IEEE Power & Energy Society
Switchgear Committee
C37.20.7 Working Group Report
17-September-2013

The working group met on Tuesday, September 17, at 8:02AM.

Patents:
Those registered at the Switchgear Committee meeting in San Antonio had to acknowledge the IEEE-SA rules on Patents, and therefore, review in this meeting is not required. Nevertheless, the chair displayed the Patents slides and reminded attendees of their obligations. The participants were reminded that anti-competitive issues are never allowed for discussions.

General:

The PAR for this project was approved by the IEEE-SA Standards Board on November 9, 2011, and is valid through 2015.

Members introduced themselves, identified their company and their affiliation. Total attendance was 63 persons. Attendance included 26 working group members (of 31, with 3 absent and 2 excused, plus 37 guests. Attendance is as shown below:

Members / Affiliation	Members / Affiliation	Guests / Affiliation	Guests / Affiliation
C. Ball (P) – S&C P. Barnhart (P) - UL J. Baskin (P) – Federal Pacific R. Boyce (P) – Eaton J. Bowen (P) - Aramco E. Byron (E) - Schneider J. Earl (P) - ABB D. Edwards (E) - Siemens M. Flack (A) – Southern Nuclear K. Flowers (P) - Siemens D. Gohil (P) - AZZ S. Hutchinson (A) – Shallbetter H. Josten (P) - Siemens A. Jur (P) – Eaton C. Kennedy (A) - Schneider M. Lafond (P) - GE	D. Lemmerman (P) - Exelon F. Mayle (P) - Technibus D. Mazumdar (P) - AZZ D. Mohla (P) – DCM Technical Consulting A. Morse (P) - Eaton T. Olsen (P) - Siemens M Orosz (P) - Schneider A. Patel (P) - GE C. Schneider (P) - Schneider J. Smith (P) - Eaton P. Sullivan (P) - DuPont C. Tailor (P) - Eaton M. Valdes (P) - GE M. Wactor (P) – Powell R. Warren (P) - KEMA	S. Benson (P) – Volta LLC J. Campbell (P) - Powell R. Cohn (P) - Powercon D. Dart (P) – Noja Power E. Dullni (P) - ABB D. Dunne (P) - Schneider D. Elliott (P) – ABB L. Farr (P) – Eaton S. Flores (P) - Schneider A. Gibbs (P) - Schneider P. Gingrich (P) - AZZ L. Grahor (P) - Eaton T. Hawkins (P) - Siemens J. Hidaka (P) - UL D. Hrncir (P) – Eaton J. Joseph (P) - Toshiba P. Ingamells (P) - Schneider J. Kaminski (P) - Siemens A. Livshitz (E) - Schneider R. Martinez (P) – CFE LAPEM S. Meiners (P) – GE A. Morgan (A) - retired	R. Morris (P) - Eaton D. Moser (P) – ABB O. Parks (P) – ABB M. Parvin (P) – Chicago Bridge & Iron E. Peters (P) – Powell S. Powell (P) - AZZ I. Profir (A) - Rockwell R. Puckett (E) – retired S. Reddy (P) – Powell M. Roberson (P) – AZZ R. Rohr (P) - Powell A. Rowell (P) - Eaton T. Schiazza (P) - Schneider M. Seabrook (P) – GE J. Shullaw (P) - GE G. Sims (P) – Eaton T. Sorvari (P) - Enbridge R. Tanner (P) – Schneider L. Yonce (E) – Eaton T. Woodyard (P - Siemens J. Zawadzki (A) - Powertech

The minutes from the Spring, 2013 meeting were approved as distributed. D. Mohla moved to approve and H. Josten seconded. Passed unanimously.

Wire size for arc initiation:
R. Morse made a presentation concerning the wire size used for arc initiation on the load side of the short-circuit protective device (SCPD) in low-voltage MCCs (Annex H). His proposal is to change the wire size for arc initiation on the load side of the SCPD in Annex H from #10 AWG to #14AWG. This proposal would not affect the size of wire for arc initiation on the line side of the SCPD. This change is also proposed for any product (e.g., switchboards, metal-enclosed bus) that may have low rated SCPD (600A or less) are incorporated. This proposal was accepted for inclusion in the next draft.

R. Morse also suggested revisions to clause 5.2.6.1 to make the conditions under which arc extinction is permissible more clear. This was also accepted for inclusion in the next draft, along with corresponding changes to the relevant annexes.

