

NEED/OPPORTUNITY STATEMENT (NOS)



Various Locations VT Renewal Program

NOS- 000000001442 revision 5.0

Ellipse project no.: P0008397

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Project reason: Capability - Asset Replacement for end of life condition

Project category: Prescribed - Asset Renewal Strategies

Approvals

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Date submitted for approval	10 November 2017	

Change history

Revision	Date	Amendment
0	19 April 2016	Initial issue
1	29 June 2016	Clarification of scope in CVT replacements, update risk cost, removal of attachment 1, updated MVT list.
2	11 November 2016	Updated asset list and risk costs and minor wording.
3	22 November 2016	Update to format
4	10 November 2017	Update of Haefley CVT type fault issue, risk cost and CVT list.

1. Background

Voltage transformers (VTs) are essential for the operation of the high voltage network and are used to indicate the main system voltage at a level which can be used in protection, metering, indication and control functions.

Oil insulated VTs can be categorised as:

- > Magnetic voltage transformers (MVTs) in which the required secondary voltage is derived using oil insulated transformer windings. These are typically used at voltages of 132kV and below.
- > Capacitive voltage transformers (CVTs) in which the main system voltage is first divided down to a lower value using oil insulated capacitive insulation layers and is then converted to the required secondary voltage using oil insulated transformer windings in the base of the CVT. CVTs are also able to be used in powerline carrier communications due to the capacitive coupling between ground and the high voltage line. These are typically used at 132kV and above but TransGrid has a small number of 66kV CVTs.

There are a limited number of SF₆ gas insulated MVTs, as well as GIS MVTs but these are excluded from this Need/Opportunity Statement (NOS).

The typical failure mode of oil MVTs and CVTs is through insulation degradation through age or contamination leading to internal fault. This may cause the explosive failure of the unit and scattering of fragmented porcelain from the outer insulation. CVTs are ideally taken out of service when the development of a fault is detected as described in more detail in the following section.

Certain MVTs have been assessed as approaching end of life based on available dissolved gas analysis (DGA) and age.

The calculated annual failure rate for CVTs remains fairly constant and only increases slowly throughout its life. This is in contrast to other assets which have a failure rate that increases rapidly with age. The relatively constant failure rate and the run to failure approach for CVT means the exact CVTs which will require replacement cannot be determined for the general CVT population. Some CVTs types have been estimated to have an increased failure rates due to previous failures for these types.

The management of the risks associated with the failure of oil filled VTs is required by this NOS.

2. Need/opportunity

VTs are in general, considered to be reliable, low maintenance items of plant. TransGrid's asset management strategy is broadly designed to monitor instrument transformer condition and retire units prior to when the risk of explosive failure increases to an unacceptable level. The condition and associated risk have been developed for both types of VT.

MVTs

Condition data on MVTs is limited but a health index has been developed using the most recent DGA modified by an ageing factor based on the commissioning date of the MVT. The health index has then been correlated to the estimated remaining life of each MVT. MVTs without the facility to take oil samples for DGA have been assessed based on their age in relation to the nominal or expected technical life of the MVT due to the absence of measurements indicating condition.

As the MVT approaches the end of its life, the risk of failure increases and the replacement of the unit has an increased economic benefit. MVTs that are estimated to reach end of life in the next regulatory period, or which are deemed to have a high ratio of risk reduction to investment, are covered in this NOS and should be considered for action. There are 142 MVTs which are identified by this NOS as potentially requiring action.

CVTs

CVTs are monitored by a voltage unbalance monitoring circuit connected to the low voltage output and by relying on this system they are effectively run to failure. The monitor will detect a partial breakdown in the capacitive insulation in one of the CVTs by comparison to the other two phases and then provide an alarm. If the alarm appears valid, the CVT can be removed from service by the operator and the cause of the alarm confirmed. There is no routine condition data currently being collected to indicate aging, such as DGA.

Although the failure rates of CVTs is fairly constant throughout its life, it is estimated that failure will occur eventually due to age at some point because of factors such as mechanical fatigue, electrical stresses in insulation, sealing system failure or general component degradation and rust. This has been modelled in order to determine an appropriate risk cost for CVTs identified as approaching end of life.

