

Mains Maintenance Instruction

Maintenance of self-contained fluid-filled cables

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Mains Maintenance Instruction

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MMI 0033 Maintenance of self-contained fluid-filled cables

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1.0 PURPOSE

To specify the technical requirements for maintenance of self-contained fluid-filled (SCFF) cable systems currently installed in the Endeavour Energy underground transmission network.

2.0 SCOPE

This specification covers the required maintenance of Endeavour Energy's 132 kV SCFF cable systems including the routine testing to be carried out to assess and monitor the integrity of the cable's;

- main insulation / impregnating insulating fluid;
- outer sheath insulation;
- associated ancillary equipment including:
 - pressure gauges
 - alarms (electrical contacts)
 - pressure tanks
 - link boxes and sheath voltage limiters (SVL)

All SCFF specific maintenance requirements have been incorporated into this document. Where this documents conflicts with another internal standard, this document shall prevail. Significant inconsistencies should be referred to Network Mains Manager for resolution.

Endeavour Energy also has 33kV and 66kV SCFF cables currently installed in the network, however at this point in time the maintenance / testing requirements in this document are limited to those listed in Table 1.

3.0 REFERENCES

Internal

- Company Policy 9.9.1 – Network Asset Maintenance
- Company Procedure GSY 1031 – Endeavour Energy's Electrical Safety Rules
- Network Management Plan December 2013 Review
- Environment Management Standard EMS 0008 – Environmental Incident Response and Management
- Drawing 86203 – "Profile & Schematic of the Guilford to Camellia (Feeders 228, 233 & 93F/2) 132 kV Oil Filled Underground Cables"
- Drawing 86204 – "Profile & Schematic of the Guilford to Camellia (Feeders 93J/2B 9J8) 132 kV Oil Filled Underground Cables"
- Drawing 346042 – "William St Granville to Granville ZS 132kV Feeder 93J/2B & 226 Cable Rearrangement"

External

- ASTM D1500 – Standard Test Method for ASTM Color of Petroleum Products
- ENA National Electricity Network Safety Code (Doc 01-2008)
- IEC 60156 (1995) - Insulating liquids —Determination of the breakdown voltage at power frequency - Test method
- IEC 62021 – Insulating liquids - Determination of acidity
- IEC 60247 – Insulating liquids - Measurement of relative permittivity, dielectric dissipation factor (tan d) and d.c. resistivity
- IEC 60475 – Method of sampling insulating liquids
- IEC 60666 – Detection and determination of specified additives in mineral insulating oils
- IEC 60814 – Insulating liquids - Oil-impregnated paper and pressboard - Determination of water by automatic coulometric Karl Fischer titration
- Work Health and Safety Regulation 2011
- Work Health and Safety Act 2011

4.0 ABBREVIATIONS AND DEFINITIONS

Cross-bonded systems	A system that sectionalises the cable metallic screen along the route into minor sections and cross connecting them to approximately neutralise the total induced voltage over the major section.
DDF	Dielectric Dissipation Factor
DGA	Dissolved gas analysis
Major section	The section between two solidly grounded segments of a cable in a cross bonding system.
RGP	Residual gas pressure
SCADA	Supervisory control and data acquisition
SCFF	Self-Contained Fluid-Filled
SVL	Sheath voltage limiter
SS	Switching station
Stop joint	Cable joint installed between hydraulically isolated two cable sections of the circuit high
TDG	Total dissolved gasses
TS	Transmission substation
XLPE	Cross linked polyethylene
ZS	Zone substation

5.0 ACTIONS

5.1 Endeavour Energy SCFF asset information

5.1.1 General Information

All SCFF cables are insulated with impregnated paper however, unlike paper insulated non-drain solid cables, the impregnating compound used in SCFF cable is a low viscosity insulating fluid (such as mineral oil or synthetic oil). The insulating fluid is required to completely fill the entire cable circuit, including the joints and terminations of the SCFF cable circuit whilst maintaining a positive pressure at all points inside the cable circuit to remain functional.

The oil pressure inside the cable is affected by changes in the conductor temperature and ambient temperature due to the oil expanding and contracting. A pressure tank (oil reservoir) is connected to each phase (via either independent or common connections), of each section of cable and contains a number of gas-tight compressible metal bellows filled with inert gas immersed in a tank of the cables insulating fluid. When a rise in temperature causes an increase in the cable pressure, the oil is forced into the pressure tanks compressing the metal bellows. During a cooling cycle a contrary action takes place and the oil is forced back into the cable by the compressed gas in the pressure tank.

The static pressure at any point in a fluid filled cable system will depend upon the feed points tank pressure and hydraulic head at that point, which is a result of the variation in the route profile. The pressure tanks are manufactured to operate within particular pressure ranges, with the gas in the bellows generally fluctuating between 1.5 and 3 atm.

The pressure tanks and oil gauges are installed at sealing ends (termination) and Stop Joints along the cable circuits. The pressure tanks connected at sealing ends inside substations are plinth mounted above ground and the tanks connected to stop joints are installed in the ground, however the oil connections are brought into accessible

underground chambers at locations on the road side of the cable route near the connected joint bay. Underground pits may be considered as a confined space.

In order to keep the oil pressures within acceptable limits, the route is divided into one or more self-contained hydraulic sections by the means of stop joints. A stop joint contains a barrier plate which provides complete hydraulic isolation between the adjacent cable sections while permitting electrical continuity of the cable cores. The location of the stop joints and operating pressure of the oil reservoirs are designed to achieve the desired positive pressure inside the cable at all times.

5.1.2 General Requirements of SCFF Cables

The location of the pressure tanks, oil gauges and stop joints can be identified via the information provided Annexure 5.

The cables shall never be disconnected from their normal oil supply (reservoirs/pressure tanks) before an alternative uninterrupted oil supply has been connected. The breaking and making of any oil connection shall be carried out in manner that prevents air entering the system.

