STCP21-2 Issue 001 Network Asset Risk Metric (NARM) Data Exchange Guidance

Guidance Document Authorisation

Company	Name of Party Representative	Signature	Date
National Grid Electricity System Operator plc			
National Grid Electricity Transmission plc			
SP Transmission plc			
Scottish Hydro Electric Transmission plc			
Offshore Transmission Owners (OFTO)			

Guidance Document Control History

Issue 001	31/01/2020	New guidance and data exchange forms

Guidance on Calculating Boundary Risk Costs

Introduction

The Onshore Transmission Owner's (TOs) Network Asset Risk Annexes (NARAs) outline the process by which $R_{boundary}$, the monetised consequence of increased generation constraints due to asset unavailability, is calculated. This guidance gives more detail on how this process is to be implemented by both the Electricity System Operator (ESO/ NG ESO) and the Onshore TOs.

Calculating Average Hourly Boundary Costs (B_y)

The first step of the process is to calculate the annual average hourly boundary cost in pounds per hour, B_y, for every relevant boundary on the network. This is the average additional cost NG ESO could be expected to incur for every hour a circuit on the boundary is not available due to an asset failure. To determine this value for all relevant boundaries several steps need to be undertaken by different parties. These are laid out in order below.

1. Identifying Relevant Boundaries

The TOs and NG ESO must agree on a list of relevant boundaries to be considered, these boundaries must be consistent with the output of the latest Network Options Assessment (NOA). The agreed list of boundaries for study may be a subset of those identified by the NOA process. A boundary's relevance is determined by whether NG ESO and the TO believe that a boundary's B_y values will be significant within the wider calculations of asset risk. It is likely that this threshold will be relatively low, a B_y value of a few thousand pounds would be significant, representing an average constraint of a few 10's of MW. It is better for this list of boundaries to be exhaustive than to be overly restricted as returning immaterially small values is preferential to missing out boundaries that would have material impact on overall asset monetised risk.

2. Determining Boundary Capabilities

The TOs must provide a set of boundary capabilities for each boundary, intact, N-1 and N-2. It is important to be clear in defining these capabilities. The definitions are outlined in the table below.

NARM Terminology Boundary State	NOA Equivalent Terminology	Description
Intact System	N-D/N-1	The power flow in MW that can pass across a boundary while all circuits relevant to that boundary are intact. This level of flow must enable NG ESO to operate the system as per the SQSS, securing the system for the next N-D & N-1 event, considering permissible post-fault actions.
N-1	N-1-D/N-1-1	As for intact, but with one relevant circuit on the boundary out of service for a sustained period (> 1hr). The pre-fault condition is therefore N-1, the post fault condition is N-1-D/N-1-1.
N-2	N-2-D/N-2-1	As for intact, but with two relevant circuits on the boundary out of service for a sustained period (> 1hr). The pre-fault condition is therefore N-2, the post fault condition is N-2-D/N-2-1.

If the TOs and NG ESO agree to it, seasonal factors can be used to modify these boundary capabilities to more accurately model year-round system capability in NG ESO's economic analysis.

3. Calculating Annual Boundary Costs

Because system boundaries are often interactive it is difficult to link a specific cost incurred by NG ESO to a specific boundary. Because of this, absolute costs of boundary constraints are not calculated, instead the increase in system constraint cost associated with a specific reduction in the capability of a specific boundary is calculated. This gives a cost delta that can be solely and wholly attributed to the reduction in capability of a single boundary.

Each cost to be calculated is a whole system, year-round constraint cost that is the standard output of NG ESO's economic model (BID3). Each cost is the output of a single run of NG ESO's economic model considering:

- A single year of operation, the current baseline year used for NOA analysis
- A single generation/demand scenario in the baseline year
- A fixed network without any future reinforcement

The runs of the model to be made are:

- All boundaries intact, all boundary capabilities are set to 'Intact System' as defined in the table above
- One run for each boundary with that boundary set to the 'N-1' capability as defined in the table above, and all other boundaries set to their 'Intact System' capability
- One run for each boundary with that boundary set to the 'N-2' capability as defined in the table above, and all other boundaries set to their 'Intact System' capability

The number of runs required is therefore 2α+1, where α is the number of relevant boundaries.

