EREC G5 Stage 2 Sub-group

Meeting No. 4

Held at ABB Ltd, Daresbury Park, Warrington WA4 4BT

On Wednesday 12th October 2016 10:00-15:00

Meeting Notes

Attendee	Affiliation	Initials	Role
Forooz Ghassemi	National Grid	FGh	Guest
Ben Gomersall	National Grid	BG	Guest
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.	**Agree Notes of Previous Meeting** Agreed.	
3.	**Actions from Meeting 3**	
3.1	ECRC Report 1681 SPS has obtained the report from EATL. SPS explained that this report underpins ETR112 (which in turn underpins the k values for 6.6kV/11kV/20kV/22kV PCC in EREC G5/4-1; namely in Table 8). The report was briefly discussed. It was noted that the test used current injection at LV and the frequency range covered 75Hz to 975Hz. Members asked that SPS see if EATL are happy for the WG Members to have a copy.	SPS
3.2	Definition of Converter Types AS provided a definition of Active Front-end (AFE) converters with diagram. This was discussed by FG and FGh. It was agreed that a definition with diagram for 6-p and AFE converters would be sensible and that the switching devices in the diagram should be generic rather than specifically IGBTs. AS will circulate a draft.	AS
4	**$\sum S_{equ}$ Derivation (replacement for EREC G5/4-1 Table 6 & 10)**	
4.1	Impact of Size & Numbers of equipment FG explained how the assumptions affect the current emissions. The more disturbing equipment the lower the current emissions so the assumed values are conservative.	
4.2	Basis of Values in Stage 1 Table 5 & Stage 2 Table 7 Draft SPS recapped on how the values in the existing EREC G5/4-1 Table 6 & 10 have been derived. The aggregate permitted emissions in ACE 73 Table V are based on the current required to give an incremental voltage distortion as set out in	

	ACE 73 Table I and with current emissions assumed in ACE 73 Appendix C. See ACE 73 Table IV. The Table V values were used to derive the limits in EREC G5/4-1 by dividing the values by 8 for LV PCC and 6 for HV PCC. The 8 and 6 were derived by assuming 20 and 10 pieces of equally sized disturbing equipment and allowing for phase angle diversity. It was noted that the emissions based on modern analysis give higher 5^{th} harmonic content for 6-pulse converters. SPS explained that the proposed values in draft Stage 1 Table 5 are based on assuming 15 pieces of existing disturbing equipment giving voltage distortion at 75% of the planning level leaving 5 items to give the remaining 25% taken together with a coincidence factor of 0.9. A similar approach was used for draft Stage 2 Table 7 based on a total of 10 pieces of disturbing equipment.	
4.3	IEC 61000-2-6 Typical 6-pulse values SPS explained that this standard has a method of calculating harmonic current emissions. SPS to show at next meeting.	SPS
4.4	Example LV background measurement data – impact on assumptions SPS showed background measurements from a location in central Bristol. In this particular case the 5^{th} harmonic background level was 2.84% and so not far from the 75% of the 4% Planning Level. However, the 25^{th} harmonic was 0.0047% and very much less than 75% of the 0.7% Planning Level. For this example case the assumption that voltage distortion levels for the 25^{th} harmonic are conservative.	
5	**Stage 1 & 2 Draft**	
5.1	Stage 1 & 2 Draft – Update SPS explained the major changes to the draft text, highlighting the changes to Fig 2 and aggregation in particular.	
5.2	Aggregation & Derivation of $\sum I_{equ}$ values in Fig 2 SPS explained how the $\sum I_{equ}$ values had been derived. Example: **1-phase Equipment, Service Current Capacity ≥100A Example** • Assumed source impedance @ supply terminals = 0.25 + j 0.25 ohm (see Table 2). • 1-phase fault current phase-neutral @ supply terminals = 230V/(0.25 + j0.25 ohm) = 650.538A. • Assumed source impedance @ PCC/source impedance @ supply terminals ratio = 0.8. • 1-phase fault current phase-neutral @ PCC = 650.538A/0.8 = 813.173A. • For 16A max equipment I_5 = 1.14A from IEC 61000-3-2 Class A table. • V_{hc}% @ PCC for 16A rated equipment = I_h x h x k x 100%/$_{If\ ph\text{-}n}$ @ PCC = 1.14A x 5 x 1 x 100%/813.173A = 0.70%. • Planning level for 5^{th} = 4%. • 25% Planning Level for 5^{th} = 1%. • Assumed Coincidence Factor for current = 0.9. • Effective limit = 1%/0.9 = 1.111%. • Aggregate rated current giving V_{hc}% = 1% is 16A x 1.111%/0.70% = 25.39A rounded to 25A.	
5.3	Aggregation & Derivation of $\sum_{Iequ}$ values in Fig 3 SPS explained how the $\sum_{Iequ}$ values had been derived. Example given was: **3-phase Equipment, Service Current Capacity <100A Example**	

