

# NEED/OPPORTUNITY STATEMENT (NOS)



Protection - GE Multilin Condition

NOS- 00000001379 revision 3.0

**Ellipse project no.:** P0008031

**TRIM file:** [TRIM No]

**Project reason:** Reliability - To meet overall network reliability requirements

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

## Approvals

|                                    |                  |  |
|------------------------------------|------------------|--|
| <b>Author</b>                      | Hazem Khamis     | Secondary Systems Strategist                       |
| <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> | 17 November 2016 |  |

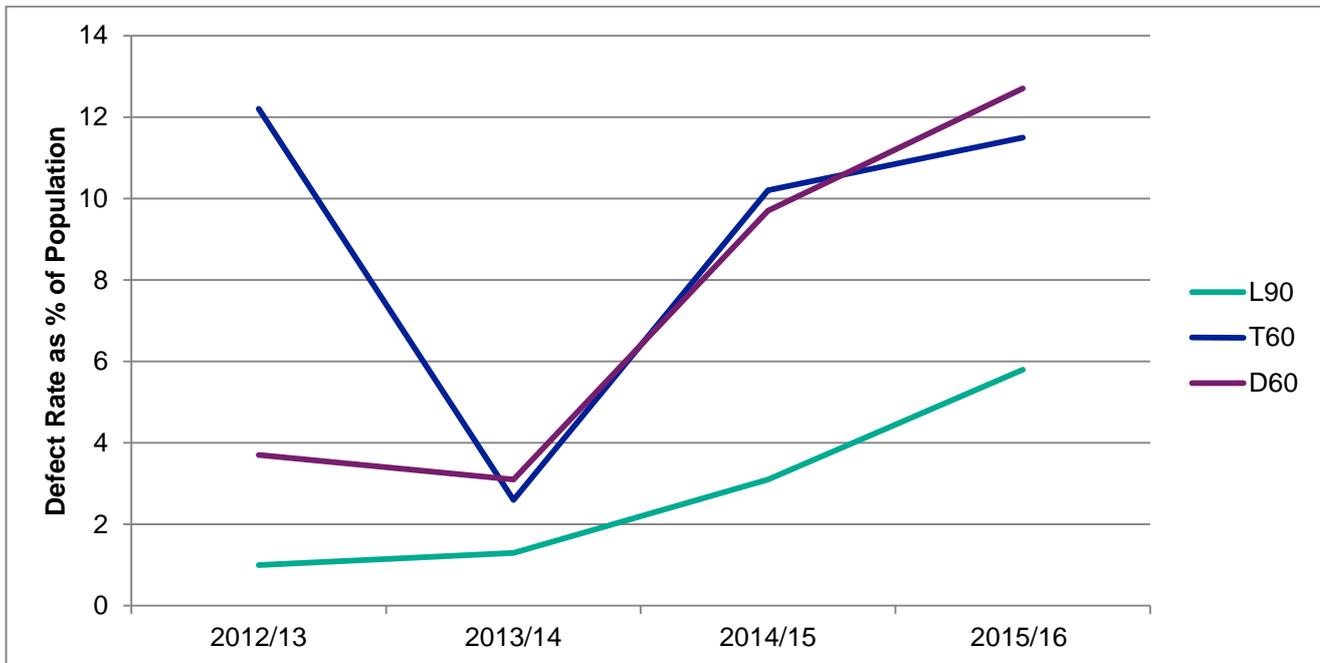
## Change history

| Revision | Date             | Amendment                 |
|----------|------------------|---------------------------|
| 0        | 28 April 2016    | Initial issue             |
| 1        | 17 October 2016  | Update to 2016/17 dollars |
| 2        | 17 November 2016 | Update to format          |

# 1. Background

The GE Multilin UR suite of protective relays, are used throughout the NSW network to protect transmission lines and transformers across all voltage levels from 22kV to 500kV. There are currently approximately 434 installed units within TransGrid's asset base with install dates between 2001 and 2016.

