Meeting Minutes

C37.01 Standard for HVDC Circuit Breakers

Chair: Joanne Hu

Secretary: Steven Chen

Time: 8:00 am – 9:45 am and 10:15 am – 12:00 pm, April 17, 2023

Location: Clearwater Beach, FL

Participants: 32 participants, including 15 members

1. Agenda and Topics

- Introduction of members and guests
- IEEE SA patent policy review
- IEEE SA copyright policy review
- Approval of minutes of previous meeting
- Document status report
- Review and discussion D2.2 – Chapter 5
- Next step

2. Introduction

Welcome and introduction by Steven Chen filling in for Joanne Hu, Chair of the WG. The roster is attached in the end of this meeting minutes.

3. Review of IEEE SA Patent and Copyright Policies

IEEE SA Patent and copyright policies were presented and reviewed.
No patents or copyright claims were identified.

4. Approval of Minutes of Previous meeting

Approval of Meeting Minutes of The Last Meeting Held Online on October 17, 2020.

The meeting minutes was posted on the IEEE PES Switchgear Committee website.

There were no comments received.
Motion to approve: Jeff Ward
Second: Dan Schiffbauer

5. Document Status Report

A draft version D2.2 has been created, however, the technology has been changing faster than the document can accommodate.

A document structure table was presented that identifies the necessary content of the document (clauses), the primary responsible person and individuals that have volunteered to

support the specific clauses. The chair requested more individuals to volunteer and support the work.

6. Review and Discussion D2.2 – Chapter 5

A discussion of the clause regarding ratings and capabilities (clause five) was begun by the chair. The chair proposes that the scope of HVDC ratings and capabilities be based on the presence of a CB in a Modular Multilevel Converter (MMC) of a Voltage Sourced Converter (VSC). The proposed applicable CB technologies are Active Current Injection (ACI) and Mechanical and Power Electronic (Hybrid). A diagram illustrating the number of components and their function for two types of CB was presented. Other CB technologies were discussed including pure mechanical and pure solid state. The industry trend has been to preclude these technologies due to their slower response time and higher losses respectively.

The next discussion topic addressed the basic requirements of the CB:

- Low conduction loss
- Fast interruption time
- Reclose capability

Question from the floor was raised regarding inclusion of superconducting technology. The chair responded that at the present time the proposed technology types are the ones that will most often be applied, and information is readily available. The chair also stated that if the WG receives enough information that technology can be included in the document.

The second topic discussed was that of maximum DC voltage that should be included in the rating. Two ranges are proposed, range I and range II. The proposed rating structure would be 110% of system voltage in range I and 105% of system voltage in range II. References were provided that support the proposed voltage values in the ranges. Voltage values were harmonized from IEEE documents and the IEC insulation coordination standard IEC 60071.

The third topic discussed was rated insulation level. Two values of voltage withstand were shown: rated withstand of direct voltage and rated lightning impulse withstand.

Discussion was held between an attendee and the chair regarding the difference between range I system voltage and maximum voltage, calling attention to the fact that the maximum voltage in some cases is greater than 110% within range I. The attendee suggested wording that reflects what the values are and not a typical value that doesn't reflect the actual values.

Discussion was also held on the topic of lightning withstand and the difference between the same BIL value used for AC and DC systems but the different system voltage values (AC being rms and line-line, DC being peak line-ground).

A question from an attendee was asked if wet and dry withstand values would be included. The chair responded that testing details have not been established yet. This led to

discussion regarding what the direct voltage testing duration should be. Several attendees suggested that the time duration be based on research results. The chair acknowledged that is a good idea.

A proposal from an attendee was made to ensure that adequate explanation was provided in the document to explain the reasoning for ratings, capabilities, features, etc.

Range II insulation levels include rated DC withstand, rated switching impulse withstand, and rated lightning impulse withstand.

A question from an attendee was asked; will the rating structure have one required value or several possible values? Further discussion was held and the concept of the AC BIL values are necessary because power transformers for some voltage classes have multiple BIL values. However, since this is a new standard and the power transformers will be directly exposed to lightning impulses one value of BIL can be selected.

A question arose to why DC systems need switching surge ratings. The chair responded that further research would be performed and the reasoning provided at the Fall meeting.

Coffee break 9:45 am – 10:15 am

Continuation of range II insulation levels.

