WILSON WALTON

CATHODIC PROTECTION SYSTEM

OPERATIONS MANUAL

BRISBANE CITY COUNCIL

LOGAN CITY TRUNK MAIN

ANSTEAD - BRISBANE RIVER

CONTRACT No. R97-92/93

WWI REF No. Q5917.Anst

Doc 101375.MAN

Prepared by: W. A. R. Burns

Approved by: W. A. R. Burns

WILSON WALTON

C O N T E N T S

WILSON WALTON INTERNATIONAL (QLD) PTY LTD

WILSON WALTON

1. INTRODUCTION

This manual covers the operation of the cathodic protection systems installed for the corrosion protection of the buried steel pipeline that is installed between the Anstead Tie-in and the Brisbane River. This section of pipeline is part of a multi stage development of a trunk main that tees off from the Mount Crosby to Brisbane pipeline at Anstead and will ultimately terminate at Logan City, south of Brisbane.

2. DESCRIPTION OF STRUCTURES

The pipeline is 2.2 kilometres in length, of 1700mm diameter, of mild steel construction and cement lined internally. The externals of the pipeline are coated with a fusion bonded Polyethylene coating system in order to provide it with primary corrosion protection. The pipeline is a fully welded structure over its entire length and field welded joints are wrapped in a proprietary commercially available two tape Butyl system. Construction joints and swabbing pits etc are bridged out with bond cable installations in the pits. Further details are provided on the construction drawings and as per Brisbane City Council standard construction details.

The cathodic protection system comprises of one only 5 Amp 25 Volt DC output capacity impressed current cathodic protection system. This systems provides a complimentary protection system to the coating system in order to prevent corrosion at areas of coating damage (holidays).

In conjunction with the installation of the cathodic protection system, test points have been installed at all air valves, scour valves in the above ground structures.

At all test points on this pipeline on the Anstead Section, grading rings have been installed, generally as shown on the construction drawings. The grading rings are directly connected to the pipeline in test point installations housed in flush mounted ground chambers. Corrosion coupons have been installed at the impressed current installation site adjacent to the pipeline. Permanent zinc monitoring electrodes have been installed at the extremities of the underground section of the pipeline as well as test points at 500m intervals along the length of the pipeline.

WILSON WALTON

The pipeline between the Anstead Tee-off and the Brisbane River is fitted with two permanent earths that are directly connected to the pipeline via ground pit chamber connections. These earths comprise of zinc coated steel bars and are installed at the chainages nominated in the construction drawings.

3. DESCRIPTION OF SYSTEM

Impressed Current System

The cathodic protection system installed for the protection of the pipeline is of the impressed current type. This system utilises one only transformer rectifier unit to supply direct current to the anodes installed generally as shown on the construction drawings attached.

A cathodic protection unit is housed in a plinth mounted mild steel enclosure and has been installed in the field generally as shown on the contruction drawings. The anode groundbed contain 3 only 50mm x 1500 long silicon iron chromium anodes backfilled in metallurgical coke breeze. The anodes are installed to protect the pipeline over its entire buried length. Refer to Drawing No. ANST1B Locality Plan attached..

The system includes permanent reference electrodes that are buried adjacent to the pipeline at transformer rectifier site. They are also installed at each end of the pipeline and at 500m intervals along the length of the pipeline. These electrodes are installed to monitor the performance of the cathodic protection system as well as at the transformer rectifier site enabling the unit to be operated in an automatic mode.

Test points are installed along the entire length of the pipeline generally as detailed in the specification and as shown on the construction drawings attached.

A corrosion coupon is installed adjacent to the pipeline at the impressed current cathodic protection installation. At this location the coupon is inter-connected to the system at the transformer rectifier to allow the coupon to be cathodically protected in a similar nature to a defect associated with the pipeline coating system.

WILSON WALTON

Grading rings made from zinc material are buried around all of the structures that terminate at ground level along the length of the pipeline. As nominated by Brisbane City Council, the grading rings are directly and permanently connected to the pipeline via the ground chamber type test point installations at each location. They are provided as personnel safety devices for operations personnel in the event of an electrical surge condition on the pipeline.

Insulating flange gasket kits have been installed at each extremity of the pipeline in addition to all air and scour valve installations. At the extremity of the pipeline, an IJP 230 type insulting surge divertor has been installed between the underground section relative to this contract and the pipelines upstream and downstream of this contract.

Automatic Control Transformer Rectifier Unit

The transformer rectifier unit that has been installed is capable of operating in three modes.

CONSTANT CURRENT
CONSTANT VOLTAGE
AUTOMATIC (Constant Potential)

There is a selector switch on the front panel of the Transformer Rectifier (T/R) unit to choose the desired mode. The output of the Transformer rectifier unit, whilst in any of the three modes, can be adjusted by turning the output control dial.

CONSTANT CURRENT
The output current of the Transformer Rectifier will remain constant in this mode after the output is set.

CONSTANT VOLTAGE
The output voltage of the Transformer Rectifier will remain constant in this mode after the output is set.

AUTOMATIC
The Transformer Rectifier output will be automatically adjusted by the Control Unit to maintain a preset pipeline potential voltage. (Potential Reading)

WILSON WALTON

To set the input potential, the operator should take a voltage reading with their multimeter across the "structure" and "reference" terminals located at the bottom right of the T/R. Then by adjusting the output control dial the ON potential can be set whilst reading the voltage. Alternatively, an external dummy lead can be used.

4. OPERATION OF SYSTEM

4.1 Impressed Current Cathodic Protection System

The transformer rectifier unit is of the automatic operation type and is controlled by a permanent zinc half cell installed at the installation location as shown on the construction drawings. This causes a corresponding current to flow between each of the anodes and coating defects on the pipeline.

The output current and operating voltages are monitored from the ammeter and voltmeter installed within the cathodic protection transformer rectifier unit. It should be noted that the output voltmeter will continue to indicate a slight voltage reading even when the Transformer Rectifier unit is switched off. This is because of the potential difference between the structure and the anodes. The voltmeter should only be zeroed when the positive and negative cables are disconnected from the unit.

The Transformer Rectifier unit is supplied and fitted with a four pin plug interruptor socket and associated continuous/bypass mode switch. This allows for externally supplied current interruptors to be fitted during interference testing or instantaneous off potential testing.

Note: The output of the unit should not be varied without reference to the potential changes produced on the pipeline. Refer below.

WILSON WALTON

4.2 Monitoring System

The protection potentials of the buried sections of the pipeline are monitored at each of the locations where the permanent zinc reference electrodes have been installed. The protection potential is a function of the location of the reference electrode, not the point at which electrical contact is made with the structure. Each of the zinc reference cells can be tested in turn by monitoring the DC voltage between each of the permanent reference cell wires and the structure/pipeline connection monitoring wires located in each of the Field Test Point installations or within the Transformer Rectifier enclosure itself.

The value of the ON reference control in the Transformer Rectifier is set to ensure that the 'instant OFF' potential along the entire pipeline (determineed by field tests) is between -0.85 and -1.20 volts (WRT Cu/CuSO4) or + 0.25 and -0.25 volts (WRT Zinc).

The soils on the pipe route vary in nature. They are predominantly black clays and silt with some sandstone/ shale experienced in the last two to three hundred meters before the Brisbane River Termination of the pipeline. The positioning of the anode bed is aimed at allowing an even distribution of the cathodic protection current to the pipeline along its route with minimal interference, if any being caused to the foreign structures.

Note: Instant OFF potentials more negative than -1.200 volts (-1200 mV) can cause coating disbonding for certain types of coatings in normal operating conditions. This is of less significance in this installation as the pipeline coating's resistance to coating disbonding is good.

Precautions should be taken to minimise the overall structure potentials where ever possible. The system should, wherever possible, always be adjusted within the limitation specified.

WILSON WALTON

4.3 Measurement of ON & INSTANTANEOUS OFF Potentials

It is well documented and recognised that the "ON" potential readings most often contain a degree of error in the reading due to the current flowing through the soil between the anode bed and the pipeline under protection.

In order to remove this error (referred to as IR ERROR or IR Component) it is normal practice to switch the cathodic protection system/s off. At the instant that the cathodic protection system/s are switched off, one records the "INSTANT OFF" polarised potential of the structure.

If the technologist conducting the testing does not have access to a data logging type instrument, it is normal practice to record the "INSTANT OFF" potential within one second of the system/s switching off.

It needs to be understood that the potentials that are relevant when conducting a survey of the pipeline are the maximum "ON " potential and the "INSTANT OFF" potential voltage. The OFF readings will continue to decay once the system is deactivated. Readings many seconds or more after the rectifiers are switched off are of little value as any record of corrosion protection of the pipeline. The zinc grading rings are solidly connected to the pipeline. Instand off potentials were therefore not practical. The 'ON' potential has been set just above the potential of the pipeline/grading rings so as to provide them with protection also.

4.4 Digital Synchronous Interrupters

For normal testing of the Anstead to Brisbane River section of pipeline only, it is possible to use one single current interruptor. However should it be necessary to switch a number of systems along the Logan City Main, to do instant off potentials or interference testing, it will be necessary to use synchronously switched interruptors. Such units would be MC Miller Type JR1 or JR1Y units. A copy of the data sheet on these units is attached.

WILSON WALTON

Under normal operating conditions the TEST/NORMAL switch on the transformer rectifier unit should be in the "Normal" or continuous mode.

If the interruptor is to be utilised, the four pin plug and leads etc. should be connected prior to switching the unit to the "Test" or Continuous setting mode.

5. MAINTENANCE

The cathodic protection system should be reliable in operation and require only minimal maintenance. However, we would recommend the following preventative maintenance program to ensure the satisfactory operation of the system.

5.1 Monthly Inspection

(a) Check the operation of the transformer rectifier unit and record its output (amps & volts DC).

(b) Check and record pipeline potentials against the permanent zinc reference electrode at each of the electrode installation test point facilities. As the Transformer Rectifier unit is automatic in operation, the output should not need any manual adjustment.

5.2 Six Monthly Inspection

(a) Carry out a visual inspection of components installed within the system.

(b) Check the condition of the transformer rectifier unit. Remove the output fuse and record the maximum and minimum output voltage to check operation of the control circuit. Recalibrate to zero volts, replace the output fuse and reactivate the unit/s. If any adjustment of the unit/s is required, refer to the technical operations manual for the transformer rectifier unit/s.

WILSON WALTON

(c) Check pipeline potentials at the test point nearest the rectifier and calibrate the permanent zinc electrodes at the groundbed test point using a portable copper / copper sulphate reference electrode.

(d) Monitor the potentials of the pipeline using a portable copper/copper sulphate reference electrode and a MC MILLER type LC4 variable input resistance corrosion meter or equivalent. If practical, the electrode should be located centrally over the top of the pipeline. Ideally six monthly inspections should be conducted by an independent corrosion consultant, but on a maximum of 12 monthly intervals.

(e) We suggest that the results of 5.1 and 5.2 above be sent to Wilson Walton International (Qld) Pty Ltd on a monthly basis to permit an appraisal of the system operation and to provide a history of protection maintained on the structures. This will enable recommendations to be made where considered necessary to ensure continued safe operation of the system/s.

6. FAULT FINDING

If the system is not operating satisfactorily, reference to the following procedures should assist in locating the fault.

i) No Voltage, No Current

(a) Check the main switch.
(b) Check the AC fuse.
(c) Check the AC power supply to the unit.
(d) Check the current limiting setting on the auto controller.

ii) Voltage, No Current

(a) Check the DC output fuse.
(b) Check connections in the "Groundbed Terminal Box"
(c) Check the rectifier bridge.
(d) Check structure negative connections.
(e) Check DC cabling.

WILSON WALTON

iii) Low Voltage, Low Current

(a) Check the rectifier bridge.
(b) Check the T/R unit output adjustment.
(c) Check the "SET POINT" setting on the automatic controller of the transformer rectifier unit.
(d) Check the potential of the fixed, permanent copper / copper sulphate reference cell that drives the automatic controller in the T/R unit. If considered faulty, replace the permanent cell with a portable cell temporarily to confirm satisfactory operation of the transformer rectifier unit/s.

iv) Structure Potentials Insufficiently Negative

(a) Check the operation of the cathodic protection system.
(b) Check the adjustment of the transformer rectifier unit.
(c) Check the "SET POINT" of each transformer rectifier unit to confirm that an adequate potential setting has been programmed. Also re-check the current limiting setting on each unit has not been set a too low a threshold setting.

v) Structure Potentials Abnormally Negative

(a) Check the operation of the cathodic protection system.
(b) Check the adjustment to transformer rectifier.
(c) Check the effectiveness of insulating flanges.
(d) Check the "SET POINT" of each transformer rectifier unit has not been set too high.

Following location and rectification of the fault, an examination of the system should be carried out to determine the cause and avoid a recurrence of the fault. The cause of the fault and the rectification work carried out should be recorded in the system log book and appear in the monthly operating log.

Any modifications or alterations to the equipment or the system/s should be recorded in a monthly log, and a copy should be forwarded to Wilson Walton International (Qld) P/L in order that an up dated profile can be maintained. This will assist in consultation in times of malfunctioning should WWI be called upon to assist.

WILSON WALTON

7. MAINTENANCE PARTS, SERVICE

Maintenance parts and service for the complete system are available from the nearest office of Wilson Walton International.

Queensland: 30 Chetwynd Street,
Loganholme, Brisbane, 4129.
Ph. 07 - 801 4077
Fax 07 - 801 1044.

29 The Strand,
Townsville, Qld 4810.
Ph. 077 - 712 223.

WILSON WALTON INTERNATIONAL (QLD) PTY LTD.

WILSON WALTON

APPENDIX 1.

TECHNICAL SPECIFICATION

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

INVITATION TO TENDER

DOCUMENTS FOR

LOGAN CITY TRUNK MAIN AMPLIFICATION

CONSTRUCTION OF MILD STEEL WELDED PIPELINE

ANSTEAD TO BRISBANE RIVER

Sealed Tenders, endorsed : "TENDER FOR CONTRACT NO. - R. 97/92/93"
GENERAL MANAGER
BRISBANE CITY COUNCIL

Tender Documents must be delivered by placing same in the Tender Box on the Customer Service Centre, Ground Floor, Brisbane Administration Centre, 69 Ann Street, Brisbane, not later than 12 Noon on the closing date mentioned below, or by posting same to reach the Town Clerk by this time and date.

Notice advising location of opening of Tenders will be on top of Tender Box, Brisbane Administration Centre.

The charge for each copy of the documents relative to this contract is ***$100.00 NON-RETURNABLE***

DATE OF ISSUE : 24 April 1993 **DATE OF CLOSING : 28 May, 1993**

15CC491a(M6 10/88)

TYPW(C.03/78.1147)

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

CONTRACT NO. R. 97/92/93

LOGAN CITY TRUNK MAIN AMPLIFICATION CONSTRUCTION OF MILD STEEL WELDED PIPELINE ANSTEAD TO BRISBANE RIVER

PART 7C - SPECIFICATION FOR EARTHING AND CATHODIC PROTECTION SELECTED SUBCONTRACTOR WORK

TABLE OF CONTENTS

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWERAGE

SPECIFICATION FOR EARTHING AND CATHODIC PROTECTION SELECTED SUBCONTRACT WORKS

7C.1 GENERAL

The Contractor shall subcontract the following works to a Select Subcontractor:

(a) Provision of advice on temporary pipeline earthing and construction safety under high voltage power lines.

(b) Design of the temporary earthing equipment.

(c) Design and installation of the permanent earthing system including calculations, resultant induced voltages under all conditions at various pipe locations, and all documentation.

(d) Design and installation of earth grading rings at valve pits within the influence of the high tension power lines.

(e) Performance of a High Voltage Induction Study of the pipeline route by a suitably qualified and experienced engineer, who is a member of Institution of Engineers, Australia. The completion of this study prior to the commencement of the construction schedule is not essential as the installation of the Earth Grading Rings is intended to proceed.

(f) Design and installation of a suitable impressed current cathodic protection system including calculations and documentation, including provision of suitable power supply, liaison with SEQEB and connection charges.

(g) Co-ordination and liaison with the Queensland Electricity Commission (QEC).

(h) Liaison with foreign structure owners in accordance with the Queensland Electricity Act.

(i) Provision of drawings "For Construction" and "As Built", including all documentation and calculations.

(j) Any other aspect of the works not specifically covered by this Specification but necessary for the satisfactory completion and commissioning of the Earthing and Cathodic Protection works.

Full documentation is required for all stages of the installation, including design, installation and as-built, for both hazardous voltage mitigation and cathodic protection. All documentation shall be submitted to the Superintendent for approval prior to payment.

The Contractor shall be responsible for the suitability of the design, for the suitability of the materials selected and for the installation of both the earthing systems and the cathodic protection system.

7C.2 SELECT SUBCONTRACTORS

The Contractor shall subcontract the select subcontract works to one of the following select subcontractors:

(a)	Corrosion Control Engineering Pty Ltd	(07) 395 6374
(b)	Corrosion Specialists Pty Ltd	(07) 376 4006
(c)	Solomon Corrosion Consulting Services Pty Ltd	(03) 598 8660
(d)	Wilson Walton International Pty Ltd	(07) 343 8633

The Contractor may propose an alternative subcontractor, for approval by the Superintendent, to carry out the select subcontract works.

7C.3 MATERIALS

All materials utilised for temporary or incorporated into permanent works shall be new and suitable for the service required.

7C.4 RELEVANT STANDARDS AND CODES

All select subcontract work shall comply to the relevant Australian Standards detailed below, where applicable, or where no such standards exist then relevant British or NACE standards should be considered.

AS 1020 The control of undesirable static electricity.
AS 2239 Galvanic (sacrificial) anodes for cathodic protection.
AS 2832 Guide to the cathodic protection of metals Parts 1 and 2.
AS 3000 Wiring rules.
AS 1768 Lightning protection.
AS 2210 Safety footwear.
Queensland Electricity Act Part 10.
Queensland Electricity Regulations Part 8 1989.

7C.5 EARTHING

7C.5.1 General

The proposed pipeline closely parallels QEC easements where additional safety requirements and procedures are necessary due to the proximity of high voltage power lines sub station, where hazardous induced voltages and fault currents may develop.

The subcontractor shall review the existing safety specification for personnel and equipment in order to assist the Contractor.

7C.5.2 Temporary Pipeline Earthing

Temporary pipeline earthing shall be designed for installation by the Contractor at distances not exceeding 0.5 km. The ends of each section of pipeline where work is being undertaken shall also be earthed.

All temporary pipeline earthing shall not exceed a maximum of 15 ohms earth stake to soil resistance as per the standard structure to remote earth test procedures.

7C.5.3 Permanent Pipeline Earthing

The pipeline shall be connected to at least two (2) earth beds by the subcontractor as required by the design calculations in respect of hazardous voltages.

The permanent earth bed shall be comprised of zinc anode material, or an alternative material approved by the Superintendent and shall not exceed a maximum of 2 ohms resistance, earth bed to remote earth as per the standard structure to remote earth test procedures.

Scour valve outlets shall be electrically isolated from the mainline and shall be fitted with a trailing earth strap for discharge of static electrical charges.

7C.5.4 Valve Pit Polarising Test Point

All valve pits on this pipeline shall be fitted with earth potential grading rings. The polarising test points shall consist of:

(a) Hot dip galvanised upstand and suitably sized lockable junction box
(b) 35 mm^2 earth building wire for pipeline and grading ring connections
(c) Grading ring material
(d) Passive voltage surge device

The grading rings shall be located a minimum of 1 m offset from the outside circumference of the valve pit plinths.