The defect rate for these assets has increased significantly in the past 3 years. These defects have been spread throughout the network regardless of voltage level or geographical location. These defects have frequently resulted in the mal-operation of relays. The historical defect rates of the relays are summarised below<sup>1</sup>:



There have been several issues identified with these relays, across all age brackets, resulting in high priority corrective maintenance across the installed asset base including:

- > D60 Firmware upgrade program - 37 units - due to an issue identified with the incorrect operation of internal protection schemes
- > D60 Facia replacement program - 27 units - due to the failure of the LCD displays on relays limiting the ability of maintenance to be performed
- > L90 Firmware upgrade program - all units - due to an issue identified with the incorrect operation of internal protection schemes
- > Analogue Input Card Replacement Program - 243 units - due to an identified issue with the Digital Signal Processing methodology of existing cards

Additionally, approximately 46.9% of these relays were installed prior to 2008, and will have reached the end of their estimated life by 2023. Manufacturer support for these older models will have ceased meaning no firmware or hardware upgrades would be available and spares currently held by TransGrid for these models are projected to be exhausted.

<sup>1</sup> 2015/16 values extracted from Ellipse 22/04/2016

The use of duplicated protection schemes across all transmission lines and transformers 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 assets raised within this need have exhibited an increased defect rate resulting in a high consequence failure mode. These assets have additionally created an above average amount of corrective maintenance works and expenditure which has resulted in the application of operational resources exceeding the expected requirements for modern microprocessor based protection relays.

The following relay models are covered by this need:

| Relay Model | Primary Asset Protected                           | Quantity Installed |
|-------------|---|--------------------|
| D60         | Transmission Lines, Cables, Frequency Injection   | 157                |
| L90         | Transmission Lines, Cables, Generator Inter-zones | 103                |
| T60         | Transformers                                      | 139                |

The risk cost associated with the GE Multilin UR suite of protection relays is \$26m per annum. The most significant element of concern is the reliability consequence associated with the explosive failure of a primary asset due to malfunction of the protection relays resulting in a failure to clear a fault. The relays protect a mix of loads and are installed at every voltage level including the 330kV and 500kV backbones of the network and carry a risk of a system black event. It is estimated that 16 hours would be required to recover any loss of load after an explosive failure. 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>2</sup>. These probabilities are forecast to continue increasing over the coming years as they move past their expected life.