The following types of CVTs are regarded as having higher failure rates than the general population:

- > Trench CVTs type TEMP300 have a history of failure in TransGrid with a total of 18 units failing between 2008 and 2015. Failures have also been experienced in Powerlink. The cause of failure of these units appears to be ingress of moisture and a long term solution has not been identified. There are 47 CVTs of this type which need to be addressed under this NOS. It is estimated that 25% of these CVTs, that is 12 CVTs, will fail in the next regulatory period and require replacement. There are also three 500kV Trench CVTs at Eraring substation which are not currently holding nitrogen pressure which is likely to be allowing moisture to ingress. This is also likely to lead to it reaching end of life and require replacement.
- > Haefely 330kV and 220kV CVTs type HAFCVE have had faults where erroneous secondary voltages were detected following the failure of the electronic circuit forming part of the ferro-resonance damping system. These voltage fluctuations may have an impact on the correct functioning of secondary systems, particularly the metering and protection and uncontrolled ferro-resonance may cause failure of the CVT. Additional CVTs with faulty ferroresonance have been detected recently (Darlington Point X5 220kV CVT in August 2017 and Liddell 84 Line 330kV CVT in September 2017) indicating that the remainder of the population is have an increasing risk of failure.

In summary, the following quantities of CVTs are expected to be detected as reaching end of life in the 2019-23 regulatory period and will require replacement.

Failure of an MVT or CVT can have the following key consequences:

- > System – Extended supply outages could occur
- > Financial – There is a risk of damage to adjacent plant due to expulsion of porcelain fragments
- > Operational – Reduced outages or loss of certain control, protection or metering functions
- > People – Injury to nearby personnel due to explosive failure mechanisms

The risk cost associated with the CVTs is \$1.0m per annum.

The risk cost associated with the MVTs is \$3.7m per annum.

This risk cost is on a per annum basis and is based on the average probability in the next regulatory period.

3. Related needs/opportunities

Separate programs for other substation assets including circuit breakers, current transformers and secondary system are being developed and should be considered when packaging work.

4. Recommendation

It is recommended that options be considered to address the identified need.

Attachment 1 – MVTs included in this Need Statement

Equipment Reference	PIC Number	Equipment Description	Voltage
SWSDN24L2	A07185/4	844 BARHAM 66KV FEEDER BAY	66
SWSBKH7G	EC00009662	NO4 RAILWAY TOWN 22KV FEEDER	22
SWSBKH3C1	EC00014999	X2 BURONGA 220KV FEEDER BAY	220
SWSBKH7L	EC00009658	NO7 WEST 22KV FEEDER	22
SWSBKH3E1	EC00015000	X4 BROKEN HILL MINES 220KV FEEDER BAY	220
SWSBKH3E1	EC00015002	X4 BROKEN HILL MINES 220KV FEEDER BAY	220
CMSSE11B2	EC00001025	NO2 TRANSFORMER 330/132/16KV TRANSF BAY	132
CMSSE11B2	EC00001026	NO2 TRANSFORMER 330/132/16KV TRANSF BAY	132
CMSSE11B2	EC00001024	NO2 TRANSFORMER 330/132/16KV TRANSF BAY	132
SWSTU24K1	A07238/1	NO1 SECTION 66KV BUSBAR	66
SWSTU24K2	A07238/2	NO2 SECTION 66KV BUSBAR	66
SWSBKH3E1	EC00015001	X4 BROKEN HILL MINES 220KV FEEDER BAY	220
NNSTOM1C1	EC00003361	NO3 TRANSFORMER 330KV BAY	330
NNSTOM1C1	EC00003359	NO3 TRANSFORMER 330KV BAY	330
NNSTOM1C1	EC00003360	NO3 TRANSFORMER 330KV BAY	330
NNSTOM1A	EC00003366	NO1 TRANSFORMER 330KV CB BAY	330
NNSTOM1A	EC00003367	NO1 TRANSFORMER 330KV CB BAY	330
NNSVP12E3	EC00024291	95T/STN TX 3/TIE TX 1 COMMON EQUIP BAY	132
NNSMRK2F	EC00005332	95U SINGLETON 132KV FEEDER	132
NNSMRK2F	EC00005333	95U SINGLETON 132KV FEEDER	132
NNSMRK2F	EC00005334	95U SINGLETON 132KV FEEDER	132
SWSYA26BB1	A07428/1	NO1 SECTION 33KV BUSBAR	33
SWSYA26BB3	A07428/2	NO3 SECTION 33KV BUSBAR	33
NNSTOM1A	EC00003368	NO1 TRANSFORMER 330KV CB BAY	330
NTSAR14N	A08182/7	665 ARMIDALE 66 SS - 66KV FEEDER	66
NTSTTF7BA1	A08109/1	NO1 SECTION 22KV BUSBAR	22

