SINCLAIR KNIGHT MERZ
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TRANSFIELD
SERVICES

Cabramatta SPS Electrical Earthing

DESIGN REPORT

- Rev. 0
- 27 October 2011

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- Rev. 0
- 27 October 2011

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Contents

1. Executive Summary 1
1.1. Methodology and Assumptions 1
1.2. Earth Grid Design 3
2. Soil Resistivity Tests and Soil Modelling 5
3. Fault Current Calculations and Protection Clearance Time 8
4. Touch and Step Voltage Limits and Calculations 9
Appendix A Reference Drawings 12
Appendix B Photos 13
B.1 Transformer Compound 13
B.2 415V Earth Link 15
Appendix C Sydney Water Map 16
Appendix D Soil Resistivity Tests 17
Appendix E 11kV Dropout Fuse 18
Appendix F Argon Calculation Outputs 19

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1. Executive Summary

This report documents the work that has been carried out to design the earth grid for the new extended 11/0.415kV transformer compound at Cabramatta SPS. The prospective touch and step voltages within the transformer compound and on the boundary fence have been derived. It should be noted that the touch and step voltage hazard assessments of the on-site generator, pump equipment, LV switchboard and other facilities within Cabramatta SPS are not part of the scope of this earth grid design report.

The two existing transformers will be replaced by two new 1000kVA transformers. The existing transformer compound will be extended in order to accommodate the new transformers.

The electrical single line diagram, site survey and preliminary general arrangement of the new transformer compound are shown in Appendix A.

1.1. Methodology and Assumptions

Based on the soil resistivity tests and the developed soil model (refer to Section 2), the following iterative steps have been performed until the design meets the requirements of the applicable design standard AS 2067:2008:

- Design the earth grid
- Calculate the maximum single-phase-to-ground fault current (refer to Section 3)
- Calculate the touch and step voltages and compare with the limits given in the above standards (refer to Section 4)

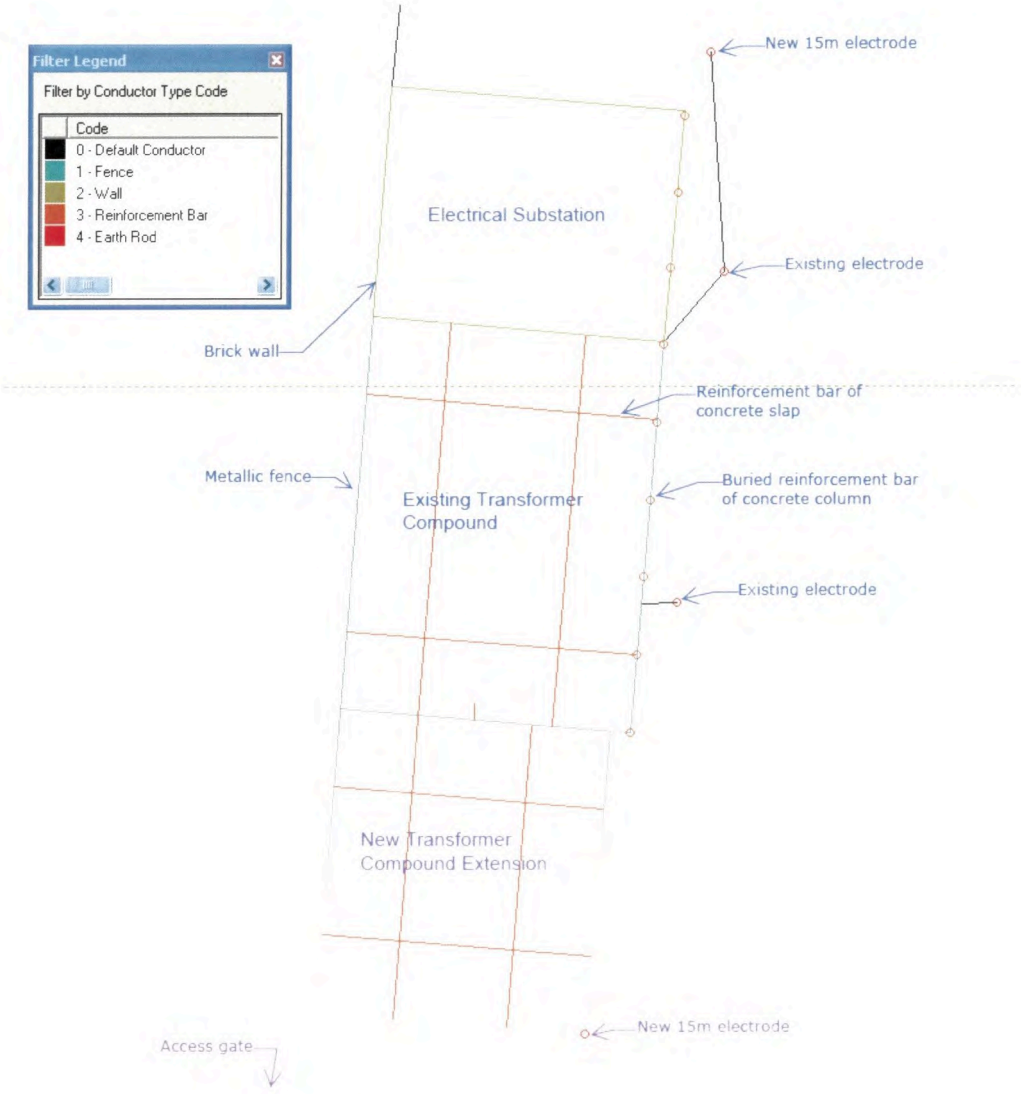
The steps mentioned above are based on the following observations and assumptions:

- The details of the existing earth electrodes of the substation are unknown. For the new design, each existing earth electrode has been assumed to be 2.4m long with 15mm diameter.
- Based on Drawing 33253 (refer to Appendix A), the transformer compound and the adjacent switchroom are on top of a concrete slap and are elevated from the ground surface. There is a 6-inch gap between the concrete slap and the ground surface. 18ft reinforcement concrete columns are buried in the ground to support the concrete slap.
- Based on the photos taken at the site (refer to Appendix B.1), the transformer compound fence is bonded to the concrete slap. This indicates that the existing concrete slap had been designed to provide an equipotential surface.
- Based on the site investigation (refer to Appendix B.2 and drawing 5292-E-1201), the cast iron water mains are believed to be bonded to the earthing system of the transformer compound.

- The earthing designs of the incomer feeder poles of Endeavour Energy are not part of the scope of this earthing design report. It is assumed that the existing earthing of the poles complies with the relevant Australian Standards.
- In accordance with the single line diagram (Drawing S187/6), the 11kV supplies to the 11/0.415kV transformers are protected by pole top dropout fuses. As advised by Endeavour Energy (email dated 13 October 2011), the dropout fuse type is ABB Class K 100A.

The earth grid design proposed in this report is dependent on the accuracy of the observations and assumptions stated in this report. Sydney Water shall confirm and accept the observations and assumptions are reasonable and correct.

1.2. Earth Grid Design



- **Figure 1: Transformer earth grid model**

Figure 1 shows the resulting earth grid model for the transformer compound. The details of the existing earth electrodes and the reinforcement bar inside the concrete columns are unknown, but have been presumed and included in the model to give indicative results.

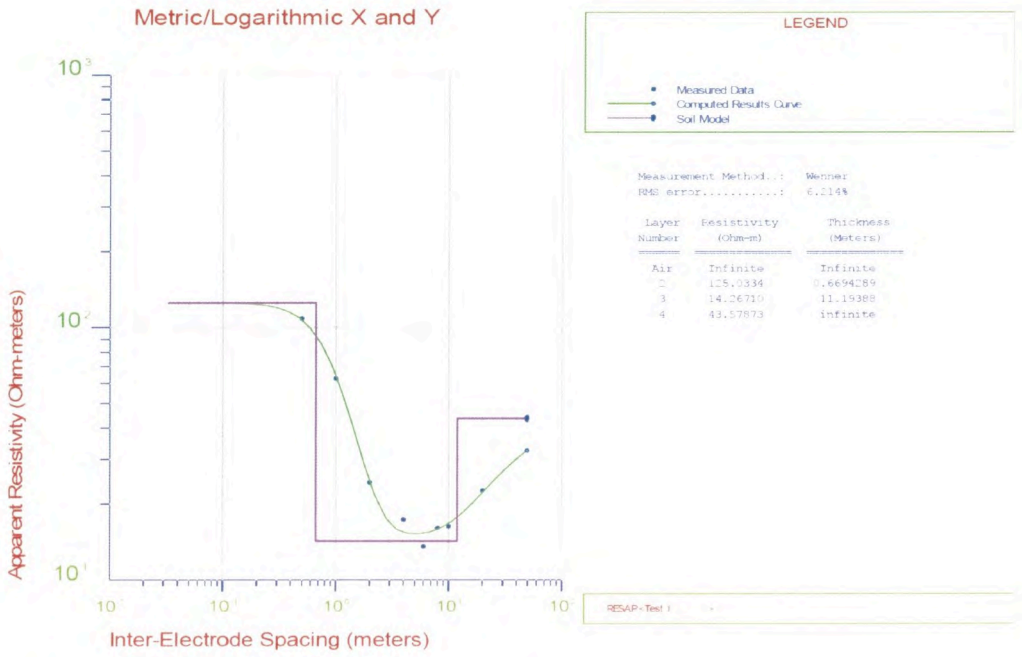
The required augmentation to the existing earth grid to comply with AS 2067:2008 is as follows:

- Two new 15m earth electrodes should be installed at the locations shown in Figure 1. Each earth electrode should be installed in a 70mm diameter drilled hole and back filled with Eritech GEM or equivalent.
- Asphalt of 100mm thickness should be installed surrounding the transformer compound. The width of the asphalt should not be less than 1.5m.
- A 2.4m insulating fence panel should be installed between the transformer compound the access gate to prevent voltage transfer via the fence. Note that the other end of the fence of the transformer compound stops at the brick wall of the switchroom.
- Refer to photo in Appendix B.1, there are two sign boards adjacent to the transformer compound. The back supports of the sign boards should not be bolted to the concrete slap of the transformer compound to prevent voltage transfer.
- The reinforcement bars of the new section of the transformer compound should be electrically continuous by bonding them to the reinforcement bars of the existing section of the transformer compound.
- The new fence section should be electrically continuous by bonding it to the existing fence section and to the reinforcement bars of the new compound section.

The simulation results for the proposed earthing design are given in the following sections.

2. Soil Resistivity Tests and Soil Modelling

Four soil resistivity tests have been carried out on 23 August 2011 (refer to Appendix D). The resulting soil models calculated by CDEGS are shown in Figure 2 to Figure 5. The four models indicate that the soil test results are consistent. For conservative design, the soil model of Test 1 has been used.