All oil sampling, testing and condition assessments requiring access to link boxes will be required to be conducted under outage conditions. Therefore all tests shall be coordinated so that the circuit outages are minimised as far as possible.

All leaks identified greater than 5 Litres per day shall be reported to Endeavour Energy's Network Mains Manager and an Environment Incident shall be raised as per the requirements of EMS 0008 - Environmental Incident Response and Management.

5.1.3 SCFF cable details

The 132 kV SCFF cables currently installed in Endeavour Energy's network are listed in Table 1. A schematic drawing, geographic representation and oil profile of these cable circuits can be found in Annexure 1, Annexure 2 and Annexure 6 respectively.

The SCFF cables are oil impregnated paper insulated single cores with an oil duct in the centre of the stranded copper conductor. The SCFF cables within Endeavour Energy's network have been supplied by two different organisations BICC and Furukawa.

The BICC cables have been in service for approximately 45 years whilst the Furukawa cable circuits have been in service for approximately 38 years.

Also the BICC cables have a lead sheath whereas the Furukawa cables have a corrugated aluminium sheath. All the cables are protected by an extruded PVC serving with graphite coating on the outer surface of the serving.

A cross sectional drawing of the BICC 0.65 in², 1.0 in² cables are provided in Annexure 3 and the Furukawa 430 mm² cable in Annexure 4. No drawing is currently available for the BICC 0.55 in² cable at this point in time, however its construction is generally the same as the BICC 0.65 in² and 1.0 in² cables identified.

The cables metallic screens have generally been cross bonded with modifications made during the building of Granville ZS and East Parramatta SS.

The details provided in Table 1 are sourced from the Endeavour Energy Transmission Network Characteristics Report (April 2015) and the original design drawings and therefore may need onsite verification due to the age of the information.

Table 1: 132 kV SCFF cables installed in the Endeavour Energy network

Feeder Number	From	To	Cable Description (SCFF sections listed only)	Oil Filled Cable Length (km)
226	Camellia TS	Granville ZS	430mm ² Cu 1C Furukawa	3.03
22U	Guildford TS	Granville ZS	430mm ² Cu 1C Furukawa	7.57
228	Guildford TS	East Parramatta SS	0.55in ² 1C BICC 3	6.84
			0.65in ² 1C BICC 1	0.27
			1.00in ² 1C BICC 2	0.14
233	Camellia TS	East Parramatta SS	0.55in ² 1C BICC 3	2.12
9J8	Guildford TS	Camellia TS	430mm ² 1c Furukawa	10.58
22W	Guildford TS	Camellia TS	0.55in ² 1C BICC 3	9.63
			0.65in ² 1C BICC 1	0.27
			1.00in ² 1C BICC 2	0.14

5.1.4 Ancillary equipment

The cable system also consists of a variety of ancillary equipment that is required to allow the cable system to function as originally designed. At each “Oil Sampling Point” location listed in Annexure 5, the following ancillary equipment (unless otherwise indicated) is located:

- oil pressure tanks;
- oil pressure gauges;
- electrical contacts / alarms; and
- valves.

Pressure gauges are fitted to the feed points (such as stop joints and terminations) in each hydraulic section to provide visual indication of the pressure in the oil section and also to transmit alarms in the event of decreasing oil pressure.

Feeders 228, 22W and 233 (supplied by BICC) have a single pressure gauge and single stage alarm system for all three phases at various stop joints and sealing ends along each feeder.

Feeders 22U, 226 and 9J8 (supplied by Furukawa) have a pressure gauge and three stage alarm installed on each phase of these circuits at various stop joints and sealing ends along each feeder.

None of the assets currently have the capability to be remotely monitored and/or have pressure values transmitted.

The copper piping connecting the oil tanks/gauges to the joint and terminations of the cable circuit are insulated from the ground to allow sheath testing.

5.2 Testing Requirements

The primary intent of the following testing requirements is to provide a clear overview of the SCFF cables current and ongoing performance to guarantee sufficient information is collected to make appropriate decisions on the future maintenance, repair options and replacement of the asset.

Endeavour Energy will consider any alternative proposals to that described below if it can be demonstrated that the proposed changes to the test(s) provides an equal or greater level of assessment / knowledge of the asset whilst providing other technical, safety or financial benefits.

The following tests on the SCFF cable circuit and accessories shall be carried out at the intervals specified in the relevant clauses. All results / reports are to be submitted electronically to Endeavour Energy's Network Mains Manager no longer than two weeks after completion on the test / inspection.

When sampling oil, no air shall enter the oil circuit under any circumstances. Procedures shall be provided to demonstrate the work methods proposed are capable of meeting this requirement.

5.2.1 Oil sampling requirements

Oil samples shall be taken at each of the following locations along each of the cable circuit(s):

- Oil Pressure Tanks
- Cable Terminations
- Transition & Feed Joints
- Stop Joints (both sides of the joint)

In addition to performing an oil sample at each of the above locations an additional oil sample is to be taken from within the cable itself, as and when requested by Endeavour Energy's Network Mains Manager.

Oil sampling shall be taken from the pressure tanks, terminations and all transition, feed and stop joints prior to any sampling being taken from the cable. This is to make sure the oil samples from the cable accessories are the oil that has been in these locations since the previous tests.

For the purposes of taking an oil sample from the cable, the oil shall be extracted (via the sampling point at the cable accessory) until such time that the predefined volume of oil has been extracted and the oil sample represents oil from the cable and not the accessories. Information detailing the volume of oil / calculations used to obtain this volume of oil shall be submitted for review by Endeavour Energy's Network Mains Manager prior to sampling.

A list of locations that are required to have oil samples are provided in Annexure 5 for each feeder. Due to the age of the information available any deviations / errors found in the data shall be communicated to Endeavour Energy's Network Mains Manager for clarification prior to continuing oil sampling / testing.

