

# NEED/OPPORTUNITY STATEMENT (NOS)



Transformer Renewal 2018/19 – 2023/24

NOS- 000000001354 revision 5.0

**Ellipse project no.:** P0007976

**TRIM file:** 2016/0371

**Project reason:** Capability – Improve Asset Management

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

## Approvals

|                                    |                                  |  |
|------------------------------------|----------------------------------|--|
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| <b>Endorsed</b>                    | Tony Gray                        | Substations Asset Manager                                    |
| <b>Approved</b>                    | Lance Wee                        | Manager Asset Strategy                                       |
| <b>Date submitted for approval</b> | 22 November 2016                 |  |

## Change history

| Revision | Date             | Amendment   |
|----------|------------------|---|
| 0        | 24 March 2016    | Initial issue.  |
| 1        | 24 March 2016    | No change.  |
| 2        | 20 April 2016    | Updated wording.  |
| 3        | 14 November 2016 | Updated transformer list, risk costs, minor wording and full content of attachments included. |
| 4        | 22 November 2016 | Update format   |

## 1. Background

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Power transformers are major high voltage (HV) substation items of plant and are the most expensive substation items of HV plant. TransGrid has a population of 238 power transformers in service across its network, out of which 227 use oil as their primary insulating medium, and have oil-impregnated paper insulated windings. The remainder are SF<sub>6</sub> gas insulated (Haymarket and Munyang).

Over a period of time, transformer condition may deteriorate due to a range of issues leading to increase in the risk of failure and accelerated ageing. There are significant safety and environment risks associated with transformer failure.

While the majority of the substations are planned and built to provide N-1 supply security, failure of a transformer will result in compromised network security and may result in loss of partial load in some cases. Replacement of a failed transformer is a major undertaking and requires 3-5 weeks of work. Where a spare is not available manufacture of a replacement may take up to 18 months.

TransGrid performs periodic maintenance on these transformers, which includes oil sampling and analysis, as well as electrical diagnostic testing and this provides data on which to base an assessment of condition.

Based on the analysis of the transformer population through the development of a health index combined with detailed condition assessments a number of power transformers have been identified having high risk cost. If the identified issues are addressed within the 2018/19 – 2022/23 regulatory period, a net gain resulting from a reduced failure risk and an extended life is expected to be realised.

## 2. Need/opportunity

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As part of condition assessment and monitoring, oil sampling of all power transformers is routinely carried out annually and electrical diagnostic testing is carried out 4 yearly. TransGrid monitors a variety of condition indicators and intervenes when assets have condition indicators that are approaching acceptable limits. TransGrid's limits of acceptability for each condition indicator (consistent with International standards) are defined in the Condition Monitoring Manual.

The results of the condition assessment and monitoring are provided in the *Network Asset Condition Assessment or NACA* report and are used to determine the health index (HI) and an approximate estimate of the remaining life of each transformer.

In line with the risk management approach, TransGrid conducts criticality analysis on each transformer and calculates the risk cost. The following factors are considered in to the economic calculations for the risk cost.

- > Probability of failure
- > Environmental failures
- > Explosive failures
- > Incentive schemes for achieving higher availability
- > Supply reliability
- > Market impact of supply interruption

The overall steps in the assessment are as follows:

1. Available condition data has been analysed to assess the remaining life/failure risk of each transformer. This assessment takes into account defect rates, age, load, operations of tap changer, defect cost, oil analysis

and oil quality results and insulation integrity. For details, please refer to Transformer and Reactor Health Index Method Description D2016/03779.

2. Consequences for each failure mode are assessed based on criticality in the network and estimated risk to personnel and the environment along with the factors mentioned above.
3. The combination of consequence and probability of failure are combined to estimate risk cost for each power transformer.

In summary, the condition assessment and health index suggest that the identified transformers listed below are in poor condition with high risk cost to TransGrid. Refer to the items listed in Attachment 2 which are proposed to address identified condition issues.

It is important that transformer life is maximised in light of their high capital cost. The appropriate risk treatment of these transformers is expected to result in an opportunity to maximize life of some of these assets, which will also provide an economic benefit.

The transformers which have been identified with condition issues and an associated risk cost are listed below.

| Transformer              | Equipment Reference | PIC        |
|--------------------------|---------------------|------------|
| Ingleburn 330 kV Tx 1    | CMSING1A1           | EC00008977 |
|                          | CMSKCR0B4           | EC00008619 |
| Kemps Creek 500 kV Tx 2  | CMSKCR0B4           | EC00008618 |
|                          | CMSKCR0B4           | EC00008620 |
| Kemps Creek 500 kV Tx 3  | CMSKCR0C1           | EC00008621 |
|                          | CMSKCR0C1           | EC00008617 |
|                          | CMSKCR0C1           | EC00008616 |
| Liverpool 330 kV Tx 1    | CMSLP11A2           | EC00011909 |
| Liverpool 330 kV Tx 2    | CMSLP11B2           | EC00011910 |
| Moree 132 kV Tx 1        | NTSMRE2A2           | EC00003281 |
| Moree 132 kV Tx 2        | NTSMRE2B2           | EC00003280 |
| Murray 330kV Tx 1        | SWSMUR1A2           | ETA8449    |
| Murray 330kV Tx 2        | SWSMUR1B2           | ETA8450    |
| Murrumburrah 132 kV Tx 1 | SWSMUR1A2           | ETA8449    |
| Panorama 132 kV Tx 1     | COSPMA2A1           | EC00003262 |
| Panorama 132 kV Tx 2     | COSPMA2B1           | EC00003261 |
| Sydney North 330 kV Tx 3 | CMSSYN1C2           | EC00001718 |
| Sydney North 330 kV Tx 4 | CMSSYN1D2           | EC00006996 |