- Figure 2: Soil resistivity model of Test 1

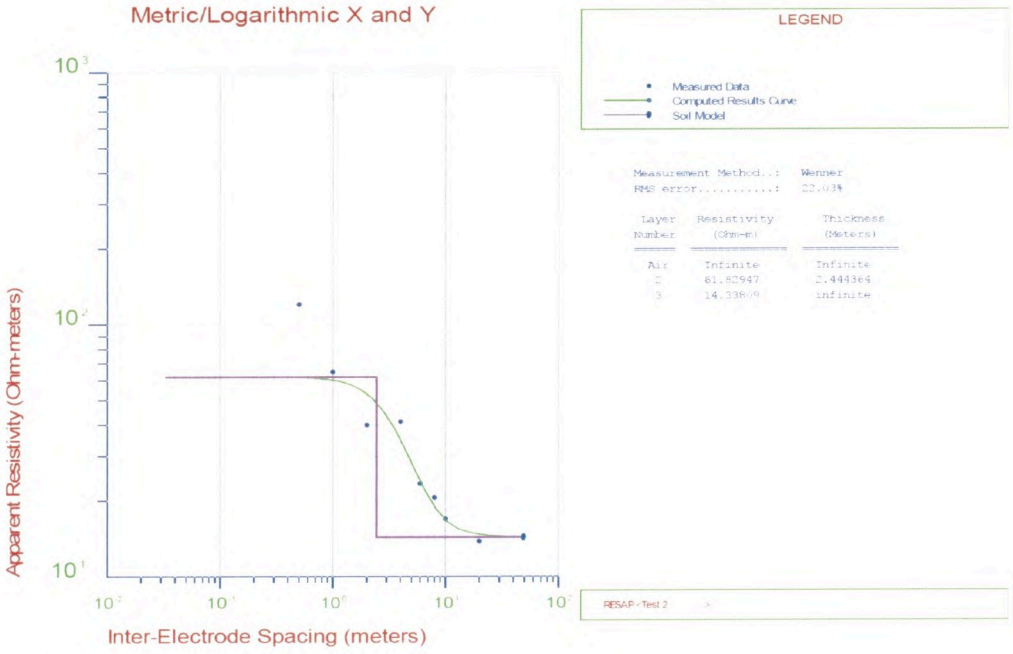
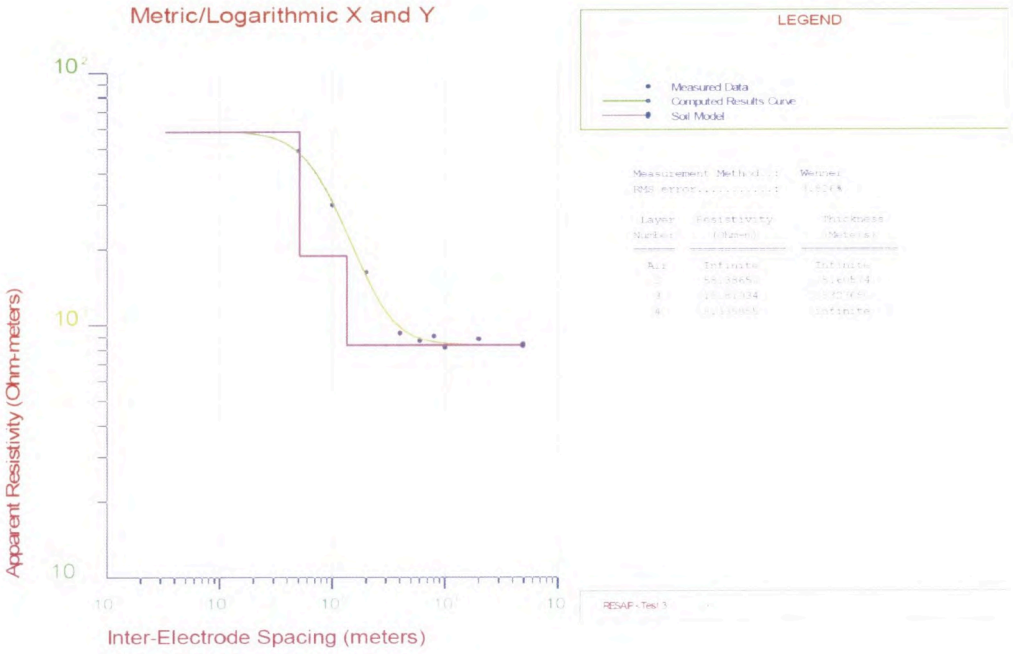
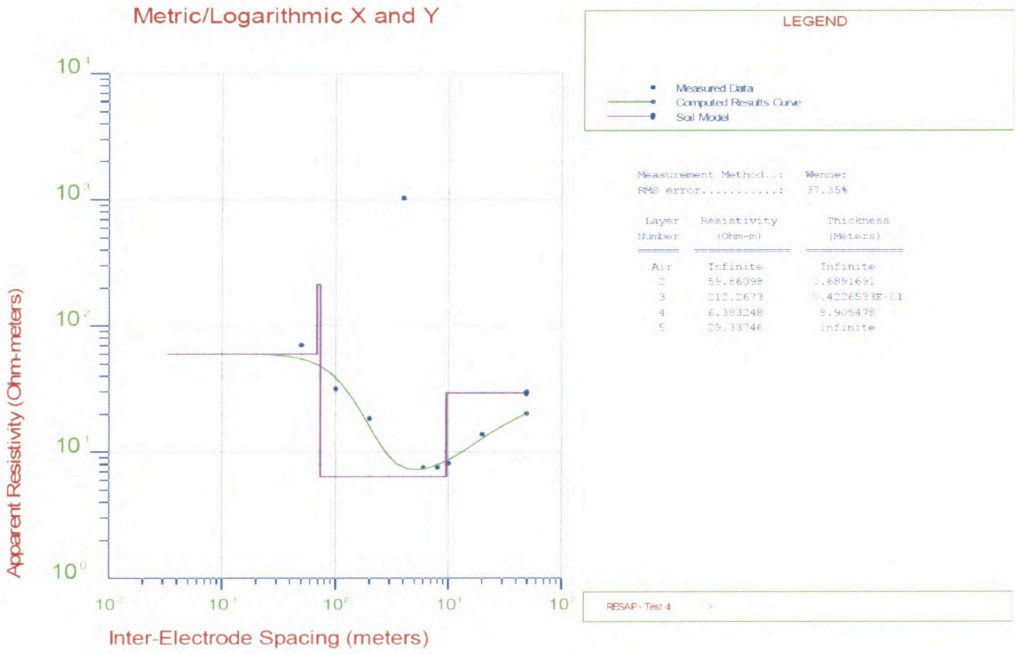


Figure 3: Soil resistivity model of Test 2



- **Figure 4: Soil resistivity model of Test 3**



- **Figure 5 Soil resistivity model of Test 4**

3. Fault Current Calculations and Protection Clearance Time

As advised by Endeavour Energy (dated 27 September 2011), the 11kV solid earth fault level at the point of connection between Sydney Water and Endeavour Energy is 3.502∠-71° kA.

Based on the earth grid model given in Figure 1 and the soil resistivity model, the resulting earth grid resistance is 0.68Ω.

Based on the site investigation (refer to Appendix B.2 and drawing 5292-E-1201), the water mains are believed to be bonded to the earthing system of the transformer compound – *this shall be confirmed by Sydney Water*. There are two cast iron mains leaving the pumping station to remote locations (refer to Appendix C). It is understood the cast iron mains do not have insulation coating and are direct buried in the ground. Thus, the cast iron mains effectively provide an earthing path for the pumping station. For the purpose of the earth grid design for the transformer compound, the effective earth resistance of the cast iron mains is assumed to be 1.0Ω.

Hence, the combined earth resistances of the transformer compound earth grid and the cast iron water mains is 0.40Ω. The loaded earth fault level is 3.208∠-60° kA. The EPR is 1283V.

As advised by Endeavour Energy (email dated 13 October 2011), the transformer compound is protected by 100A dropout fuse of ABB Class K. In accordance with the time-current characteristic of the dropout fuse (Appendix E), for a 3.208kA earth fault, the minimum pre arc time is 30ms. For touch and step voltage limits calculation, 100ms has been used as the protection clearance of the fuse.

4. Touch and Step Voltage Limits and Calculations

Touch and step voltage limits have been calculated in accordance with the methodology described in Appendix A of AS 2067:2008 by using ENA Argon software. The input data and the voltage limits are as follows:

- **Table 1: Input data and touch voltage limit for public access area – outside boundary fence**

	Value	Source
Fault frequency per year	0.2	Assume 10 faults/100km/year for 2km of unshielded overhead line
Fault duration	0.1s	As derived Section 3 above
Individual contacts per year	2000	Assume urban interface where people visit occasionally
Contact duration	4s	Assume typical touch contact duration
Footwear type	Standard	Assume standard footwear resistance
Surface soil resistivity	100Ωm	Conservative assumption – 50Ωm is less that the surface resistivity of 125Ωm
Probability of fatality target	$<10^{-6}$	Generally accepted target
Resulting touch voltage limit	620V	Refer to Appendix F for Argon output

- **Table 2: Input data and touch voltage limit for restricted access area – within boundary fence**

	Value	Source
Fault frequency per year	0.2	Assume 10 faults/100km/year for 2km of unshielded overhead line
Fault duration	0.1s	As derived Section 3 above
Individual contacts per year	200	Assume remote interface where people visit occasionally
Contact duration	4s	Assume typical touch contact duration
Footwear type	Standard	Assume standard footwear resistance
Surface soil resistivity	100Ωm	Conservative assumption – 50Ωm is less that the surface resistivity of 125Ωm
Probability of fatality target	$<10^{-6}$	Generally accepted target
Resulting touch voltage limit	1100V	Refer to Appendix F for Argon output

It should be noted that the above voltage limits have been derived based on the assumption that there will be no more than 30 people present on the site and the surrounding fence.

Figure 6 shows the ground surface EPR of the Cabramatta SPS under an earth fault condition. The applied potential to the earth grid is 1283V.

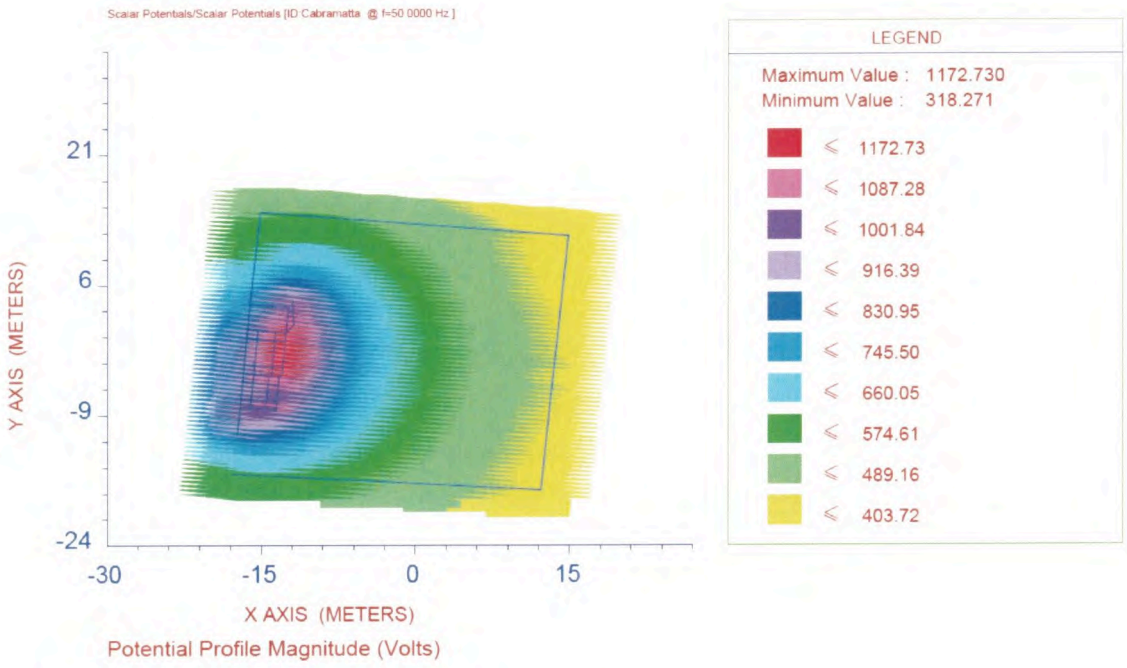
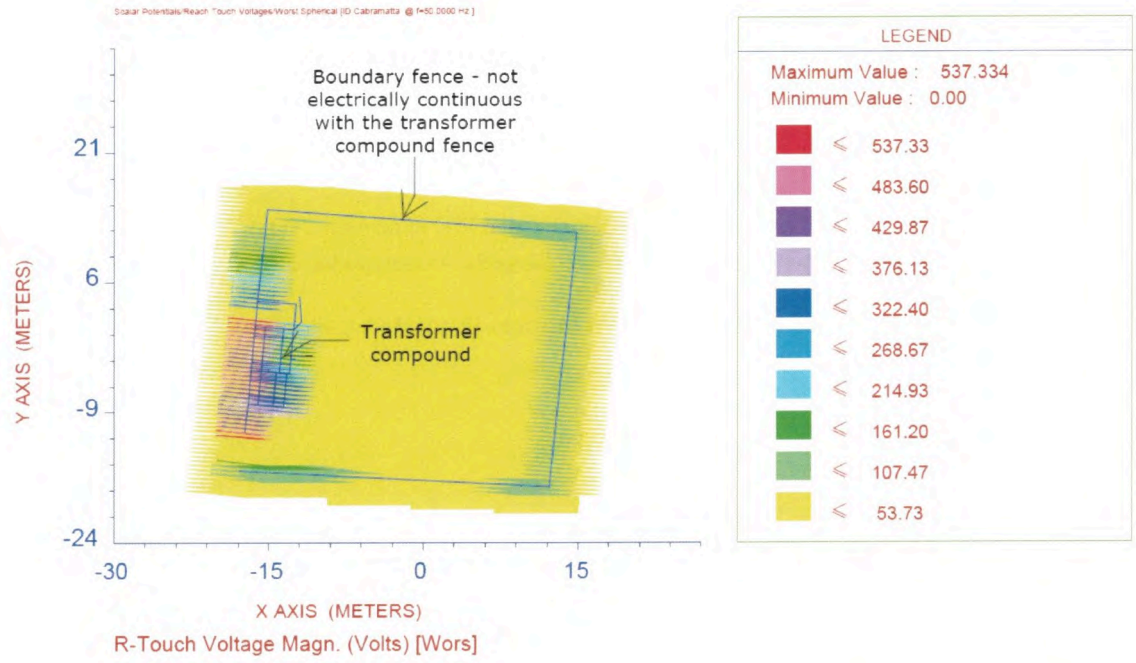


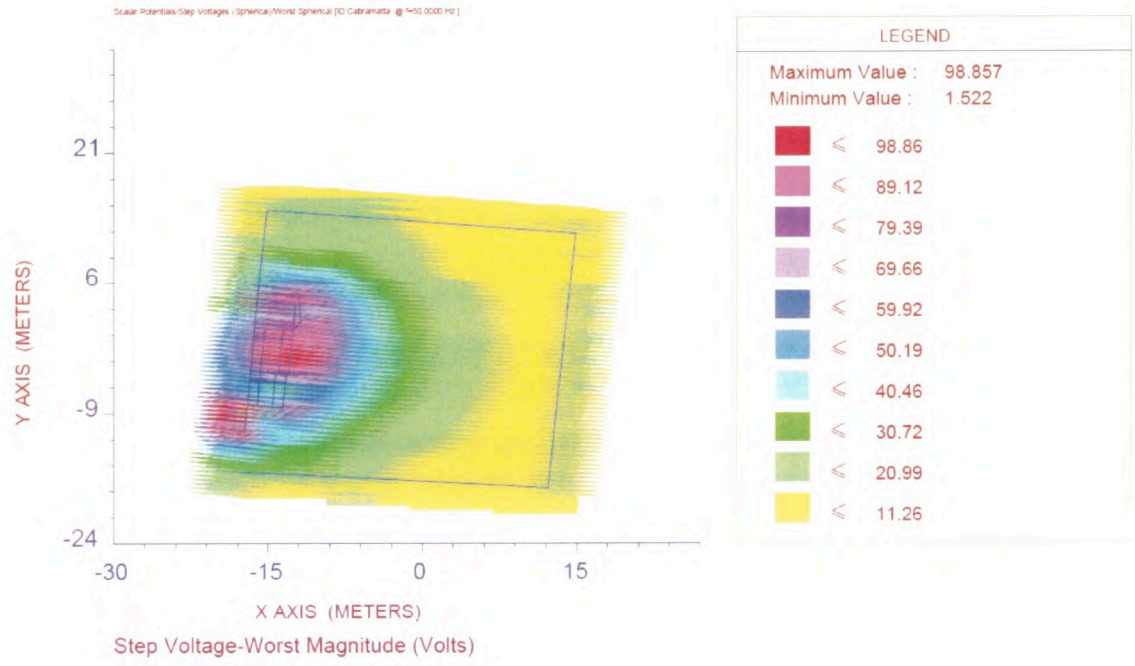
Figure 6: Ground surface EPR of Cabramatta SPS

The prospective touch voltages within the transformer compound and on the boundary fence are shown in Figure 7. The maximum prospective touch voltage is less that the allowed voltage limits for both public and restricted access areas – 620V and 1100V, respectively. There is no touch voltage hazard in accordance with AS 2068:2008.

The prospective step voltages of Cabramatta SPS are shown in Figure 8. The maximum prospective step voltage is 99V. The step voltage limit has not been derived in this report, but the step voltage limit is approximately 20 times higher than the touch voltage limit. Thus, there is no step voltage hazard in accordance with AS 2068:2008.



- **Figure 7: Prospective touch voltages of the transformer compound and boundary fence**

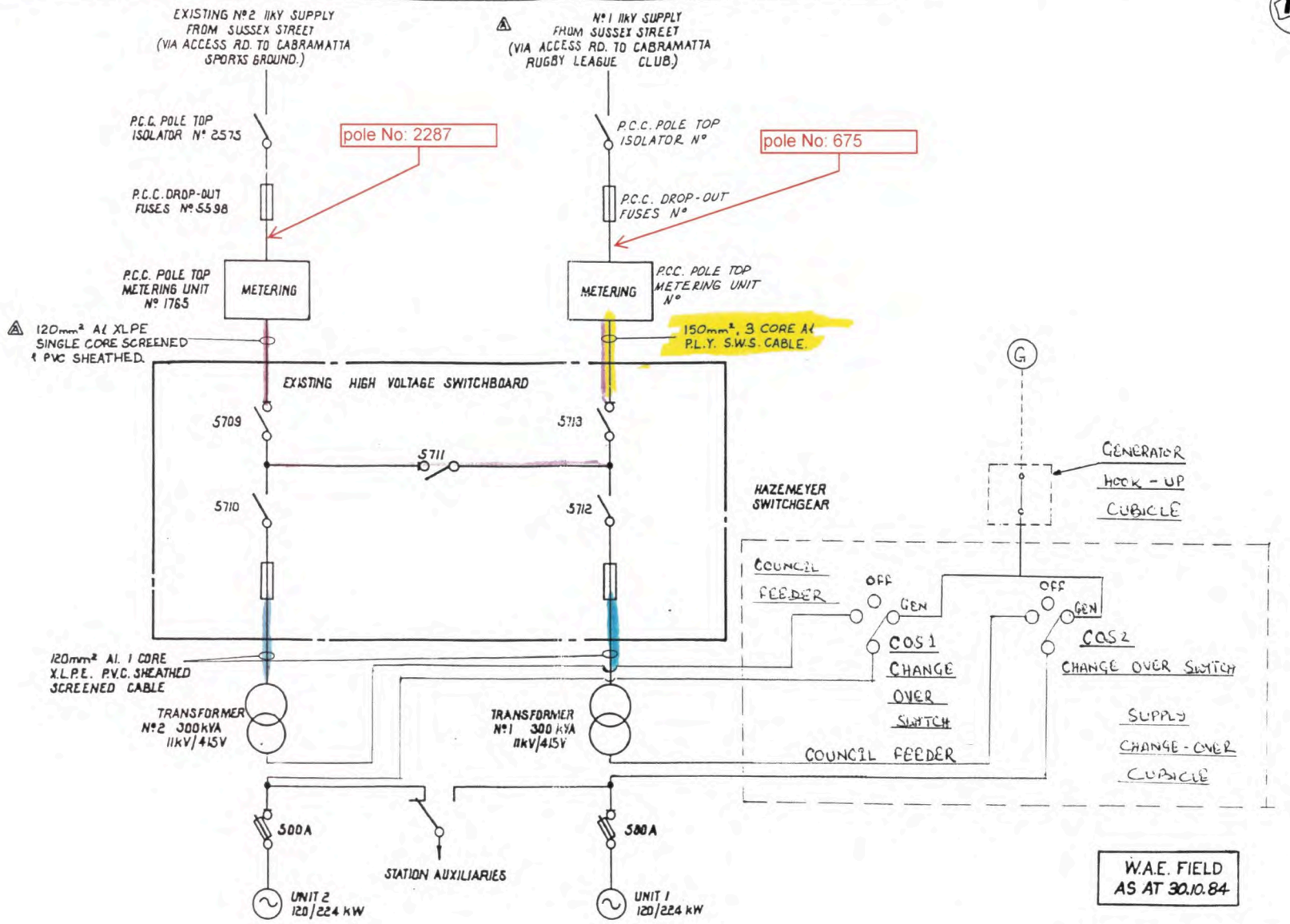


- **Figure 8: Prospective step voltages**

Appendix A Reference Drawings

Drawing No.	Descriptions
S187/6	SPS 187 Cabramatta Single Line Diagram
N/A	Site survey
SK001	General Arrangements and Reinforcement Details
33253	L.L.P.S No. 187 – Sussex Str – Cabramatta, Electrical Substation Reinforcement Details of Beam and Slap
5292-E-1201	Upgrade of SP018 Sussex St, LV Main Switchboard Three Line Diagram

DIMENSIONS IN MILLIMETRES | DO NOT SCALE | REPORT ANY ALTERATIONS AND CHECK FOR LATEST ISSUE WITH ELECTRICAL DRAWING OFFICE, HEAD OFFICE



ITEM	MATERIAL	No. OFF	LETTER	AMENDMENT	MADE BY	DATE	APPVD BY
			B	GENERATOR HOOKUP & SUPPLY CHANGE OVER CUBICLES ADDED	MG	23/11/83	
			A	W.A.E. FIELD	G.H.	30-10-84	31-10-84

DESIGNED: 17.11.83 A/ ENGINEER, DRAWING OFFICE
DRAWN: 4.12.81
CHECKED: 25.10.83. 23/11/83 ELEC. DESIGN & CONTRACTS ENGINEER
EXAMINED: 16.11.83 A/ 5/12/83 ASST. PRINCIPAL ENGINEER, ELECTRICAL
ENGINEER: 21.11.83 13/12/83 PRINCIPAL ENGINEER, ELECTRICAL

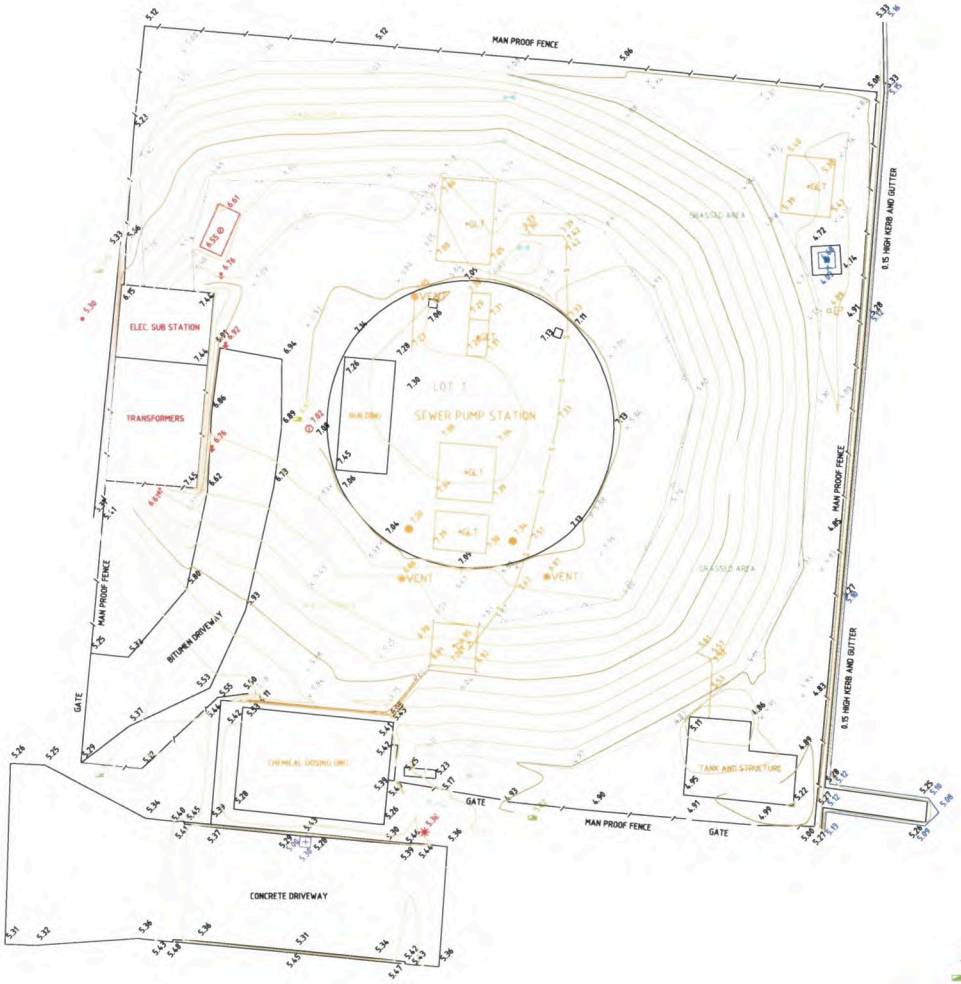
METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD

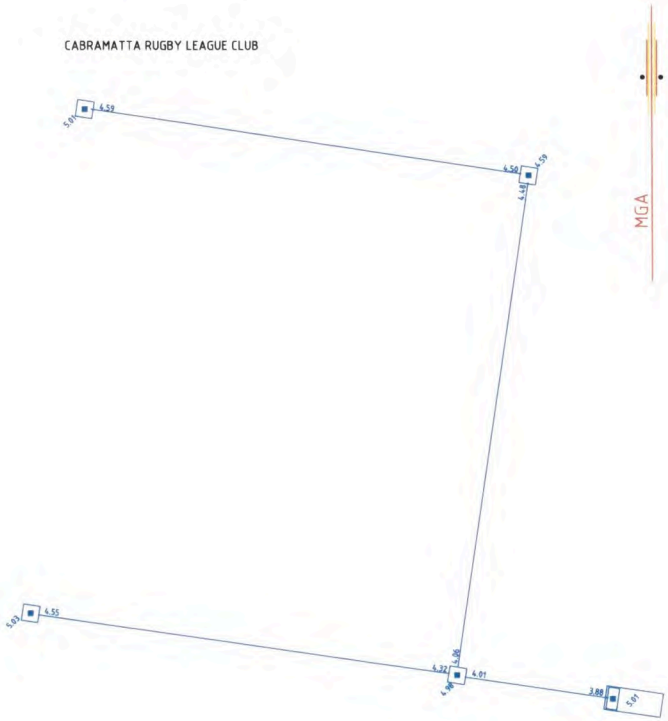
SPS 187 CABRAMATTA

SINGLE LINE DIAGRAM

SCALE | A2

ISSUE: A, B
ELECT. DWG. No. EE 5187/6
DESIGN BCH. DWG. No.





