EREC G5 Stage 2 Sub-group

Meeting No. 1

Held at William Gilbert Meeting Room, REEC Building, Sir William Siemens House, Princess Road, Manchester, M20 2UR

On Monday 13th June 2016 10:30-14:30

Meeting Notes

Attendee	Affiliation	Initials	Role
Frank Griffiths	ABB	FG	Member
Andrew Oliver	TNEI	AO	Member
Simon Scarbro	WPD	SPS	Chair
Ahmed Shafiu	Siemens	AS	Secretary

Item	Topic & Note	Action
2.	Sub-group Chair & Secretary SPS agreed to chair and AS to take notes.	
3.	Terms of Reference (ToR) SPS: The ToR requires us to consider whether alignment with other standards (e.g. IEC TR 61000-3-6) is appropriate.	
4.	Review Stage 2 & possible changes • Existing Stage 2 approach – overview AO highlighted an error in the flow chart of Figure 1. The failed condition "complies with Table 12" should be an input to "DNO determines network distortions". FG noted that lack of understanding over scaling of the tables 6, 7, 10 & 12 leads to issues contractually. Clarity should be improved if such tables remain. There was discussion over whether application of Stage 2 really requires measurements in all cases. Post-meeting note. SPS: Table 10 doesn't require measurement, although the values quoted are derived from Table 12 (which does as it assumes 75% PL is left); however, Table 10 is based on the current emission percentages in ACE 73 Appendix C being used to derive the largest equipment rating that met the current limits in 12. These kVA values were rounded and then divided by 6 to give the values in Table 10. So Table 10 is not sensitive to	

		measured values unless very close to or above Planning Level.> FG believes it would be useful to provide a method for calculating HV distortion from LV measurements (including the phase angles). AS stated that LV measurement point will not exist for the current connection and will have to rely on an existing LV connection point. Here LV is 400V. FG stated then it comes down to whether the LV measurement available is a representative of the connection point upstream. FG noted that the current emission spectrum differs for working power value compared with maximum power value and also changes if the amount of equipment changes. He suggested that therefore the assessment should primarily consider not the rated conditions of the equipment, rather the working power conditions. This will especially be the case for plant items having significant short term overload capability. FG noted that under unbalance conditions the current emissions change; notably triplen behaviour. He also stated that unbalances on the network will cause triplens to pass through to the LV side which has nothing to do with the connected load. AO & FG raised the possibility of revising the assessment such that it predicts the voltage distortion on the basis of fault level and ~~percentage of Planning Level~~ equipment current emission profile. This may avoid the need to measure background if the values are small (the limit to be determined) and may allow Table 12 to be removed. FG agreed to write this up/prepare possible flow chart. AO highlighted the need to consider DNO discretion which may allow connection without background measurement. • Previous suggested text (Aug 2011 draft) The previous text prepared by Geoff Brown was briefly reviewed. The following were highlighted by SPS: o Current limits on per MVA and per 10MVA basis. o The inclusion of active infeed converters. o Change of the Typical value of F for 11kV from 100MVA to 60MVA (default). • Requirements arising from draft EREC G5/5 Draft V6 o Alignment with Stage 1 approach o Including a 'Compliant with Resonant plant requirement?' FG stated it is not clear whether in Equation 5 considers the presence of detuning or inrush reactors in cap bank. o Aggregation as per general text. FG stated that straight additions of 5th harmonic may not be the right approach. It was noted by all that the working group has decided IEC summation approach. o Extension to 100th harmonic. SPS expressed concern over measurements at 11kV of	FG

	higher orders. AS stated accuracy of the models at higher frequency is also a concern. ○ No allocation (except as inferred in the two tables equivalent to Stage 1 tables 13 and 14). ○ Ignore transfer from upstream. AS stated that calculation of transfer from upstream would require detail modelling. ○ No alignment with Stage 2 of IEC TR 61000-3-6. • New considerations (NB Agenda items below) ○ Voltage source versus current source FG stated that majority of the sources connected are voltage not current source based. ○ Worst case network impedance/ETR112/values of 'k' ○ Aggregation/summation – see notes of full WG ○ $S_i/S_c \leq 0.2\%$ (IEC TR 61000-3-6)	
5.	Agree outline spec for Stage 2 update	
6.	Detailed review	
6.1	Worst case network impedance/ETR112/values of 'k' (G5/4-1 Table 8) SPS showed a graph produced by a consultant looking at the driving point impedance for three types of Primary substation: rural, urban (all cable) and mixed. This raised the concern that the maximum impedance envelope may not be conservative in all cases, noting that the resonant peak may be beyond the 8th harmonic. AS stated the resonant peaks are also impacted by the upstream and downstream network arrangement. It also illustrated that there may be advantage in doing a more detailed study of harmonic impedance at the PCC (e.g. Stage 2 plus). After discussion AO agreed to consider how best to do modelling to examine various substations to see if the maximum impedance envelope needs updating and also if the impedance envelopes from various substations can be generalised; it may be that a quote could be prepared. Post-meeting note. SPS: I have discussed this issue also with Edif ERA. They may also be able to do something similar.	AO
6.2	Simple reactance model & voltage source versus current source SPS: Time did not allow a detailed discussion. FG considers nature depends on ratio of fault level (source impedance) to equipment rating. Review of the frequency dependent supply impedance in ETR112 suggests that Table 12 , and Table 7 , be scrapped and a voltage distortion calculation be made – based on estimated load harmonic spectrum and frequency dependent impedance values. This approach would replace 'k' values with a revised impedance ratio equations for typical supply arrangement e.g cable vs overhead line.	

