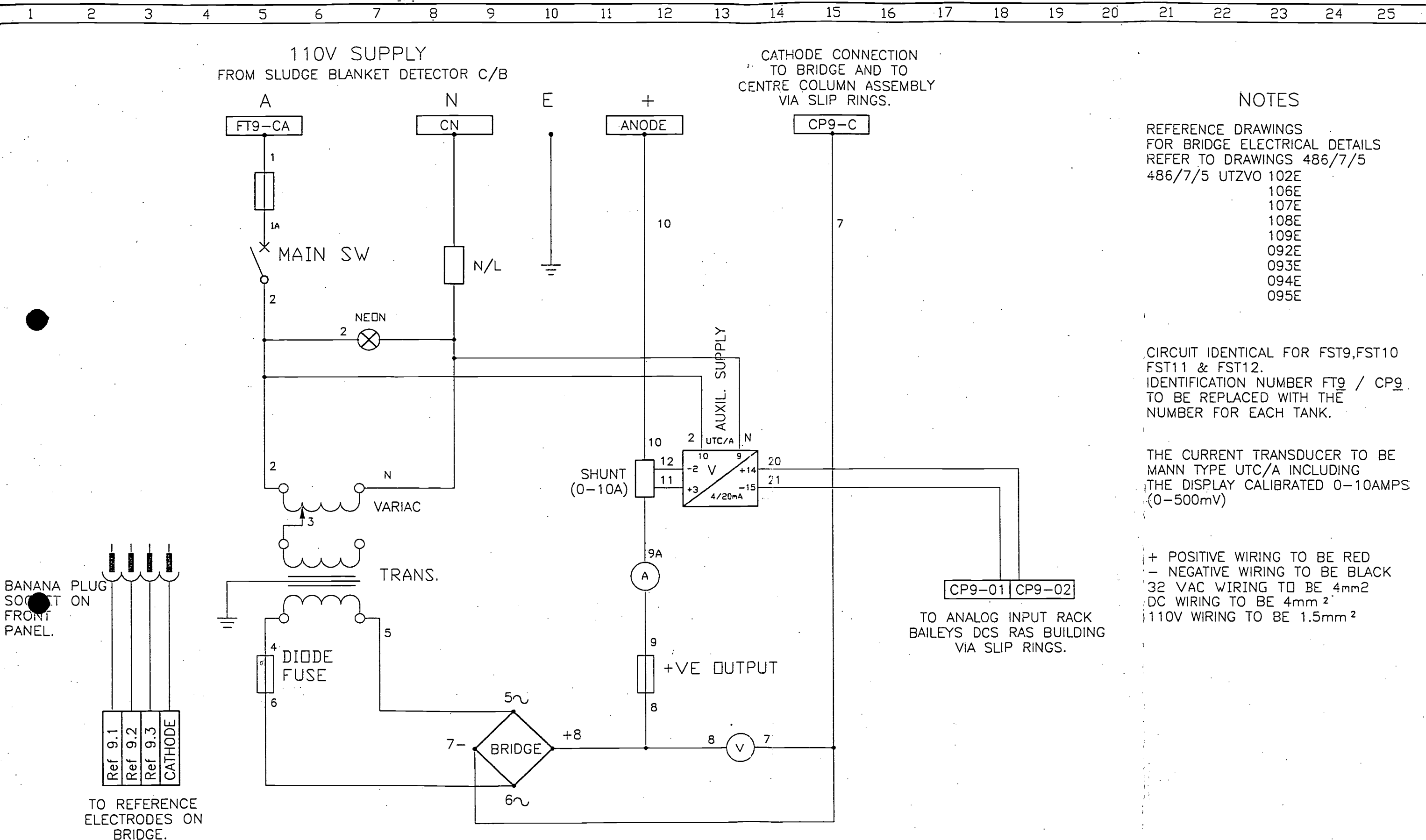
System Operating Volts: 4 System Operating amps 5.5

Test Voltage:		Test Current:	
(volts)		(amps)	
2		1	
3		2.9	
4		5.6	
5		8.1	
6		10.9	

Loop Resistance (ohms)
0.377358

**Graph of System voltage vs current.**





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32844 CENT

### CATHODIC PROTECTION NOTES.

ANODE POSITIONS IDENTICAL FOR ALL ARMS PER TANK.  
RECTIFIER SWBD ON ONE ARM PER TANK.  
ZINC REFERENCE POINTS INSTALLED 1.0M. FROM BASE OF TANK.

