

# NEED/OPPORTUNITY STATEMENT (NOS)



Protection - Capacitor Condition

NOS- 000000001387 revision 2.0

**Ellipse project no.:** P0008047

**TRIM file:** [TRIM No]

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

**Project category:** Prescribed - Asset Renewal Strategies

## Approvals

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<b>Endorsed</b>	Mark Jones	Secondary Systems and Communications Asset Manager
<b>Approved</b>	Lance Wee	M/Asset Strategy
<b>Date submitted for approval</b>	9 November 2016	

## Change history

Revision	Date	Amendment
0	3 May 2016	Initial issue
1	17 October 2016	Update to 2016/17 dollars
2	9 November 2016	Update to format

## 1. Background

Capacitor protection relays are used throughout the NSW network to isolate capacitor bank faults and their impacts on system stability and network infrastructure. The relays under investigation are installed at 66kV, 132kV and 330kV voltage levels. There are currently approximately 135 installed units within TransGrid's asset base with install dates between 1965 and 2008.

All relays under investigation will have reached or exceeded their estimated technical life by 2023. Manufacturer support for the majority of models has ceased meaning no repair or replacement facilities exist and spares currently held by TransGrid for these models are projected to be exhausted. Additionally there are higher costs associated with managing and maintaining spares and the continuing maintenance capability required for obsolete models.

The use of duplicated protection schemes across all capacitor banks are a continuing requirement of the Australian Energy Regulator (AER) as outlined in the National Electricity Rules (NER). These protection schemes are required into the foreseeable future.

## 2. Need/opportunity

The relay models in Table 1 are covered by this Need.

**Table 1 – Asset quantities**

Relay Model	Primary Asset Protected	Quantity Installed
RI	<= 220kV Capacitor Banks	4
2DCC	<= 220kV Capacitor Banks	6
REX521	>= 330kV Capacitor Banks	3
CDGx	<= 220kV Capacitor Banks	46
DCD424A	<= 220kV and >= 330kV Capacitor Banks	13
MCGGx	<= 220kV Capacitor Banks	17
RLC	<= 220kV and >= 330kV Capacitor Banks	38
SPAJx	<= 220kV Capacitor Banks	2
MIC8020	<= 220kV Capacitor Banks	6

The risk cost associated with the Capacitor protection relays is \$1.5m per annum. The most significant element of concern is the reliability consequence associated with a protection system failing to operate during a genuine fault due to the malfunction of the protection relays identified for replacement above. This hazard can result in a number of different outcomes including load shedding, explosive failure of associated primary assets, offloading generation or in the most extreme case, black start of the entire network. The relays protect assets connected to busbars supplying a mix of loads and are installed at the 66kV, 132kV and 330kV voltage levels of the network and those at the 330kV level carry a risk of a system black event. It is estimated that 16 hours would be required to recover any loss of load after a hazardous event. The risk costs are based on 2015/16 probabilities of failure taken as a trend of existing defect rates of the assessed assets derived from the condition assessment<sup>1</sup>. These probabilities are forecast to continue increasing over the coming years as they move past their expected life.

<sup>1</sup> Refer NACA-SSAP - Protection

### 3. Related Needs/opportunities

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NIL

### 4. Recommendation

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It is recommended that options be considered to address the identified Need/opportunity.

## Attachment 1 – Risk costs summary

Summary of results is attached below. Refer to supporting document in PDGS for full risk assessment.

### Current Option Assessment - Risk Summary

Project Name: Protection - Capacitor Condition

Option Name: 1387 - Base Case

Option Assessment Name: 1387 - Base Case - Assessment 1

Rev Reset Period: Next (2018-23)