	• Assumed source impedance @ supply terminals = 0.24 + j 0.15 ohm (see Table 3) = 0.2830 ohm. • Assumed source impedance @ PCC/source impedance @ supply terminals ratio = 0.8. • 3-phase fault current @ PCC = 400V (√3 x 0.8 x 0.283 ohm) = 1019.98A. • Rating implied by this fault current for equipment compliant with IEC 61000-3-12 with Rsce = 33 is 1019.98A/33 = 30.9A rounded to 31A.	
5.4	Stage 1 & 2 Draft – Review Comments The comments from AO and FGh/BG were reviewed. See attachments with inserted comments and responses. Actions arising from AO comments: • Add reference to Note 2 in Figure 2. • Add reference to Note 1 in Figure 3. • Amend title of column 1 in Table 4a and 4b to 'Aggregate Equipment Rating $\sum I_{equ}$ (A). • Amend title of column 1 in Table 4a and 4b to 'Aggregate Equipment Rated Apparent Power $\sum S_{equ}$ (kVA)'. • Reference Stage 1D, AS agreed to obtain data for Siemens AFE of similar rating and pass to FG for analysis. • Amend Stage 2A title to '…Aggregate Equipment Rated Apparent Power $\sum S_{equ}$' • Amend Stage 2B title to '…Aggregate Equipment Rated Apparent Power $\sum S_{equ}$' • It was agreed that an example should be added to the Worked Examples document that covers the application of the Thevenin equivalent in Stage 2C. FG agreed to prepare an example. • Units in formulae need to be defined and be consistent. SPS to amend text. • It was agreed that under Stage 2C it is necessary to check all harmonic orders. SPS to amend text. • Post-meeting note: Note that the CDV for IEC 61000-2-2 (77A/926/CDV) proposes having CL for h>40 (i.e. 2kHz) up to 150kHz. In the range up to 9kHz (i.e. h=180) limits are given in 200Hz bands. This will add a complication to assessment. Actions arising from FGh/BG comments: • SPS to check whether the 32A, 22A, 42A & 25A in Table 2 and Fig 2 would change if other harmonics were checked. • Reference Fig 3, SPS to consider whether, in addition to the 3-phase and 1-phase cases, it is necessary to cover interphase equipment (400V phase-phase equipment) or split phase (460V case). • Reference Fig 3, 'Table 3a/3b' should be 'Table 4a/4b'. SPS to amend. • SPS to review whether the approach of ensuring Rsce ≥33 in Stage 1B needs modification given that the harmonic current emissions permitted by IEC 61000-3-12 for Rsce = 33 result in voltage distortion exceedances for some harmonics based on the Table 8 'k' values. • SPS to amend symbol for current source.	SPS SPS SPS SPS AS/FG SPS SPS FG SPS SPS SPS SPS SPS SPS

5.5	Stage 1 & 2 Draft Worked Examples - Review Time did not permit a review of the worked examples. This was deferred to the next meeting.	
5.6	Contrast with draft G5 v8-1 text This was deferred to the next meeting.	
6	**Agree Further Work** Save for the actions recorded above, this item was deferred until the next meeting.	
7	**AOB** This was deferred to the next meeting.	
7.1	IEC TR 61400-21-3 Thevenin Model This was deferred until the next meeting.	
7.2	77A/926/CDV: Amendment 1 to IEC 61000-2-2 Ed.2 This was deferred until the next meeting.	
7.3	Maintenance of IEC 61000-3-12 This was deferred until the next meeting.	
8	**Future meetings** • Dates The date of the next meeting was agreed as 9 November. Venue to be arranged by BG to be at Warwick. Post-meeting Note: Now arranged at National Grid, Warwick. • Agenda items Not discussed.	BG: