Public

Guidance on TNUoS Locational Onshore Security Factor Calculation

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NESO
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Contents

Disclaimer

In the event of any inconsistencies between this guidance note and the CUSC, then the latest CUSC will take precedence.

The latest CUSC can be downloaded from the National Energy System Operator website.

What is the Locational Onshore Security Factor?

The Transmission Network Use of System (TNUoS) wider tariffs consist of two parts:

- **the locational tariffs:** rates that vary by zone to send investment signals.
- **the non-locational (residual) tariffs:** a flat rate across all zones to ensure the recovery of TNUoS revenue.

In the wider TNUoS methodology, there is a Locational Onshore Security Factor, referred to as the Security Factor in this paper, which applies uniformly across the network.

This Security Factor is required to consider the additional redundancy that is built into the network through the obligation on the TOs to meet the SQSS requirements, and to accommodate flows under both planned and unplanned circuit outages.

How is the Security Factor used in TNUoS?

TNUoS locational tariffs are calculated using the DC Load Flow (DCLF) transport model and are derived on a purely unconstrained network, assuming all circuits are in service. This is to obtain relatively stable long-term locational prices which are not subject to short-term operational measures (e.g. choice of specific circuit outages or dispatch patterns).

After calculating the wider locational prices on the unconstrained network, the locational prices are “stretched” by multiplying them by the Security Factor, to reflect the extra capacity in the transmission network (i.e. the level of redundancy designed into the transmission network).

After multiplying the locational prices by the Security Factor, the wider (zonal) tariffs are calculated by applying weighted average to the “stretched” locational prices at relevant sites within that zone. Therefore, all generator and demand users are affected by the value of the security factor.

How to calculate the Security Factor?

The Security Factor is derived using a Secured DCLF (SECULF) programme, which calculates the marginal cost for each node. The programme considers the requirement to meet the peak demand, despite simulating circuit faults resulting in maximum flows for each circuit.

The SECULF programme uses the same network and nodal input data as the DCLF transport model. The network analysis is carried out without expansion factors, i.e. the base network data is used with the physical circuit lengths without being “stretched” by the expansion factors.

Firstly, the SECULF calculates marginal costs for each node for the intact system. The SECULF then calculates the marginal cost for each node, this time considering the requirement for the network to be secure against the worst “credible” contingency. The programme does this by identifying the circuit outages which cause the maximum flow for each circuit. The secure and intact marginal costs are then compared on a nodal basis, and a “least squares fit” is employed to derive the wider network security factor.

Which background was used to calculate the security factor?

CUSC 14.15.88[1] states that the security factor should be calculated under the same market background as used for generation zoning, while CUSC 14.15.42 says that generation zoning is determined using the generation background with the most MWkm. Therefore, we calculated the Security Factor using the year-round background, as it has higher MWkm than that under the peak security background.

It is worth noting that the scenario, known as “year-round background”, in the CUSC, is in fact referred to as the “economy background” in the SQSS, and is set up under the ACS (average cold spell) peak demand condition with an intact system.

Which factors affect the value of the Security Factor?

There are a few factors that affect the value of the security factor:

- **Onshore wider network**: the topology and parameters (lengths and reactance) of the onshore wider network will affect the calculation. On the other hand, onshore local circuits and offshore network are not relevant to the calculation and are ignored by the SECULF programme. A few onshore wider circuits that have the special security factor of 1.0, e.g. remote island links, are also ignored by the SECULF programme.
- **Generators**: the TEC value at each node and generator fuel types will affect the calculation.
- **Nodal net demand**: nodal net demand data for the transport model is used in the calculation.

For clarity, expansion constant / factors are not needed for the calculation of the security factor.

A worked example of SECULF calculation

The following example is used to illustrate how the security factor is calculated by SECULF.

Figure 1 shows the network, where the generator (G) produces 100MW, and the demand at node 1 absorbs 10MW. The two circuits between node 1 and node 2 have equal length (10km each) and equal reactance. Therefore, 45MW flows through each circuit.

