Small Network Analysis

The network

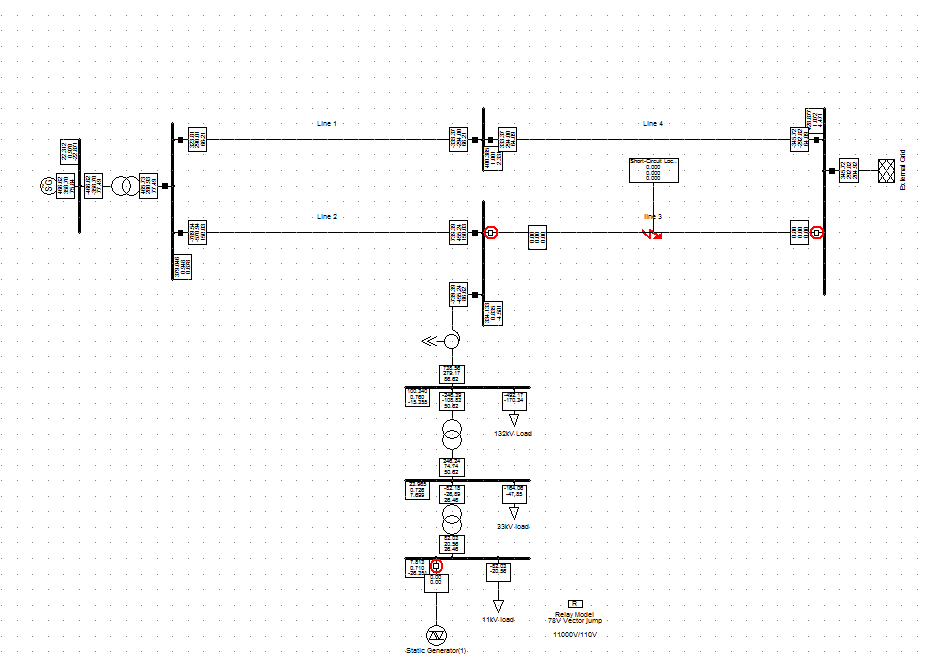
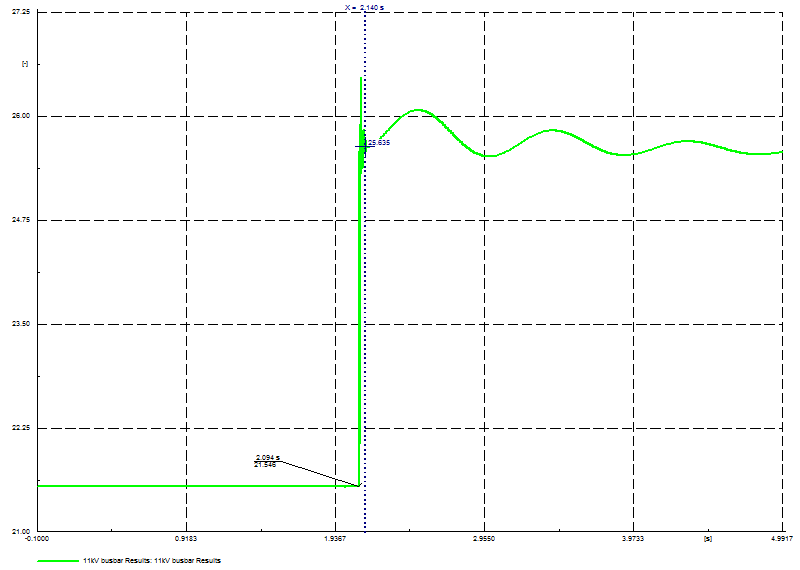