Equipment Reference	PIC Number	Equipment Description	Voltage
NTSTTF7BA3	A08109/2	NO3 SECTION 22KV BUSBAR	22
SWSDN24G2	A07185/3	822 MOULAMEIN TEE DENI 66KV FEEDER BAY	66
SWSDN24K2	A07184/2	845 DENILQUIN 66 - 66KV FEEDER BAY	66
NNSTRE4L	EC00004359	867 OCC FAILFORD 66KV FEEDER	66
SWSGRF6P2	A07373/2	NO2 SECTION 33KV BUSBAR	33
NNSNEW1B2	A09355/3	NO2 330KV TRANSFORMER BAY	132
NNSNEW1B2	A09355/1	NO2 330KV TRANSFORMER BAY	132
NNSNEW1B2	A09355/2	NO2 330KV TRANSFORMER BAY	132
NNSNEW1C2	A09355/5	NO3 330KV TRANSFORMER BAY	132
NNSNEW1C2	A09355/6	NO3 330KV TRANSFORMER BAY	132
NNSTRE4G	A09100/2	862/1 KEW TEE JOHNS RIVER 66KV FDR	66
NTSKLK4K	A08413/1	0825 KOOLKHAN PS 66KV FEEDER	66
NNSPMQ6P	EC00006512	708 OWEN ST NO2 33KV FEEDER	33
NNSMRK1A1	EC00005358	NO1 330KV TRANSFORMER BAY	132
NNSMRK1A1	EC00005356	NO1 330KV TRANSFORMER BAY	132
NNSMRK1A1	EC00005357	NO1 330KV TRANSFORMER BAY	132
NTSAR14H	A08182/4	661 OAKY PS 66KV FEEDER	66
NNSMRK2E	EC00005359	95H MUSWELLBROOK 132KV FEEDER	132
NNSMRK2E	EC00005361	95H MUSWELLBROOK 132KV FEEDER	132
NNSMRK2E	EC00005360	95H MUSWELLBROOK 132KV FEEDER	132
NNSTRE4E	EC00013271	861 WHITBREAD ST ZONE SS 66KV FEEDER	66
NNSTRE4E	EC00013296	861 WHITBREAD ST ZONE SS 66KV FEEDER	66
SWSJDA1A2	EC00007297	NO1 TRANSFORMER 330KV TRANSF BAY	132
SWSJDA1B2	EC00007294	NO2 TRANSFORMER 330KV TRANSF BAY	132
NTSCOF4R	T00148/3	706 SOUTH COFFS HARBOUR 66KV FEEDER	66
SWSMUR8A3	TG004986	No.1 Section 11kV Bus at 11kV Building	11
SWSBKH7H	EC00007583	NO5 TALC ST-2 22KV FEEDER	22
SWSBKH7K	EC00020244	NO6 TALC ST-1 22KV FEEDER	22

Equipment Reference	PIC Number	Equipment Description	Voltage
NNSNEW1C2	A09355/4	NO3 330KV TRANSFORMER BAY	132
SYSMRU4K	EC00004187	83A MURRUMBURRAH 66KV FEEDER	66
NNSTRE6Q	EC00004308	NO5 COUNCIL KANANGRA DRIVE 33KV FEEDER	33
CMSING4J	EC00009475	864 MACQUARIE FIELDS 66KV FEEDER BAY	66
CMSING4J	EC00009476	864 MACQUARIE FIELDS 66KV FEEDER BAY	66
CMSING4J	EC00009477	864 MACQUARIE FIELDS 66KV FEEDER BAY	66
SYSCA12K	A06597/2	NO1 WODEN 132KV FEEDER	132
SYSCA12K	A06597/3	NO1 WODEN 132KV FEEDER	132
SYSCA12K	A06597/1	NO1 WODEN 132KV FEEDER	132
NNSPMQ6V	EC00009205	712 ROCKS FERRY TEE 33KV FEEDER	33
NNSTRE6L	A08612/2	NO3 COUNCIL WINGHAM 33KV FEEDER	33
NTSGN22B2	EC00006966	NO2 TRANSFORMER 132KV TRANSFORMER BAY	66
SWSBK7F	EC00009664	NO3 SOUTH 22KV FEEDER	22
NNSTRE6B	A09219/8	NO2 33KV TRANSFORMER CB BAY	33
SWSFNY2A	EC00013276	NO1 TRANSFORMER 66KV CB BAY	66
NNSPMQ6E	EC00009199	701 ROCKS FERRY 33KV FEEDER	33
NNSKS26S2	EC00004310	NO3 SECTION 33KV BUSBAR	33
SYSMRU4L	EC00009896	890 YOUNG 66KV FEEDER	66
SYSMRU4L	EC00009897	890 YOUNG 66KV FEEDER	66
SYSMRU4L	EC00009898	890 YOUNG 66KV FEEDER	66
SWSBK7A	EC00007581	NO1 TRANSFORMER 22KV CB BAY	22
SWSBK7B	EC00007582	NO2 TRANSFORMER 22KV CB BAY	22
NTSKLK4P1	A08447/1	0896 MACLEAN 66KV FEEDER BAY	66
SWSJDA1A2	EC00007295	NO1 TRANSFORMER 330KV TRANSF BAY	132
SWSJDA1A2	EC00007296	NO1 TRANSFORMER 330KV TRANSF BAY	132
SWSJDA1B2	EC00007292	NO2 TRANSFORMER 330KV TRANSF BAY	132
SWSJDA1B2	EC00007293	NO2 TRANSFORMER 330KV TRANSF BAY	132
NTSCOF4R	T00148/2	706 SOUTH COFFS HARBOUR 66KV FEEDER	66