Cable entries to valve pits, where required shall be via suitably sized conduits which shall be effectively sealed on completion of the grading ring installation.

Selection of the passive voltage surge device shall meet the following criteria as this pipeline is not regularly inspected. This voltage surge device shall be non consuming and re-usable following a voltage surge with any maintenance requirements being limited to annual inspections.

In addition the voltage surge device shall energise the grading ring when a potential difference of approximately 2 volts is applied between the pipeline and grading ring.

Where test point and grading ring installations coincide then the test point cabling shall be incorporated and external test point monitoring facilities shall be provided.

7C.5.5 Insulating Joint Surge Divertor

Mainline insulating joints shall be fitted with gas charged surge divertors or similar which shall be mounted within a test point junction box.

In cases where polarising earth grading rings are installed the surge divertors should be incorporated. Typically the Critec IJP230 or similar should be considered.

7C.6 CATHODIC PROTECTION SYSTEM

7C.6.1 General

The subcontractor shall be responsible for the design, documentation and installation of a cathodic protection (CP) system. The CP design is to be compatible with the permanent earthing design and grading ring installations where applicable. The cathodic protection system shall be designed to achieve a uniform electrode potential of -0.86 volts to -1.1 volts (instantaneous off) along the entire length of the pipeline with respect to a $Cu/CuSO_4$ reference cell.

(FOR INFORMATION ONLY) The pipeline project is divided into three (3) separate contracts with the Brisbane River crossing contract being electrically isolated and bifurcated. The pipeline river crossing will incorporate a permanent earthing system on each side of the Brisbane River.

7C.6.2 Test points

Above ground test points shall be provided within the design at approximately 0.5 km spacings and shall be located at valve pits or real property boundaries where practicable. Above ground test points shall be comprised of:

(a) mild steel baseplate
(b) mild steel pipe upstand
(c) suitably sized metallic enclosure

All mild steel components shall be hot dip galvanised for corrosion resistance.

Test points shall be installed during construction such that they may be utilised for earthing and/or cathodic protection.

Where test point and grading ring installations coincide then the test point cabling shall be incorporated and external test point monitoring facilities shall be provided. External connections and permanent identification shall be provided for all reference and other connections at test points.

7C.6.3 Cabling

Test point cabling shall comprise one 6 mm^2 single and at least one 16 mm^2 core double insulated (SDI) (black sheath) with a minimum of two (2) pipe connections being made at field joints.

Sacrificial anode cabling shall be comprised of 6 mm^2 SDI (red sheath), if installed.

Impressed current systems shall be comprised of:

(a) DC positive and anode cabling shall be a minimum of 16 mm^2 SDI (red sheath).

(b) DC negative cabling shall be a minimum of 16 mm^2 SDI (black sheath) with two (2) pipeline negative connections being provided.

Zinc reference electrode cabling shall be a minimum of 4 mm^2 building wire (yellow sheath) where installed.

Polarisation coupon cabling shall be installed at the impressed current drain point test point. Comprised on two (2) 2.5 mm^2 building wires, as a minimum, sheathed red and black or similar.

Earthing and Grading Ring cabling shall be 35 mm^2 earth building cable.

7C.6.4 Polarisation Coupon(s)

Polarisation coupons shall be comprised of a mild steel disc with a minimum cross sectional area of 25 mm dia. Two (2) colour coded 2.5 mm^2 building wires shall be attached and encapsulated prior to burial at the pipe invert depth adjacent to the drain point test points. Additional coupons may be installed in areas where high soil resistivity is encountered.

7C.6.5 Zinc Reference Electrodes

Stabilised zinc reference electrodes shall be installed adjacent to each polarisation coupon. The zinc reference electrodes shall be of minimum dimensions 20 mm dia x 250 mm long and be prepackaged in a gypsum bentonite backfill. These electrodes shall be pre-wetted prior to installation.

7C.6.6 Sacrificial Anode Current Shunts

Where sacrificial anodes are installed for cathodic protection purposes a calibrated current shunt of 0.1 ohm resistance shall be incorporated into each anode test point. Sacrificial anodes shall have a full operational life in excess of 10 years.

7C.6.7 Impressed Current Groundbeds

The design of impressed current groundbeds shall conform to the Queensland Electricity Act and Regulations with regard to the level of interference to foreign structures. Ground beds shall be located, where possible, in Council or public access areas. Impressed current anodes shall have a full operational life in excess of 15 years.

7C.6.8 Insulating Flange Joints

(FOR INFORMATION ONLY)
All specified insulating flange joints shall be electrically isolated by non conducting full faced gaskets suitable for the duty required. The Table C flange gaskets shall be the equivalent of Central Plastics G3 Phenolic.

In addition all insulating flange bolts shall be effectively isolated on both sides of the flange by proprietary sleeve and washer kits, preferably of the combined sleeve and washer type. Typically, Central Plastics Minlon or high density polyethylene sleeves shall be acceptable.

7C.6.9 Testing

All insulation joints shall be tested after installation to ensure adequate insulation. Testing shall be carried out in three stages, prior to backfilling, after backfilling and after the main is charged with water. The overall integrity of the pipeline insulation shall be tested after backfilling has been complete. Any holidays or defects shall be rectified. The cost of all testing and rectification shall be deemed to be included in the Contract Sum.

7C.6.10 Rectifier Unit

The Rectifier Unit shall be installed in Cubicle (Plinth Mounted) suitable for roadside location. Cubicle to include SEQEB metering and all compartments to be lockable with Lockwood 201 series locks.

The rectifier is to include standard 4 pin interrupter socket for instantaneous "Off" potential measurements, and shall include voltage and current indicators.

Telemetry Requirements

The cabinet shall provide sufficient space to allow installation of data logging and telemetry equipment by others. Minimum space on escutcheon 300 x 400 - 200 deep.

A terminal strip shall be provided for wiring into data logging by others. Data logger inputs/outputs are as follows: (To be wired to terminal strip)

1. Rectifier current
2. Rectifier voltage
3. De energise rectifier for remote installations off potential measurements
4. Local pipe reference potential
5. Soil resistivity at rectifier location

Data Logger System Voltage - analog $\pm$ 2.5 V dc or 4 -20mA
- Digital + 32 V dc

Rectifier unit circuitry shall be suitable for remote de-energisation of rectifier unit.

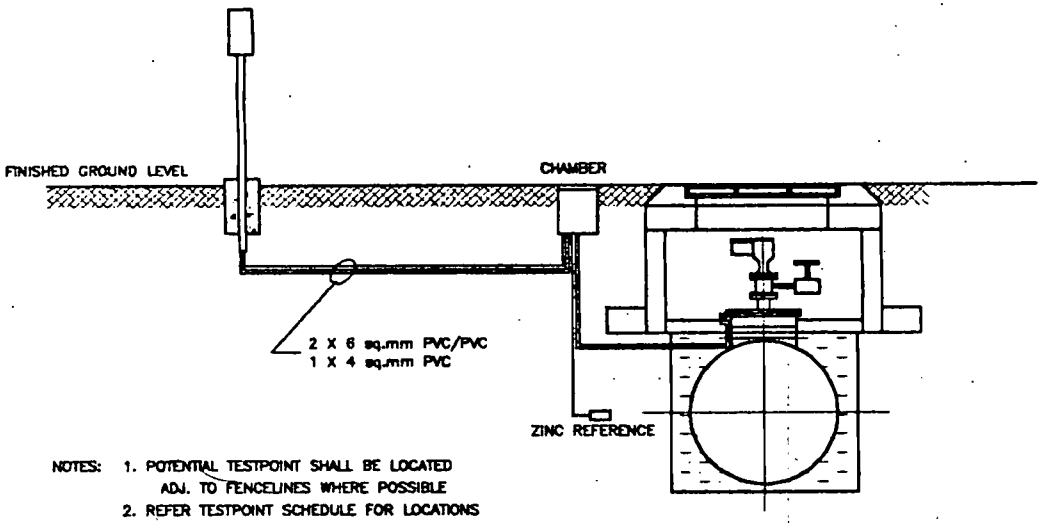
WILSON WALTON

APPENDIX 2

TRANSFORMER/RECTIFIER DATA

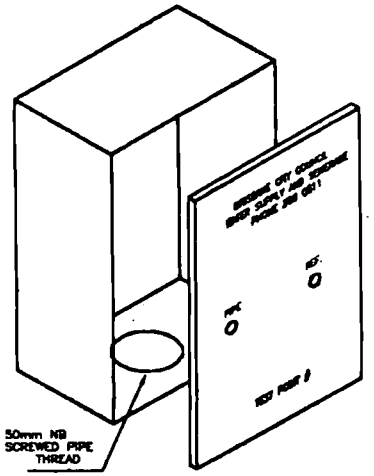
SHEETS AND DRAWINGS

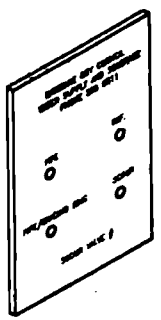
POTENTIAL TESTPOINT (TYPICAL)



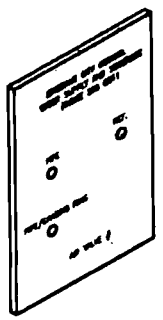
NOTES: 1. POTENTIAL TESTPOINT SHALL BE LOCATED ADJ. TO FENCELINES WHERE POSSIBLE
2. REFER TESTPOINT SCHEDULE FOR LOCATIONS

POTENTIAL TESTPOINT TYPE J3 BOX





SCOUR VALVE TERMINATION PLATE (CHAMBER TYPE)

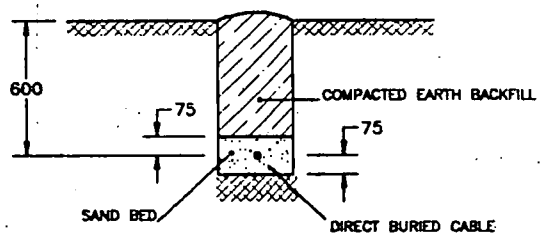


AIR VALVE TERMINATION PLATE (CHAMBER TYPE)