Prior to any work being conducted in a pit, all water and organic material (on top and within) shall be removed.

Each oil sample shall be tested as specified in Clause 5.2.2.

5.2.2 Oil Testing

The required tests and testing intervals for each oil sample are specified below:

Table 2: Tests on insulating oil.

Test		Units	Frequency	Test Method	
Residual gas pressure (RGP)		torr	Annually	-	
Dissolved gas analysis (DGA) - Hydrogen (H₂) - Methane (CH₄) - Acetylene (C₂H₂) - Ethylene (C₂H₄) - Ethane (C₂H₆) - Carbon monoxide (CO) - Carbon dioxide (CO₂) - Oxygen (O₂) - Nitrogen (N₂) - Total (TGA)		ppm	Annually and if RGP is ≥ 30 torr	-	
Resistivity*	at 30°C	GΩ.m	Annually	IEC 60247	
	at 60°C				
	at 90°C				
Breakdown voltage		kV		IEC 60156	
Dielectric dissipation factor * (DDF)	at 30°C	—		Annually	IEC 60247
	at 60°C				
	at 90°C				
Colour	-				ASTM D1500
Acidity (Neutralisation)	mg KOH/g				IEC 62021
Viscosity at 40°C	mm²/s				ISO 3104
Water content		ppm	IEC 60814		
Total dissolved gasses (TDG)		ppm	IEC 60475		
PCB (polychlorinated biphenyls content)		Wt%	Initial Test Only		IEC 60666

*Oil tests that are required at multiple temperatures (resistivity and DDF) shall have the samples physically heated to these values for the test and not theoretically adjusted.

5.2.2.1 Oil Testing - Reporting Requirements

All oil test reports shall be provided in an agreed upon electronic format (e.g. Excel file) to the Network Mains Manager at the completion of the testing of each feeder. In addition to the results to each test mentioned above (in Table 2) the following information is also required to be submitted:

- Date / Time of Oil Sample
- Oil temperature at the time of sampling
- Feeder Number
- Asset Type (e.g. oil pressure tank, feed joint, stop joint, termination etc.) and the oil section identified
- Physical location of oil sample (e.g. joint # 2/3)
- Which side of the stop joint the sample has been taken (if applicable)
- Volume of oil extracted prior to sample (cable oil sample only)
- Phase (if applicable)
- Type, model, serial number and calibration date of the of the apparatus used for the measurement / testing

5.2.2.2 Oil Testing – Evaluation Requirements

The following details at a minimum shall be provided to the Network Mains Manager before any work commences:

- Equipment available to perform the oil sampling
- Testing laboratory name and location, its accreditation and calibration processes for the instruments involved in each of the required tests.
- Oil Sampling procedures to show both the quality of the oil sampled as well as the integrity of the cable / insulating material within it are maintained.
- Examples of the proposed test reports to be submitted

5.2.3 Ancillary equipment – Condition Assessment

In addition to the oil tests on some parts of the ancillary equipment (e.g. pressure tanks) required in Clause 5.2.1 a condition assessment report containing the following information as a minimum shall be provided for the ancillary equipment located along each of the cable circuits.

The general overall condition / functionality of each piece of the ancillary equipment shall be confirmed as part of this inspection. The condition assessment report shall at a minimum provide:

- Date of condition assessment
- Clear photos of each piece of ancillary equipment
- Details of any corrosion or physical damage to each piece of equipment
- Details of the condition of the pit walls / lids
- Operability of each valve
- Details of any active oil leaks or poor oil connections
- Visibility of the oil gauges readings
- Confirmation of oil gauge output readings (refer to clause 5.2.3.1)
- Confirmation of the electrical contacts / alarms operating (refer to clause 5.2.3.2)
- Details of the alarms levels for each gauge
- Confirmation that each oil section is adequately alarmed to detect an oil leak

An individual condition asset report, detailing the information (as a minimum) stated above shall be provided for each of the “Oil Sampling Points” locations referenced in Annexure 5.

5.2.3.1 Oil Gauge Calibration

The oil gauges output / reading shall be confirmed to be correct via the most economical means (e.g. calibration of the existing gauges or replacement of the unit). Details of the proposed method shall be provided prior to work commencing.

5.2.3.2 Electrical contacts / Alarms

The electrical contacts in the pressure gauges shall be actively tested by manually closing the contacts at the gauge and verifying an alarm is received at Endeavour Energy's Control Room.

The gauge pressure at which the alarms are currently set shall be recorded as part of the condition assessment report for that gauge.

5.2.4 Oil Pressure Readings

Pressure readings shall be taken at all "Oil Sampling Points" (with a gauge) as referenced in Annexure 5, at the frequencies shown in Table 3.

Table 3: Frequency of oil pressure readings

Cable type	Feeders	Pressure Reading
SCFF Cables with a single level alarm	228, 22W and 233	Every 2 weeks
Oil-filled, with three-level alarms	22U, 226 and 9J8	Every 4 weeks

Records of the oil pressure readings shall be recorded in an editable electronic format (e.g. Excel file) conducted at the frequency indicated above and copies provided to the Endeavour Energy's Network Mains Manager on a six monthly basis. Each oil pressure reading shall at a minimum record:

- Date / Time of pressure reading
- Feeder number
- Phase (when applicable)
- Location of pressure reading / associated oil section
- Pressure reading
- Ambient temperature
- Load on the feeder (in Amps) at the approximate time of the reading (to be obtained from SCADA)

5.2.5 Cable Bonding System

Each feeder's metallic sheath bonding system shall be confirmed (as much as practically possible) to align with the description / information provided in Annexure 5.

Prior to any work being conducted in a pit, all water and organic material shall be removed prior the opening of the link box. Additionally if any water or organic material is found within the link box after it is opened, it shall also be removed prior to any testing.

The following tests, as detailed in the sections below, shall be carried out on the cable bonding system.