## 3. Related needs/opportunities

NIL

## 4. Recommendation

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

<sup>2</sup> Refer NACA-SSAP - Protection

# 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 - GE Multilin Condition

Option Name: 1379 - Base Case

Option Assessment Name: 1379 - 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) |
|------------------------|-----|------------------|---|-----------------|-------------------|-------------------|------------|------------------|------------------|-----------------|------------------|------------------|------------------|------------------|
| D60 Prot <=150MW       | 43  | Protection       | Unplanned Outage - HV (D60 Prot <=150MW)            | \$0.25          | Failure           | \$10.92           | 8.50%      | \$0.93           | \$0.54           | \$0.39          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| D60 Prot <=150MW       | 43  | Protection Relay | Explosive Failure of Asset (D60 Prot <=150MW)       | \$0.11          | Failure           | \$4.66            | 8.50%      | \$0.40           | \$0.22           | \$0.14          | \$0.00           | \$0.04           | \$0.00           | \$0.00           |
| D60 Prot >=330kV       | 83  | Protection       | Unplanned Outage - HV (D60 Prot >=330kV)            | \$0.11          | Failure           | \$8.76            | 8.50%      | \$0.74           | \$0.00           | \$0.74          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| D60 Prot >=330kV       | 83  | Protection Relay | Explosive Failure of Asset (D60 Prot >=330kV)       | \$1.73          | Failure           | \$143.22          | 8.50%      | \$12.17          | \$11.50          | \$0.59          | \$0.01           | \$0.08           | \$0.00           | \$0.00           |
| D60 Prot >150MW        | 2   | Protection       | Unplanned Outage - HV (D60 Prot >150MW)             | \$1.10          | Failure           | \$2.20            | 8.50%      | \$0.19           | \$0.17           | \$0.02          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| D60 Prot >150MW        | 2   | Protection Relay | Explosive Failure of Asset (D60 Prot >150MW)        | \$0.45          | Failure           | \$0.89            | 8.50%      | \$0.08           | \$0.07           | \$0.01          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| L90 Prot >=330kV       | 19  | Protection       | Unplanned Outage - HV (L90 Prot >=330kV)            | \$0.11          | Failure           | \$2.00            | 3.10%      | \$0.06           | \$0.00           | \$0.06          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| L90 Prot >=330kV       | 19  | Protection Relay | Explosive Failure of Asset (L90 Prot >=330kV)       | \$1.72          | Failure           | \$32.75           | 3.10%      | \$1.02           | \$0.96           | \$0.05          | \$0.00           | \$0.01           | \$0.00           | \$0.00           |
| L90 Prot >150MW        | 36  | Protection       | Unplanned Outage - HV (L90 Prot >150MW)             | \$1.30          | Failure           | \$46.80           | 3.10%      | \$1.45           | \$1.33           | \$0.12          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| L90 Prot >150MW        | 36  | Protection Relay | Explosive Failure of Asset (L90 Prot >150MW)        | \$0.52          | Failure           | \$18.86           | 3.10%      | \$0.58           | \$0.53           | \$0.04          | \$0.00           | \$0.01           | \$0.00           | \$0.00           |
| L90 Protection <=150MW | 11  | Protection       | Unplanned Outage - HV (L90 Protection <=150MW)      | \$0.40          | Failure           | \$4.36            | 3.10%      | \$0.14           | \$0.10           | \$0.04          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| L90 Protection <=150MW | 11  | Protection Relay | Explosive Failure of Asset (L90 Protection <=150MW) | \$0.16          | Failure           | \$1.79            | 3.10%      | \$0.06           | \$0.04           | \$0.01          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| T60 Prot <=150MW       | 46  | Protection       | Unplanned Outage - HV (T60 Prot <=150MW)            | \$0.13          | Failure           | \$6.15            | 19.00%     | \$1.17           | \$0.25           | \$0.92          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| T60 Prot <=150MW       | 46  | Protection Relay | Explosive Failure of Asset (T60 Prot <=150MW)       | \$0.05          | Failure           | \$2.25            | 19.00%     | \$0.43           | \$0.10           | \$0.33          | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
| T60 Prot >=330kV       | 63  | Protection       | Unplanned Outage - HV (T60 Prot >=330kV)            | \$0.11          | Failure           | \$6.65            | 19.00%     | \$1.26           | \$0.00           | \$1.26          | \$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) |
|------------------|-----|------------------|---|-----------------|-------------------|-------------------|------------|------------------|------------------|-----------------|------------------|------------------|------------------|------------------|
| T60 Prot >=330kV | 63  | Protection Relay | Explosive Failure of Asset (T60 Prot >=330kV) | \$0.44          | Failure           | \$27.83           | 19.00%     | \$5.29           | \$4.28           |                 | \$1.00           | \$0.00           | \$0.00           | \$0.00           |
| T60 Prot >150MW  | 0   | Protection       | Unplanned Outage - HV (T60 Prot >150MW)       | \$0.23          | Failure           | \$0.00            | 19.00%     | \$0.00           | \$0.00           |                 | \$0.00           |                  |                  | \$0.00           |
| T60 Prot >150MW  | 0   | Protection Relay | Explosive Failure of Asset (T60 Prot >150MW)  | \$0.09          | Failure           | \$0.00            | 19.00%     | \$0.00           | \$0.00           |                 | \$0.00           | \$0.00           | \$0.00           | \$0.00           |
|                  |     |                  |   | \$9.00          |                   | \$320.09          |            | \$25.96          | \$20.09          |                 | \$5.72           | \$0.02           | \$0.14           | \$0.00           |

Total VCR Risk: \$20.09      Total ENS Risk: \$0.00