Equipment Reference	PIC Number	Equipment Description	Voltage
NTSCOF4R	T00148/1	706 SOUTH COFFS HARBOUR 66KV FEEDER	66
NNSTRE6H	A09387/2	7G2 HARRINGTON Tee COOPERNOOK	33
NNSTRE6F	ETA5596	NO1 COUNCIL BOOTAWA 33KV FEEDER	33
NTSKLK2B2	EC00009055	NO2 TRANSFORMER 132KV TRANSFORMER BAY	66
NTSKLK2B2	EC00009053	NO2 TRANSFORMER 132KV TRANSFORMER BAY	66
NTSKLK2B2	EC00009054	NO2 TRANSFORMER 132KV TRANSFORMER BAY	66
SWSDN24M2	EC00009902	NO6 MOAMA 66KV FEEDER BAY	66
SWSDN24M2	EC00009903	NO6 MOAMA 66KV FEEDER BAY	66
SWSDN24M2	EC00009904	NO6 MOAMA 66KV FEEDER BAY	66
SWSDN24A	A07185/1	NO1 TRANSFORMER 66KV CB BAY	66
SWSDN24B	A07185/2	NO2 TRANSFORMER 66KV CB BAY	66
NNSTRE4E	EC00013283	861 WHITBREAD ST ZONE SS 66KV FEEDER	66
SYSMRU4A	EC00009860	NO1 TRANSFORMER 66KV CB BAY	66
SYSMRU4A	EC00009859	NO1 TRANSFORMER 66KV CB BAY	66
SYSMRU4A	EC00009861	NO1 TRANSFORMER 66KV CB BAY	66
NNSTRE4C	EC00004353	NO3 66KV TRANSFORMER CB BAY	66
NNSTRE6A	A09387/3	NO1 33KV TRANSFORMER CB BAY	33
NTSGN24H	EC00006954	88K GUNNEDAH 66 SS - 66KV FEEDER	66
NTSGN24H	EC00006957	88K GUNNEDAH 66 SS - 66KV FEEDER	66
SWSFNY2F	EC00013288	84B FINLEY 66KV FEEDER	66
SWSFNY2G2	EC00013308	84A JERILDERIE 66KV FEEDER BAY	66
NNSPMQ6T	EC00006511	711 CLEARWATER CRESCENT 33KV FEEDER	33
SYSMRU4M	EC00009893	836 COOTAMUNDRA 66KV FEEDER	66
SYSMRU4M	EC00009894	836 COOTAMUNDRA 66KV FEEDER	66
SYSMRU4M	EC00009895	836 COOTAMUNDRA 66KV FEEDER	66
SWSBKH7M	EC00009663	NO8 COCKBURN 22KV FEEDER	22
NTSCOF4T	EC00009379	705 SOUTH COFFS HARBOUR 66KV FEEDER	66
NTSCOF4T	EC00009380	705 SOUTH COFFS HARBOUR 66KV FEEDER	66