LEGEND

- COMMS JUNCTION BOX/PIT
- DRAINAGE SUMP
- ELEC EARTH STAKE
- LIGHT POLE
- ELEC MANHOLE
- POWER POLE
- SEWER INSPECTION OPENING
- SEWER MANHOLE
- GLT TRAP GULLY
- VENT SEWER VENT
- INVERT OF PIPE
- TREE
- HYDRANT PILLAR
- WATER SUPPLY MISCELLANEOUS
- WATER STOP / SLUICE VALVE

NOTES

- CONTOURS ARE AN INDICATION OF THE TOPOGRAPHY AND SHOULD ONLY BE USED FOR PLANNING PURPOSES. IF DETAILED DESIGN IS TO BE UNDERTAKEN, SPOT LEVELS SHOULD BE USED. SOME SPOT ELEVATIONS HAVE NOT BEEN SHOWN TO REDUCE CONGESTION AND OVERPRINTING. ALL SPOT HEIGHTS ARE AVAILABLE IN DIGITAL FILE.
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Date of Survey:	30/5/2011	Vertical Datum:	AHD SSM 36766 RL 4.237
CAD System:	AutoCAD	File No:	Cabramatta SPS.dwg
Drawn:	ASS		

REV	AMENDMENT	DATE	DRAWN	CHKD
A	PLAN ISSUED			

SCALE 1:150 @ A2
REV: A
DRAWING No: Cabramatta SPS.dwg

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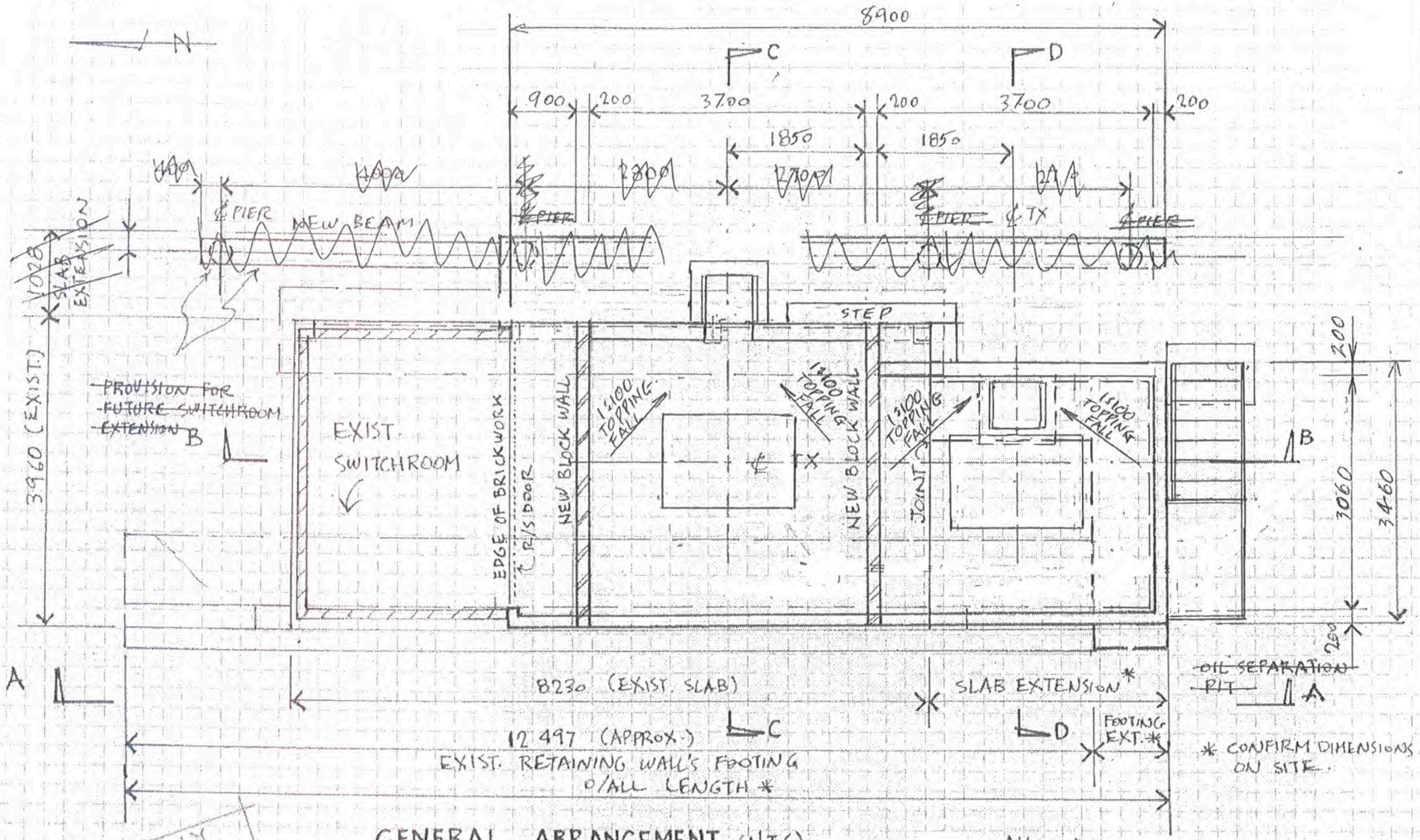
Switchboard: (02) 9928 2000
Facsimile: (02) 9928 2224

SKM

PLAN SHOWING DETAILS AND LEVELS
CABRAMATTA SEWER PUMP STATION
SPS187 - SUSSEX ST, CABRAMATTA

A2

Jun 01, 2011 - 8:38am D:\11 Jobs\WESROT\Cabramatta\Cabramatta SPS.dwg



GENERAL ARRANGEMENT (N.T.S.)

PRELIMINARY ONLY NOT FOR CONSTRUCTION

NOTES:
- FENCE & GATES ARE NOT SHOWN FOR CLARITY.
- DETERMINE SIZE & LOCATION OF OIL SEPARATION PIT.

ALLOW FOR:
- TREES REMOVAL & EARTHWORKS
- SUBGRADE PREPARATION
- CABLES PENETRATIONS IN EXIST. & NEW COMPOUND SLABS & CONDUITS.
- SEALING OF REDUNDANT PENERATIONS
- PENETRATIONS IN NEW SOUTHERN RET. WALL (AS REQ'D).

SKM Sinclair Knight Merz Pty Ltd ABN 37 001 024 095	PROJECT CABRAMATTA SPS 0187 TRANSFORMER COMPOUND UPGRADE	Prepared by / Checked by	Date 22/9/11 / Date	CLIENT TRANSFIELD SERVICES PROJECT N° EN02833-4153	TITLE GENERAL ARRANGEMENTS AND REINFORCEMENT DETAILS	DRAWING N° SK001 REVISION A3

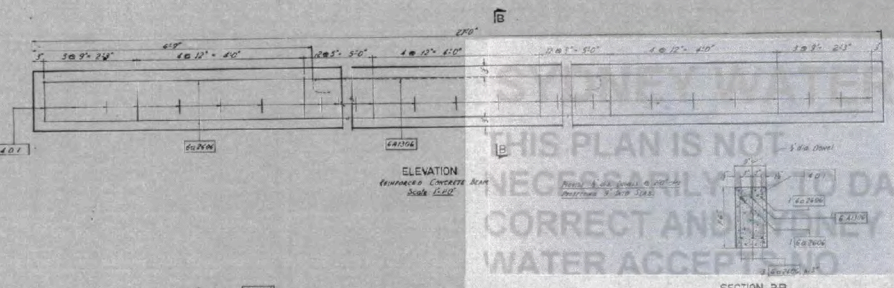
PHOTO SECTION

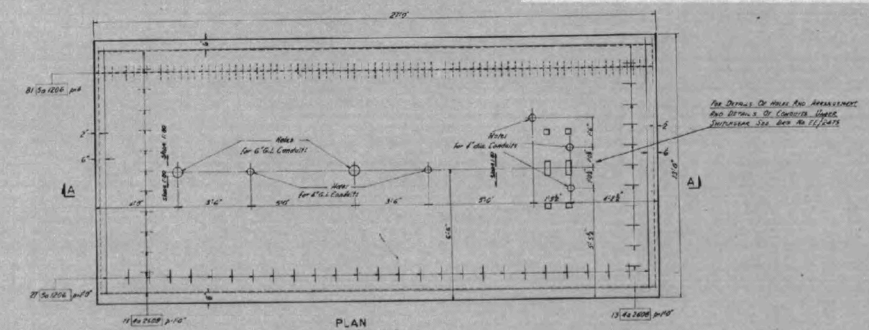
R.A

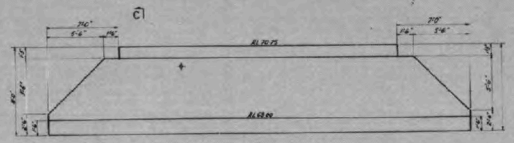
8 5 61

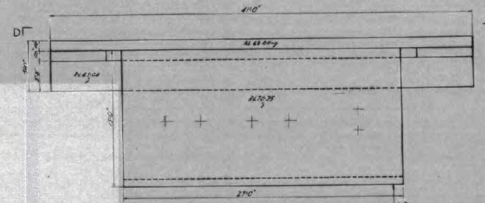
M.W.S.&D.B.

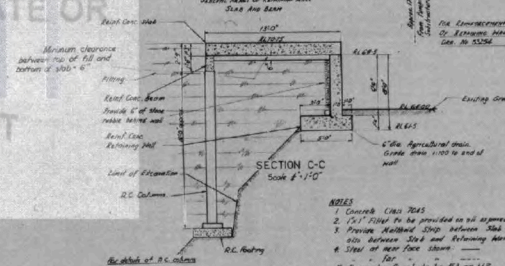
72











NOTES

1. Concrete Class 20/15
2. 1½" Fillet to be provided on all exposed corners
3. Provide Hessian Strip between Slab and Brass adh. between Slab and Retaining Wall
4. Steel at near face shown ——
   Far ——
5. Concrete Finish to be F3 or U2.
6. Provide blockouts for posts of chain wire Fence where required.

REFERENCE DRGS.

Arrangement of Station and Valve Chamber on S.B.
5971 — General Arrangement of Substation Steel List 2340
33254 — Reinforcement details of Retaining Wall
33329 — Electricity Substation & Valve Chamber Reinforcement Details of Foundations Steel List No. 2340

STORMWATER
THIS PLAN IS NOT NECESSARILY UP TO DATE OR CORRECT AND SYDNEY WATER ACCEPTS NO RESPONSIBILITY IN THAT REGARD.

METROPOLITAN WATER SEWERAGE AND DRAINAGE BOARD SYDNEY, N.S.W.

FAIRFIELD SEWERAGE
L.I.P.S. No 487 — SWARBS Dist. CABRAMATTA
ELECTRICITY SUBSTATION
REINFORCEMENT DETAILS OF BEAM AND SLAB

CONTRACT OR JOB No. W.S.&D.B. | DRG No. 42/3312 | SCALES As Shown
DESIGNED K.A.M. | DRAWN B.M.C. 10.64 | CHECKED M.A.B. 7.64 | DRG. No. 33253
SUPERVISED | CHECKED | SHEET No. | DRAWING No.

BASIS OF PREPARATION | ISSUED | DETAIL OF AMENDMENT | MADE BY | DATE

NOTES:

1. THE SWITCHBOARD SHALL PROVIDE FORM 3b SEGREGATION AND ARC FAULT CONTAINMENT, TYPE TESTED TO AS3439.1 ANNEX 'ZD' STANDARD TEST i.e. ARC INITIATED ON LOAD SIDE OF THE PROTECTIVE DEVICE.