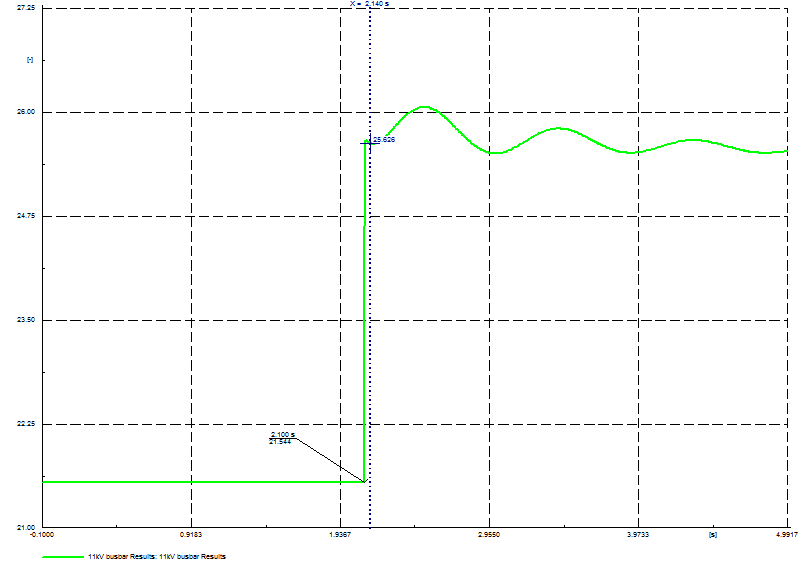
Fig 1

For a Fault on line 3 with a fault clearing time of 140ms the following were observed on the 11kV busbar

1. **Result Using EMT simulation**



1. Results From RMS simulation



Result summary

|  |  |  |
| --- | --- | --- |
| Study | EMT | RMS |
| Three phase fault | 4.082 | 4.079 |

**Conclusion**.

EMT studies include in their simulation the impact of fast electromagnetic transients e.g. stator transients of an induction machine. These are ignored in the RMS simulation. From the various analyses on this network, the change in angle is almost the same. We have concluded that the use of the RMS simulation will be a good indicator of the changes in the angle.

GB Network Analysis

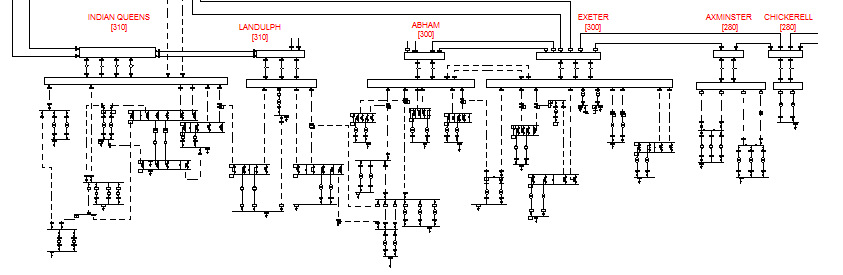
The network used is composed the GB transmission network modelled explicitly with all the components while the DNO is as submitted by the DNO in line with their Grid Code obligation. Small and medium embedded generations in England and Wales have been netted of the demand.

**Network k Background**

|  |  |  |  |
| --- | --- | --- | --- |
| **Demand[MW]\*** | **Synchronous Generation** | **Non synchronous** | **HVDC(imports)** |
| **27350** | **24790** | **540** | **2800** |

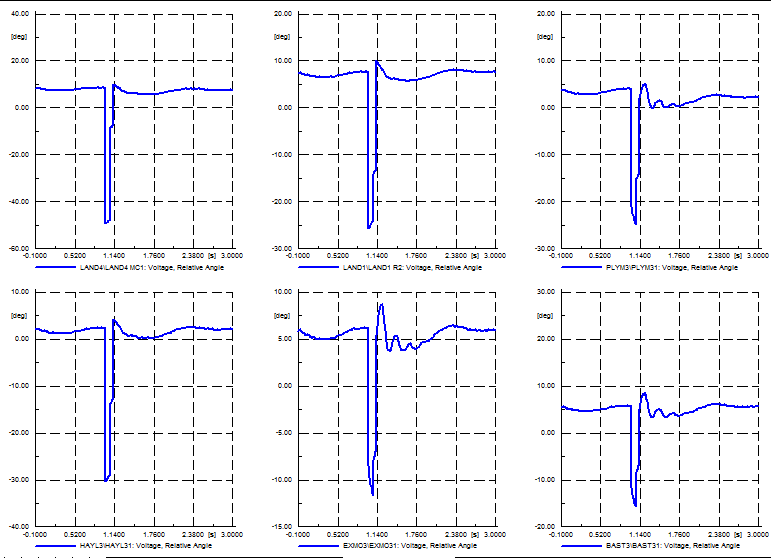
\*This is net of embedded generation for England and wales