Equipment Reference	PIC Number	Equipment Description	Voltage
NTSCOF4T	EC00009381	705 SOUTH COFFS HARBOUR 66KV FEEDER	66
NNSPMQ2B2	EC00009575	NO2 TRANSFORMER 132KV TRANSFORMER BAY	33
SYSMRU4K	EC00004185	83A MURRUMBURRAH 66KV FEEDER	66
SYSMRU4K	EC00004186	83A MURRUMBURRAH 66KV FEEDER	66
SYSMRU4G	EC00009884	83D MURRUMBURRAH 66KV FEEDER	66
SYSMRU4G	EC00009885	83D MURRUMBURRAH 66KV FEEDER	66
SYSMRU4G	EC00009886	83D MURRUMBURRAH 66KV FEEDER	66
NTSGN22B2	EC00006970	NO2 TRANSFORMER 132KV TRANSFORMER BAY	66
NTSGN22B2	EC00006983	NO2 TRANSFORMER 132KV TRANSFORMER BAY	66
NNSPMQ2A2	A09387/1	NO1 TRANSFORMER 132KV TRANSFORMER BAY	33
SYSMRU4F	EC00009914	837 JUGIONG 66KV FEEDER	66
SYSMRU4F	EC00009915	837 JUGIONG 66KV FEEDER	66
SYSMRU4F	EC00009916	837 JUGIONG 66KV FEEDER	66
NNSPMQ6G	EC00009201	703 BORONIA ST TEE 33KV FEEDER	33
NNSPMQ6N	EC00009202	707 BORONIA ST NO2 33KV FEEDER	33
NNSPMQ6S	EC00009203	710 CLEARWATER CRESCENT 33KV FEEDER	33
NNSTRE4D	A09386/1	NO4 66KV TRANSFORMER CB BAY	33
NNSVP12F3	EC00024307	957/STN TX 4/TIE TX 2 COMMON EQUIP BAY	132
SWSTU24F	A07239/1	828 GUNDAGAI 66KV FEEDER	66
SWSBKH7V	EC00009660	NO1 22KV BUS VT BAY	22
SWSBKH7W	EC00009659	NO2 22KV BUS VT BAY	22
NNSTRE6N	EC00009562	33kV FREQ INJECTION	33
NTSGN24H	EC00006963	88K GUNNEDAH 66 SS - 66KV FEEDER	66
SWSFNY2F	EC00013305	84B FINLEY 66KV FEEDER	66
SWSFNY2F	EC00013294	84B FINLEY 66KV FEEDER	66
SWSFNY2G2	EC00013295	84A JERILDERIE 66KV FEEDER BAY	66
SWSFNY2G2	EC00013313	84A JERILDERIE 66KV FEEDER BAY	66
NNSKS24G1	A08614/1	NO1 SECTION 66KV BUSBAR	66

Equipment Reference	PIC Number	Equipment Description	Voltage
NNSKS24G2	A08614/2	NO3 SECTION 66KV BUSBAR	66
NNSKS26S1	TG006926	NO1 SECTION 33KV BUSBAR	33
SWSFNY2A	EC00013285	NO1 TRANSFORMER 66KV CB BAY	66
SWSFNY2A	EC00013287	NO1 TRANSFORMER 66KV CB BAY	66

Attachment 2 - CVTs included in this Need Statement

Equipment Reference	PIC Number	Equipment Description	Volts
CMSBFW1AB	EC00002457	41 SYDNEY SOUTH 330KV FEEDER	330
CMSBFW1AB	EC00002455	41 SYDNEY SOUTH 330KV FEEDER	330
CMSBFW1AB	EC00002456	41 SYDNEY SOUTH 330KV FEEDER	330
SWSBKH3C1	EC00007499	X2 BURONGA 220KV FEEDER BAY	220
COSWW11D1	EC00017669	76 SYDNEY SOUTH 330KV FEEDER BAY	330
COSWW11D1	EC00017667	76 SYDNEY SOUTH 330KV FEEDER BAY	330
COSWW11D1	EC00017668	76 SYDNEY SOUTH 330KV FEEDER BAY	330
NNSBAY1AF1	EC00004545	32 SYDNEY WEST 330KV FEEDER BAY	330
NNSBAY1AF1	EC00004546	32 SYDNEY WEST 330KV FEEDER BAY	330
NNSBAY1AF1	EC00004544	32 SYDNEY WEST 330KV FEEDER BAY	330
NNSLD11AC1	EC00024620	82 TOMAGO 330KV FEEDER BAY	330
NNSLD11AC1	EC00024618	82 TOMAGO 330KV FEEDER BAY	330
NNSLD11AC1	EC00024619	82 TOMAGO 330KV FEEDER BAY	330
NNSTOM1J1	EC00007458	82 LIDDELL 330KV FEEDER BAY	330
NNSTOM1J1	EC00007460	82 LIDDELL 330KV FEEDER BAY	330
NNSTOM1J1	EC00007459	82 LIDDELL 330KV FEEDER BAY	330
CMSSE11P1	A02051/5	28 SYDNEY NORTH 330KV FEEDER BAY	330
CMSSE11P1	A02051/3	28 SYDNEY NORTH 330KV FEEDER BAY	330
CMSSE11P1	A02051/4	28 SYDNEY NORTH 330KV FEEDER BAY	330
NNSVP11GB1	TG007633	NO1 SECTION 330KV GENERATOR BUSBAR	330
CMSDPT2X	EC00002940	98F MT TERRY 132KV FEEDER	132
CMSDPT2X	EC00002938	98F MT TERRY 132KV FEEDER	132
CMSDPT2X	EC00002939	98F MT TERRY 132KV FEEDER	132
NNSTRE2C1	B01978/2	964 PORT MACQUARIE 132KV FEEDER BAY	132
NNSMRK1D1	EC00012421	88 TAMWORTH 330KV FEEDER BAY	330
NNSMRK1D1	EC00012422	88 TAMWORTH 330KV FEEDER BAY	330