Peak current requirements with reduced voltage testing:
E. Dullni made a presentation concerning the peak current requirements and test experience when reduced voltage tests are used due to laboratory limitations. In the case of reduced voltage tests, the requirement is that peak current be at least 90% of the rated peak current. If you fail to meet the peak, you must retest. If you cannot meet the peak, you have to increase the symmetrical test current or increase the test voltage sufficiently to meet the peak current requirement. If you again miss the 90% peak, you have to test yet again.

Mr. Dullni presented a proposal to modify the requirements with respect to peak current requirements during reduced voltage testing to avoid “over-testing” the equipment (testing to a higher current level than is necessary purely to meet the peak current of 90%). This proposal involves integrating the arc energy in the tests. Mr. Dullni’s presentation will be provided with the minutes.

Grounding during tests:
The working group had been asked to comment on the method of grounding (or not grounding) of the generator during testing. This has been discussed earlier, but no input was forthcoming subsequent to the Spring meeting.

Frequency during tests:
This is the subject of one of the comments in the consolidated list. The document dictates that frequency not decline by more than 8% during the test. This is thought to be too restrictive for medium voltage tests at very high short-circuit currents (e.g., 50kA and above). The power laboratory representatives were asked to comment on the frequency decline that they have experienced during tests. This question will also be conveyed to the STLNA (Short-Circuit Testing Liaison for the Nations of the Americas) when they meet later on September 17.

Symmetrical current vs. total current:
A question was raised relative to whether the important criterion for test validity is the symmetrical current or should be related simply to the peak current experienced in the test. The consensus is that the peak is important and the symmetrical current value is not as important. This question will also be conveyed to the STLNA (Short-Circuit Testing Liaison for the Nations of the Americas) when they meet later on September 17

Review of consolidated comments on draft 4:
Draft 4 of the document had been distributed for the Spring meeting, and comments were submitted by various participants. Comments received prior to the meeting were consolidated into one list, with a “strawman” resolution for consideration by the working group. This list was reviewed and formal working group resolutions determined.

Prior to the meeting, an extensively edited draft 4B was distributed, and changes to this draft resulting from the resolution of comments will be incorporated, to create a draft D5.

The comments were reviewed and resolutions agreed. The revised comments list will be distributed along with the revised draft.

Indicators:
Discussion occurred regarding the indicators and measurement of the energy released. Several commented that calorimeters would probably provide better data but use of calorimeters in the power laboratories is not presently practicable, because of the availability of the measuring devices, and more particularly, the need for many more data channels than the laboratories have available.

The meeting adjourned at 11:52AM.

Report submitted by: M. Wactor, WG Chair

C37.20.7 Task Group

Internal Arcing Fault:
Arc Ignition and Solid Insulation

09-16-2013

Arc Initiation Wire-Draft 4

C37.20.7 Draft 4 Initiation wire summary comparison chart								
Paragraph	Arc initiation D.4	Arc initiation E.4	Arc initiation F.5.1.1.2	Arc initiation G 4.2.2	Arc initiation - General H.4.1	Arc initiation I.5.3	Arc initiation J.4	Wire size K.4.1
Product	Metal-enclosed low-voltage power circuit breaker switchgear	Metal-clad switchgear (IEEE Std C37.20.2)	Metal-enclosed interrupter switchgear	Outdoor equipment	LV MCC	Medium-voltage ac controllers	Switchboards	Metal-enclosed bus
LV initiation Wire	Copper wire 2.6mm diameter or 10AWG Class K prevent premature extinction at lower voltages				Copper wire chosen in accordance with Table H.1 Class K prevent premature extinction at lower voltages		Copper wire 2.6mm diameter or 10AWG Class K prevent premature extinction at lower voltages	Copper wire 2.6mm diameter or 10AWG Class K prevent premature extinction at lower voltages
MV initiation wire		Copper wire 0.5 mm diameter or 24 AWG	Copper wire 0.5 mm diameter or 24 AWG	Copper wire 0.5 mm diameter or 24 AWG		Copper wire 0.5 mm diameter or 24 AWG		Copper wire 0.5 mm diameter or 24 AWG

