Part of the Energy Queensland Group

# Standards Alert

| Subject: | **Ratings Parameters and Assumptions for Connections >1.5MVA** | **Control Ref No:** | StdsA421a |
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| | | **Date Issued:** | 04/12/2020 |
| | | **Supersedes:** | StdsA421 |
| For Policy/Procedure/Manual: | **Plant Rating Manual, Standard for Sub-Transmission Overhead Line Design, Substation Design Manual, Generator Capacity Management** | **Expiry Date:** | 30/12/2021 |
| Originating Dept: | **Asset Standards: Line Standards & Ratings** | | |

## 1. Amendment Record

| Version | Date | Author | Amendments |
|---|---|---|---|
| Initial | 02/10/2018 | Greg Caldwell | Initial Issue. |
| a | 10/11/2020 | Greg Caldwell | Title change to include all connections including loads greater than 1.5MVA. Update to Section 5 for application of continuous load factor. Update to Section 6 for allowance of individual transformer ageing studies and expanded on tap changers affected by reverse power flow. Update to Section 6 with reference to STNW1175. |

## 2. Objective

This Standards Alert is to communicate changes to the Energy Queensland distribution networks rating parameters in determining network capacity for connections including Energy Storage Systems (ESS) > 1.5MVA.

## 3. Introduction

From the Distribution Network Service Provider (DNSP) perspective, generator connections have changed network power flows, in many cases increasing the frequency in which constraints on primary assets are approached. This has resulted in a number of emerging risks where some assets have the potential to exceed design limits while others experience accelerated ageing. The three main types of assets currently being impacted are overhead lines, underground cables and power transformers. The impacts to and recommendations for these assets are discussed below. While other assets such as circuit breakers, current transformers and isolators have thermal limits, their operating environment is controlled and well understood.

## 4. Overhead Lines

Statutory clearances to ground and structures are absolute and are maintained by operating an overhead conductor below its design temperature. Elevated line temperatures not only increase the risk of breaching clearances as the conductor elongates; but cumulative loss of tensile strength is also experienced in aluminium conductors as line temperatures rise above 100°C, reducing conductor life. Additional risks include localised hotspots in accessories such as terminations, deadends and joints. This is particularly pertinent where a line has been lightly loaded historically and a step change in utilisation levels is expected with the introduction of large distributed generation or loads.

Given a line design temperature, the driving parameters in determining the rating of an overhead line is wind speed at a given ambient temperature. Wind speed is also one of the most variable parameters and wind speeds below the assumed value can cause a temperature rise above the design temperature. To mitigate against the risk of low wind speeds and an increasing frequency of intense heatwaves, the following recommendations apply:

1. **Generators connected to AAC, AAAC, HDBC and ACSR lines with design temperatures above 75°C will have their line rating limited to 75°C using standard network rating climate parameters. Higher operating temperatures may be permitted after seeking advice from Asset Standards.**

2. **Curtailment schemes for overhead lines are to limit line temperatures to 100°C following activation of a scheme.**

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| **CAUTION** | **Generators connecting to existing overhead lines shall have the stated design temperature and statutory line clearances validated by detailed engineering assessment. (LIDAR data or recent line surveys may be available to inform this study)** |

## 5. Underground Cables

The primary underground cable design aspects which influence cable rating include depth of burial, mutual heating from nearby circuits, bonding arrangement and cyclic load factor.

Cable size is selected to ensure that under normal operation, the maximum conductor and insulation temperatures are not exceeded. To apply consistent methodology under all operating conditions, including periods of prolonged dry spells and drought, the following parameters are to be used for generator connections >1.5MVA:

3. **A continuous load factor of 1.0 is to be used in design of cable systems for all generator types including solar, wind, hybrid, gas turbine and ESS.**
4. **Consideration of impact to existing customer and network cable systems is to be investigated where mutual thermal coupling will occur. Where the proposed cable system will be located within 5m of existing circuits, either through a cable crossing or a parallel route, a cable study is to be performed to assess derating impact to existing circuits published in source systems.**

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| **CAUTION** | **Results from thermal resistivity (TR) testing should be used for design of the cable systems.** |

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| **CAUTION** | **In many locations, extensive use of paper lead insulated cables exist with maximum operating temperatures below 90°C. Where mutual thermal coupling occurs with paper lead cables, cable studies are to limit XLPE cables to 70°C.** |

## 6. Power Transformers

There are three scenarios under which generators can connect to the network through a power transformer. Firstly, the generator may procure and maintain ownership of power transformer assets beyond the connection point. Secondly, the generator may procure the power transformer and transfer ownership to the network business to operate and maintain. The third scenario is where the generator is connecting to an existing network owned power transformer.