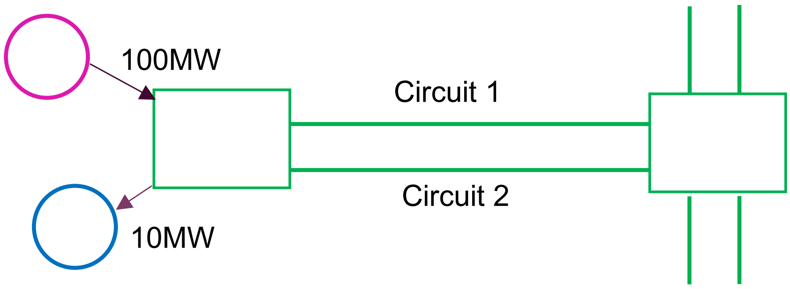


Figure 1 The intact network

To calculate the marginal cost at node 1 under the intact network, generator (G) increases its output by 1MW, resulting in additional flow of 0.5MW on each of the two circuits between node 1 and node 2 (assuming there is a large demand centre at node 2). Therefore, the marginal cost at node 1 is $0.5\text{MW} \times 10\text{km} + 0.5\text{MW} \times 10\text{km} = 10\text{MWkm}$. The marginal costs obtained under the intact network is called the “unsecured” marginal costs, as contingencies have not been given consideration yet.

The next step is identifying the worst contingency for each of the circuits; the SECULF model simulates a list of circuit outages and identifies the circuit outage that causes the maximum flow on each circuit.

For circuit 1, the worst contingency is the loss of circuit 2[2], as illustrated in Figure 2, where the energy flows from node 1 to node 2 via circuit 1.

[1] If both circuit 1 and circuit 2 are lost, Node 1 will be cut off from the wider network. Under this situation, SECULF will not be able to calculate the marginal cost for node 1. Therefore, this contingency is deemed irrelevant and is not included in the list of circuit outages for the Security Factor calculation.

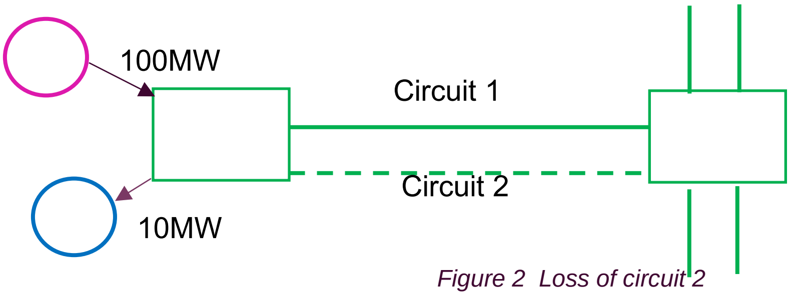


Figure 2 Loss of circuit 2

Similarly, SECULF identifies that for circuit 2, the worst contingency is the loss of circuit 1, as illustrated in Figure 3, where the energy flows from node 1 to node 2 via circuit 2.

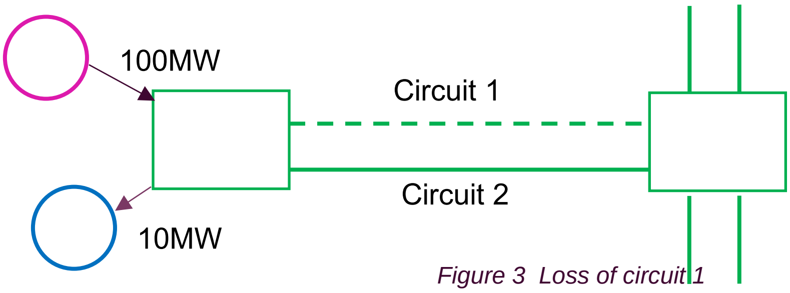


Figure 3 Loss of circuit 1

Next, calculating the secured nodal marginal costs: the "secured" marginal cost for node 1 is the sum of additional MWkm under the worst contingency for each of the relevant circuit. The marginal MWkm incurred on circuit 1 is$1\text{MW} \times 10\text{km} = 10\text{MWkm}$, and the marginal MWkm incurred on circuit 2 is also $1\text{MW} \times 10\text{km} = 10\text{MWkm}$, therefore the secured marginal nodal cost for node 1 is 20MWkm.