2 THE SWITCHBOARD IS TO BE WIRED IN COPPER CABLES 2.5sqmm 0.6/1kV PVC FLAME RETARDANT 105°C MAX. TEMPERATURE RATING.

3. CASTELL KEY INTERLOCKS FOR Q1M, Q2M, Q3M & Q4M SHALL PREVENT THE OUT OF SEQUENCE OPENING/CLOSING OF THE CIRCUIT BREAKERS. CIRCUIT BREAKER Q1M SHALL ONLY BE ABLE TO CLOSE WHEN CIRCUIT BREAKERS Q2M & Q3M ARE OPEN OR WHEN Q2M &Q4M ARE OPEN, SUCH THAT WHEN BUS-TIE Q4M IS CLOSED ONLY ONE SUPPLY INCOMER (TRANSFORMER OR GENERATOR) CIRCUIT BREAKER CAN BE CLOSED.

4. CIRCUIT BREAKER Q4M CAN FIT BOTH KEY 'A' OR 'B'.

5. SWITCH SOCKET FOR PORTABLE PUMP OUTLET TO BE MOUNTED ON FRONT OF DISTRIBUTION DOOR.

6. THE CONTACT OF THE VOLTAGE MONITORING RELAY SHALL BE NORMALLY CLOSED WHEN THE SELECTED POWER SUPPLY IS HEALTHY & RETURN TO THE OPEN POSITION WHEN THE SELECTED SUPPLY FAILS.

7. PHASE SEQUENCE INDICATOR (P30) & FUSES TO BE MOUNTED NEAR THE MAIN SWITCHES.

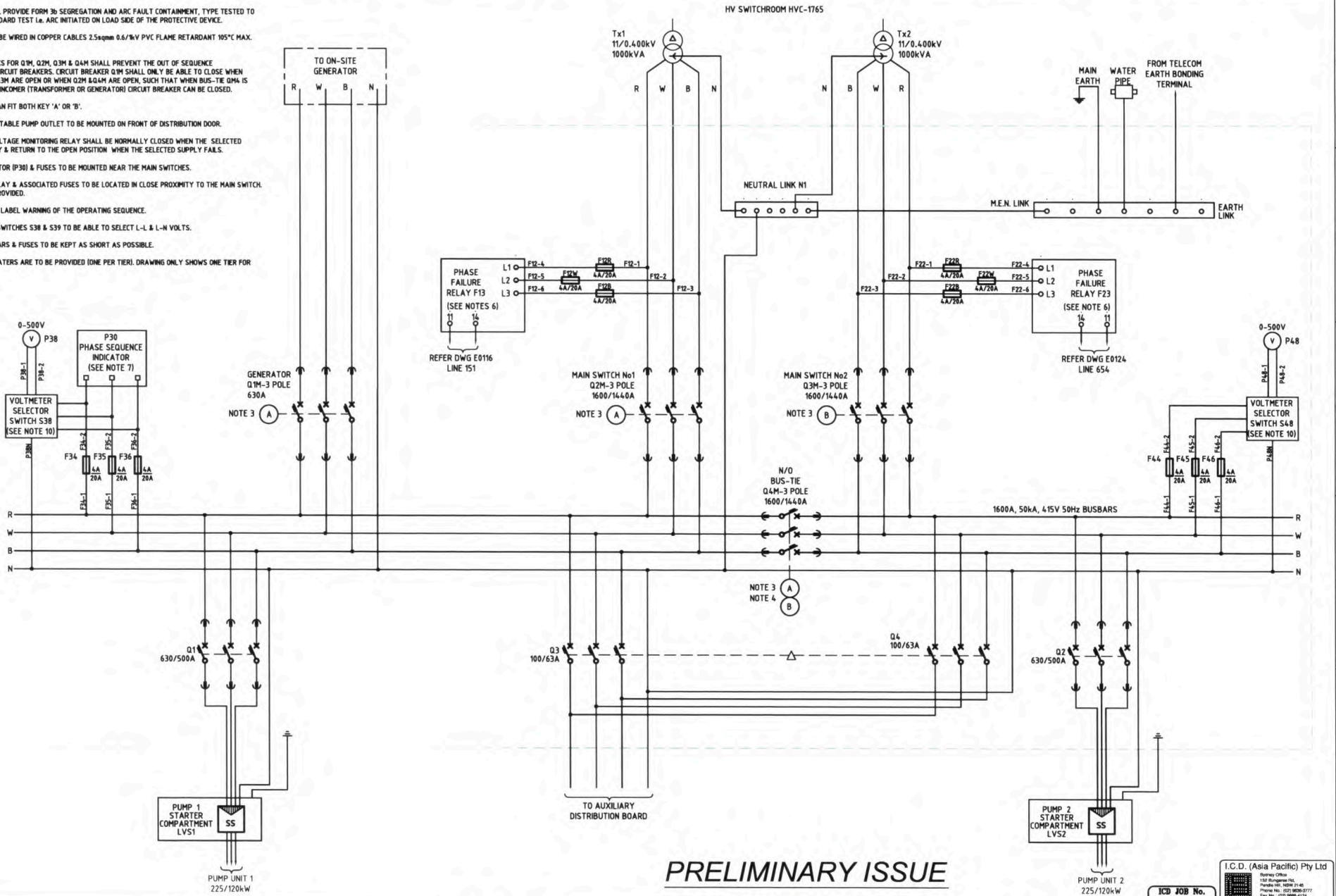
8.VOLTAGE MONITORING RELAY & ASSOCIATED FUSES TO BE LOCATED IN CLOSE PROXIMITY TO THE MAIN SWITCH. SAFE ACCESS SHALL BE PROVIDED.

9. MAIN SWITCH TO HAVE A LABEL WARNING OF THE OPERATING SEQUENCE.

10. VOLTMETER SELECTOR SWITCHES S38 & S39 TO BE ABLE TO SELECT L-L & L-N VOLTS.

11. CABLES BETWEEN BUSBARS & FUSES TO BE KEPT AS SHORT AS POSSIBLE.

12. ANTI CONDENSATION HEATERS ARE TO BE PROVIDED (ONE PER TIER). DRAWING ONLY SHOWS ONE TIER FOR CLARITY.



PRELIMINARY ISSUE

ICD JOB No. 5292

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Fax No.: (02) 9688-4124
E-Mail Address: icdeng@icdasiapacific.com.au

ISSUE	DETAIL OF AMENDMENT	DATE	ISSUE APP'D
1	PRELIMINARY	15/11/10	

DESIGNED NM 15/11/10 | DRAWN NM

ENDORSED | ACCEPTED | FILE No 5292-E-1201 | CONTRACT No

Sydney WATER

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SewerFix Pumping Stations Program
SP0187 - CABRAMATTA
UPGRADE OF SP018 SUSSEX ST
LV MAIN SWITCHBOARD THREE LINE DIAGRAM

SCALE NTS A3

ISSUE 1 | DRAWING NUMBER SP0187 5292-E-1201

A3

Appendix B Photos

B.1 Transformer Compound

B.2 415V Earth Link

Appendix C Sydney Water Map

DBYD Address:
Sussex St
Cabramatta NSW 2166

DBYD Job No: 371042

DBYD Sequence No: 22435747

Copyright Reserved Sydney Water 2011
No warranty is given that the information shown is complete or accurate.
SYDNEY WATER CORPORATION

Scale: 1:1500

Date of Production: 22/08/2011

Plan 2 of 3

0m 9m 18m 27m 36m

Appendix D Soil Resistivity Tests

Project: 4153 Cabramatta SP0187 Earthing System Assessment
Location: Cabrammata SPS (Oval opposite SPS)
Method: Wenner 4 Electrode Method
Test personnel: 1. Peter Yip
2. Nevin Zeng

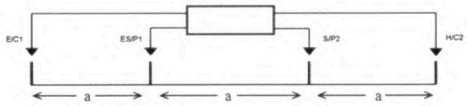
Project Number: EN02833.4153
GPS Coordinates:

Test date: 26/08/2011

Test Equipment: 1 Megger DET4TD

Calibrated: 23/08/2011

Calculations: Apparent Resistivity r (Ω.m) = 2 * π * a (m) * R(Ω)

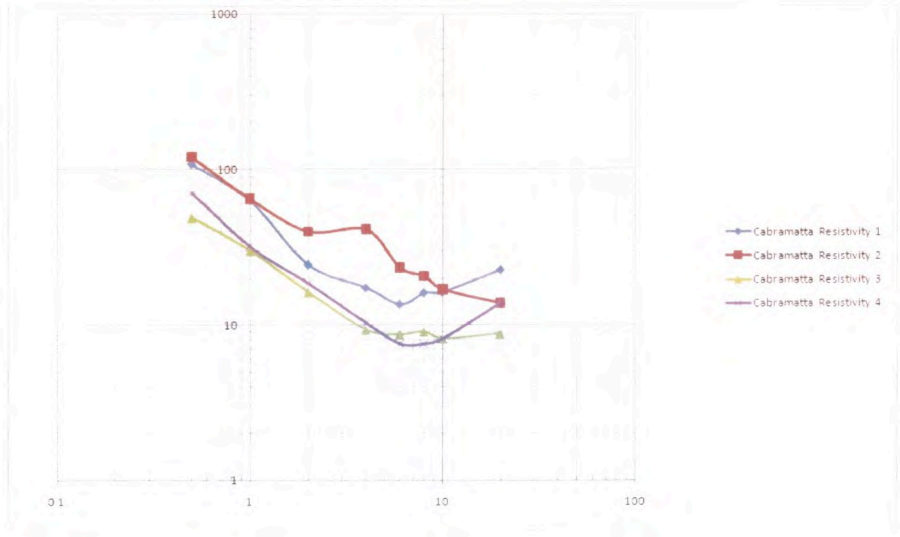


Test results:

a(m)	2πa (m)	Test 1		Test 2		Test 3		Test 4	
		Measured R(Ω)	Actual ρ (Ω.m)	Measured R(Ω)	Actual ρ (Ω.m)	Measured R(Ω)	Actual ρ (Ω.m)	Measured R(Ω)	Actual ρ (Ω.m)
20	126	0.18	23	0.11	14	0.07	9	0.11	14
10	63	0.26	16	0.27	17	0.13	8	0.13	8
8	50	0.32	16	0.41	21	0.18	9	0.15	8
6	38	0.36	14	0.62	23	0.23	9	0.2	8
4	25	0.69	17	1.64	41	0.37	9	0.41	10
2	13	1.94	24	3.18	40	1.29	16	1.47	18
1	6	10.02	63	10.32	65	4.77	30	5.07	32
0.5	3	34.5	108	38.3	120	15.57	49	22.5	71

Site conditions:

	Details
Temperature	20 degrees C
Weather on day	Sunny
Weather week	Clear
Grid diagonal (m)	9m estimate based on preliminary transormer yard size



Appendix E 11kV Dropout Fuse

PROLINK

High Performance Fuse Links
For Expulsion Dropout Fuses
Rated Voltage 12-36kV
Rated Current 2-100A
Medium Voltage

