LCN Fund Full Submission

Supplementary Answer Form

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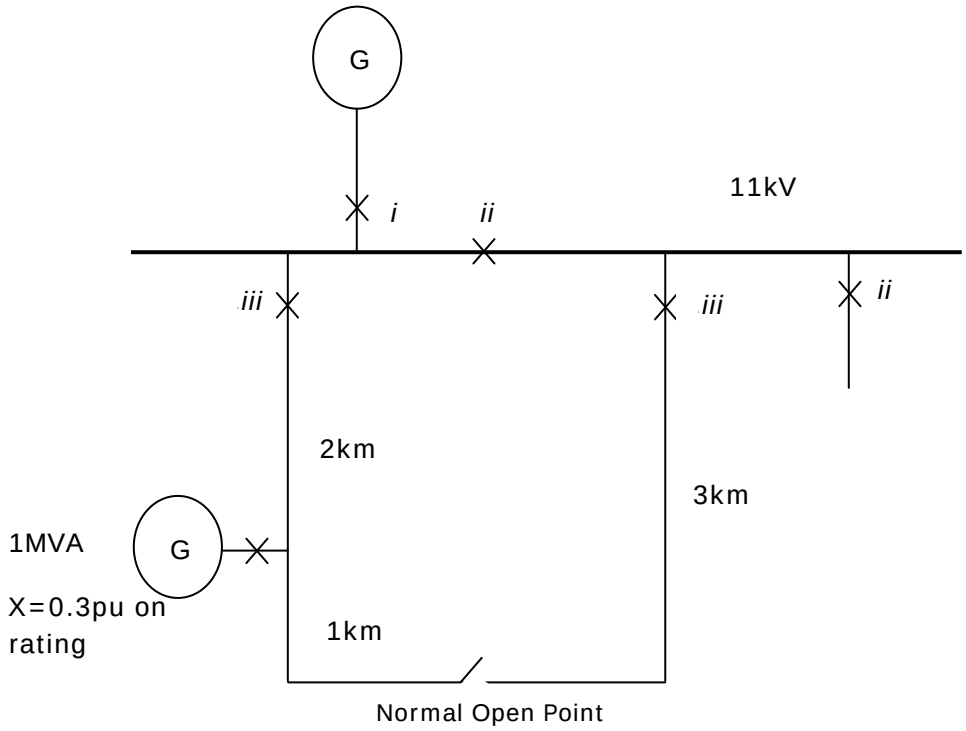
Project code:	ENWLT2003	Question Number	Additional Answer 3
Question date	7 September 2011	Answer date	16 September 2011
Submission section question relates to	Consultants Review session		
Topic	Change in fault levels with closing the HV ring		
Question	Will the change in fault levels affect the operation of the HV network?		
Notes on question	At the Consultants Review session the bid team answered the question regarding the change in fault level from closing the NOP forming an HV closed ring. The answer provided by the bid team without using diagrams or drawing upon an example. We felt that a written worked example would help illustrate the change in fault level which would support and reinforce the answer provided at the Consultants Review session.		
Answer	**Effect of Closing 11kV Ring on Primary Substation Fault Current** The purpose of this note is to illustrate how the 11kV fault currents at a primary substation would be modified by a change from open to closed ring operation of the circuits supplied. Fault levels are normally dominated by the fault current flowing from the upstream system, and there may be a contribution from motors within the network load. Closing an 11kV ring will not alter the substation fault level attributable to the upstream system. However, closing the ring would lead to a small theoretical increase in the contribution from downstream motors, but this is small compared to the upstream contribution and therefore the overall change in the substation fault level due to would be insignificant. Closing the ring would have the largest effect on substation fault levels if embedded generation was connected to the 11kV ring.		

A simple fault current analysis has been carried out on a typical system including embedded generation to illustrate the prospective change:



The symmetrical break duty fault current at the primary substation without any embedded generation is assumed to be 8kA (152MVA). This is represented as an equivalent generator connected to the primary substation busbar. 8kA is a typical value for the ENWL system. The embedded generator is assumed to be rated at 1MVA and to have a reactance of 0.3 per unit, representing the generator, transformer and connecting cables. The ring system cables are assumed to be 300mm^2 triplex, with route lengths as shown. Resistances are ignored in this calculation.

The symmetrical break duty fault currents are calculated for the following two cases:

a) Open ring
b) Closed ring

For each case, the maximum fault current duties are calculated for the circuit breaker positions indicated in the diagram. Not all circuit breakers are required to switch the total substation fault level due to the different direction of fault currents from the upstream and downstream systems. The maximum current circuit breaker *i* would need to switch is that due to the upstream system and this is also the case for circuit breakers labelled *iii*. However, circuit breakers *ii* would be required to switch the summed fault currents from the upstream and downstream systems.

The calculation results are tabulated below:

	<table><tr><td rowspan="2">Case</td><td colspan="3">Fault current (kA) at circuit breaker position</td></tr><tr><td>i</td><td>ii</td><td>iii</td></tr><tr><td>(a) Open ring</td><td>8.00</td><td>8.17</td><td>8.00</td></tr><tr><td>(b) Closed ring</td><td>8.00</td><td>8.59</td><td>8.00</td></tr></table> It can be seen that the increase in fault current is relatively small and is confined to a small number of circuit breakers. Secondary substations are excluded from this analysis. The change from open to closed ring could have a proportionately greater effect on the fault currents at secondary substations. However, the potential fault currents would tend to be significantly lower than those at the primary substation. The ENWL 11kV design fault level is 13.1kA (250MVA) and the switchgear at ENWL primaries is rated between13.1kA and 25kA, with almost all primary switchgear rated at 25kA. Fault levels at secondary substations, where switchgear is usually rated at 7.88kV (150MVA), could typically be less than 2.6kA (50MVA). It is worth noting that automatic devices at distribution substations are usually HV fuses which are rated at 80kA.
Attachments	None.
Verbal Clarifications (Consultants)	None.