LUGGAGE POINT W.W.T.P  
FINAL SETTLING TANKS  
N'S 9, 10, 11, 12.  
CATHODIC PROTECTION  
POSITION OF ANODES  
AND REFERENCES  
NOV 1993

SPLICE LINE  
ZINC REFERENCE POINT

A  
092147

3 ANODES  
FRONT STRING

40300 I.D.

3 ANODES  
FRONT STRING

SPLICE LINE

3 ANODES  
FRONT STRING

ZINC REFERENCE POINT

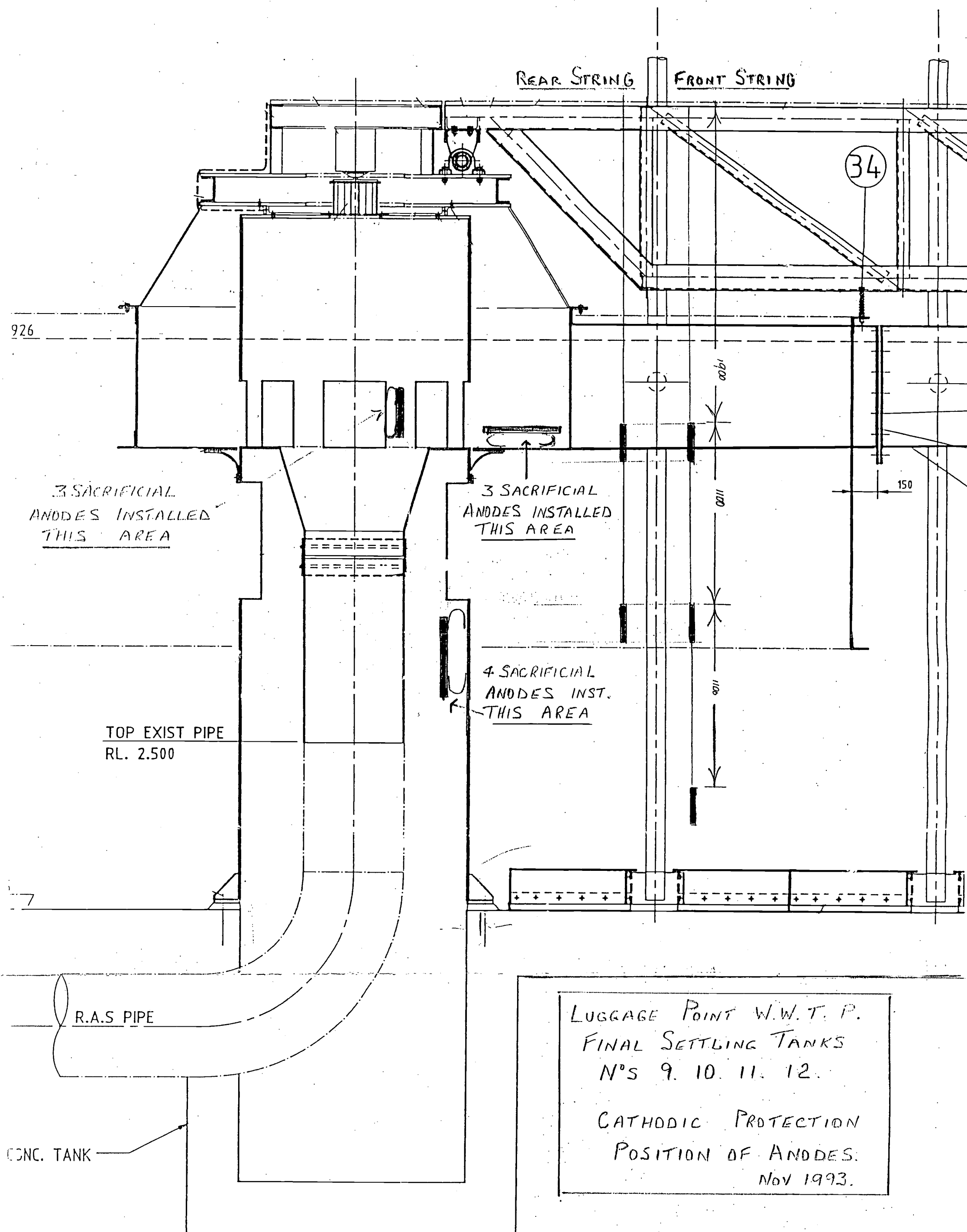
ZINC REFERENCE POINT

CATHODIC PROTECTION  
RECTIFIER SWBD

2 ANODES  
REAR ANODES

B  
092147

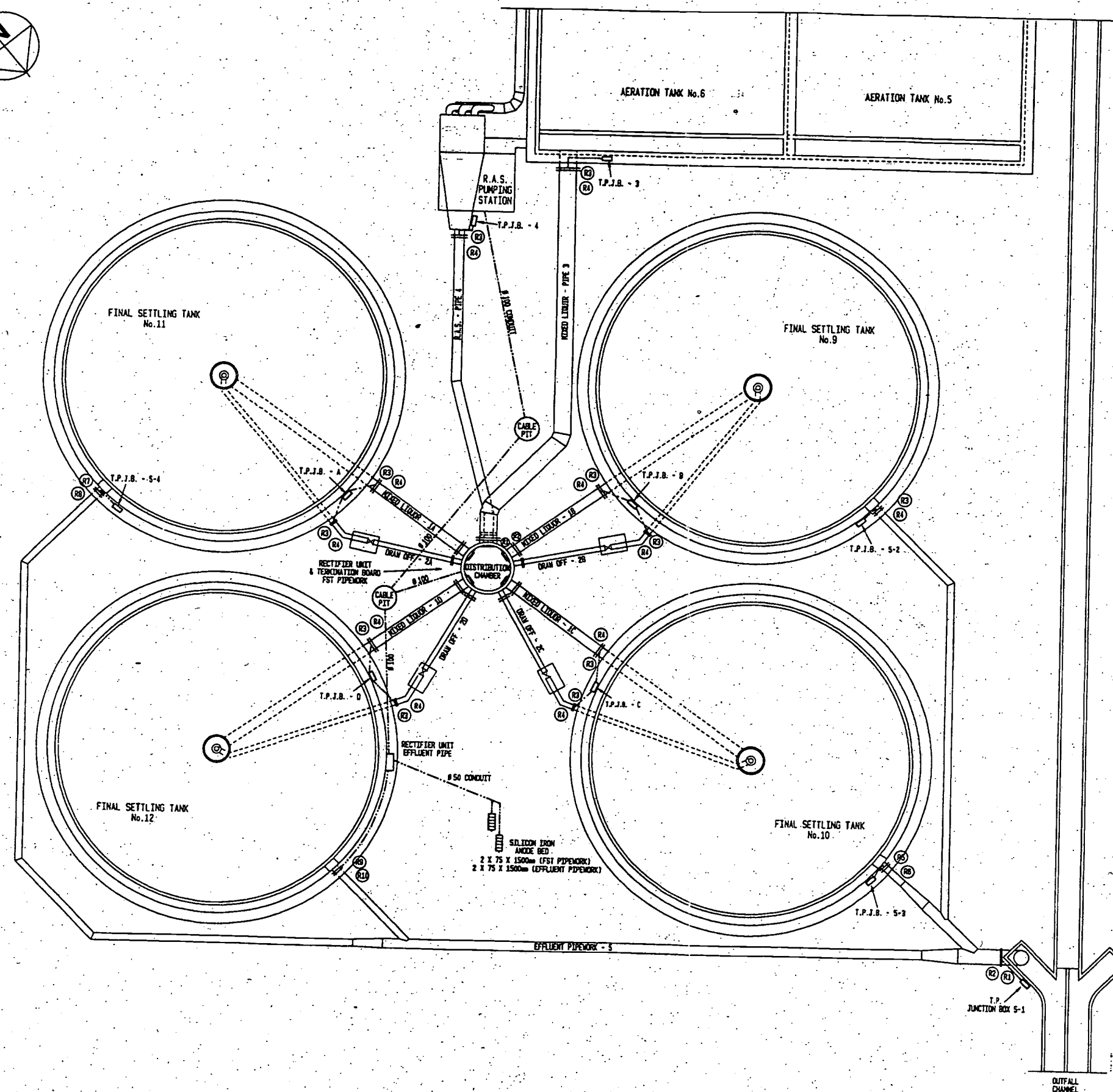
B  
092147







SCALE:	No.	OF	SHEET
DRAWING No.			AMEND
486/7/5-UT2C0015E			A



LEGEND:

⊙ - ZINC REFERENCE ELECTRODE

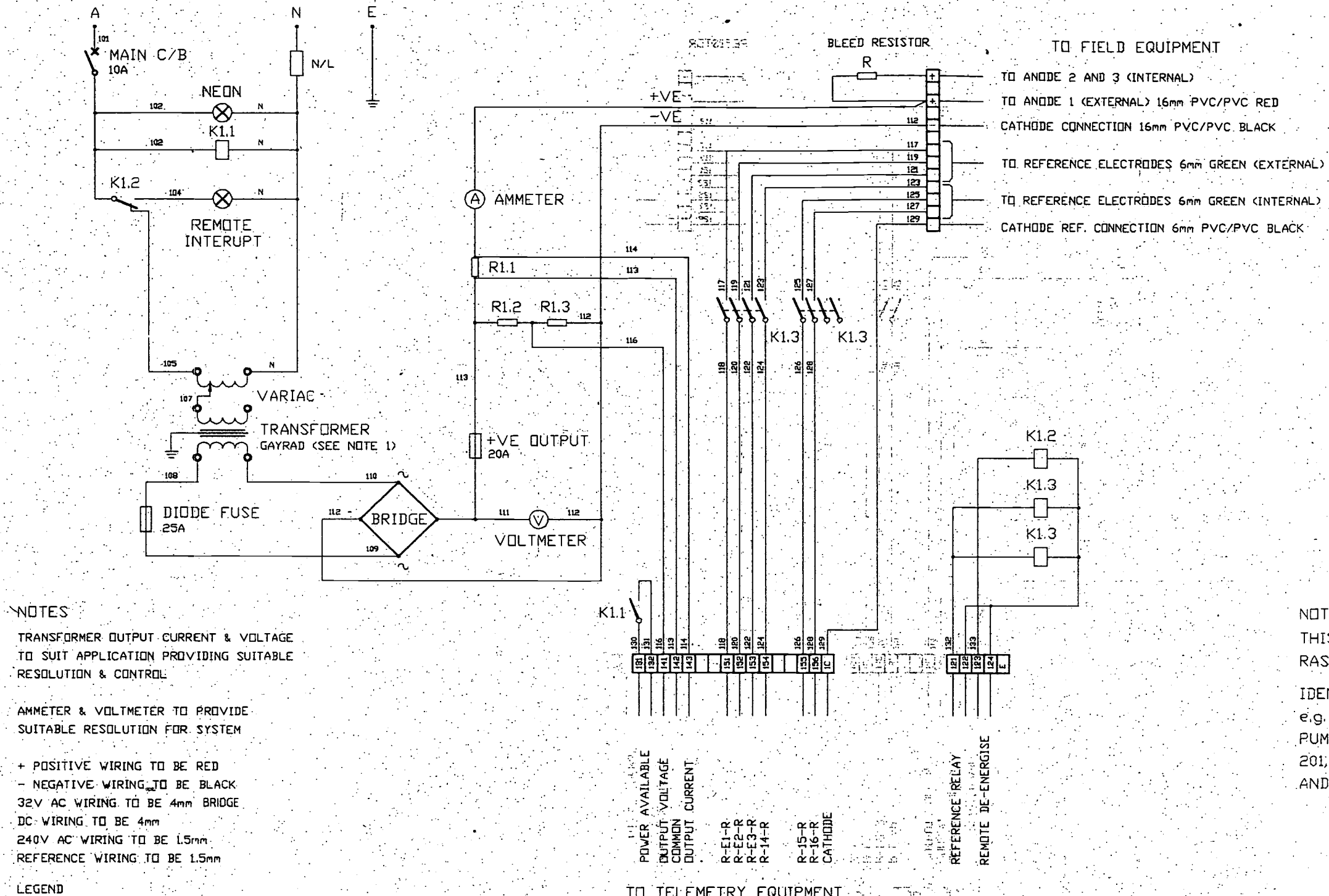
T.P. - TEST POINT

J.B. - JUNCTION BOX

## NOTES

1. ALL INSULATING FLANGES TO HAVE TYPE 'C' TEST POINT INSTALLED. REFER Dwg. 2/10.159.
  2. REFERENCE ELECTRODES WITH ODD NUMBERS CORRESPOND TO PIPEWORK ENTERING CONCRETE STRUCTURES.
  3. REFER TO DRAWING 486/7/5-UT2C0015E FOR RECTIFIER / TERMINATION BOARD - FST PIPEWORK.
  4. REFER TO DRAWING 486/7/5-UT2C0015E FOR RECTIFIER / TERMINATION BOARD - EFFLUENT PIPEWORK.
  5. ALL REFERENCE POTENTIALS TAKEN ADJACENT TO DISTRIBUTION CHAMBER. R9 & R10 ARE TO BE MONITORED BY THE TELEMETRY SYSTEM.
  6. REFER TO DRAWING 3013/2500-2 FOR CONDUIT DETAILS.
  7. REFER TO DRAWING 2/14.159 FOR TEST POINT DETAILS.
  8. SURGE PROTECTION DEVICES TO BE INSTALLED ACROSS ALL EXPOSED INSULATION FLANGES TO REDUCE POTENTIAL HAZARDS TO PERSONNEL, IF REQUIRED.
- (PIPE 1A/1B/1C & 1D - DISTRIBUTION CHAMBER PIPE 4 - R.A.S. - PUMP STATION)

A 2.01 ISSUED FOR APPROVAL		O.L.P.
DATE	AMENDMENT / ISSUE TO / ISSUE FOR	INITIALS
AMENDMENT & ISSUE REGISTER		
MANAGER	DIRECTOR OF PLANNING & DESIGN	
DATE	DATE	DATE
DIRECTOR OF CONSTRUCTION	DIRECTOR OF W & E SERVICES	DIRECTOR OF SEW. OPERATIONS / W.S. DISTRIBUTION
DATE	DATE	DATE
DESIGN	J.S.	20.11.90
DRAWN	O.L.P.	26.11.90
CHECKED		
DESIGNED		
TRACED		
CHECKED		
A.H. DATUM	SURVEYED	
CADD No.	REFERENCES	
750011A		
<b>BRISBANE CITY COUNCIL</b> DEPARTMENT OF WATER SUPPLY & SEWERAGE MECHANICAL & ELECTRICAL SERVICES		