Table H.1 – Draft 4

Internal Arcing Short-Circuit Current (kA)	Arc Initiation Wire Size (AWG)
< 0.30	28
0.31 – 0.50	26
0.51 – 0.80	24
0.81 – 1.30	22
1.31 – 2.10	20
2.11 – 3.40	18
3.41 – 5.40	16
5.41 – 8.70	14
8.71 – 13.70	12
> 13.70	10

Arc Initiation LV - Wire Sizing

Wire Sizing	
LV initiation Wire Sizing	The arc shall be initiated by means of a Copper wire 2.6mm diameter or 10AWG.
New text	The arc initiating wire shall be Copper wire 2.6mm diameter or 10AWG at location other than the load side of SCPD with both current and duration limiting characteristics up to 600A. The initiating copper wire shall be 1.31mm or 14AWG on the load side of SCPD with both current and duration limiting characteristics up to 600A.

Arc Initiation LV - Wire Sizing

Wire Sizing				
Paragraph	Arc initiation D.4	Arc initiation - General H.4.1	Arc initiation J.4	Wire size K.4.1
Product	Metal-enclosed low-voltage power circuit breaker switchgear	LV MCC	Switchboards	Metal-enclosed bus
LV initiation Wire Sizing	The arc shall be initiated by means of a Copper wire 2.6mm diameter or 10AWG.	Copper wire chosen in accordance with Table H.1	The arc shall be initiated by means of a Copper wire 2.6mm diameter or 10AWG.	The arc shall be initiated by means of a Copper wire 2.6mm diameter or 10AWG.
New text	The arc initiating wire shall be Copper wire 2.6mm diameter or 10AWG.	The arc initiating wire shall be Copper wire 2.6mm diameter or 10AWG at location other than the load side of SCPD with both current and duration and limiting characteristics up to 600A. The initiating copper wire shall be 1.31mm or 14AWG on the load side of SCPD with both current and duration limiting characteristics up to 600A.	The arc initiating wire shall be Copper wire 2.6mm diameter or 10AWG at location other than the load side of SCPD with both current and duration and limiting characteristics up to 600A. The initiating copper wire shall be 1.31mm or 14AWG on the load side of SCPD with both current and duration limiting characteristics up to 600A.	The arc initiating wire shall be Copper wire 2.6mm diameter or 10AWG at location other than the load side of SCPD with both current and duration and limiting characteristics up to 600A. The initiating copper wire shall be 1.31mm or 14AWG on the load side of SCPD with both current and duration limiting characteristics up to 600A.

Arc Initiation Wire
Class K Stranding

Class K **No change to this original text**	It is recommended that the arc initiation wire be a fine stranded wire type. Wire with Class K stranding has been found to provide consistent results with regards to arc duration.
Class K **Original**	Wire with fewer strands may not produce enough ionized gas quickly enough to prevent premature extinction at **lower voltages**.
Class K **New Text**	When testing **LV equipment**, a wire with fewer strands may not produce the ionized gas rapidly enough to help feed and maintain the arc and prevent premature extinction. Note: Self extinguish is acceptable when conditions per 5.2.6.1 a), b), c) are met.

Clause 5.2.6.1

The arc should not extinguish before the intended arcing duration (rated arcing duration) has elapsed. It is recognized that some designs may have phase spacing large enough to extinguish arcing at maximum rated voltage. Should the arc in a test sample extinguish prior to completion of the rated arcing duration, the test is considered valid if the following conditions are met:

a) The test voltage at the start of the test is set in accordance with 5.2.3 to the rated maximum rated voltage of the equipment.

b) The calibration current requirements of 5.2.4 are met.

c) There are no other phase spacing configurations for this design. If there are smaller phase spacings, the test must be repeated with the minimum spacing.