### 3. Related needs/opportunities

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Other needs have been developed for other substation needs, and these should be considered when delivering the final scope of works.

### 4. Recommendation

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It is recommended that options be considered to address the identified condition and associated risk of the identified power transformers.

## Attachment 1 – Risk costs summary

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

| Transformer       | Risk cost (\$M) |
|-------------------|-----------------|
| Ingleburn No.1    | 0.29            |
| Kemps Creek No.2  | 0.43            |
| Kemps Creek No.3  | 0.46            |
| Liverpool No.1    | 0.15            |
| Liverpool No.2    | 0.07            |
| Moree No.1        | 0.09            |
| Moree No.2        | 0.17            |
| Murray No.1       | 0.09            |
| Murray No.2       | 0.07            |
| Murrumburrah No.1 | 0.15            |
| Panorama No.1     | 0.21            |
| Panorama No.2     | 0.22            |
| Sydney North No.3 | 0.08            |
| Sydney North No.4 | 0.11            |
| <b>Total</b>      | <b>2.6</b>      |

## Attachment 2 – Transformer Works to Address Identified Condition Issues

| Transformer              | PIC        | Oil Replacement / treatment | Transformer oil (Material cost) | Oil filtering & degassing | Moisture Removal - Single Cycle | Moisture Removal - each additional cycles | Leak Repairs - whole of unit | Corrosion repair and re-painting (Major) | Replace Bushings - HV | Replace Bushings - LV | Modify Conservator - air space rectification | Inspection of selector - report on condition + recommendations |
|--------------------------|------------|-----------------------------|---------------------------------|---------------------------|---------------------------------|---|------------------------------|--|-----------------------|-----------------------|--|--|
| Ingleburn 330 kV Tx 1    | EC00008977 |                             |                                 | •                         |                                 |   | •                            |  | •                     | •                     |  | •  |
| Kemps Creek 500 kV No.2  | EC00008619 |                             |                                 | •                         | •                               |   | •                            | •  | •                     | •                     |  |  |
| Kemps Creek 500 kV No.2  | EC00008618 |                             |                                 | •                         | •                               |   | •                            | •  | •                     | •                     |  |  |
| Kemps Creek 500 kV No.2  | EC00008620 |                             |                                 | •                         | •                               |   | •                            | •  | •                     | •                     |  |  |
| Kemps Creek 500 kV No.3  | EC00008621 |                             |                                 | •                         | •                               |   | •                            | •  | •                     | •                     |  |  |
| Kemps Creek 500 kV No.3  | EC00008617 |                             |                                 | •                         | •                               |   | •                            | •  | •                     | •                     |  |  |
| Kemps Creek 500 kV No.3  | EC00008616 |                             |                                 | •                         | •                               |   | •                            | •  | •                     | •                     |  |  |
| Liverpool 330 kV Tx 1    | EC00011909 |                             |                                 | •                         |                                 |   | •                            | •  | •                     | •                     |  | •  |
| Liverpool 330 kV Tx 2    | EC00011910 |                             |                                 | •                         |                                 |   | •                            |  |                       |                       |  | •  |
| Moree 132 kV Tx 1        | EC00003281 |                             |                                 | •                         |                                 |   | •                            | •  | •                     |                       |  | •  |
| Moree 132 kV Tx 2        | EC00003280 |                             |                                 | •                         |                                 |   | •                            | •  |                       |                       |  | •  |
| Murray 330 kV Tx 1       | ETA8449    |                             |                                 | •                         | •                               |   |                              |  | •                     | •                     |  | •  |
| Murray 330 kV Tx 2       | ETA8450    |                             |                                 | •                         | •                               |   |                              |  |                       |                       |  | •  |
| Murrumburrah 132 kV Tx 1 | EC00006545 | •                           | •                               | •                         |                                 |   | •                            |  | •                     | •                     |  | •  |
| Panorama 132 kV Tx 1     | EC00003262 |                             |                                 | •                         | •                               |   | •                            |  | •                     | •                     | •  | •  |
| Panorama 132 kV Tx 2     | EC00003261 |                             |                                 | •                         | •                               |   | •                            |  | •                     | •                     | •  | •  |
| Sydney North 330 kV Tx 3 | EC00001718 | •                           | •                               | •                         | •                               |   | •                            |  | •                     | •                     |  | •  |
| Sydney North 330 kV Tx 4 | EC00006996 | •                           | •                               | •                         | •                               |   | •                            |  | •                     | •                     |  | •  |