Note : Most estimates of harmonic spectra assume a linear impedance/frequency relation for the supply impedance. If we account for the variability of supply impedance with frequency then the cited spectra will have to be adjusted accordingly. This is because we are dealing with voltage source , not current source.

SPS Post-meeting note: A balance is required so that not all studies require very detailed modelling if possible. We are looking to investigate further the impedance envelope by use of modelling to see if a maximum impedance envelope approach can be used.

6.3 Aggregation/summation – see notes of full WG

6.4 Default fault levels (G5/4-1 Table 9)

SPS The 100MVA typical value is too high. Levels at the ends of rural 11kV circuits can be as low as 10MVA.

6.5 Current emission limits (G5/4-1 Table 12 & ETR 122)

SPS explained how Table 12 had been derived. Table 12 the currents equate to ¼ of the PL for those subject to linear summation and this allowed them to have 66.7% of the PL for those subject to quadratic addition (from sqrt(1^2 - 0.75^2) = 0.66). If we change the summation exponents for voltage to IEC then the figures will need to be reworked

See comments 6.2 above

6.6 kVA limits (G5/4/1 Table 10)

SPS explained how Table 10 has been derived, referring to ACE 73 and the current profiles assumed in Appendix C. FG noted that these assumptions appear out of date.

Review of Table 10 derivation shows a 'mix' of G5/3 and ACE73.The typical harmonic ratios in Table C1 are no longer representative of 6 pls diode bridge feeding a capacitor bank. Typical values are now ;

Harm	New ratios	ACE73 : Table C1
5	31.5 %	17.5%
7	13.9 %	11.0%
11	8.1 %	4.5%
13	5.1 %	2.8%

These revised values reflect back to Stage 1 : Table 10 as

Supply Voltage	Three Phase Converters	
	6 Pulse (KVA)	12 Pulse (KVA)
400V	6.67	35.6

This assumes that these values match the harmonic current corresponding to a 25% planning level margin @ 10MVA LV fault,

	an assumed power ratio of 6 (as per ? para 5 section 5.2 ACE73) and an impedance ratio of 0.5 (relative to symmetrical fault level impedance)	
6.7	$S_i/S_c \leq 0.2\%$ (IEC TR 61000-3-6) SPS highlighted this approach from Stage 1 of the IEC TR; it has caveats regarding resonance, existing background distortion levels and risk of interference. AO noted that Table 10 is similar, albeit referring to equipment rating.	
7.	Update spec for Stage 2 update Due to lack of time, SPS asked that each member list their requirements for the revision of Stage 2 in terms of minimum requirements and possible requirements.	All
8.	Allocate tasks See Actions.	
9.	AOB None	
10.	Future meetings • Dates To be polled. • Agenda items. To be agreed by email. Voltage source versus current source.	

Draft Spec for Stage 2 Update (SPS version 1)

Serial	Item	Comment
1	Alignment with Stage 1 approach.	
2	Include a 'Compliant with Resonant plant requirement?'	
3	Aggregation as per general text. NB This will affect Table 10 & 12 values.	
4	Extension to 100th harmonic.	
5	No allocation (except as inferred in the two tables, equivalent to Stage 1 tables 13 and 14).	
6	Ignore transfer from upstream.	
7	No alignment with Stage 2 of IEC TR 61000-3-6.	
8	Improve clarity over scaling of values in Tables 10 & 12.	
9	Update harmonic emission profiles used to derive Table 10. NB This will affect values in Table 10.	
10	Change typical fault level to be more typical (e.g. 60MVA for 11kV). Dependant on approach used for item 8 this would also feed into Table 12 values.	
11	Bring table 11 values into line with updated planning limits.	
12	G5/5 draft 6 brings all 33kV connections into stage 2, we should provide a view to the main group on whether including 33kV connections in stage 2 is appropriate. SPS post-meeting note: I have asked Forooz whether 33kV connections should go to Stage 3.	

Minimum Requirements

Serial	Item	Comment
1	Update for voltage sources.	
2	Review Maximum Impedance Zh Envelope.	
3	Consider including $S_i/S_c \leq 0.2\%$ simplified assessment.	
4	Provide method of inferring HV levels from measurement at LV.	
5	Revise assessment to predict voltage distortion on basis of fault level and % PL	
6	Consider Stage 2 plus (simplified Stage 3) where the actual Z versus frequency driving point impedance is used rather than Maximum Impedance Envelope	
7	Consider if PWHD clause for many marginal current exceedences $23 \leq h \leq 50$ of table 12 is worthwhile or if the connection in that case should just proceed to the voltage calculation.	

Possible Review/Requirements