5.2.5.1 Cable serving (sheath) test

An insulation resistance (IR) test of the cable sheath shall be completed for each of the feeders to demonstrate the condition of the cables outer serving.

All earthing links and SVL's connected to the cable sheath shall be disconnected prior to the following tests.

IR measurements shall be taken every 60 seconds until the reading stabilises. The duration of the test shall be for a minimum of three (3) minutes.

The IR test shall be completed using 1 kV d.c. The final IR result shall be converted to the equivalent 20°C value, with the date and ambient temperature at the time of the test recorded.

If the sheath IR of a section of the cable (with 1 kV d.c. applied) is $\geq 0.5 \text{ M}\Omega$ a d.c. withstand test shall be performed on that section of cable sheath. If the sheath IR is $< 0.5 \text{ M}\Omega$ no further testing of the sheath shall be conducted and the low IR value recorded on the test report.

The d.c. withstand test shall apply 2.5 kV d.c. between the metallic cable sheath and the earth for 1 minute.

The sheath tests may be initially completed on larger sections at once (e.g. the entire feeder), however if the larger section fails either of the tests the cable sheath shall be sectionalised (to minor sections) from link boxes and the individual minor section shall be retested in order to identify the faulty section(s).

5.2.5.2 Cable surge voltage limiters

Each major section of the cable circuit has a number of cross-bonding joints, as detailed in Annexure 5.

The functionality of each SVL shall be checked. A d.c voltage shall be applied across the individual SVL and gradually increased, the value at which the d.c reference current (1 mA) flows shall be recorded.

In addition to the measured d.c. reference current, if any name plate details exist on the SVL these should also be recorded and included in the report.

5.2.5.3 Link box / Pit – Condition Assessment

In addition to the electrical tests on cable sheath and SVL as required in Clause 5.2.5.1 and 5.2.5.2, a condition assessment report containing the following minimum information shall be provided for each link box indicated in Annexure 5.

For the purposes of this section the condition assessment shall cover the link box (internal and external), the links, the SVLs, any visible bonding leads, and the pit itself.

The general overall condition / functionality of each piece of equipment shall be confirmed as part of this inspection. The condition assessment report shall at a minimum provide:

- Date of condition assessment
- Clear photos of each piece of equipment
- Details of any corrosion (inside or outside) or physical damage to the link box
- Details of the condition of the bonding leads
- Moisture Ingress into the link box / condition of lid seals
- Details of the condition of the pit lid / pit walls

An individual condition asset report, detailing the information (at a minimum) stated above shall be provided for each of the "Cable Screen Link Box" locations referenced in Annexure 5.

5.2.6 *Storage of Reports*

All test reports and data obtained from this testing to be stored in a structured format within G:\OH & UG Mains folder until such time that all assets within the scope of this document are decommissioned.

Copies of all reports / data shall be submitted to Endeavour Energy's Network Mains Manager to organise storage of the data.

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and the responsibility for approving this instruction

Manager Asset Standards and Design has the authority and responsibility for reviewing this instruction and making recommendations to the General Manager Asset Management.

Network Mains Manager has the authority and responsibility for:

- updating this instruction in accordance with Company policies;
- requesting the need for additional tests (e.g. oil samples from the cable itself);
- reviewing the information requested prior to testing / sampling;
- issuing Technical Bulletins on issues that arise between amendments to this document;
- storing the test reports / records received;
- approving any deviation from the Standards.

Project Manager has the authority and responsibility for:

- Obtaining the required resources to effectively conduct the sampling and testing required in this document

7.0 DOCUMENT CONTROL

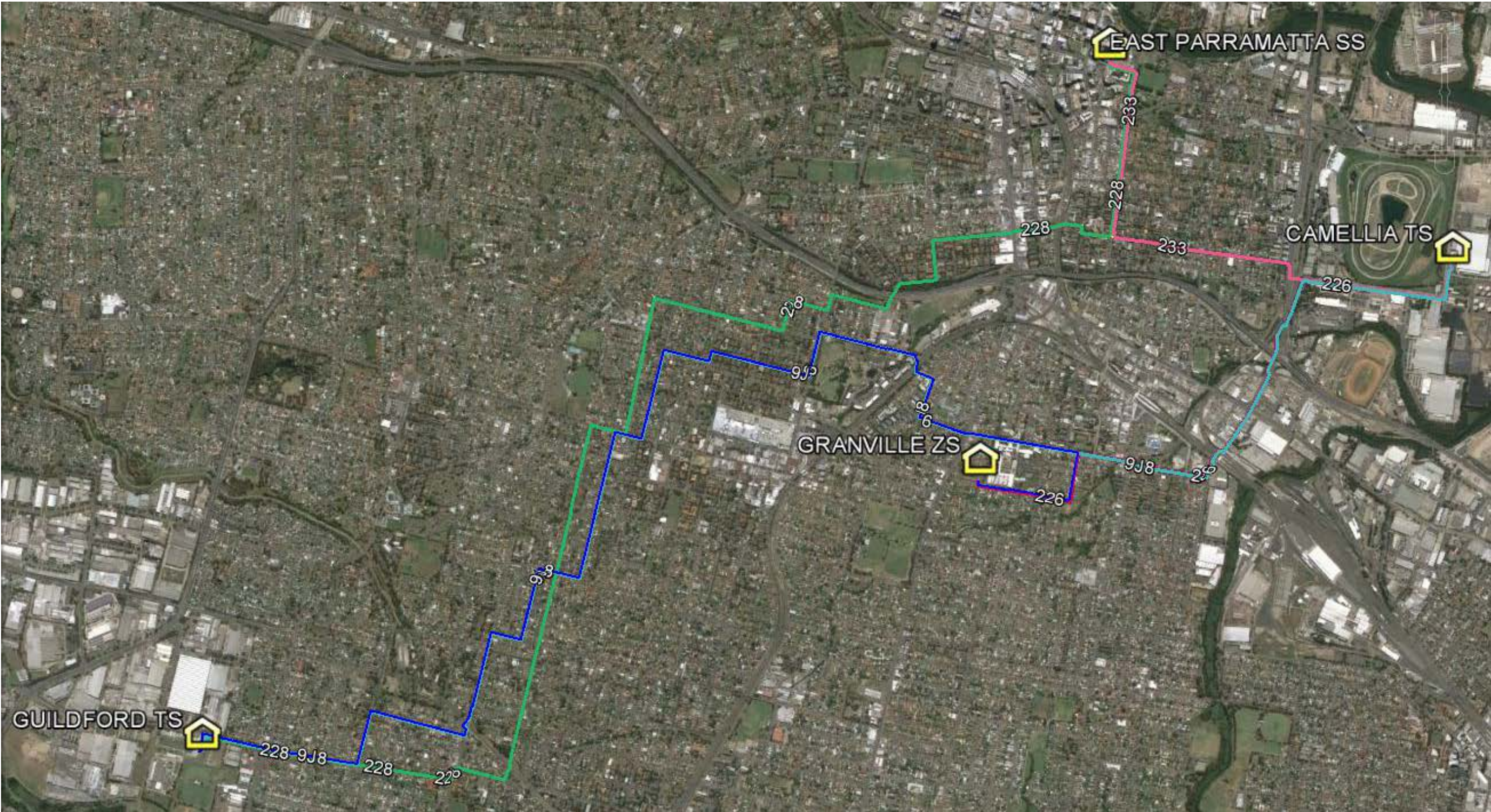
Documentation content coordinator: Network Mains Manager