NOTES: 1. TERMINATION PLATES SHALL BE FIXED TO UNDERGROUND CHAMBERS WITH S/S BOLTS/NUTS

TEST POINT SCHEDULE

CHAINAGE	LOCATION	TYPE	CHAINAGE
20	A1215-A1216	IPGE CABINET	GRADING RING - POTENTIAL TP - ZINC REF - SURGE DIVERTOR
57	S1157	CHAMBER	GRADING RING - FOREIGN STRUCTURE BONDS
80	A1219	CHAMBER	GRADING RING
236	S1158	CHAMBER	GRADING RING - EARTHING BED
270	A1220	CHAMBER	GRADING RING
480	FENCELINE	T/R CABINET	T/R - ANODE BED - POTENTIAL TP - ZINC REF
723	S1159	CHAMBER	GRADING RING
755	A1221	CHAMBER	GRADING RING
827	S1160	CHAMBER	GRADING RING
918	FENCELINE	UPSTAND	POTENTIAL TP - ZINC REF
920	A1222	CHAMBER	GRADING RING
1192	S1161	CHAMBER	GRADING RING
1264	A1223	CHAMBER	GRADING RING
1335	S1162	CHAMBER	GRADING RING
1469	A1224	CHAMBER	GRADING RING
1543	S1163	CHAMBER	GRADING RING
1581	A1225	CHAMBER	GRADING RING
1583	FENCELINE	UPSTAND	POTENTIAL TP - ZINC REF
1642	S1164	CHAMBER	GRADING RING
1718	A1226	CHAMBER	GRADING RING
1860	S1165	CHAMBER	GRADING RING - EARTHING BED
2150	A1227	CHAMBER	GRADING RING
2163	S1166	CHAMBER	GRADING RING
2200	TIE - IN	UPSTAND	POTENTIAL TP - ZINC REF



TYPICAL BURIED CABLE

NR	DETAILS OF REVISIONS	DATE

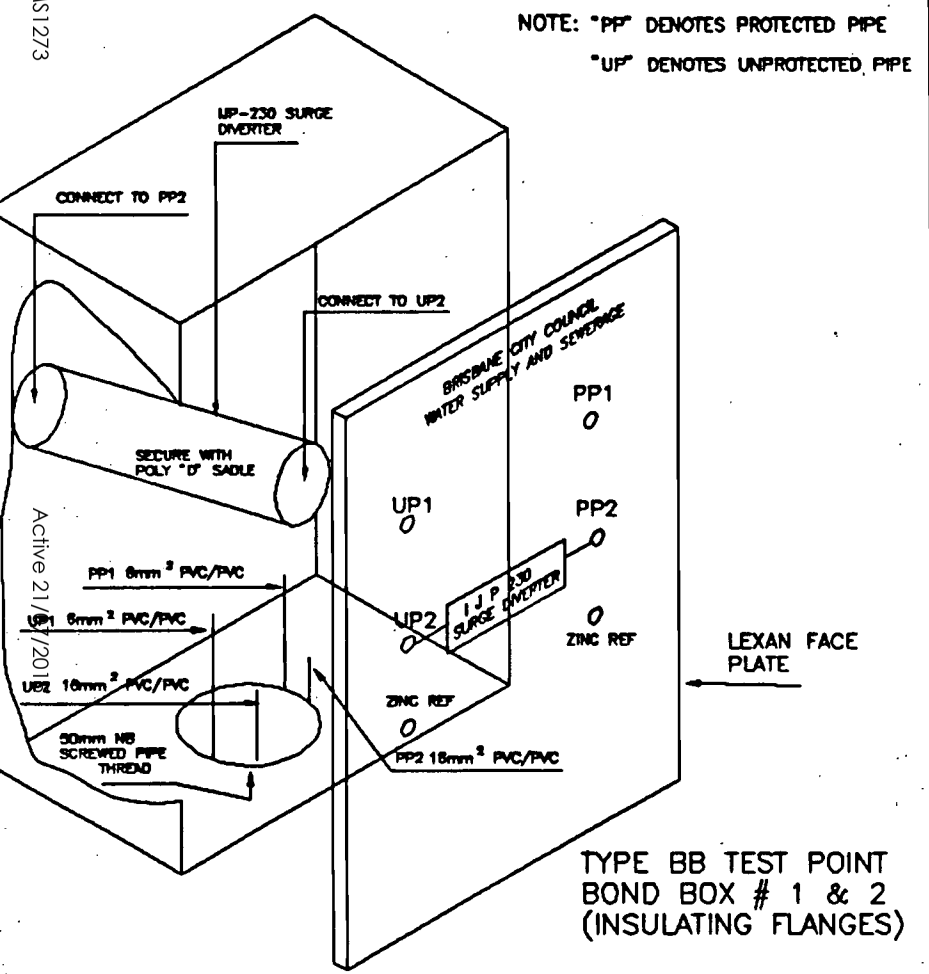
GULF ENGINEERING

CATHODIC PROTECTION INSTALLATION SYSTEM DETAILS

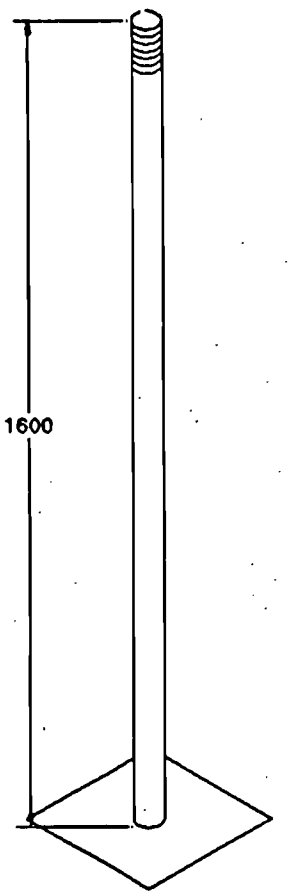
ANSTEAD TO BRIS. RIVER TRUNK MAIN

Checked | Date APR 94 | Drawn GJK | Scale —— | Drawing No. Q5917-23 | Sheet No. 3 OF 5 | Rev A

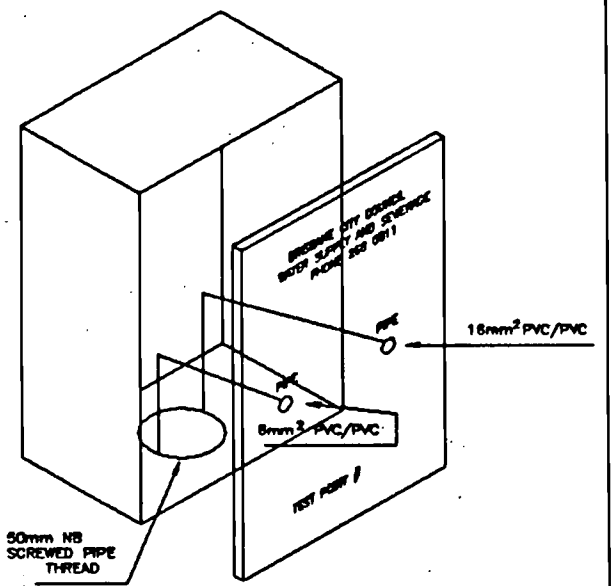
NOTE: "PP" DENOTES PROTECTED PIPE
"UP" DENOTES UNPROTECTED PIPE



TYPE BB TEST POINT
BOND BOX # 1 & 2
(INSULATING FLANGES)