Equipment Reference	PIC Number	Equipment Description	Volts
COSBER2J	B01330/3	94B WELLINGTON 132KV FEEDER BAY	132
COSBER2J	B01330/1	94B WELLINGTON 132KV FEEDER BAY	132
COSBER2J	B01330/2	94B WELLINGTON 132KV FEEDER BAY	132
CMSAVS1A	A05947/6	17 MACARTHUR 330KV FEEDER	330
CMSAVS1A	A05947/7	17 MACARTHUR 330KV FEEDER	330
CMSDPT2F	EC00006217	98W MT TERRY 132KV FEEDER	132
SWSLT11G1	ETA6462	L1 Tumut 3 330kV Feeder Bay (Units 1-2)	330
SWSLT11G1	ETA6463	L1 Tumut 3 330kV Feeder Bay (Units 1-2)	330
SWSLT11G1	ETA6464	L1 Tumut 3 330kV Feeder Bay (Units 1-2)	330
SWSLT11H1	ETA6458	L3 Tumut 3 330kV Feeder Bay (Units 3-4)	330
SWSLT11H1	ETA6465	L3 Tumut 3 330kV Feeder Bay (Units 3-4)	330
SWSLT11H1	ETA6382	L3 Tumut 3 330kV Feeder Bay (Units 3-4)	330
SWSLT11J1	ETA6468	L5 Tumut 3 330kV Feeder Bay (Units 5-6)	330
SWSLT11J1	ETA6466	L5 Tumut 3 330kV Feeder Bay (Units 5-6)	330
SWSLT11J1	ETA6467	L5 Tumut 3 330kV Feeder Bay (Units 5-6)	330
NNSMRK1C1	EC00003087	83 LIDDELL 330KV FEEDER BAY	330
NNSMRK1C1	EC00003085	83 LIDDELL 330KV FEEDER BAY	330
NNSMRK1C1	EC00003086	83 LIDDELL 330KV FEEDER BAY	330
SWSWG11F1	A07119/3	62 JINDERA 330KV FEEDER BAY	330
SWSWG11F1	A07119/2	62 JINDERA 330KV FEEDER BAY	330
SWSWG11F1	A07119/1	62 JINDERA 330KV FEEDER BAY	330
COSWL11D1	EC00004543	79 WOLLAR 330KV FEEDER BAY	330
COSWL11D1	EC00004541	79 WOLLAR 330KV FEEDER BAY	330
COSWL11D1	EC00004542	79 WOLLAR 330KV FEEDER BAY	330
CMSSYW2S	A03122/9	93Z BLACKTOWN 132KV FEEDER BAY	132
CMSSYW2S	A03122/7	93Z BLACKTOWN 132KV FEEDER BAY	132
CMSSYW2S	A03122/8	93Z BLACKTOWN 132KV FEEDER BAY	132
NNSVP11AF1	EC00020755	23 MUNMORAH 330KV FEEDER BAY	330

Equipment Reference	PIC Number	Equipment Description	Volts
SWSYA22G	A07432/2	99JGRIFFITH132KVFEEDER	132
SWSYA22G	A07432/4	99JGRIFFITH132KVFEEDER	132
SWSYA22G	A07432/3	99JGRIFFITH132KVFEEDER	132
CMSRGV1D1	EC00006087	38 SYDNEY WEST 330KV FEEDER BAY	330
CMSSYS1N1	EC00002312	12 LIVERPOOL 330KV FEEDER BAY	330
CMSSYS1N1	EC00002311	12 LIVERPOOL 330KV FEEDER BAY	330
CMSSYS1N1	EC00002310	12 LIVERPOOL 330KV FEEDER BAY	330
CMSKCR1A3	EC00010757	37 MACARTHUR 330KV FEEDER BAY	330
COSCW22F	A01109/2	999YASS330-132KVFEEDERBAY	132
COSCW22F	A01109/1	999YASS330-132KVFEEDERBAY	132
COSCW22F	A01109/3	999YASS330-132KVFEEDERBAY	132
SWSUT11V1	ETA8226	2Yass330-330kVFeederBay	330
SWSUT11V1	ETA8227	2Yass330-330kVFeederBay	330
SWSUT11V1	ETA8228	2Yass330-330kVFeederBay	330
CMSSE11E1	A02051/2	A1 SECTION 330KV BUSBAR	330
CMSSE11F1	A02051/1	B1 SECTION 330KV BUSBAR	330
CMSSE11E2	A02051/7	A2 SECTION 330KV BUSBAR	330
CMSSE11F2	A02051/6	B2 SECTION 330KV BUSBAR	330
SWSWG12H2	A07115/6	9R5 WAGGA NORTH 132KV FEEDER BAY	132
SWSWG12H2	A07115/5	9R5 WAGGA NORTH 132KV FEEDER BAY	132
CMSDPT2K	EC00005382	981 BELLAMBI CREEK 132KV FEEDER	132
CMSDPT2K	EC00005380	981 BELLAMBI CREEK 132KV FEEDER	132
CMSDPT2K	EC00005381	981 BELLAMBI CREEK 132KV FEEDER	132
CMSKCR1A3	EC00010759	37 MACARTHUR 330KV FEEDER BAY	330
COSWW11E1	EC00017673	77 INGLEBURN 330KV FEEDER BAY	330
COSWW11E1	EC00017671	77 INGLEBURN 330KV FEEDER BAY	330
COSWW11E1	EC00017672	77 INGLEBURN 330KV FEEDER BAY	330
COSWW11E1	EC00017675	77 INGLEBURN 330KV FEEDER BAY	330