The final step is to calculate the ratio of secured and unsecured marginal costs for all the nodes, and to work out the average ratio using least square fit. In this illustrative example, node 1 is the only one under study. The ratio of secured marginal cost to unsecured marginal cost for node 1 is$20\text{MWkm} \div 10\text{MWkm} = 2$, meaning that the network between node 1 and node 2 has 100% redundancy.

Security factor for years 2021/22 – 2025/26

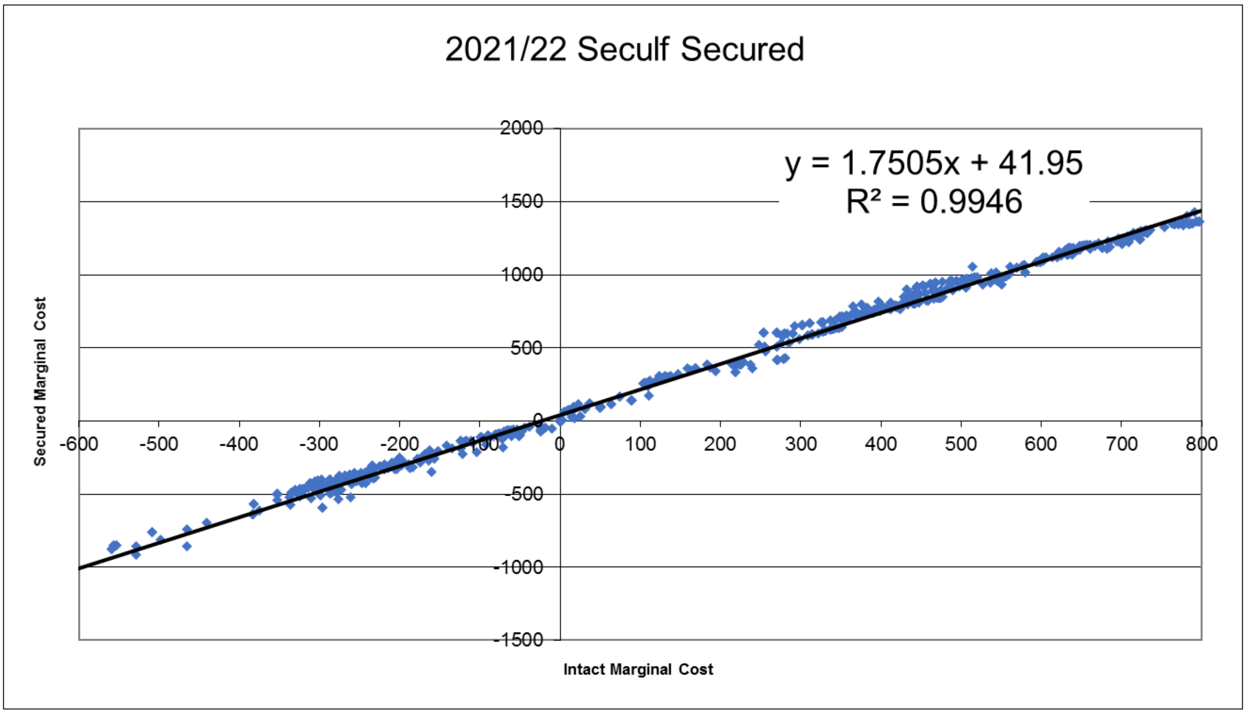
For a charging year, the ratio of secured marginal costs to unsecured marginal costs, based on average least squares fit method for all the nodes on the wider network, is the security factor.

We have calculated the global security factor, using the network models for RIIO-T2 (2021/22 – 2025/26), and have derived the security factor for each year. The values are listed in the following table (values are rounded to 4 decimal places, as displayed in excel trendline by default).

The average of the five figures gives us the security factor to be applied for RIIO-T2 charging years.

Year	Security Factor
2021/22	1.7505
2022/23	1.7481
2023/24	1.7677
2024/25	1.7550
2025/26	1.7561

An example of the 2021/22 result is shown here.



Contact us

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