Major Component	No.	Minor Component	Sel Hazardous Event	LoC x CoF (\$M)	Failure Mechanism	NoxLoC xCoF (\$M)	PoF (Yr 1)	Total Risk (\$M)	Risk (\$M) (Rel)	Risk (\$M) (Op)	Risk (\$M) (Fin)	Risk (\$M) (Peo)	Risk (\$M) (Env)	Risk (\$M) (Rep)
2DCC <=150MW	3	Protection	Unplanned Outage - HV (2DCC <=150MW)	\$0.13	Failure	\$0.38	16.70%	\$0.06	\$0.01	\$0.01	\$0.05			\$0.00
2DCC <=150MW	3	Protection Relay	Explosive Failure of Asset (2DCC <=150MW)	\$0.06	Failure	\$0.19	16.70%	\$0.03	\$0.01		\$0.02	\$0.00		\$0.00
2DCC >=330kV	0	Protection	Unplanned Outage - HV (2DCC >=330kV)	\$0.00	Failure	\$0.00								
2DCC >=330kV	0	Protection Relay	Explosive Failure of Asset (2DCC >=330kV)	\$0.00	Failure	\$0.00								
2DCC >150MW	2	Protection	Unplanned Outage - HV (2DCC >150MW)	\$0.33	Failure	\$0.66	16.70%	\$0.11	\$0.07		\$0.04			\$0.00
2DCC >150MW	2	Protection Relay	Explosive Failure of Asset (2DCC >150MW)	\$0.26	Failure	\$0.53	16.70%	\$0.09	\$0.07		\$0.01	\$0.00		\$0.00
CDGx <=150MW	23	Protection	Unplanned Outage - HV (CDGx <=150MW)	\$0.12	Failure	\$2.80	0.80%	\$0.02	\$0.00		\$0.02			\$0.00
CDGx <=150MW	23	Protection Relay	Explosive Failure of Asset (CDGx <=150MW)	\$0.06	Failure	\$1.28	0.80%	\$0.01	\$0.00		\$0.01	\$0.00		\$0.00
CDGx >=330kV	0	Protection	Unplanned Outage - HV (CDGx >=330kV)	\$0.00	Failure	\$0.00								
CDGx >=330kV	0	Protection Relay	Explosive Failure of Asset (CDGx >=330kV)	\$0.00	Failure	\$0.00								
CDGx >150MW	5	Protection	Unplanned Outage - HV (CDGx >150MW)	\$0.26	Failure	\$1.30	0.80%	\$0.01	\$0.01		\$0.00			\$0.00
CDGx >150MW	5	Protection Relay	Explosive Failure of Asset (CDGx >150MW)	\$0.20	Failure	\$0.98	0.80%	\$0.01	\$0.01		\$0.00	\$0.00		\$0.00
DCD424A <=150MW	5	Protection	Unplanned Outage - HV (DCD424A <=150MW)	\$0.12	Failure	\$0.61	7.70%	\$0.05	\$0.01		\$0.04			\$0.00
DCD424A <=150MW	5	Protection Relay	Explosive Failure of Asset (DCD424A <=150MW)	\$0.05	Failure	\$0.27	7.70%	\$0.02	\$0.01		\$0.01	\$0.00		\$0.00
DCD424A >150MW	0	Protection	Unplanned Outage - HV (DCD424A >150MW)	\$0.19	Failure	\$0.00	7.70%	\$0.00	\$0.00		\$0.00			\$0.00

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF (\$M)	Failure Mechanism	NoxLoC xCoF (\$M)	PoF (Yr 1)	Total Risk (\$M)	Risk (\$M) (Rel)	Risk (\$M) (Op)	Risk (\$M) (Fin)	Risk (\$M) (Peo)	Risk (\$M) (Env)	Risk (\$M) (Rep)
DCD424A >150MW	0	Protection Relay	Explosive Failure of Asset (DCD424A >150MW)	\$0.13	Failure	\$0.00	7.70%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
DCD424A >330kV	1	Protection	Unplanned Outage - HV (DCD424A >330kV)	\$0.11	Failure	\$0.11	7.70%	\$0.01	\$0.01	\$0.00	\$0.01	\$0.00	\$0.00	\$0.00
DCD424A >330kV	1	Protection Relay	Explosive Failure of Asset (DCD424A >330kV)	\$0.60	Failure	\$0.60	7.70%	\$0.05	\$0.04	\$0.01	\$0.01	\$0.00	\$0.00	\$0.00
MCGG22 <=150MW	9	Protection	Unplanned Outage - HV (MCGG22 <=150MW)	\$0.12	Failure	\$1.12	5.90%	\$0.07	\$0.01	\$0.01	\$0.06	\$0.00	\$0.00	\$0.00
MCGG22 <=150MW	9	Protection Relay	Explosive Failure of Asset (MCGG22 <=150MW)	\$0.06	Failure	\$0.52	5.90%	\$0.03	\$0.01	\$0.01	\$0.02	\$0.00	\$0.00	\$0.00
MCGG22 >=330kV	0	Protection	Unplanned Outage - HV (MCGG22 >=330kV)	\$0.00	Failure	\$0.00								
MCGG22 >=330kV	0	Protection Relay	Explosive Failure of Asset (MCGG22 >=330kV)	\$0.00	Failure	\$0.00								
MCGG22 >150MW	6	Protection	Unplanned Outage - HV (MCGG22 >150MW)	\$0.33	Failure	\$1.98	5.90%	\$0.12	\$0.08	\$0.04	\$0.04	\$0.00	\$0.00	\$0.00
MCGG22 >150MW	6	Protection Relay	Explosive Failure of Asset (MCGG22 >150MW)	\$0.26	Failure	\$1.58	5.90%	\$0.09	\$0.08	\$0.01	\$0.01	\$0.00	\$0.00	\$0.00
MIC8020 <= 150MW	2	Protection	Unplanned Outage - HV (MIC8020 <= 150MW)	\$0.11	Failure	\$0.22	9.00%	\$0.02	\$0.00	\$0.02	\$0.02	\$0.00	\$0.00	\$0.00
MIC8020 <= 150MW	2	Protection Relay	Explosive Failure of Asset (MIC8020 <= 150MW)	\$0.04	Failure	\$0.09	9.00%	\$0.01	\$0.00	\$0.01	\$0.01	\$0.00	\$0.00	\$0.00
MIC8020 >150MW	3	Protection	Unplanned Outage - HV (MIC8020 >150MW)	\$0.31	Failure	\$0.93	9.00%	\$0.08	\$0.06	\$0.03	\$0.03	\$0.00	\$0.00	\$0.00
MIC8020 >150MW	3	Protection Relay	Explosive Failure of Asset (MIC8020 >150MW)	\$0.24	Failure	\$0.73	9.00%	\$0.07	\$0.06	\$0.01	\$0.01	\$0.00	\$0.00	\$0.00
RI Prot <=150MW	4	Protection	Unplanned Outage - HV (RI Prot <=150MW)	\$0.13	Failure	\$0.50	25.00%	\$0.13	\$0.02	\$0.11	\$0.11	\$0.00	\$0.00	\$0.00
RI Prot <=150MW	4	Protection Relay	Explosive Failure of Asset (RI Prot <=150MW)	\$0.06	Failure	\$0.23	25.00%	\$0.06	\$0.02	\$0.04	\$0.04	\$0.00	\$0.00	\$0.00
RI Prot >=330kV	0	Protection	Unplanned Outage - HV (RI Prot >=330kV)	\$0.00	Failure	\$0.00								
RI Prot >=330kV	0	Protection Relay	Explosive Failure of Asset (RI Prot >=330kV)	\$0.00	Failure	\$0.00								
RI Prot >150MW	0	Protection	Unplanned Outage - HV (RI Prot >150MW)	\$0.00	Failure	\$0.00								
RI Prot >150MW	0	Protection Relay	Explosive Failure of Asset (RI Prot >150MW)	\$0.00	Failure	\$0.00								
RLC <=150MW	12	Protection	Unplanned Outage - HV (RLC <=150MW)	\$0.12	Failure	\$1.45	3.00%	\$0.04	\$0.01	\$0.04	\$0.04	\$0.00	\$0.00	\$0.00