PROJECT: LUGGAGE POINT WASTEWATER TREATMENT PLANT		
TITLE: CATHODIC PROTECTION FINAL SETTLING TANKS PIPEWORK		
SCALE: 1 : 250	No.	OF SHEETS
DRAWING No.	486/7/5-UT2C0015E	27



NOTES

TRANSFORMER OUTPUT CURRENT & VOLTAGE TO SUIT APPLICATION PROVIDING SUITABLE RESOLUTION & CONTROL

AMMETER & VOLTMETER TO PROVIDE SUITABLE RESOLUTION FOR SYSTEM

+ POSITIVE WIRING TO BE RED  
- NEGATIVE WIRING TO BE BLACK  
32V AC WIRING TO BE 4mm BRIDGE  
DC WIRING TO BE 4mm  
240V AC WIRING TO BE 1.5mm  
REFERENCE WIRING TO BE 1.5mm

LEGEND

K1 - 240V RELAY  
K2,K3 - 24V DC RELAYS  
R1 - SHUNT RESISTOR (SIZED TO PRODUCE A 1V DROP AT FULL LOAD)  
R2,R3 - VOLTAGE DIVIDER (SIZED TO PRODUCE A VOLTAGE OF 10V ACROSS R2 AT MAX. OUTPUT VOLTAGE)

NOTES

THIS DRAWING IS TYPICAL FOR RAS PUMPS No.4, No.5, AND No.6

IDENTIFICATION NUMBERS e.g. 101, K1.1, R1.1, ETC. FOR PUMP No.1 SHOULD READ 201, K2.1, R2.1, ETC. FOR PUMP No.2 AND 301, K3.1, R3.1, ETC. FOR PUMP No.3



BRISBANE CITY COUNCIL  
DEPARTMENT OF WATER SUPPLY & SEWERAGE  
MECHANICAL & ELECTRICAL SERVICES

PROJECT LUGGAGE POINT WWTP CATHODE PROTECTION RAS PUMPS  
TITLE RECTIFIER WIRING DIAGRAM WITH TELEMETRY MONITORING

DRAWN	NAME RMW	DATE 27.5.93	SUPER ENG.	NAME M.JUKES	DATE 12.8.93	SCALE	SIZE A3
DESIGN	J.SAY	27.5.93	SENIOR ENG.				
CHECKED	J.SAY	4.8.93	ELECT. ENG.				
DRAWING No.	486/7/5-UT2C0330E					ACAD12 FILE No.	A75C330E
AMEND	A						