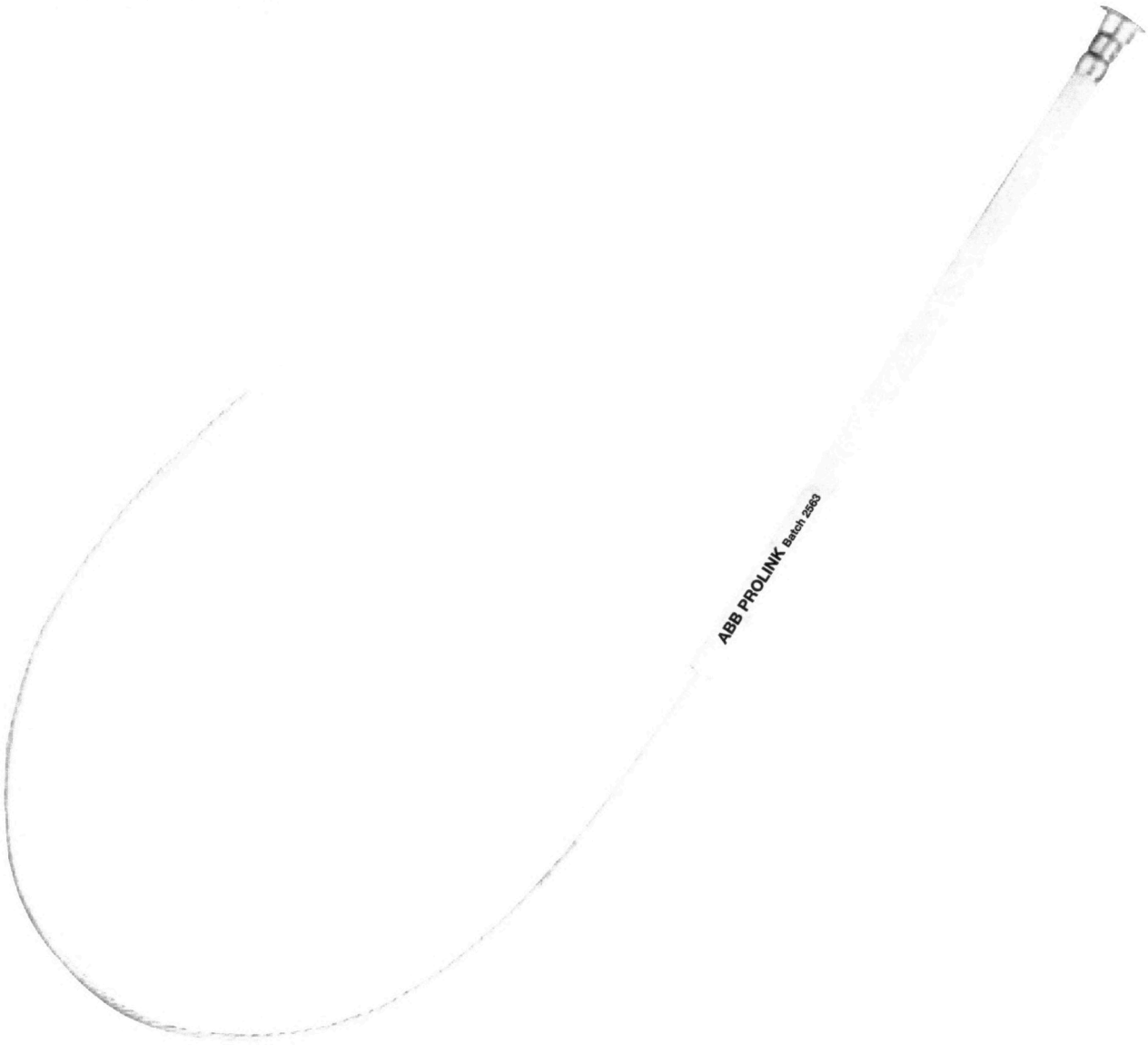


ABB Power Distribution

PROLINK

High Performance Fuse Links

FUSE LINKS

The ABB PROLINK high performance fuse links for use with expulsion dropout fuses, have been developed to meet the stringent requirements of International Standards specifications in respect of:

- emission of incandescent particles
- fault clearance in severe conditions of high TRV frequencies
- clearance of low or high values of fault current.

These fuselinks have been the subject of exhaustive investigations at 12, 24 and 36 kV, the result of which is:

- compliance with Spark Performance Category A to AS 1033-1 based on results of tests by various certified laboratories.
- wide use by supply authorities particularly in high fire risk areas.

A comprehensive range of current ratings is available in both class K (Fast) and class T (slow) types.

APPLICATION

ABB high performance fuse links may be fitted in most expulsion fuse units (or cutouts) to provide overload and short circuit protection of distribution lines and equipment. The superior interrupting performance of ABB fuselinks have been verified in ABB "V" series expulsion fuse. PROLINK fuselinks upgrade the performance of older fuse units, and, in particular, improve interruption at lower fault currents.

IMPORTANT NOTE

The "V" Series Expulsion Dropout Fuse when used with ABB PROLINK fuse links significantly reduces the risk of emission of incandescent particles. However, incandescent particles which may ignite combustible materials, such as dry grass, can be emitted occassionally. In such situations additional protection is available in the form of the ABB Emission Control Device (ECD).

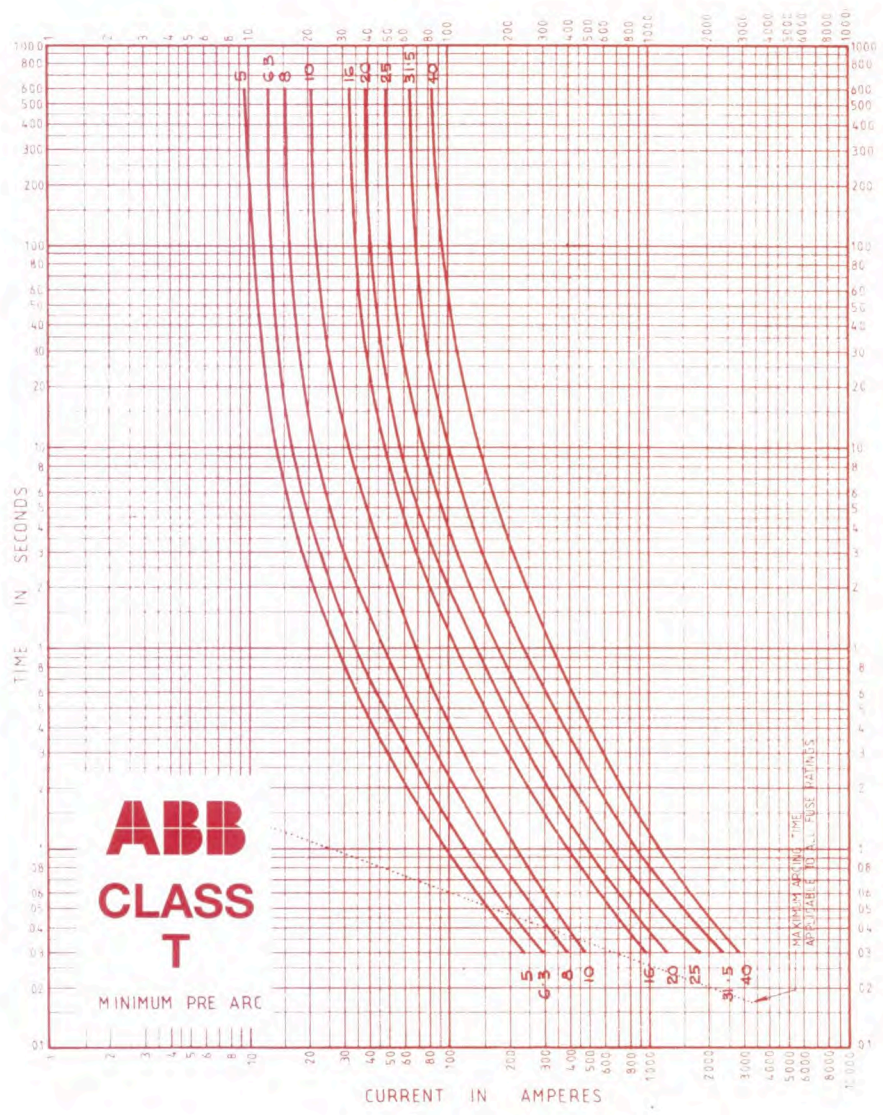
CONSTRUCTION

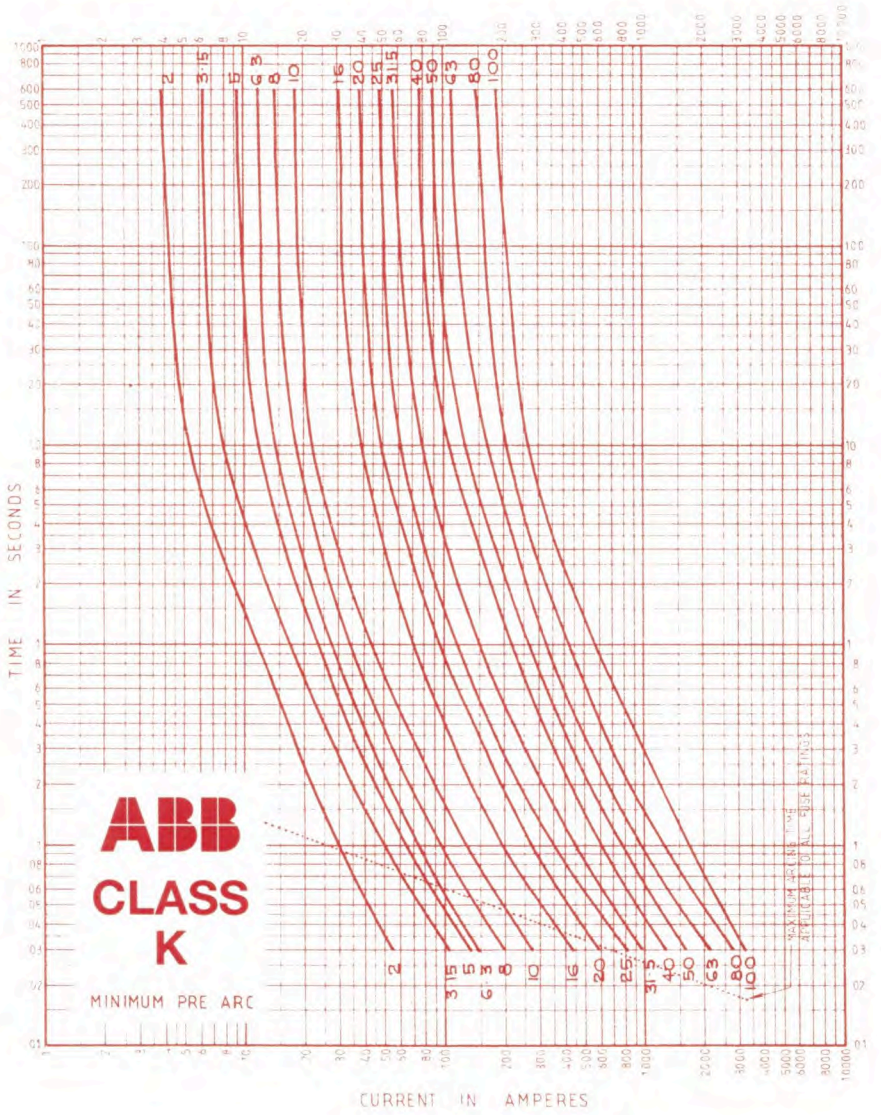
- Removable button head to allow the fuse to be used with expulsion dropout fuses incorporating an arc shortening rod for high fault current interruption duty.
- A low melting point alloy fusible element designed to vaporise during interruption to minimise emission of incandescent particles.
- Non-metallic strain cord providing fuse link tensile loadings of 70N min (static) and 130N min (shock).
- Element sheath provides improved interruption at very low currents and reduces generation and emission of incandescent particles.
- Auxiliary tube to confine gas pressure to effect expulsion during low current clearance as well as produce an arc quenching gas during high current clearance.
- Ferrules of suitable copper alloy selected to reduce generation of incandescent particles.
- Flexible tail insulating sleeve to reduce the voltage stress and prevent corrosion due to corona effect and to prevent wadding or bunching of flexible strands during expulsion and, therefore, ensure smooth ejection from auxiliary pressure tube.
- Flexible tail of tinned copper stranding having a minimum cross sectional area of 4.2mm^2 to reduce corona.
- Flexible tail end treatment to prevent fraying.