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF (\$M)	Failure Mechanism	NoxLoC xCoF (\$M)	PoF (Yr 1)	Total Risk (\$M)	Risk (\$M) (Rel)	Risk (\$M) (Op)	Risk (\$M) (Fin)	Risk (\$M) (Peo)	Risk (\$M) (Env)	Risk (\$M) (Rep)
RLC <=150MW	12	Protection Relay	Explosive Failure of Asset (RLC <=150MW)	\$0.05	Failure	\$0.66	3.00%	\$0.02	\$0.01		\$0.01	\$0.00		\$0.00
RLC >=330kV	3	Protection	Unplanned Outage - HV (RLC >=330kV)	\$0.11	Failure	\$0.32	3.00%	\$0.01	\$0.00		\$0.01			\$0.00
RLC >=330kV	3	Protection Relay	Explosive Failure of Asset (RLC >=330kV)	\$0.60	Failure	\$1.81	3.00%	\$0.05	\$0.05		\$0.01	\$0.00		\$0.00
RLC >150MW	3	Protection	Unplanned Outage - HV (RLC >150MW)	\$0.24	Failure	\$0.72	3.00%	\$0.02	\$0.01		\$0.01			\$0.00
RLC >150MW	3	Protection Relay	Explosive Failure of Asset (RLC >150MW)	\$0.17	Failure	\$0.52	3.00%	\$0.02	\$0.01		\$0.00	\$0.00		\$0.00
SPAJx <=150MW	2	Protection	Unplanned Outage - HV (SPAJx <=150MW)	\$0.13	Failure	\$0.27	50.00%	\$0.13	\$0.03		\$0.11			\$0.00
SPAJx <=150MW	2	Protection Relay	Explosive Failure of Asset (SPAJx <=150MW)	\$0.07	Failure	\$0.14	50.00%	\$0.07	\$0.03		\$0.04	\$0.00		\$0.00
SPAJx >=330kV	0	Protection	Unplanned Outage - HV (SPAJx >=330kV)	\$0.00	Failure	\$0.00								
SPAJx >=330kV	0	Protection Relay	Explosive Failure of Asset (SPAJx >=330kV)	\$0.00	Failure	\$0.00								
SPAJx >150MW	0	Protection	Unplanned Outage - HV (SPAJx >150MW)	\$0.00	Failure	\$0.00								
SPAJx >150MW	0	Protection Relay	Explosive Failure of Asset (SPAJx >150MW)	\$0.00	Failure	\$0.00								
				\$5.79		\$23.50		\$1.50	\$0.71		\$0.78	\$0.01		\$0.00