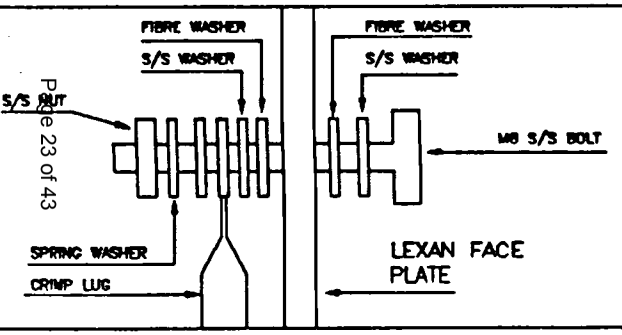


NOTE: STANDARD 50x1600mm GALVANISED UPSTAND



W3 STANDARD TYPE TEST POINT

CABLE SECURING DETAIL

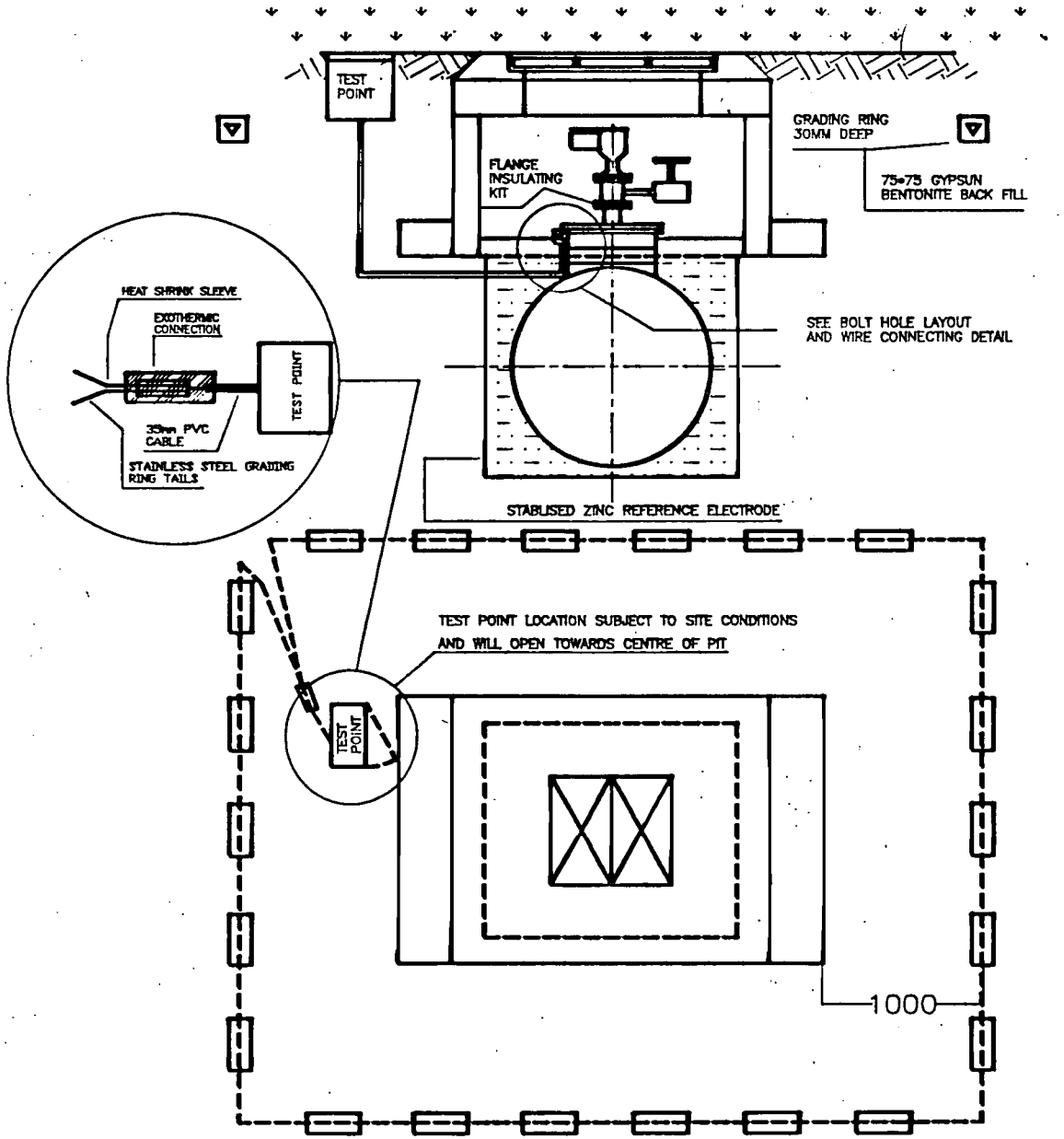


WILSON WALTON INTERNATIONAL (QLD) PTY LTD

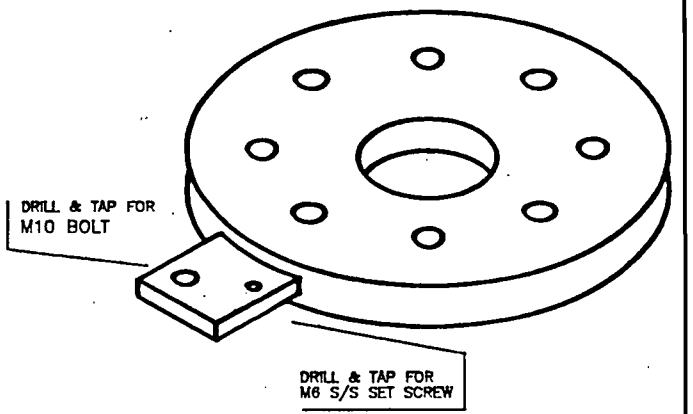
TITLE
ANSTEAD TO BRISBANE RIVER TRUNK MAIN
TEST POINT WIRING DETAIL

PROJECT
CONTRACT No R97-92/93

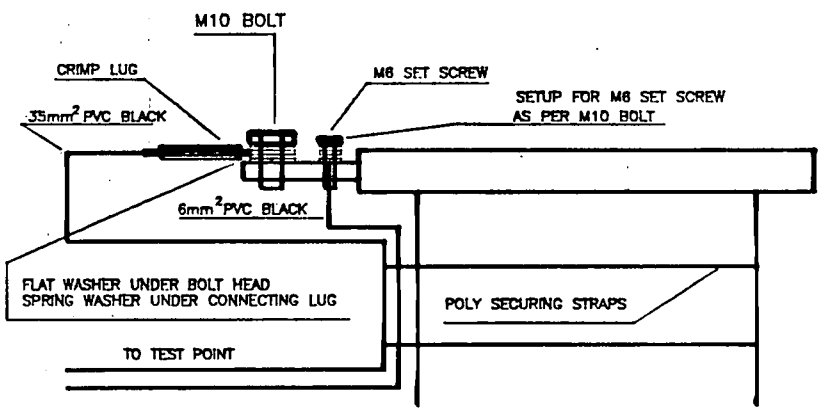
CLIENT						
GULP ENGINEERING	Checked	Date 5/10/93	FILE No Q5917	DRAWING No. ANST-06	SHEET 6 OF 10	REV
	Drawn TS	Scale N.T.S.				



BOLT HOLE LAYOUT



WIRE CONNECTING DETAIL



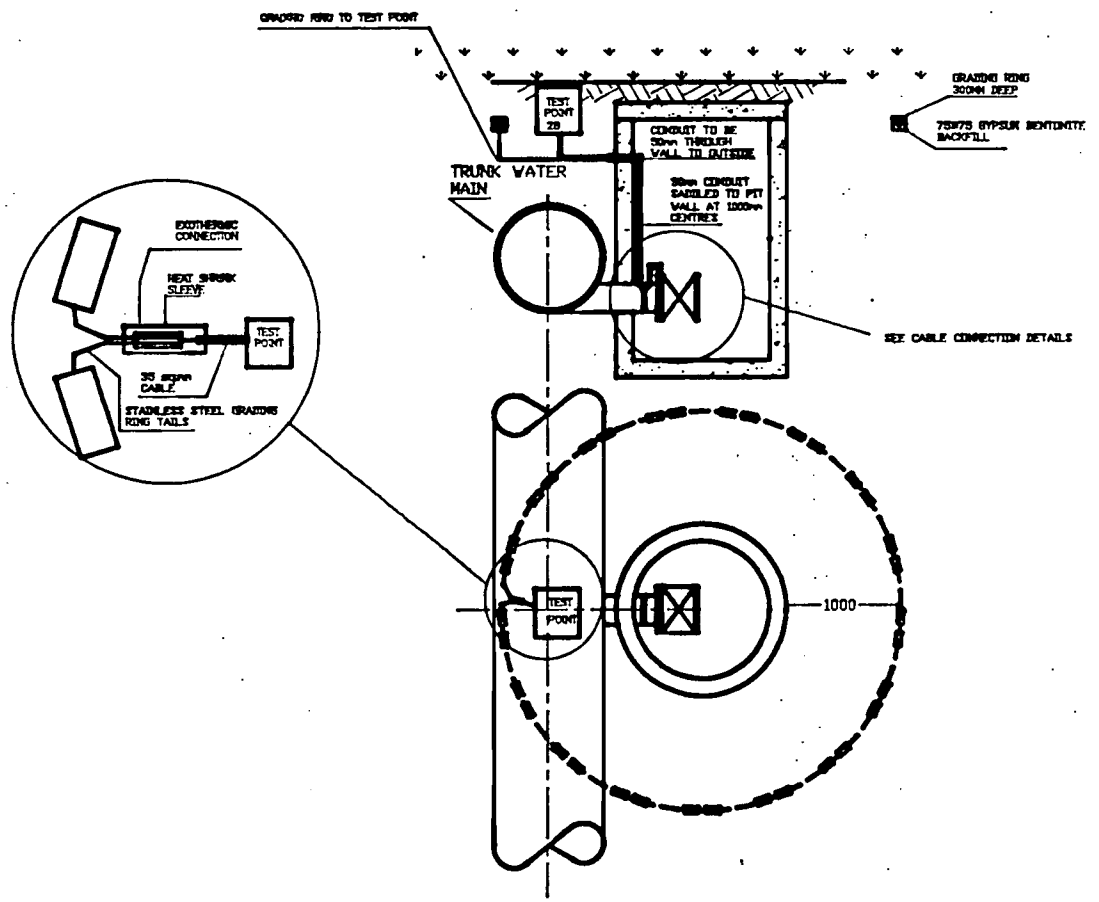
WILSON WALTON INTERNATIONAL (QLD) PTY LTD

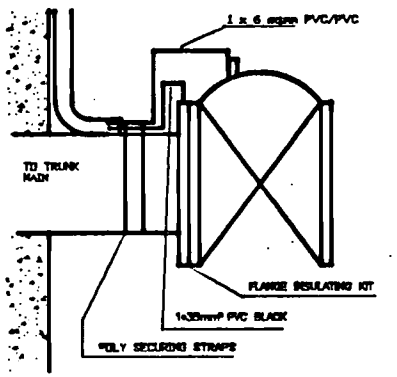
TITLE
ANSTEAD TO BRISBANE RIVER TRUNK MAIN
AIR VALVE, GRADING RING COMBINATION
TEST POINTS – GENERAL

PROJECT
CONTRACT No. R97–92/93

CLIENT						
GULF ENGINEERING	Checked	Date JUN 94	FILE No	DRAWING No.	SHEET OF	REV
	Drawn TS	Scale N.T.S.	Q5917	ANST–02	2 10	