Equipment Reference	PIC Number	Equipment Description	Volts
CMSLP11H1	EC00006081	30 SYDNEY WEST 330KV FEEDER BAY	330
CMSLP11H1	EC00006091	30 SYDNEY WEST 330KV FEEDER BAY	330
CMSLP11E1	EC00006075	12 SYDNEY SOUTH 330KV FEEDER BAY	330
CMSLP11E1	EC00006101	12 SYDNEY SOUTH 330KV FEEDER BAY	330
CMSLP11E1	EC00006099	12 SYDNEY SOUTH 330KV FEEDER BAY	330
CMSLP11H1	EC00006077	30 SYDNEY WEST 330KV FEEDER BAY	330
SWSJDA1D1	EC00007269	060 WODONGA 330KV FEEDER BAY	330
SWSJDA1D1	EC00007268	060 WODONGA 330KV FEEDER BAY	330
SWSJDA1D1	EC00007270	060 WODONGA 330KV FEEDER BAY	330
SWSUNT3E2	EC00015403	X5/1 BALRANALD 220KV FEEDER BAY	220
SWSUNT3E2	EC00015405	X5/1 BALRANALD 220KV FEEDER BAY	220
COSMTP1B1	EC00006113	330KV 72 WELLINGTON FEEDER BAY	330
COSMTP1B1	EC00006114	330KV 72 WELLINGTON FEEDER BAY	330
COSMTP1B1	EC00006111	330KV 72 WELLINGTON FEEDER BAY	330
SWSBRG3D2	EC00015416	X5/3 BALRANALD 220KV FEEDER BAY	220
SWSBRG3D2	EC00015417	X5/3 BALRANALD 220KV FEEDER BAY	220
SWSBRG3D2	EC00015415	X5/3 BALRANALD 220KV FEEDER BAY	220
SWSUT11J1	ETA8214	65Murray330kVFeederBay	330
SWSUT11J1	ETA8215	65Murray330kVFeederBay	330
SWSUT11J1	ETA8216	65Murray330kVFeederBay	330
CMSING1C1	EC00004527	78 SYDNEY SOUTH 330KV FEEDER BAY	330
CMSING1C1	EC00004526	78 SYDNEY SOUTH 330KV FEEDER BAY	330
CMSING1C1	EC00004528	78 SYDNEY SOUTH 330KV FEEDER BAY	330
SWSYA22J	A07432/7	99FURANQUINTY132KVFEEDER	132
SWSYA22J	A07432/6	99F URANQUINTY 132KV FEEDER	132
SWSYA22J	A07432/5	99FURANQUINTY132KVFEEDER	132
NNSLD11AK1	EC00015387	84 TAMWORTH 330KV FEEDER BAY	330
NNSLD11AK1	EC00015386	84 TAMWORTH 330KV FEEDER BAY	330