Documentation process coordinator: Standards Process Coordinator

Transmission Substation: Holroyd 132kV

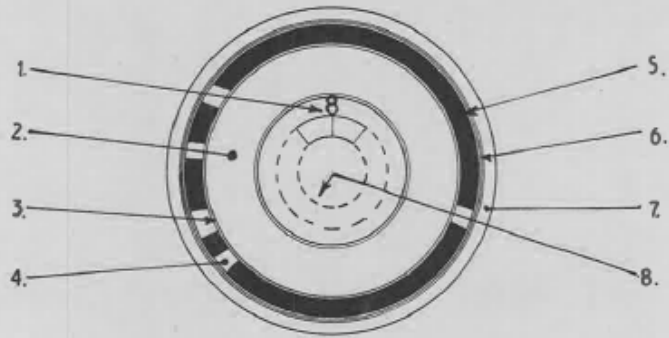


Annexure 2: Geographic Diagram of Cable Circuits

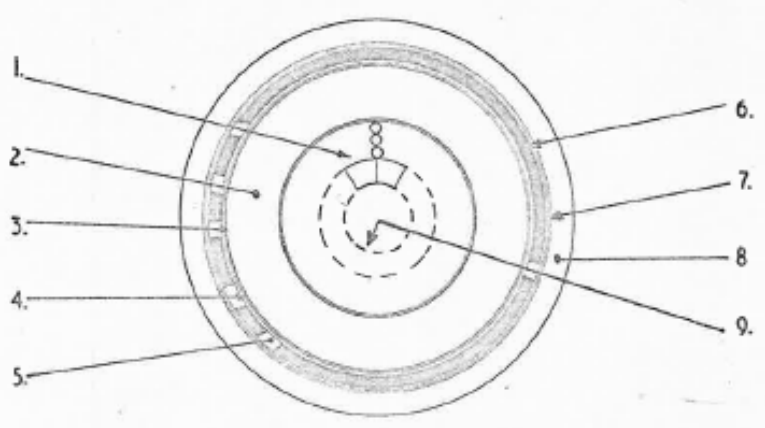


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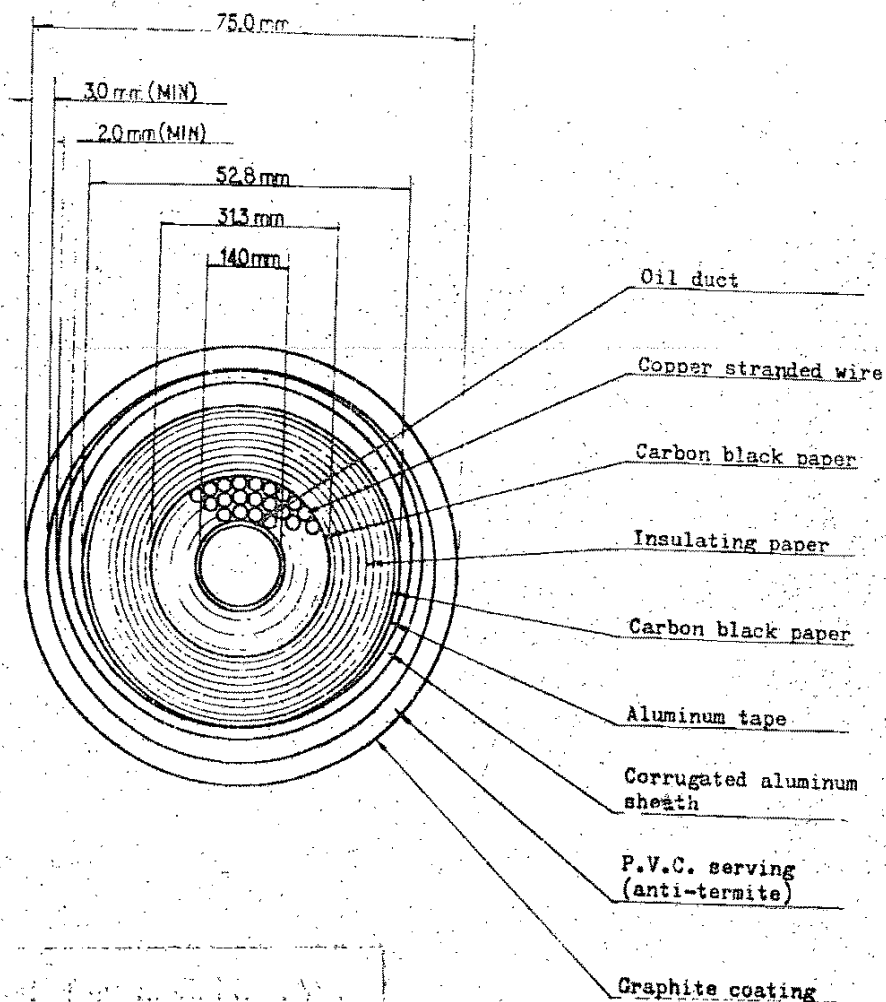
Annexure 3: BICC - Cable Cross Sectional Drawing