SCOUR VALVE--GRADING RING INSTALLATION





CABLE CONNECTION DETAILS

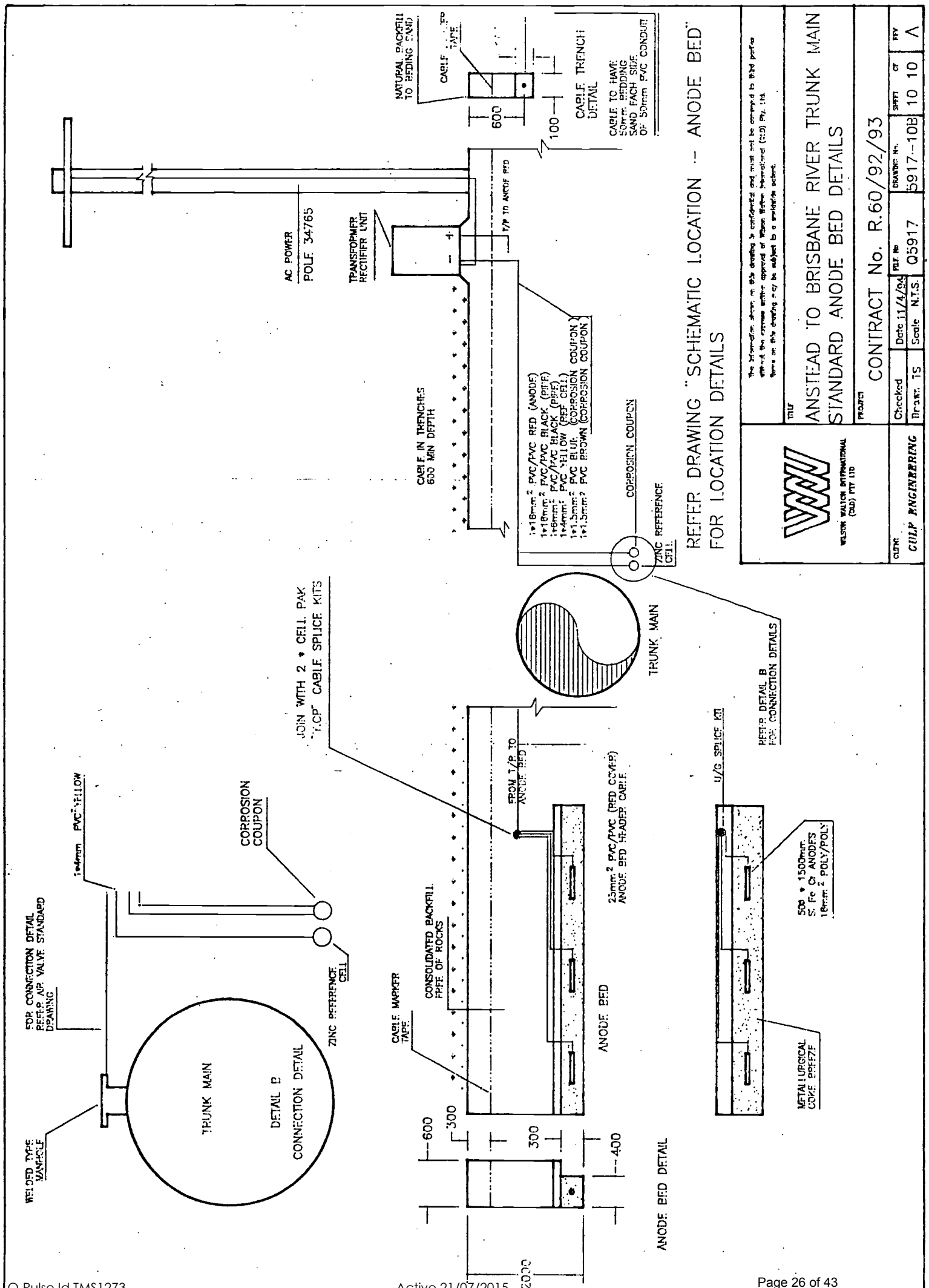
WILBUR SMITH INTERNATIONAL (QLD) PTY LTD

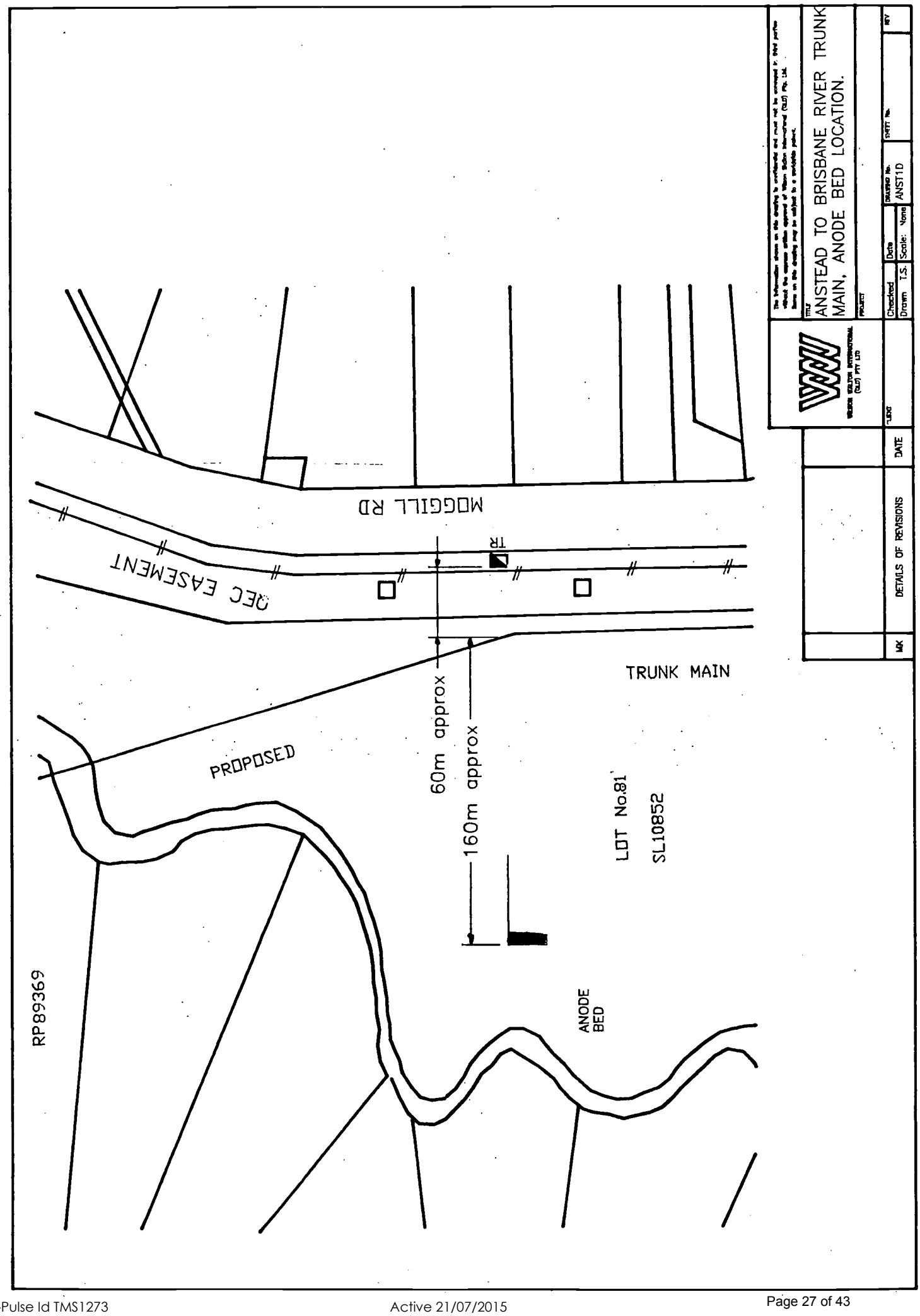
TITLE: CATHODIC PROTECTION INSTALLATION SYSTEM DETAILS TEST POINT -- GENERAL

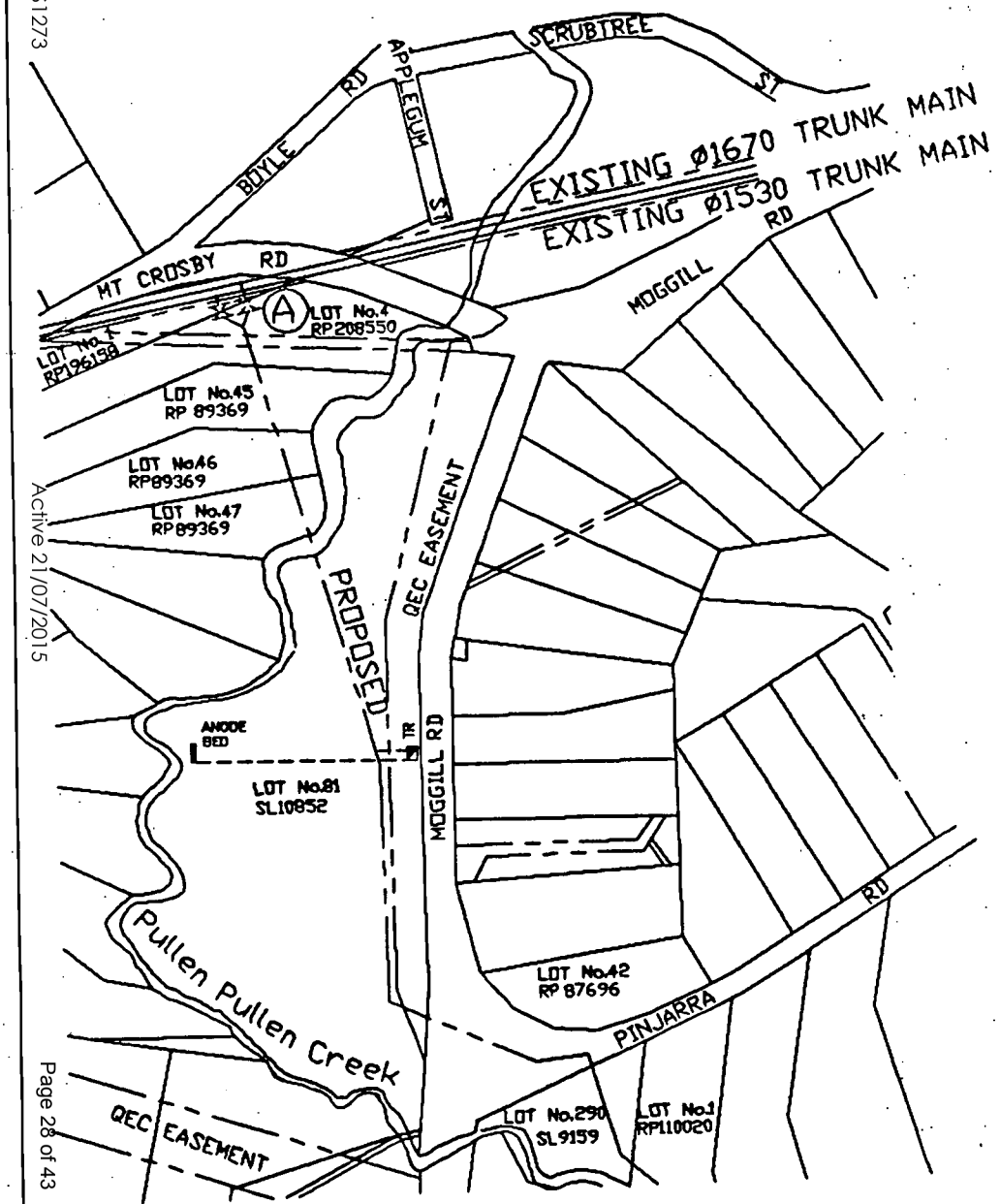
PROJECT: ANSTEAD TO BRIS. RIVER TRUNK MAIN

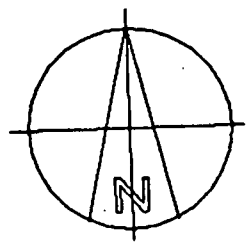
CLIENT: GHD ENGINEERS

Checked	Date APR 94	DRAWING No.	SHEET No.	REV
Drawn G.K.	Scale ——	ANST--04	2 OF 5	4


REFER DRAWING "SCHEMATIC LOCATION - ANODE BED" FOR LOCATION DETAILS
ANSTEAD TO BRISBANE RIVER TRUNK MAIN
STANDARD ANODE BED DETAILS
CONTRACT No. R.60/92/93
GULF ENGINEERING
WILSON WALTON INTERNATIONAL (QLD) PTY LTD
Checked
Drawn TS
Date 11/4/94
Scale N.T.S.
FILE No Q5917
DRAWING No. 5917-108
SHEET 10 OF 10
REV A
AC POWER
POLE 34765
TRANSFORMER RECTIFIER UNIT
+
-
T/P TO ANODE BED
CABLE IN TRENCHES 600 MIN DEPTH
CABLE TRENCH DETAIL
NATURAL BACKFILL TO BEDING SAND
CABLE TAPE
CABLE TO HAVE 50mm BEDDING SAND EACH SIDE OF 50mm PVC CONDUIT
600
100
1x16mm² PVC/PVC RED (ANODE)
1x16mm² PVC/PVC BLACK (PIPE)
1x6mm² PVC/PVC BLACK (PIPE)
1x4mm² PVC YELLOW (REF CELL)
1x1.5mm² PVC BLUE (CORROSION COUPON)
1x1.5mm² PVC BROWN (CORROSION COUPON)
CORROSION COUPON
ZINC REFERENCE CELL
TRUNK MAIN
JOIN WITH 2 x CELL PAK "COP" CABLE SPLICE KITS
REFER DETAIL B FOR CONNECTION DETAILS
U/G SPLICE KIT
FROM T/P TO ANODE BED
25mm² PVC/PVC (RED COVER) ANODE BED HEADER CABLE
CONSOLIDATED BACKFILL FREE OF ROCKS
CABLE MARKER TAPE
ANODE BED
5 OFF x 1500mm Ø Fe Ø ANODES
16mm² POLY/POLY
METALLURGICAL COKE BREEZE
ANODE BED DETAIL
600
300
300
400
2000
104mm PVC YELLOW
CORROSION COUPON
ZINC REFERENCE CELL
EDP CONNECTION DETAIL REFER AIR VALVE STANDARD DRAWING
WELDED TYPE MANHOLE
TRUNK MAIN
DETAIL B
CONNECTION DETAIL


MOGGILL RD
TR
REC EASEMENT
TRUNK MAIN
PROPOSED
60m approx
160m approx
LOT No.81
SL10852
RP89369
ANODE BED
ANSTEAD TO BRISBANE RIVER TRUNK MAIN, ANODE BED LOCATION.
DETAILS OF REVISIONS
DATE
Checked
Drawn T.S.
Date
Scale: None
DRAWING No. ANST1D





WILSON WALTON INTERNATIONAL (QLD) PTY LTD

TITLE: ANSTEAD TO BRISBANE RIVER TRUNK MAIN SCHEMATIC LOCATION – ANODE BED

PROJECT: CONTRACT No. R97–92/93

CLIENT						
GULP ENGINEERING	Checked	Date 14/3/94	FILE No. Q5917	DRAWING No. ANST1B	SHEET OF	REV
	Drawn TS	Scale N.T.S.				

WILSON WALTON

APPENDIX 3

BRISBANE CITY COUNCIL

LOGAN CITY TRUNK MAIN

ANSTEAD - BRISBANE RIVER

CONTRACT No. R97-92/93

COMMISSIONING REPORT

CATHODIC PROTECTION

WILSON WALTON

C O N T E N T S

WILSON WALTON

Q5917 - CONTRACT No. R97-92/93
BRISBANE CITY COUNCIL
LOGAN CITY TRUNK MAIN - ANSTEAD SECTION
CATHODIC PROTECTION COMMISSIONING REPORT
MAY, 1994.

1.0 SUMMARY

The cathodic protection system installed under Contract No. R97-92/93 is operating satisfactorily with pipeline potential levels being maintained within the as specified range of -0.85 to -1.2 volts versus a copper/copper sulphate reference electrode.

2.0 INTRODUCTION

As part of the Contract No. R97-92/93, Wilson Walton International (QLD) Pty Ltd conducted commissioning works associated with the impressed current cathodic protection system installed on the Anstead-Brisbane River Section of the Logan City Trunk Main Water Supply Pipeline.

Final system commissioning was undertaken during May, 1994 following the installation of the impressed current cathodic protection system in conjunction with interference testing.

The purpose of the survey was to establish the following:

(i) Carry out testing of the cathodic protection system and associated equipment.

(ii) Determine the degree of cathodic protection being maintained on the buried sections of the pipeline and note any requirements for adjustments, modifications or repairs to the system considered necessary to maintain an adequate degree of protection on the pipeline.

(iii) Carry out confimatory testing to ensure that the pipeline was electrically isolated at the extremities of buried sections.