Table of Current Ratings Ampers

TYPE K	2	3.15	5	6.3	8	10	16	20	25	31.5	40	50	63	80	100
TYPE T			5	6.3	8	10	16	20	25	31.5	40				

Time/Current Curves
Prolink Fuselink



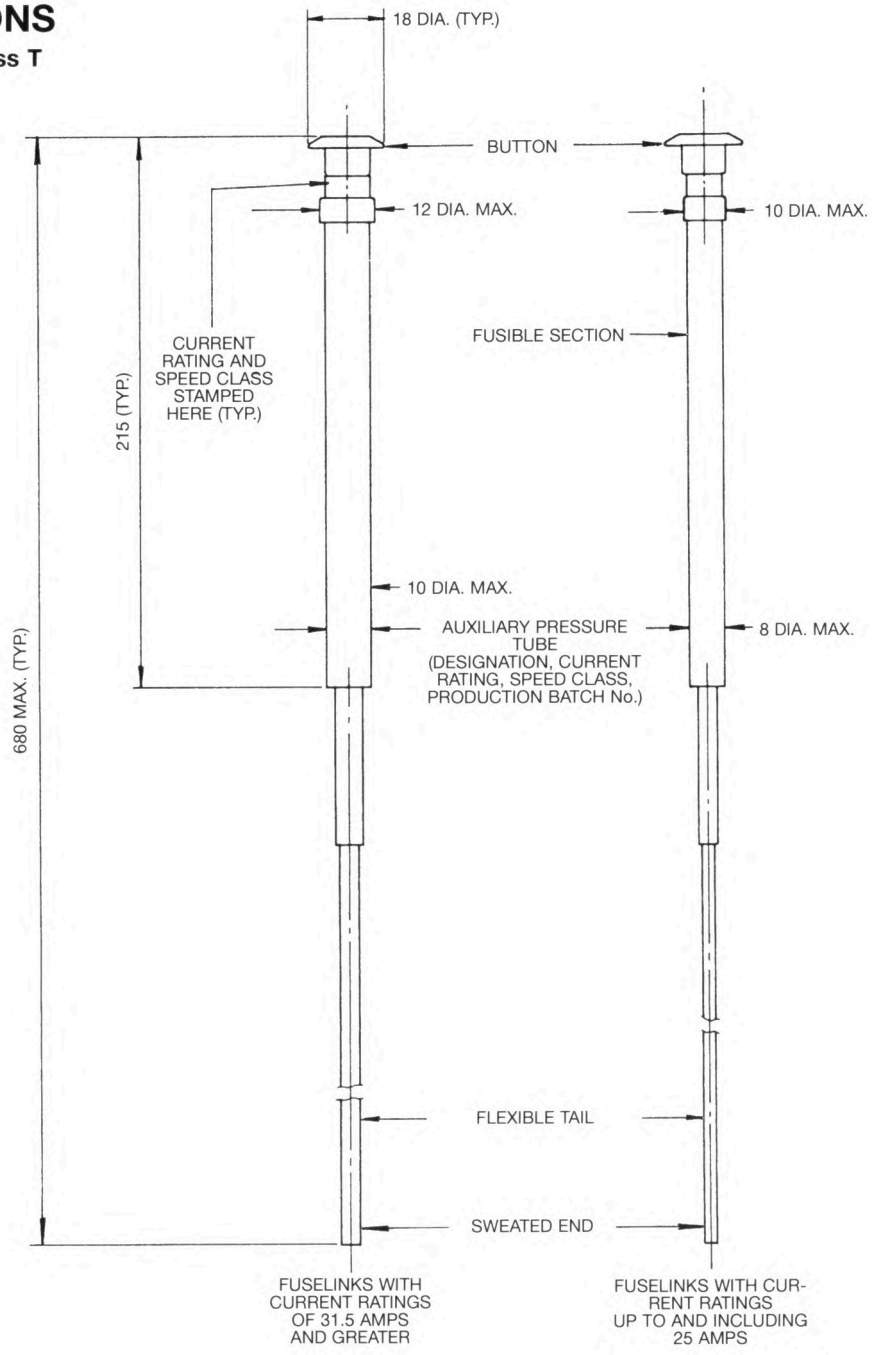


PROLINK

High Performance Fuse Links

DIMENSIONS

Class K or Class T



ALL DIMENSIONS IN MM

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Appendix F Argon Calculation Outputs

ARGON - SAFETY ASSESSMENT REPORT

Report Generated On : 26/10/2011

Report Generated By :

from : SKM

Design Location : Cabramatta SPS (Outside Boundary Fence)

INTRODUCTION

Individual Probability of Fatality

This report outlines the results of a risk-based safety criteria assessment study for the above location. The analysis is based on the fact that a fatality due to contact with an external voltage can only occur if both a person is present when a fault occurs and the touch (or step) voltage generated is sufficient to allow a large enough current to pass through the body for sufficient time to cause fibrillation of the heart muscle. The probability that an individual will be present and in contact with an item at the same time that the item is affected by a fault is defined as the Probability of Coincidence (Pcoinc). The probability that the heart will enter ventricular fibrillation due to contact with an external voltage is the Probability of Fibrillation (Pfibrillation) This situation can be described by the following simple equation:

$$P_{fatality} = P_{coinc} * P_{fibrillation}$$

The probability of coincidence has been calculated using contact and fault data as shown below. The probability of fibrillation has been calculated using the impedance and applied voltage / clearing time information as detailed below.

The calculation of the probability of fatality allows the design to be classified according to accepted risk targets (1e-6 to 1e-4) as either negligible risk, intermediate risk or intolerable risk.

Societal Probability of Fatality

For situations where more than one person may feasibly be present at any time, the individual process outlined above is modified slightly to allow for an altered societal probability of coincidence and hence probability of fatality to be calculated in accordance with accepted F-N curves. For societal probability of fatality, the targets are altered from the individual targets based on the frequency of occurrence of N or more deaths. This allows sliding scales to be defined which classifies the negligible, intermediate and intolerable risk zones for a given population size. A design curve can be defined over a range of clearing times which corresponds to the highest applied voltage in the negligible region for each clearing time.

Design Compliance

Designs with low risk determination are accepted and the attached design curve(s) may be used at locations with similar contact, fault and series impedance characteristics. Designs which are determined as high risk are not acceptable and there is no valid design curve available until mitigation results in a compliant design. Designs placed in the intermediate risk range may be considered compliant as a result of applying the ALARA (As Low As Reasonably Achievable) principle. For designs of this type, documentation is supplied at the end of this report outlining the justification.

The following information outlines the design assumptions and classifies the compliance of the design.

COINCIDENCE PROBABILITY

Access / Fault Assumptions

Scenario Name User Defined Assumptions

Description Enter Contact data as required

	Individual		*Societal* (population = 30)				
Contact Frequency	2000	*per Year*	2000	*ave / Year / Person*	**Fault Frequency**	0.2	
Contact Duration	4	*seconds*	4	*seconds*	**Fault Duration**	0.1	*seconds*

Coincidence Reduction

Coincidence Reduction Method None

Coincidence Reduction Factor 1

Individual Coincidence Probability = 5.2e-5

FIBRILLATION PROBABILITY

Assumptions

Current Path	Touch Voltage	
Footwear	Standard Footwear	
Wet / Dry ?	Dry	
Soil Resistivity	100	*ohm-m*
Applied Voltage	620	*volts*
Fault Duration	0.1	*seconds*

Surface Layer

Type	None	
Resistivity	0	*ohm-m*
Depth	0	*metres*
Flashover Voltage	Not Specified	*volts*