SYSTEMS ENGINEERING DEPT (POWER CABLES DIVISION)		BICC	DESIGN OF CABLE				
TYPE:- OIL FILLED.		VOLTAGE:- 132 KV.		CORES:- 1.			
SPECN. OR DESIGN No:- 0.3887		CONDUCTOR SIZE:- 0.65 $\square^{\circ}$		DESIGN STRESS:- 110KV/CM.			
CUSTOMER:- ELECTRICITY COMMISSION OF NEW SOUTH WALES.							
							
SCALE:- FULL SIZE							
ITEM	MAKE UP	MIN. RAD. WALL INCHES	DIAMETER INCHES. (NOMINAL)				
1	CONDUCTOR. COPPER. INC M.P. SCREEN.		1.103				
2	INSULATION PAPER.	0.355	1.843				
3	CORE SCREEN ALUMINIUM.	0.0075	1.858				
	LAID UP CORES.						
	BINDER CWF TAPE.						
4	SHEATH LEAD ALLOY.	0.110	2.09				
5	BEDDING	0.012	2.11				
6	REINFORCEMENT. TIN-BRONZE.	0.004	2.12				
7	SERVING. Q _x CONTAINS 0.2% DIELDRIN.	0.130	2.42				
8	I.D. OF CONDUCTOR 12 M.M.						
<table border="0" style="width: 100%;"> <tr> <td style="width: 33%;">ENQUIRY No F 4295. CONTRACT No 1428.</td> <td style="width: 33%;">DRN BY:-  DATE:- 4.2.64.</td> <td style="width: 33%;">R.E.O. 5376.</td> </tr> </table>					ENQUIRY No F 4295. CONTRACT No 1428.	DRN BY:-  DATE:- 4.2.64.	R.E.O. 5376.
ENQUIRY No F 4295. CONTRACT No 1428.	DRN BY:-  DATE:- 4.2.64.	R.E.O. 5376.					

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SYSTEMS ENGINEERING DEPT (POWER CABLES DIVISION)		BICC		DESIGN OF CABLE				
TYPE:- OIL FILLED.		VOLTAGE:- 132 K.V		CORES:- 1.				
SPECN. OR DESIGN No:- 0. 3888		CONDUCTOR SIZE:- 1.0 ^{sq} inch		DESIGN STRESS:- 110KV / CM.				
CUSTOMER:- ELECTRICITY COMMISSION OF NEW SOUTH WALES.								
								
SCALE:- FULL SIZE								
ITEM	MAKE UP	MIN. RAD. WALL INCHES	DIAMETER INCHES. (NOMINAL)					
1.	CONDUCTOR. COPPER. INC M.P. SCREEN.		1. 353					
2.	INSULATION. PAPER.	0.335	2. 053					
3.	CORE SCREEN. ALUMINIUM.	0.0075	2. 068					
	LAID UP CORES.							
4.	BINDER C.W.F. TAPE.	0.015	2. 098					
5.	SHEATH. LEAD ALLOY.	0.100	2. 31					
6.	BEDDING.	0.012	2. 33					
7.	REINFORCEMENT. TIN-BRONZE.	0.004	2. 34					
8.	SERVING. Q _x CONTAINS 0.2% DIELDRIN.	0.130	2. 64					
9.	I.D. OF CONDUCTOR 12 M.M.							
<table border="1"> <tr> <td>ENQUIRY No F. 4295 CONTRACT No 1428</td> <td>DRN BY:- <i>[Signature]</i> DATE:- 4.2.64.</td> <td>R.E.O. 5377.</td> </tr> </table>						ENQUIRY No F. 4295 CONTRACT No 1428	DRN BY:- <i>[Signature]</i> DATE:- 4.2.64.	R.E.O. 5377.
ENQUIRY No F. 4295 CONTRACT No 1428	DRN BY:- <i>[Signature]</i> DATE:- 4.2.64.	R.E.O. 5377.						

Annexure 4: Furukawa - Cable Cross Sectional Drawing



Approved for use by
 GA Stark / *[Signature]*
 Date 25-10-78

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REVISIONS	THE 3RD ANGLE PROJECTION	FOR	E.C.N.S.W. CONTRACT No. 2607 GUILDFORD - CAMELLIA	
	SCALE; DIMENSION		NOMENCLATURE	
	WT	APPD BY	132kv 430sqmm SINGLE COPPER CONDUCTOR, PAPER INSULATED, CORRUGATED ALUMINUM SHEATHED, P.V.C. SERVED OIL FILLED CABLE	
	SNO	CHECKER		
	DNO	DESIGNER		
		TRACER		
	THE FURUKAWA ELECTRIC CO., LTD.		OFA 7606	

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Annexure 5: Oil Sampling / Link Box Locations (per feeder)

All reference numbers (Ref #) provided below are in accordance with the original drawings listed in Annexure 6.