(iv) Report on any abnormalities relating to corrosion protection and general operation and safety of the pipeline/s and make recommendations, where required, for the continued satisfactory operation of the cathodic protection system.

WILSON WALTON

3.0 COMMISSIONING TESTS

3.1 **Pipeline Potentials**

Prior to energising the cathodic protection systems, a pipeline to soil potential survey was conducted to monitor the natural potentials along the pipeline/s route.

Following energisation of the system, the output of the cathodic protection transformer rectifier unit was adjusted to levels considered suitable to permit the pipeline to soil potentials to fall within the as specified limits as nominated in the specification. ie. An "instant off" potential of -0.85V (min) -1.2V (max) versus a copper/copper sulphate reference electrode.

As the grading rings and permanent earths are directly connected to the pipeline, instant off pipeline potentials were not monitored.

3.2 **Insulating Flanges**

During on/off potential testing, integrity of all insulating flanges was confirmed by measuring the potential swing on each side of the insulating fittings.

3.3 **Groundbed Resistance**

The loop resistance of the groundbed was monitored via measurements of the voltage and associated current outputs in increments. The gradient of a plot of voltage versus current output represents the loop resistance of each system.

3.4 **Permanent Earth - Resistance to Earth**

Each of the two permanent earths installed on the pipeline were subjected to earth resistance testing as required. Testing was conducted via the 2 pin Meggar Earth Testing procedure to remote earth in accordance with AS1768.

WILSON WALTON

3.5 Foreign Structure

Interference to foreign structures was monitored via the measurement of potential swing during On/Instant Off potential measurements. Testing was undertaken on the adjacent SEC high tension tower as well as SEQEB earths, property fences and Telecom cabling in the area.

4.0 TEST INTRUMENTATION

4.1 Pipeline to Soil Potentials

All pipeline to soil potentials were monitored using an M.C. Miller LC-4 digital corrosion voltmeter with a variable input resistance of 10-200 megohm in conjunction with an M.C. Miller RE5C copper/copper sulphate reference electrode.

4.2 Earth Resistance Measurement

Permanent Earth bed earth resistance measurements were conducted using a Nilsson 400 megger 4 pin earth resistance meter.

5.0 RESULTS OF COMMISSIONING TESTING

Refer to Appendices 1 and 2 for commissioning results.

6.0 DISCUSSION OF RESULTS.

6.1 Pipeline to Soil Potentials

As shown by Appendix 1, full cathodic protection of the pipeline within the range of the intended protection levels is provided with potentials being more negative than -0.85V and less than -1.2V versus a copper/copper sulphate reference electrode.

WILSON WALTON

6.2 Insulating Fittings

Potential measurements across insulating fittings confirm that satisfactory electrical isolation of the protected pipeline from structures not requiring protection has been achieved.

6.3 Groundbed Resistance

A loop resistance of 2.2 ohms for the impressed current anode bed confirms that the installation has been completed in a satisfactory manner and within the design requirements.

6.4 Permanent Earth Installation - Resistance

As shown by Appendix 2, the resistance to remote earth of the two permanent earth beds is below the nominated 2.0 ohms.

6.5 Foreign Structures

Appendix 2 indicates that interference to the high tension transmission tower footings and earths was detected. Whilst much of the potential shift in the area was considered to be predominantly soil gradient error rather than actual potential shift, magnesium rod anodes were installed on towers 40 and 3839. The resultant installation raised the potential of the structure to well in excess of the natural corrosion potential. As such, the previously experienced positive shift in potentials has been depressed to a more negative potential than the natural potential of the tower footings.