4. Converting Annual Boundary Costs to Hourly B_y Values

Once the annual boundary costs are known the TOs can convert the hourly delta values between two network states. The TOs NARAs (Network Risk Annexes) outline how this is done:
B_Y and B_{Y+1} are calculated for each relevant boundary as follows:

$$B_Y = \frac{[(annual\ cost\ for\ boundary\ at\ N-1) - (annual\ Intact\ cost)]}{8760}$$

$$B_{Y+1} = \frac{[(annual\ cost\ for\ boundary\ at\ N-2) - (annual\ Intact\ cost)]}{8760}$$

5. Identifying Circuits Relevant to each Boundary

The TOs and ESO must then decide which circuits are relevant to each boundary. Not all circuits will be equally important to a boundary and reduce its capability as much as the worst-case fault. However, it would be infeasible to calculate capabilities for every circuit, so this simplification is made. Circuits that are designated as relevant to boundary should therefore be those that would be expected to significantly reduce the boundary capability to the same order of magnitude as the worst-case fault.
Where a circuit could be deemed relevant to more than one boundary, it should be assigned to only the boundary with the highest annual boundary cost to avoid double counting its impact.

6. Calculating $R_{boundary}$ for Each Failure Type of Lead Assets

The TOs will then calculate $R_{boundary}$ for each failure type according to the equation in the TO's NARAs:

$$R_{boundary} = D_{fm}[B_Y(1 - P_{Y+1}) + B_{Y+1}P_{Y+1}]$$

Where D_{fm} is the duration of the failure type and P_{Y+1} is the proportion of time that the boundary is expected to have an additional circuit out of service. Y is the number of circuits taken out of service for an asset failure.

Guidance on Agreeing Requirement Factors for Reactive Compensation Equipment

The purpose of the requirement factor, R_F is to reflect the fact that not all types of reactive compensation are required to operate the network under all system conditions in a given year. All the TOs agreed a methodology of categorising compensation into one of four types. These types and their respective R_F values are shown in the table below.

Reactive Compensation Type	R_F
Reactor	1
SVC (Static Var Compensator)	1
Boundary critical capacitor	1
Local voltage capacitor	0.25

Reactors, SVCs and boundary critical capacitors are given RF values of 1 to reflect their criticality to system operation throughout the year as the need for high voltage control, dynamic voltage control and to support voltage during high boundary flows can and do occur at any time during the year. Therefore, these compensation types are given an R_F of 1. Local voltage capacitors are those that are not required to support high boundary flows across main boundaries on the transmission system but instead are required to support high local demand in the region they are connected. This requirement is far more seasonal and limited to the winter months. Accordingly, this type of compensation is given a R_F of 0.25.

The TOs will assign a type of compensation to each reactive compensation device as well as any lead assets which are required to be in service to operate the compensation such as the circuit breakers which switch them in and out.

The TOs will share their lists with NG ESO (itemised as individual circuit IDs as opposed to individual assets, where many may appear on the same circuit) for comment as part of their data submission to NG ESO with any changes to previous lists highlighted. If NG ESO have any comments these will be returned to the TOs as part of the NG ESO data submission to the TOs.

Guidance on Calculating the Average Cost of Procuring MVAr from Generation Sources

This component of System Consequence is calculated by taking an annual sum (from the latest, complete financial year) of:

- all costs of generators to absorb MVArs including Balancing Mechanism actions to:
  - bring plant into service
  - constrain plant
- the cost of providing the reactive absorption service

This sum is divided by the total number of MVArs absorbed by generators over the year to give an average cost of procuring MVAr from generation sources.

Appendix A: Data Exchange Form – Boundary Risk Cost and Capability

TO and NG ESO Agree	TO Provide			NG ESO Calculate			TO Calculates		Space for TO and/or ESO Notes
	Transfer Capability (MW)			Annual Cost (£m 2018 prices)					
Boundary	Prefault Intact (N-D)	Prefault N-1 (N-1-D)	Prefault N-2 (N-2-D)	Prefault Intact	Prefault N-1 (N-1-D)	Prefault N-2 (N-2-D)	B_y	B_{y+1}	Notes
All Boundaries Intact									

Appendix B: Data Exchange Form – Requirement Factors for Reactive Compensation Equipment (with example data)

TO Provide		*TO Provide* but ESO to feedback on criticality of capacitor – boundary or local?	Space for TO and/or ESO Notes
Circuit ID	Reactive Compensation Type	R_F	Notes
Substation Capacitor Circuit	Boundary critical capacitor	1	
Substation Capacitor Circuit	Local voltage capacitor	0.25	