Fibrillation Probability = 0.019

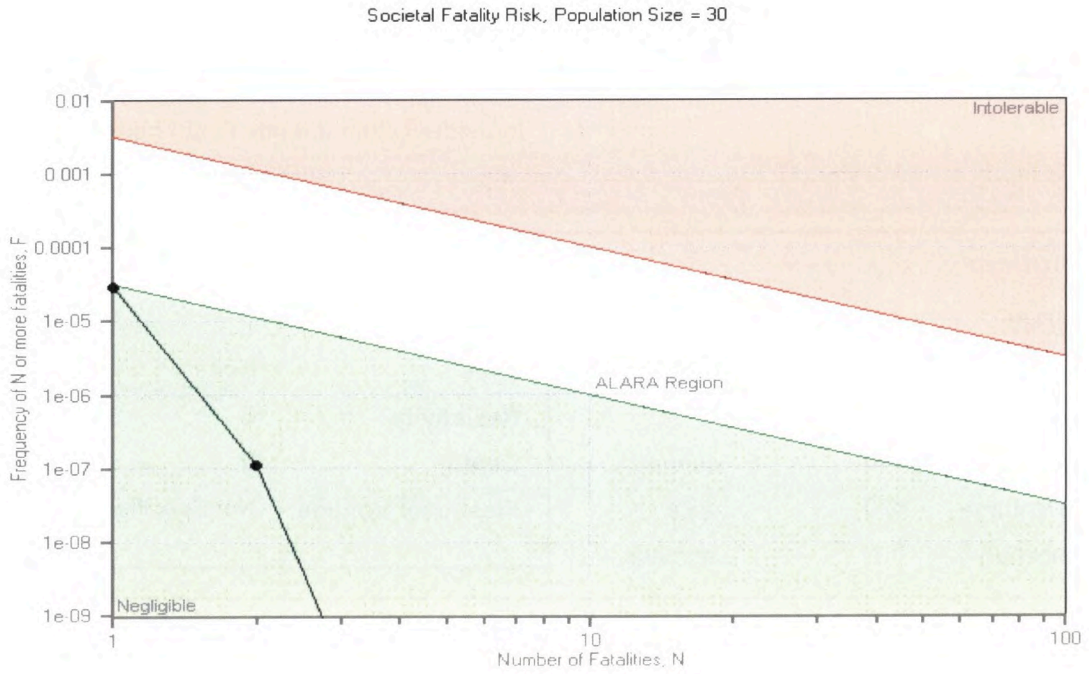
RISK DETERMINATION

Individual

Risk Zone : Negligible

Probability of Fatality = 9.93e-7

Societal



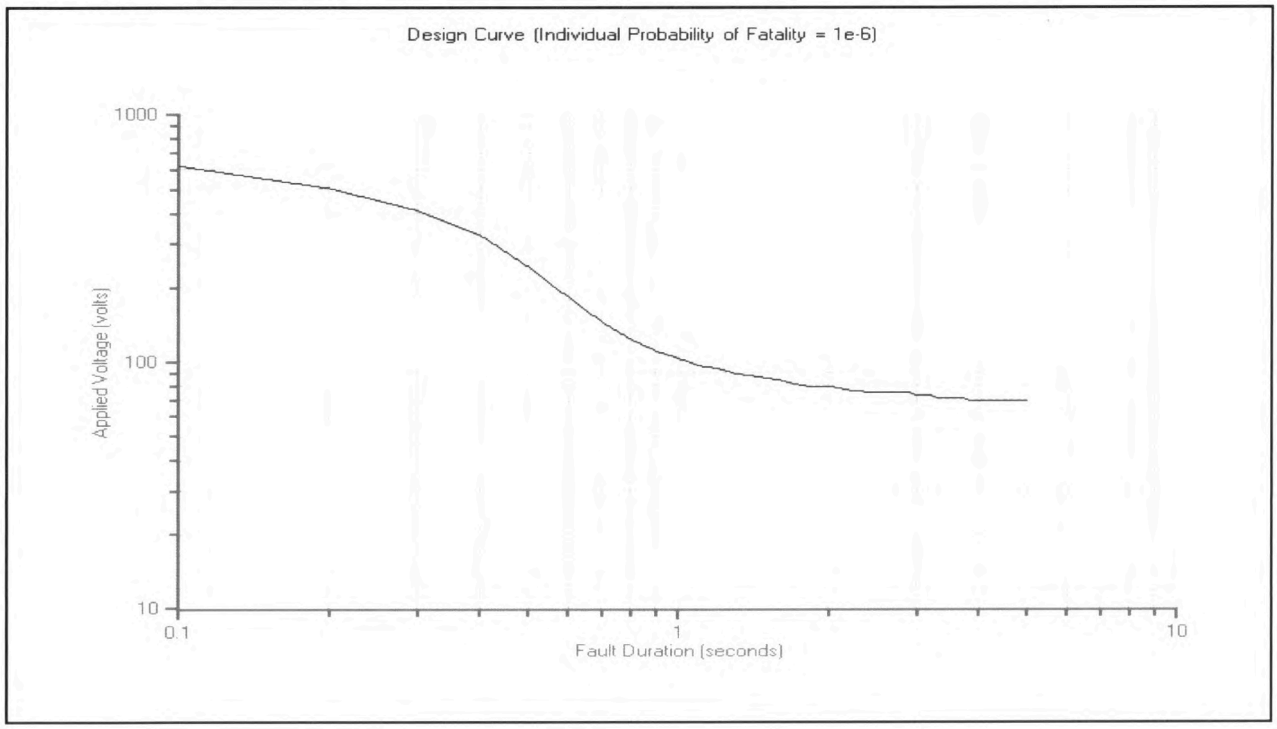
Worst Case Risk Zone

Risk Zone : Negligible

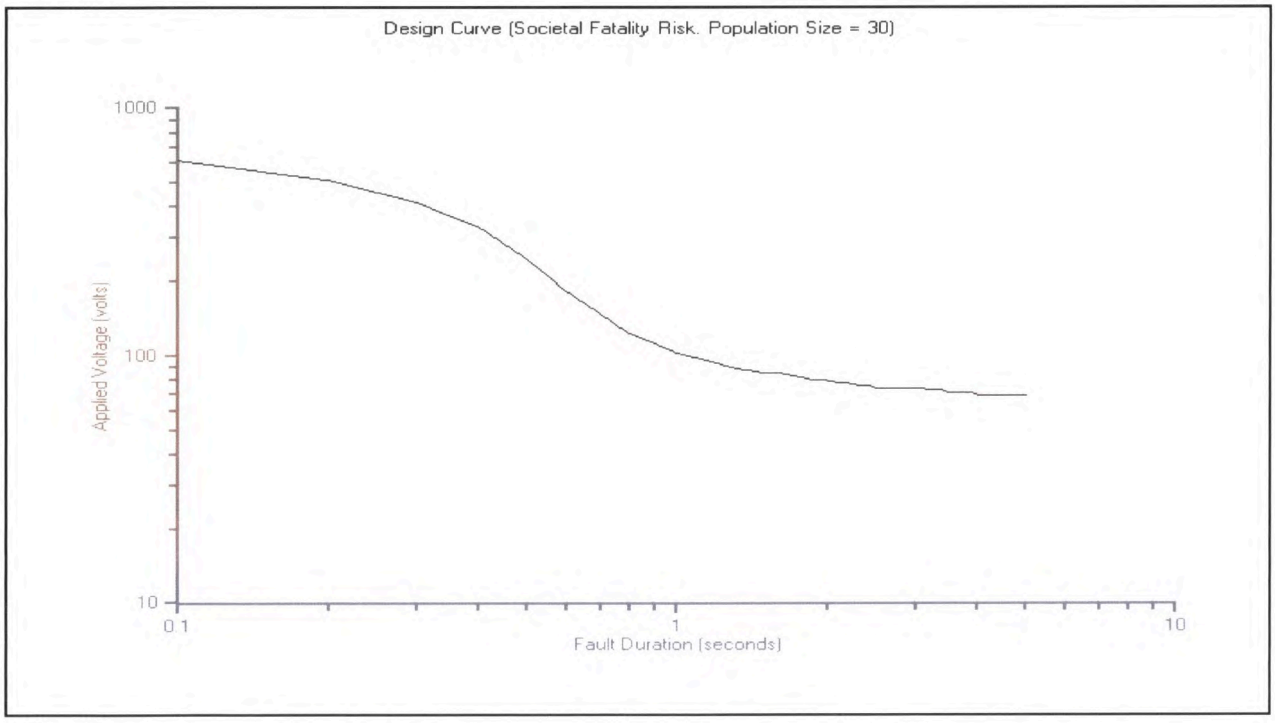
DESIGN CURVE

These curves are valid for designs which have contact, fault, and series resistance characteristics similar to those outlined in this report. Fault duration need not remain the same. Designs must be compliant with the most stringent requirements from the curves.

Individual



Societal



RISK MITIGATION COMMENTS

No additional mitigation comments provided.

SUMMARY

Based on the information supplied in this report, the design is considered to be **COMPLIANT**

ARGON - SAFETY ASSESSMENT REPORT

Report Generated On : 26/10/2011

Report Generated By :

from : SKM

Design Location : Cabramatta SPS (Within Boundary Fence)

INTRODUCTION

Individual Probability of Fatality

This report outlines the results of a risk-based safety criteria assessment study for the above location. The analysis is based on the fact that a fatality due to contact with an external voltage can only occur if both a person is present when a fault occurs and the touch (or step) voltage generated is sufficient to allow a large enough current to pass through the body for sufficient time to cause fibrillation of the heart muscle. The probability that an individual will be present and in contact with an item at the same time that the item is affected by a fault is defined as the Probability of Coincidence (Pcoinc). The probability that the heart will enter ventricular fibrillation due to contact with an external voltage is the Probability of Fibrillation (Pfibrillation) This situation can be described by the following simple equation:

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Description Enter Contact data as required

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Contact Frequency	200	*per Year*	200	*ave / Year / Person*	**Fault Frequency**	0.2	
Contact Duration	4	*seconds*	4	*seconds*	**Fault Duration**	0.1	*seconds*

Coincidence Reduction

Coincidence Reduction Method None

Coincidence Reduction Factor 1

Individual Coincidence Probability = 5.2e-6

FIBRILLATION PROBABILITY

Assumptions

Current Path	Touch Voltage	
Footwear	Standard Footwear	
Wet / Dry ?	Dry	
Soil Resistivity	100	*ohm-m*
Applied Voltage	1100	*volts*
Fault Duration	0.1	*seconds*

Surface Layer

Type	None	
Resistivity	0	*ohm-m*
Depth	0	*metres*
Flashover Voltage	Not Specified	*volts*

Fibrillation Probability = 0.162

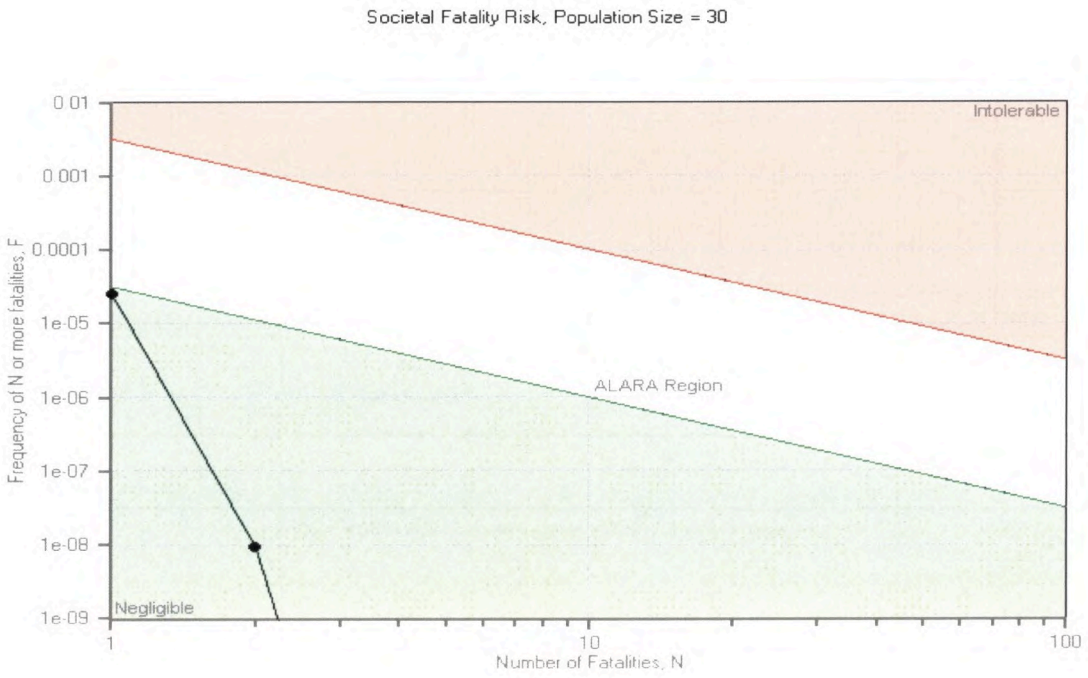
RISK DETERMINATION

Individual

Risk Zone : Negligible

Probability of Fatality = 8.43e-7

Societal



Worst Case Risk Zone

Risk Zone : Negligible

DESIGN CURVE

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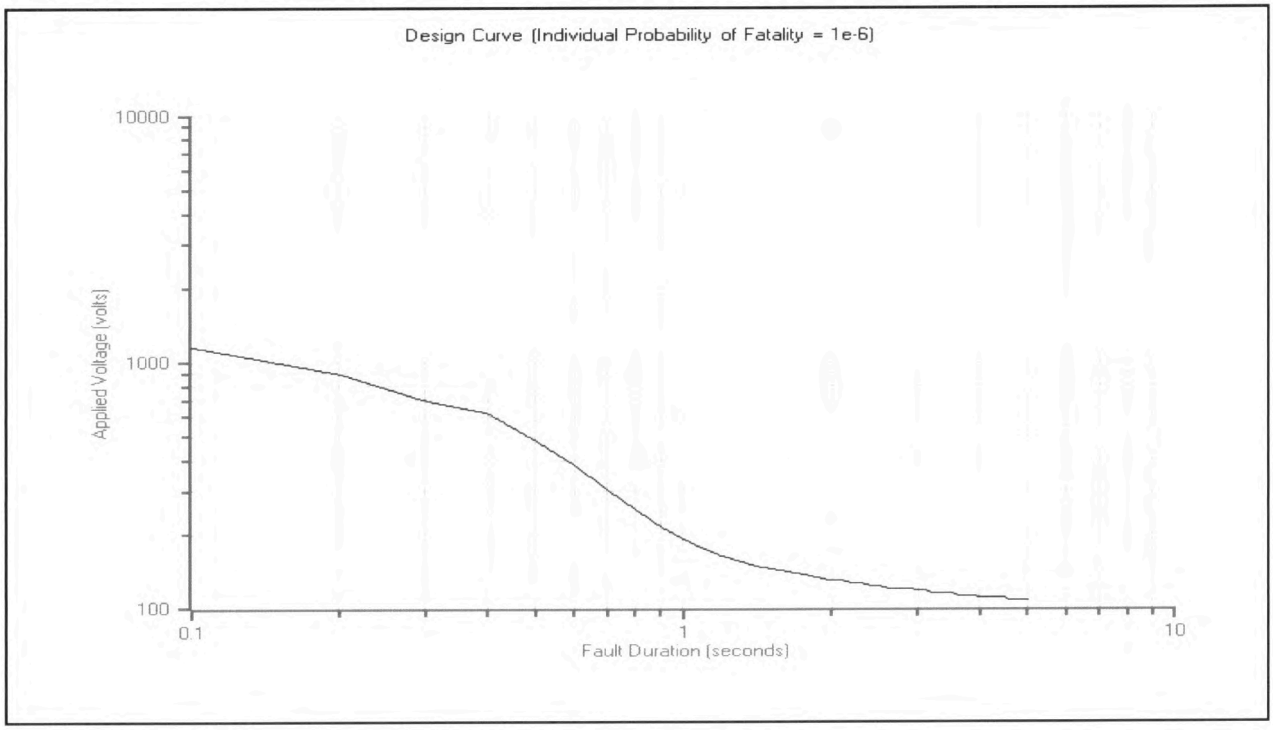
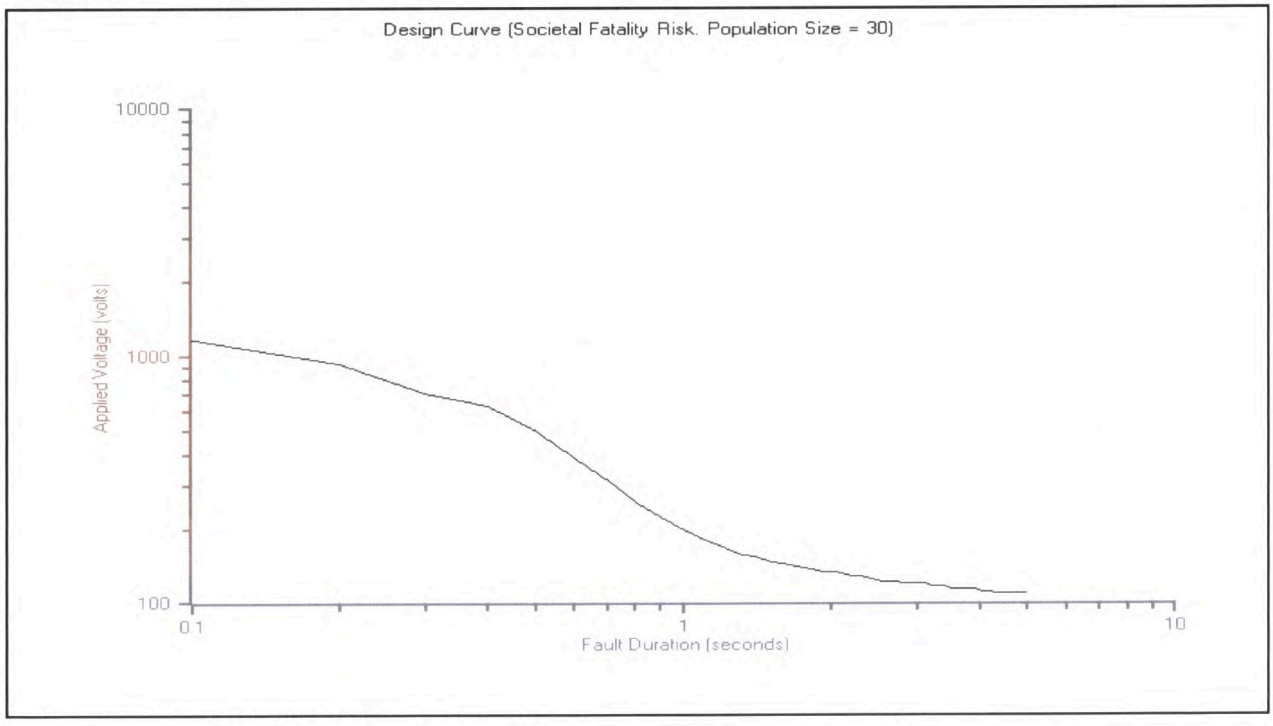
Individual



Societal



RISK MITIGATION COMMENTS

No additional mitigation comments provided.

SUMMARY

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