In addition to the high tension transmission towers, testing was conducted on low voltage power earths as well as Telecom cabling in the vicinity of the pipeline. In both instances, no adverse effects were monitored on any of the other structures nominated in the area.

WILSON WALTON

6.6 General

6.6.1 Pipeline Electrical Isolation.

The electrical isolation of the pipeline from structures not required to be protected (including scour and air valves) is achieved by the installation of flange insulating gasket kits in all circumstances.

6.6.2. Permanent Reference Cell Installations.

As shown in Appendix 1, the permanent zinc reference electrodes show some small variation when monitored against a standard copper/copper sulphate reference electrode. However, since the permanent cells are used purely as a reference to control the output of the automatic systems of both cathodic protection installation and monitor protection levels on the pipeline, such variation is not unacceptable providing a consistent potential level is maintained.

Similarly, the permanent zinc reference electrodes at each end of the pipeline and at 500m interval test point installations are used to monitor the potential levels on the pipeline. However, the potential variation in cells relative to a portable copper/copper sulphate reference electrode allows the cells to be calibrated and in a pure sense, then allows for the variation to be accounted for in interpretation of the overall readings.

WILSON WALTON

6.6.3 Corrosion Coupons

The potential testing of the corrosion coupons with the cathodic protection system connected to the coupon and switching on and off indicates polarisation occurring on the coupons soon after the system was commissioned. Due to the amount of zinc in permanent earths and grading rings, the on potential of the pipeline was set marginally higher than the open circuit potential of the zinc earth mats and grading rings.

6.6.4 Grading Ring Potentials.

As shown by Appendix 2, all the potentials associated with grading rings indicate that consumption of the zinc grading rings via galvanic dissolution is unlikely.

The potential of the pipeline and grading rings is set higher than the dissolution potential of the zinc and therefore it is anticipated that any climb in the earth system is highly unlikely.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The commissioning works indicate that the cathodic protection system is operating satisfactorily with potential levels maintained within the specified limits of -0.85 to -1.2 volts versus a copper/copper sulphate reference electrode.

Potential testing also confirms that insulating flanges fitted to all of the branches and extremities of the pipeline contract are performing satisfactorily and as such isolating the pipeline from poorly coated sections of associated fittings and/or attachments.

WILSON WALTON

TABLE 1: TEST POINT RESULTS

Test Point No.	Location	Natural Potential	Protected Potential	Zinc Ref. Cells	
28.	End of Line	-1.091	-1.190		
28A.	End of Line	-1.091	-1.190	Z1	
29.	AV1227	-1.023	-1.071		
30. *	SV1167	-1.079	-1.110		
31.	AV1226	-1.059	-1.084		
32.	SV1164	-1.035	-1.075		
33.	AV1225	-1.071	-1.151	Z2	
33A.	AV1225	-1.071	-1.151		
34.	SV1163	-1.020	-1.063		
35.	AV1224	-1.028	-1.056		
36.	SV1162	-1.076	-1.133		
37.	AV1223	-1.002	-1.037		
38.	SV1161	-1.070	-1.128		
39.	AV1222	-1.113	-1.197		
39A.	AV1222	-1.113	-1.197	Z3	
40.	SV1160	-1.076	-1.125		
41.	AV1221	-1.064	-1.104		
42.	SV1159	-1.144	-1.180	Z4	(T/R)
43. *	AV1220	-1.105	-1.138	Z5	
44.	SV1158	-1.210	-1.230		
45.	AV1219	-1.079	-1.102		
46.	SV1157	-1.104	-1.121	Z6	
47.	Start of Line	-1.075			

* Denotes location of Permanent Earths

NOTE: Transformer rectifier unit operating at 650mA/2V DC output.

Z1 to Z5 denotes permanent zinc referenc cells.

WILSON WALTON

TABLE 2: PERMANENT EARTH(S)

Chainage	Location	Resistance to Remote Earth (Ohms)
AV1220	CK/fence at McIntyre Centre.	1.70
SV1165	Adjacent to CK	0.80

WILSON WALTON

TABLE 3: INTERFERENCE TESTING RESULTS
QEC TOWERS - BEFORE MITIGATION

Tower No.	Leg No.	Potential Natural	Potential CP ON	Swing (mV)	Comments
3838	1.	-0.196	-0.188	+8	
A	2.	-0.210	-0.201	+9	
	3.	-0.193	-0.187	+6	
	4.	-0.220	-0.214	+6	
39	1.	-0.321	-0.314	+7	
B	2.	-0.330	-0.323	+7	
	3.	-0.326	-0.317	+9	
	4.	-0.342	-0.335	+7	
3839	1.	-0.276	-0.262	+14	
C	2.	-0.270	-0.260	+10	
	3.	-0.288	-0.280	+8	
	4.	-0.281	-0.270	+11	
40	1.	-0.342	-0.318	+24	
D	2.	-0.354	-0.330	+24	
	3.	-0.339	-0.315	+24	
	4.	-0.340	-0.315	+25	
3840	1.	-0.290	-0.280	+10	
E	2.	-0.286	-0.270	+16	
	3.	-0.280	-0.267	+13	
	4.	-0.290	-0.276	+14	
41	1.	-0.330	-0.315	+15	
F	2.	-0.345	-0.325	+20	
	3.	-0.335	-0.316	+19	
	4.	-0.335	-0.315	+20	
3841	1.	-0.268	-0.260	+8	
G	2.	-0.266	-0.259	+7	
	3.	-0.262	-0.253	+9	
	4.	-0.258	-0.250	+8	

WILSON WALTON

Table 3 continued.

Tower No.	Leg No.	Potential Natural	Potential CP ON	Swing (mV)	Comments
42	1.	-0.498	-0.498	0	
H	2.	-0.513	-0.513	0	
	3.	-0.513	-0.513	0	
	4.	-0.505	-0.505	0	
3842	1.	-0.290	-0.290	0	
I	2.	-0.286	-0.286	0	
	3.	-0.292	-0.292	0	
	4.	-0.288	-0.288	0	
43	1.	-0.342	-0.336	+6	
J	2.	-0.343	-0.336	+7	
	3.	-0.336	-0.328	+8	
	4.	-0.410	-0.405	+5	
44	1.	-0.352	-0.360	-8	
K	2.	-0.346	-0.355	-9	
	3.	-0.353	-0.361	-8	
	4.	-0.352	-0.360	-8	
45	1.	-0.374	-0.399	+25	
L	2.	-0.376	-0.395	+19	
	3.	-0.378	-0.400	+22	
	4.	-0.372	-0.397	+25	
46	1.	-0.376	-0.376	0	
M	2.	-0.378	-0.378	0	
	3.	-0.370	-0.370	0	
	4.	-0.380	-0.380	0	

WILSON WALTON

TABLE 4: INTERFERENCE MITIGATION (ANODES INSTALLED) QEC TOWERS

Tower No.	Natural Potential	Potential Anodes	Swing (mV)	Comments
40	0.398	0.520	-122	
3839	0.328	0.795	-467	
3840	0.335	0.365	- 30	
41	0.316	0.385	- 69	

WILSON WALTON

TABLE 5: INTERFERENCE TESTS
SEQEB POWER EARTHS

Pole No.	Location	Potential Natural	Potential ON	Comments
A3516	Moggill Road	0.410	0.410	
702_3	Moggill Road	0.405	0.405	
70L7L	Pinjarra Road	0.372	0.372	
70275	Pinjarra Road	0.327	0.327	
24689	Pinjarra Road	0.340	0.340	
70272	Pinjarra Road	0.350	0.350	
70284	Moggill Road	0.406	0.406	
70287	Moggill Road	0.390	0.390	
70288	Moggill Road	0.421	0.421	
47340	Moggill Road	0.390	0.390	
18740	Lather Road	0.370	0.370	
47614	Lather Road	0.350	0.350	
44732	Lather Road	0.329	0.329	
43036	Lather Road	0.360	0.360	
34439	Moggill Road	0.420	0.420	
34434	Moggill Road	0.460	0.460	
34790	Mt Crosby Road	0.360	0.360	
34786	Mt Crosby Road	0.250	0.250	
36524	Dolman Road	0.330	0.330	

Form 23
(7/89)

Electricity Act 1976 - 1988 (Queensland)(S.285(4))
Electricity Regulations 1989

Permit Number
P 1157

PERMIT TO INSTALL A CATHODIC PROTECTION SYSTEM

This is to certify that permission to install and test a Cathodic Protection System for the protection of the structure referred to below has been granted.

The 30 / 11 / 1994 is the date prior to which it is necessary for an authority to operate to issue as a condition precedent to the effective continuance of this permit and if the authority to operate is not issued prior to such date, this permit is by force of section 285(6) of this Act cancelled on that date and thereupon ceases to have any effect.

The system owner is required for the purposes of section 285 (7) of this Act to contact representatives of the owners of foreign structures likely to be affected by the Cathodic Protection System to arrange a date and time for interference testing.

The system owner shall ensure that interference mitigation is effected to the satisfaction of the Commission.

The system owner shall make provision for the D.C. current source to be interruptible for interference and other tests, provided that the Commission may for reasons of isolation or otherwise, give approval for this requirement to be waived.

Name and postal address of system owner: (including postcode)	BRISBANE CITY COUNCIL GPO BOX 1434 BRISBANE QLD 4001
Location of system:	MOGGILL ROAD BETWEEN MT CROSBY AND PINJARA ROADS, ANSTEAD
Structure to be protected:	1200mm DIA STEEL WATER TRUNK MAIN - MT CROSBY ROAD TO BRISBANE RIVER CROSSING

24 / 6 / 1994
Date

The Secretary,
Queensland Electricity Commission

Refer to Notes overleaf

152/10/28
1157-F
9443-1