Feeder 226

Table 4 - Oil Sampling Points (Feeder 226)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
226	Camellia TS	Granville ZS	Camellia TS	Cable Termination	-
				Oil Tank	-
				Cable	-
			Corner of William St & Harington St Granville	Stop Joint	15/16
				Oil Tank – Camellia Side	-
				Oil Tank – Granville Side	-
				Cable – Camellia Side	-
				Cable – Granville Side	-

Table 5 - Cable Screen Link Box Locations (Feeder 226)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
226	Camellia TS	Granville ZS	Camellia TS	Earthed Point	-
			James Rouse Dr (Centre Island) corner of Martha St, Granville	Cross Bonding Point	18/19
			Corner of William St & Harington St Granville	Cross Bonding Point	15/16
			Granville ZS	Earthed Point	-

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Feeder 22U

Table 6 - Oil Sampling Points (Feeder 22U)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
22U	Guildford TS	Granville ZS	Guildford TS	Cable Termination	-
				Oil Tank	-
				Cable	-
			Robertson St, Guildford	Stop Joint - Guildford Side	3/4
				Stop Joint - Granville Side	
				Oil Tank - Guildford Side	-
				Oil Tank - Granville Side	-
				Cable - Guildford Side	-
				Cable - Granville Side	-
			Davies Rd, Merrylands	Stop Joint - Guildford Side	8/9
				Stop Joint - Granville Side	8/9
				Oil Tank - Guildford Side	-
				Oil Tank - Granville Side	-
				Cable - Guildford Side	-
				Cable - Granville Side	-
			Corner of William St & Harington St Granville	XLPE Transition Joint	15a/16a
				Oil Tank	-
				Cable	-

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Table 7 - Cable Screen Link Box Locations (Feeder 22U)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
22U	Guildford TS	Granville ZS	Guildford TS	Earthed Point	
			Fowler Road (next to Sydney water Pipe line) corner of Parkes St, Guildford West	Cross Bonding Point	4/5
			Davies Rd, Merrylands	Cross Bonding Point	8/9
			Walpole Street corner of Fox street, Merrylands	Earthed Point	12/13
			Corner of William St & Harington St Granville	Cross Bonding Point	15a/16a
			Corner of Elizabeth St & The Avenue Granville	Sheath Interrupter (Cross Bonded)	-
			Granville ZS	Earthed Point	-

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Feeder 228

Table 8 - Oil Sampling Points (Feeder 228)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
228	Guildford TS	East Parra SS	Guildford TS	Cable Termination	-
				Oil Tank	-
				Cable	-
			Harris St, Guildford (no gauges or alarms)	Feed Joint	4/5
				Oil Tank	-
				Cable	-
			Lawson Park, Merrylands	Stop Joint - Guildford Side	6/7
				Stop Joint - East Parra Side	
				Oil Tank - Guildford Side	-
				Oil Tank - East Parra Side	-
				Cable - Guildford Side	-
				Cable - East Parra Side	-
			Walpole St, Merrylands (no gauges or alarms)	Feed Joint	9/10
				Oil Tank	-
				Cable	-
			Robert St, Holroyd	Stop Joint - Guildford Side	11/12a
				Stop Joint - East Parra Side	
				Oil Tank - Guildford Side	-
				Oil Tank - East Parra Side	-
				Cable - Guildford Side	-
				Cable - East Parra Side	-
			Boundary St, Parramatta (no gauges or alarms)	Feed Joint	13/14a
				Oil Tank	-
				Cable	-
			Allen St at the corner of Harris Street, Harris Park	XLPE Transition Joint	14b/14c
				Oil Tank	-
				Cable	-

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Table 9 - Cable Screen Link Box Locations (Feeder 228)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
228	Guildford TS	East Parra SS	Guildford TS	Open Point with SVL	-
			Unknown	Insulating Joint (both sides earthed)	-
			98 McCredie Rd at the corner of Charles Rd Guildford	Cross Bonding Point	1/2
			31C McCredie Rd at the corner of Lomond St Guildford	Cross Bonding Point	2/3
			Mc Credie Rd at the corner of Tamplin Rd Guildford	Earthed Point	3/4
			Harris St, Guildford	Cross Bonding Point	4/5
			Harris street corner of Charlotte street , Merrylands	Cross Bonding Point	5/6
			Lawson Park, Merrylands	Earthed Point	6/7
			Merrylands Road corner of Davies street Merrylands.	Cross Bonding Point	7/8
			Clarence street corner of Shannon avenue Merrylands	Cross Bonding Point	8/9
			Walpole St, Merrylands	Earthed Point	9/10
			Leopold street corner of Walpole St, Merrylands	Cross Bonding Point	10/11
			Robert St, Holroyd	Cross Bonding Point	11/12a
			Marsden street at the corner of Meehan street Granville	Earthed Point	12b/13
			Boundary St, Parramatta	Cross Bonding Point	13/14a
			Allen street at the corner of Harris street Harris Park	Transition Joint	14b/14c
			Harris street at the corner of Una St, Harris Park	Earthed Point	14c/14d
			East Parramatta SS	Unknown - To be confirmed	-

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Feeder 233

Table 10 - Oil Sampling Points (Feeder 233)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
233	Camellia TS	East Parra SS	Camellia TS	Cable Termination	-
				Pressure Tank	-
				Cable	-
			Allen St, Harris Park	XLPE Transition Joint	14d/14e
				Pressure Tank	-
				Cable	-

Table 11 - Cable Screen Link Box Locations (Feeder 233)

Fdr #	From	To	Ancillary Equipment Locations	Type	Joint #
233	Camellia TS	East Parra SS	Camellia TS	Earthed Point	-
			Unwin St at the corner of Shirley St	Cross Bonding Point	17/18
			Between railway line and the off-ramp of James Ruse Dr to M4	Cross Bonding Point	16/17
			Eleanor street corner of Alfred St, Granville	Earthed Point	15a/16
			Allen street at the corner of Harris street Harris Park	Transition Joint	14e/15a
			Harris St at the corner of Una St, Harris Park	Sheath Interrupter (Cross Bonded)	14d/14e
			East Parramatta SS	Earthed Point	-

