

SURVEY RESULT FROM DNO'S QUANTIFYING SMALL EMBEDDED GENERATION LOSS RISK ON CREDIBLE HIGH FREQUENCY EXCURSIONS

National Grid

BACKGROUND

GCRP paper 08/07 entitled 'Small Embedded Generation Loss Risk on System High Frequency Excursion' was presented by NGET at the February 2008 GCRP meeting. The paper presented NGET's concerns on the possible risk to the security to the GB power system likely to be posed by the loss of an unknown but significant amount of small embedded generation at time of high frequency excursions.

To allow NGET to assess and quantify any present risk to the security of the GB system, further data/clarifications were requested at the November 2008 and then the February 2009 GCRP meetings. Data was received from all DNOs by March 2009 and the outcome of the investigation is given in this paper.

SUMMARY OF THE DATA RECEIVED FROM DNO'S

The data received from all DNO's are summarized in Table 1. Column (A) shows a total of 6074 MW of installed Small embedded generation reported to have an over frequency relay setting in accordance with ER G59/1 i.e. 50.5 Hz.

Column (A') effectively represents the average output of the installed plant taking into account typical load factors. Some DNO's provided generation load factors derived from dividing the total energy metered over a period of time by the equivalent energy that could be generated based on rated output for the same period. Other DNO's used assumed typical load factors for different plant types. Adding up these averages gives a total average of 2545 MW.

Column (B) represents installed Small embedded generation with non-standard over frequency settings and shows only 12.8 MW (set at 51 Hz) in one DNO area. Column (C) shows zero MW of plant with unknown over frequency setting. Also, the DNO's confirmed that they have no expectation of there being plant with other over frequency settings.

SIMPLIFIED ANALYSIS AND DISCUSSION OF RESULTS

The total installed capacity reported at 50.5 Hz setting is just over 6 GW. This level of loss is considered to be unlikely. However, it is useful to obtain some statistical measure of the MW loss risk levels to enable an informed decision to be made regarding the way forward.

In the absence of any other information, three assumptions have been considered and the probability distribution of the total MW loss risk level is calculated for each. The probability density of the data submitted for each DNO area is assumed to be triangular with a minimum, median and maximum values that are equivalent to zero, Column (A') and Column (A). In the first assumption, the fourteen areas are treated completely independently using 14 independent triangular distributions. Under the second assumption, a single distribution is used corresponding to the 'Total' row of Table 1 i.e. an installed and median values of 6074 MW and 2545 MW respectively. Under the third assumption, three triangular distributions are used that correspond to average load factors of 0 to 35%, 36% to 65% and 66% to 100%.

The results are shown as curves a) (first assumption), b) (second assumption) and c) (third

assumption) in the Figure.

Under NGET's license standards the system frequency is permitted to rise to 50.5Hz under credible system operating conditions such as a demand loss of 1000 MW. Curve a) indicates that there is a 50% chance of losing 2367 MW or more should the frequency rises to 50.5Hz or above. When combined with a credible demand loss of 1000 MW, this would result in a net loss of at least 1367 MW of generation to the transmission system. NGET currently holds sufficient reserve to secure the system for a generation loss of 1320 MW. The implication of curve a) is that there is a 50% chance that the GB system is insecure for a credible 1000 MW demand loss or equivalent system event(s) that causes a frequency rise to 50.5 Hz and consequent generation tripping. Under these conditions the national low frequency demand disconnection scheme will operate to protect the total GB power system from a total blackout. This scheme will trip a minimum of 5% of the national system demand.

Curves b) and c) indicate a higher probability that the system will be insecure for the same credible event(s) that causes the frequency to rise to 50.5 Hz: curve b) shows a 64% probability that there will be a net generation loss of at least 1360 MW, curve c) shows a 79% probability.

FURTHER INFORMATION AND ANALYSIS

Given the system security implications of the above analysis, NGET believe there is an urgent need to

- a) establish the volume of embedded generation and number of power stations in the size category of 5 MW and above
- b) establish the volume of embedded generation in the size categories
 - i) 1 to 5 MW
 - ii) below 1 MW
- c) determine the impact on system security of increasing the high frequency trip settings of generation in these groups
- d) identify a size threshold above which DNOs should review the high frequency settings requirements for new plant and approach existing plant owners to consider if their settings could be raised above 50.5 Hz.

WAY FORWARD

The GCRP is invited to:

- a) Note the concerns of NGET regarding the risk to the security of the GB system posed by likely tripping of a significant amount of embedded generation during secured, credible high frequency deviations
- b) Note that NGET will seek further assistance from DNOs to identify plant in their areas with ratings in the above categories and request they revise their high frequency setting requirements from 50.5 to 52 Hz for plant of a size to be determined. If justified and agreed, 51 or 51.5 Hz could be acceptable.
- c) Note that NGET will pursue the issue within the current E3C Embedded Generation Working Group, including reviewing the High Frequency setting requirements in the Distribution Code and G59/2 document.
- d) Note that given the significant implications to the security of the GB power system, NGET intends to regularly update the Energy Emergency Executive Committee (E3C) on this

issue and progress made within the industry.

**Table 1 - Embedded Generation Over Frequency Trip Settings
Summary of Revised Data from DNO's (March 2009)**

DNO Area	Total Installed Capacity with Standard Over Frequency Setting (ie 50.5Hz)	Equivalent total generation loss risk taken into consideration of load factors	Total Installed Capacity with Non-standard Over Frequency Setting (other than 50.5Hz)	Total Installed Capacity with Unknown Over Frequency Setting	Comments
	(A)	(A')	(B)	(C)	
	MW	MW	MW	MW	
CEE (NEDL)	386.0	282.0	0.0	0.0	
CEE (YEDL)	656.1	535.0	0.0	0.0	
CN (East)	352.0	290.0	0.0	0.0	
CN (West)	310.2	270.2	0.0	0.0	
SP (D)	460.6	165.6	0.0	0.0	
SP (M)	676.6	279.9	0.0	0.0	
ENW	445.0	138.0	0.0	0.0	
WPD (SWales)	330.5	211.1	0.0	0.0	
WPD (SWest)	352.9	141.3	0.0	0.0	
SSE (Hydro)	192.1	150.0	12.8	0.0	12.8MW at 51Hz
SSE (Southern)	513.8	288.1	0.0	0.0	
EDFE (E)	739.0	495.6	0.0	0.0	
EDFE (S)	339.2	215.7	0.0	0.0	
EDFE (L)	320.2	189.6	0.0	0.0	
Total	6074.2	2545.1	12.8	0.0	