Equipment Reference	PIC Number	Equipment Description	Volts
NNSLD11AK1	EC00015385	84 TAMWORTH 330KV FEEDER BAY	330
CMSAVS1B	A05947/1	16 MARULAN 330KV FEEDER	330
CMSAVS1B	A05946/1	16 MARULAN 330KV FEEDER	330
CMSAVS1B	A05947/2	16 MARULAN 330KV FEEDER	330
CMSAVS1C	A05947/5	10 DAPTO 330KV FEEDER	330
CMSAVS1C	A05947/3	10 DAPTO 330KV FEEDER	330
CMSAVS1C	A05947/4	10 DAPTO 330KV FEEDER	330
NNSVP11MB1	TG007632	NO1 SECTION 330KV MAIN BUSBAR	330
SWSDNT3E2	EC00015407	X5/1 BALRANALD 220KV FEEDER BAY	220
SWSWG12K	A07113/5	993 GADARA 132KV FEEDER	132
SWSWG12K	A07114/9	993 GADARA 132KV FEEDER	132
SWSWG12K	A07114/7	993 GADARA 132KV FEEDER	132
CMSKVS1D1	A05691/3	3W CAPITAL WIND FARM 330KV FEEDER BAY	330
CMSKVS1D1	A05691/1	3W CAPITAL WIND FARM 330KV FEEDER BAY	330
CMSSYN1M	ETA2334	28 SYDNEY EAST 330KV FEEDER BAY	330
CMSSYN1M	ETA2333	28 SYDNEY EAST 330KV FEEDER BAY	330
CMSSYN1M	ETA2335	28 SYDNEY EAST 330KV FEEDER BAY	330
CMSSYN1N	ETA2362	27 SYDNEY EAST 330KV FEEDER BAY	330
CMSSYN1N	ETA2364	27 SYDNEY EAST 330KV FEEDER BAY	330
CMSSYN1N	ETA2359	27 SYDNEY EAST 330KV FEEDER BAY	330
SWSWG11L1	EC00015382	63 DARLINGTON POINT 330KV FEEDER BAY	330
SWSWG11L1	EC00015383	63 DARLINGTON POINT 330KV FEEDER BAY	330
SWSWG11L1	EC00015384	63 DARLINGTON POINT 330KV FEEDER BAY	330
NNSTOM1D	EC00022169	NO4 TRANSFORMER 330KV CB BAY	330
NNSTOM1D	EC00022168	NO4 TRANSFORMER 330KV CB BAY	330
NNSTOM1D	ETA2349	NO4 TRANSFORMER 330KV CB BAY	330
CMSRGV1C1	ETA2332	31 BAYSWATER 330KV FEEDER BAY	330
CMSRGV1C1	ETA2329	31 BAYSWATER 330KV FEEDER BAY	330

Equipment Reference	PIC Number	Equipment Description	Volts
CMSRGV1C1	ETA2331	31 BAYSWATER 330KV FEEDER BAY	330
SWSBRG3G2	EC00015413	OX1 RED CLIFFS 220KV FEEDER BAY	220
SWSBRG3G2	EC00015414	OX1 RED CLIFFS 220KV FEEDER BAY	220
SWSBRG3G2	EC00015412	OX1 RED CLIFFS 220KV FEEDER BAY	220
SYSMRNCFQ	EC00015390	4 YASS 330 - 330KV FEEDER BAY	330
SYSMRNCFQ	EC00015388	4 YASS 330 - 330KV FEEDER BAY	330
SYSMRNCFQ	EC00015389	4 YASS 330 - 330KV FEEDER BAY	330
SYSMRNCGQ	EC00015396	8 DAPTO 330KV FEEDER BAY	330
SYSMRNCGQ	EC00015393	8 DAPTO 330KV FEEDER BAY	330
SYSMRNCGQ	EC00015394	8 DAPTO 330KV FEEDER BAY	330
SYSMRNCHQ	EC00015397	16 AVON 330KV FEEDER BAY	330
SYSMRNCHQ	EC00015392	16 AVON 330KV FEEDER BAY	330
SYSMRNCHQ	EC00015395	16 AVON 330KV FEEDER BAY	330
NNSTOM1H	EC00015380	95 NEWCASTLE 330KV FEEDER	330
NNSTOM1H	EC00015381	95 NEWCASTLE 330KV FEEDER	330
NNSTOM1H	EC00015379	95 NEWCASTLE 330KV FEEDER	330
NNSBAY0A2	EC00020827	NO1 TIE TRANSFORMER 500KV BAY	330
NNSBAY0A2	EC00020826	NO1 TIE TRANSFORMER 500KV BAY	330
NNSBAY0A2	EC00020825	NO1 TIE TRANSFORMER 500KV BAY	330
NNSBAY0B2	EC00020835	NO2 TIE TRANSFORMER 500KV BAY	330
NNSBAY0B2	EC00020828	NO2 TIE TRANSFORMER 500KV BAY	330
NNSBAY0B2	EC00020830	NO2 TIE TRANSFORMER 500KV BAY	330
NNSER00CE1	EC00008705	5A2 KEMPS CREEK 500KV FEEDER BAY	500
NNSER00CF1	EC00008706	5A1 KEMPS CREEK 500KV FEEDER BAY	500
NNSER00CF1	EC00008711	5A1 KEMPS CREEK 500KV FEEDER BAY	500