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Feeder 9J8

Table 12 - Oil Sampling Points (Feeder 9J8)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
9J8	Guildford TS	Camellia TS	Guildford TS	Cable Termination	-
				Oil Tank	-
				Cable	-
			Robertson St, Guildford	Stop Joint - Guildford Side	3/4
				Stop Joint - Camellia Side	
				Oil Tank - Guildford Side	-
				Oil Tank - Camellia Side	-
				Cable - Guildford Side	-
				Cable - Camellia Side	-
			Davies St, Merrylands	Stop Joint - Guildford Side	8/9
				Stop Joint - Camellia Side	
				Oil Tank - Guildford Side	-
				Oil Tank - Camellia Side	-
				Cable - Guildford Side	-
				Cable - Camellia Side	-
			William St, Granville	Stop Joint - Guildford Side	15/16
				Stop Joint - Camellia Side	
				Oil Tank - Guildford Side	-
				Oil Tank - Camellia Side	-
				Cable - Guildford Side	-
				Cable - Camellia Side	-
			Camellia TS	Cable Termination	-
				Oil Tank	-
				Cable	-

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Table 13 - Cable Screen Link Box Locations (Feeder 9J8)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
9J8	Guildford TS	Camellia TS	Guildford TS	Earthed Point	-
			Fowler Road (next to Sydney water Pipe line) corner of Parkes Street Guildford West	Cross Bonding Point	4/5
			Davies St, Merrylands	Cross Bonding Point	8/9
			Walpole Street corner of Fox street, Merrylands	Earthed Point	12/13
			William St, Granville	Cross Bonding Point	15/16
			James Rouse Drive (Centre Island) corner of Martha St	Cross Bonding Point	18/19
			Camellia TS	Earthed Point	-

Maintenance of SCFF cables

Feeder 22W

Table 14 - Oil Sampling Points (Feeder 22W)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
22W	Guildford TS	Camellia TS	Guildford TS	Cable Termination	-
				Oil Tank	-
				Cable	-
			Harris St, Guildford (no gauges or alarms)	Feed Joint	4/5
				Oil Tank	-
				Cable	-
			Lawson Park at Merrylands	Stop Joint - Guildford Side	6/7
				Stop Joint - Camellia Side	
				Oil Tank - Guildford Side	
				Oil Tank - Camellia Side	
				Cable - Guildford Side	-
				Cable - Camellia Side	-
			Walpole St, Merrylands (no gauges or alarms)	Feed Joint	9/10
				Oil Tank	-
				Cable	-
			Robert St, Holroyd	Stop Joint - Guildford Side	11/12a
				Stop Joint - Camellia Side	
				Oil Tank - Guildford Side	-
				Oil Tank - Camellia Side	-
				Cable - Guildford Side	-
				Cable - Camellia Side	-
			Boundary St, Parramatta (no gauges or alarms)	Feed Joint	13/14a
				Oil Tank	-
				Cable	-
			Camellia TS	Cable Termination	-
				Oil Tank	-
				Cable	-

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Table 15 - Cable Screen Link Box Locations (Feeder 22W)

Fdr #	From	To	Ancillary Equipment Locations	Description	Ref #
22W	Guildford TS	Camellia TS	Guildford TS	Earthed Point	-
			98 McCredie Rd at the corner of Charles Rd Guildford	Cross Bonding Point	1/2
			31C McCredie Rd at the corner of Lomond St, Guildford	Cross Bonding Point	2/3
			Mc Credie Rd at the corner of Tamplin Rd, Guildford	Earthed Point	3/4
			Harris St, Guildford	Cross Bonding Point	4/5
			Harris street corner of Charlotte St, Merrylands	Cross Bonding Point	5/6
			Lawson Park, Merrylands	Earthed Point	6/7
			Merrylands Rd corner of Davies St, Merrylands	Cross Bonding Point	7/8
			Clarence St corner of Shannon Ave Merrylands	Cross Bonding Point	8/9
			Walpole St, Merrylands	Earthed Point	9/10
			Leopold street corner of Walpole street Merrylands	Cross Bonding Point	10/11
			Robert St, Holroyd	Cross Bonding Point	11/12a
			Marsden St corner of Meehan St, Granville	Earthed Point	12b/13
			Boundary St, Parramatta	Cross Bonding Point	13/14a
			Allen St corner of Harris St, Harris Park	Cross Bonding Point	14b/15
			Eleanor St corner of Alfred St, Granville	Earthed Point	15/16
			Between railway line and the off-ramp of James Ruse Dr to M4	Cross Bonding Point	16/17
			Unwin St at the corner of Shirley St	Cross Bonding Point	17/18
			Camellia TS	Earthed Point	-

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Annexure 6: Associated Drawings

The following drawings may also provide additional information associated with these cables:

Drawing #	Title	Comments
86203	Profile & Schematic of the Guilford to Camellia (Feeders 228, 233 & 93F/2) 132 kV Oil Filled Underground Cables	- Feeder 93F/2 renamed to 22W - Union St Switching Station renamed to East Parramatta Switching Station - Joint bay on feeder 22W at chainage 7841 renamed to 14b/15 in this document - Joint bay on feeder 22W at chainage 8422 renamed to 15/16 in this document
86204	Profile & Schematic of the Guilford to Camellia (Feeders 93J/2B & 9J8) 132 kV Oil Filled Underground Cables	- Stop joint 15/16 on feeder 93J/2B removed and diverted to Granville ZS via two XLPE transition joints - Guildford to Granville section of feeder 93J/2B renamed 22U - Granville to Camellia section of feeder 93J/2B feeder renamed 226
346042	William St Granville to Granville ZS 132kV Feeder 93J/2B & 226 Cable Rearrangement	-