The following is the network Use to analyse Case 1 to 4



# Case A: Three phase fault at Landulph substation on the line A83B toward Language, with Language Power station on and monitored the changes at Landulph 400kV and 132kV, Plymouth, Hayle, Exmouth and Barnstaple.

**Voltage Waveforms in Different Parts of the network**



# Case B: Repeat Case A with Language Power Station switched off

# Case B involve switching out a generator at Language

# Case D involves switching out a transformer at Landulph 400kV

# Below is a summary of the result

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Case A** | **Case B** | **Case C** | **Case D** |
| Substation | Busbar short Name | Change in angle | Change in angle | Change in angle | Change in angle |
| Landulph 400kV | LAND4 MC2 | 57.418 | 61.163 | 1.453 | 0.017 |
| Landulph 132kV | LAND1 R1 | 32.973 | 36.295 | 1.436 | **5.633** |
| Plymouth 33kV | PLYM31 | 25.291 | 24.063 | 1.230 | 0.130 |
| Hayle 33kV | HAYL31 | 32.366 | 32.584 | 1.299 | 0.580 |
| Exmouth 33kV | EXMO31 | 14.792 | 13.027 | 0.997 | 0.025 |
| Barnstaple 33kV | BAST31 | 17.940 | 15.796 | 1.037 | 0.349 |
| Langage 400kV | LAGA4 M1 | 33.294 | 38.451 | 1.514 | -0.201 |

From the above, **Case A** and **Case B** result is a significant change in the voltage angle. When Language Power Station is out, the vector shift is higher as the fault level at the point of fault decreases.

# Three phase Fault at Pentir substation on the circuit 2, A256, toward Wylfa and vector shift was monitored at the following substations.

|  |  |  |
| --- | --- | --- |
| Substation | Busbar short Name | Change in angle |
| Pentir 400kV | PENT4 M1 | 50.37088688 |
| Pentir 132kV | PENT1 M2 | 38.02289024 |
| Caernarvon 33kV | CANA31 | 40.00634941 |
| Rhyl Flats 132kV | RHYF11 | 28.95458762 |
| Dolgarrog 33kV | DOLG31 | 31.75623118 |
| Wylfa 132kV | WYLF1 R2 | 49.90373662 |
| Wylfa 400kV | WYLF4 R2 | 50.32591458 |
| Wylfa 132kV | WYLF1 M1 | 49.90373662 |
| Trawsfynydd 400kV | TRAW4 MC2 | 31.75954547 |
| Trawsfynydd 132kV | TRAW1 R1 | 27.8461986 |
| Maentwrog 33kV | MAEN31 | 28.9396674 |
| Cwm Dyli 33kV | CWMD31 | 28.79272107 |
| Deeside 400kV | DEES4 R2 | 22.70928399 |
| Connahs Quay 132kV | CONQ1 R2 | 24.19520133 |
| Dinorwig 400kV | DINO4R3 | 46.73011039 |

**Further actions**

1. Carry out the same simulations using another scenario e.g. winter peak
2. Replicate studies for a different generation mix
3. Analyse the impact of QB switching
4. Carry out more simulations for different DNO sites

**Questions asked by the Workgroup for further assessment**

**For EMT Studies**

1. Voltage waveforms for EMT and RMS studies, for comparison purposes, to be sent out
2. Include information about angle comparisons at all system voltages

**For GB network**

1. Show angles and fault levels against a map of the GB network and/or system diagram
2. Provide fault result on more meshed Transmission network (west midland for example)
3. Show the vector shift on 11 kV bus bar by using typical 33/11kV parameters