Transformers have the capability of operating beyond nameplate under normal and contingency conditions without adverse effect under certain conditions. Under a cyclic load, with peak durations less than 4 hours, power transformers will typically age less than day for day. However, transformers with a continuous load profile towards the nameplate rating will result in the rate of ageing to increase.

Studies are ongoing into the impact of this step change in utilisation on a power transformers life. Theory predicts that increases in weighted average temperatures of insulated paper windings can lead to accelerated ageing when combined with high oxygen levels and normal water content of paper values. Increased frequency of oil sampling and monitoring may form part of the response strategy.

The following principles apply to specification and procurement of new power transformers for generators and the rating of existing network power transformers with connected generators:

5. **Where a generator is specifying, procuring and transferring power transformer assets back to the network business, the Asset Standards power transformer building blocks are to be used. The specification of accessories being capable of 1.5p.u. may be lowered to between 1.0p.u. and 1.5p.u. depending on the likelihood of future network redeployment, network configuration and accessory standardisation.**
6. **Two considerations apply for generators where an existing network power transformer will exhibit reverse power flow:**
    - 6.1. **For power transformers without higher cooling modes i.e. ONAN only, the connection and subsequent operation shall be limited to the ONAN rating. Ageing studies conducted as part of the connection process may apply restrictions lower than the ONAN rating.**

6.2. **For power transformers with higher cooling modes i.e. ONAF/ODAF, the connection and subsequent operation shall also be restricted to the ONAN rating unless trip/curtailment schemes for the generator are in place to monitor operation of the cooling device. Ageing studies conducted as part of the connection process will determine the level of loading.**

**Accelerated ageing studies are ongoing in addition to increased oil sampling and monitoring where step changes in utilisation on power transformer assets are realised. The results of these studies will be reviewed annually to determine network impacts. The tertiary shall not be loaded beyond 1.0p.u. as per existing practice.**

7. **Curtailment schemes for generators may be required following a contingency event to prevent overloading power transformers and other primary plant beyond thermal limits.**

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| **CAUTION** | **Reverse power flows through tap changers can be a constraint on single resistor tap changers. Impacted tap changer models include Ferranti, Fuller, HSPT & ATL manufactured until the early 1980's.** |

# 7. Generator Current Contributions

As part of their connection contract, all generating systems will have a reactive power contribution, in line with the requirements of STNW1175. Line loading is affected by current (A), which can be made up of reactive power and active power. As such, the total current contribution of the generating system must be considered when determining the line rating requirement for a generating system (including ESS).

## *7.1. Voltage Disturbance Ride-Through Requirement*

Generating systems have a voltage disturbance ride-through requirement. Normal operation is expected to be within the range of 0.95 to 1.05 pu, however provision must be made for excursions to 0.9 and 1.1 pu. The rating of equipment shall account for generating system response to voltage disturbances where the generator is to be capable of continuous uninterrupted operation at 90% of the normal voltage.

In the context of a generator connecting under 5.3A of the National Electricity rules, this generally means compliance to Automatic Access Standards for both S5.2.5.1 and S5.2.5.4, refer to the example below. The plant rating of network equipment must be capable to facilitate the generator's performance to both these access standards.

The line current expected on a 33kV feeder connected to a 30MW generator would be:

$$\frac{30\text{MW}}{(0.93 \times 0.9 \times 33\text{kV} \times \sqrt{3})} = 627\text{A}$$

# 8. Update to Manuals

This Standards Alert will be incorporated into the following manuals as part of future releases. A new Energy Queensland Plant Rating Manual will be released as part of consolidation of the Ergon Energy and Energex legacy plant rating manuals.

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| NA000000R100 | Plant Rating Guidelines (Ergon) |
| | Plant Rating Manual (Energex) |
| STNW3661 | Standard for Distribution Line Design |
| 00302 | Overhead Design Manual |
| STNW3355 | Standard for Sub-Transmission Overhead Line Design |
| NI000401R121 | Substation Design Manual |
| NA000403R512 | Generator Capacity Management |

# 9. Further Information

For further information, please contact:

Greg Caldwell, Phone 0417 613 569, email greg.caldwell@energyq.com.au