Arc Initiation Wire
Class K Stranding

Class K				
Paragraph	Arc initiation D.4	Arc initiation - General H.4.1	Arc initiation J.4	Wire size K.4.1
Product	Metal-enclosed low-voltage power circuit breaker switchgear	LV MCC	Switchboards	Metal-enclosed bus
Class K Original	Wire with fewer strands may not produce enough ionized gas quickly enough to prevent premature extinction at **lower** voltages.	Wire with fewer strands may not produce enough ionized gas quickly enough to prevent premature extinction at **lower** voltages.	Wire with fewer strands may not produce enough ionized gas quickly enough to prevent premature extinction at **lower** voltages.	Wire with fewer strands may not produce enough ionized gas quickly enough to prevent premature extinction at **lower** voltages.
Class K New Text	When testing **LV equipment**, a wire with fewer strands may not produce the ionized gas rapidly enough to help feed and maintain the arc and prevent premature extinction. Note: Self extinguish is acceptable when conditions per 5.2.6.1 a), b), c) are met.	When testing **LV equipment**, a wire with fewer strands may not produce the ionized gas rapidly enough to help feed and maintain the arc and prevent premature extinction. Note: Self extinguish is acceptable when conditions per 5.2.6.1 a), b), c) are met.	When testing **LV equipment**, a wire with fewer strands may not produce the ionized gas rapidly enough to help feed and maintain the arc and prevent premature extinction. Note: Self extinguish is acceptable when conditions per 5.2.6.1 a), b), c) are met.	When testing **LV equipment**, a wire with fewer strands may not produce the ionized gas rapidly enough to help feed and maintain the arc and prevent premature extinction. Note: Self extinguish is acceptable when conditions per 5.2.6.1 a), b), c) are met.

3. Definition – Draft 4

Insulation, solid: An applied insulation that is homogeneous and essentially free of voids, conformal to the shape of the bus, and bonded to the bus in such a way that removal requires destroying the insulation. Typical examples of such insulations are epoxies or polymers applied by fluidized bed and liquid dip processes. Specifically excluded from this definition are tape, shrink tubing, and all types of boots and slip-on insulation.

3. Definition – New MV Text

MV Bus Insulation, solid: An applied insulation that is homogeneous and essentially free of voids, conformal to the shape of the bus, and bonded to the bus in such a way that removal requires destroying the insulation. Typical examples of such insulations are epoxies or polymers applied by fluidized bed and liquid dip processes. Specifically excluded from this definition are tape, shrink tubing, and all types of boots and slip-on insulation.

3. Definition – New LV Text

LV Bus Insulation, solid: An applied insulation that permanently attached to the bus. The insulation shall meet UL746C requirement for insulation that is intended to support directly or indirectly live parts that are rigid and permanently secured. Typical examples of such insulations are solid thermoset and thermoplastic parts. Interlocking insulation shall seal or comply with 1 inch over-surface spacing. Specifically excluded from this definition are insulating tape, and all types of boots and slip-on insulation that are not permanently secured to bus.

C37.20.7 may need to consider adding a new LV insulation integrity test - Dielectric test with tin foil wrapped around insulated bus to establish the insulation integrity.

Peak Current in Arc Fault Tests

Recommendations for

Working Group on C37.20.7

Edgar Dullni

Test voltage and current C37.20.7 – 2007, clause 5.2.3

- The preferred value for test voltage is the rated maximum voltage of the equipment.
  - Where this value is not possible because of laboratory constraints, a reduced voltage may be used.
- The actual current delivered to the test point will be reduced by the impedance of the arc and the test sample bus.
  - If the voltage at the start of the test is lower than the rated voltage, the peak value of the short-circuit current for the metal-enclosed switchgear under test shall not be less than 90% of the rated peak value.

What can happen during a test?

- A first test may not be valid, since the peak current is below 90% when applying the rated short-circuit current.
- A second test is done under the same conditions, but with increased short-circuit current (or increased source voltage) in order to achieve the required 90% of rated peak current.
- However, the arc voltage happens to be larger than in the first test, and (because of the higher impedance) the peak current is below 90% !
  - The second test is again not valid,
  - though the switchgear experienced a larger stress than before because of the higher arc energy!

Recommendation (1)

- If an arc fault test turns out to be not valid, because the maximum peak current did not achieve 90% of the prospective value, the arc power integrated over the first 3 half-cycles should be determined from the same test.
  - Arc power (current x arc voltage) can be supplied by the lab.

- A reference value of arc energy is obtained by multiplying the arc power integrated over the first 3 half-cycles by the ratio of 90% rated peak current and actually measured peak current.

Recommendation (2)

- A repetition test with increased mean short-circuit current or increased source voltage should be accepted as valid, if
  - either the peak value is above 90% of the rated short-circuit peak current or
  - the arc power integrated over the first 3 half-cycles is higher than the reference value of arc energy from the first test irrespective of the height of the peak current.
- Consider implementing such a condition in the guide in order to avoid repetitive arc fault tests just because of an impact of the erratic behavior of the arc.

Thank you