A comment was made by an attendee that longitudinal (open gap) lightning impulse ratings may differ than the AC case. That difference will depend on the circuit breaker technology used. For instance, a hybrid breaker may not suffer a restrike from a lightning flash because the metal oxide voltage limiter may limit the longitudinal voltage across the open gap below flashover. (The lightning flash consists of several strokes. The number of strokes and inter-stroke time are statistical in nature.) The chair agreed that this issue needs to be considered by the sub-group and an update will be provided as work progresses.

A comment was made by an attendee that the difference in severity between switching and lightning impulses is the tail duration with switching impulse tails being much longer. Another attendee commented that the waveshape, and polarity, play an important part in stressing the internal and external insulation systems.

The chair continued with discussion of other ratings and capabilities.

A discussion regarding the need for specific emergency overload values was given. The chair explained when a power electronic unit was used current magnitudes and duration were needed to define a standard capability for that breaker technology. Several attendees made comments regarding suitability of the proposed emergency current magnitudes. The chair agreed that more research is needed when requiring these ratings.

An attendee made a comment that some power electronic components have a current limitation of 200% for a micro-second timeframe.

An attendee commented that the thermal time constant is responsible for the difference in current amplitude and duration, and that the time constant is non-linear. The comment was made to support a request that a basis for the rating be provided and verified before document publication.

The chair continued with short time withstand and peak withstand rating basis explanation and discussion. The time rating will depend on the time that the AC CB will open since for a DC fault the converter will behave like a diode. The chair explained that the value is proposed to be a standard number that would be based on the R10 series.

The rated short circuit current duration was explained and discussed next. The basis of rating would be the DC CB doesn't interrupt but the AC CB does. The preferred ratings were given by the chair.

The chair continued on, presenting rated short circuit breaking current. It was explained that the interrupting time will be technology dependent with the quickest times being 1-3 ms. The short circuit breaking current value will be a R10 series number contained within a table. An attendee commented that in the F22 meeting the WG proposed a perspective current rating and prospective rate of rise with some similar concept for TRV used in HVAC CB.

An attendee proposed that a standard time to interrupt can be provided instead of a fixed value that would occur every interruption. Discussion continued and a proposal was made that a defined rated time to current peak and a typical time to current interruption could be provided.

The chair presented an explanation of rated short circuit making current and the need to determine what condition should be used as the basis of rating. Possibilities include peak withstand or peak inrush noting that peak inrush would be provided by a capacitive discharge. The WG concluded the case of short circuit making is different for DC than AC.

7. Next Steps

The WG officers have identified the need a PAR extension.
Suggestion was made to send a document summary before the F23 meeting.

8. Adjourn

Attendance

First Name	Last Name	Affiliation	Role
Koustubh	Ashtekar	JST Power	Member
Steve	Cary	2-Phase	Member
Steven	Chen	Eaton Corporation	Vice Chair
Michael	Christian	ABB	Member
Federico	Di Michele	CESI	Member
Maxwell	Eastman	Black & Veatch	Guest
Leslie	Falkingham	VIL & S&C	Member
Brennen	Fleining	Hubbell Power System	Guest
Sergio	Flores	Schneider Electric	Member
Wolfgang	Grieshaber	SuperGrid Institute SAS	Member (Excused)
Christian	Heinrich	Siemens AG	Member
Victor	Hermosillo	GE Grid Solution	Member (Excused)
Denny	Hoss	Southern States	Guest
Joanne	Hu	RBJ Engineering	Chair (Excused)
Bill	Hurst	GE Renewable Energy	Guest
Dragan	Jovcic	University of Aberdeen UK	Member (Excused)
Riyad	Kechroud	GE	Guest
Reza	kheirollahi	Drexel University	Member
Dwight	Krause	Black & Veatch	Guest
Peter	Mapp	GE	Guest
Vincent	Marchall	Southen Company	Guest
Pevel	Novak	Schneider Electric	Member (Excused)
Sumitabha	Pal	Schneider Electric	Member
Laura	Reid	Hubbell Power System	Guest
Leonel	Santos	Schneider Electric	Member
Daniel	Schiffbauer	Toshiba International	Guest
Carl	Schuetz	American Transmission Company	Member
Dustin	Sullivan	Hubbell Power System	Guest
Francois	Trichon	Schneider Electric	Guest
Pelaez	Urrego	ABB	Guest
Jeff	Ward	Doble Engineering Company	Member
John	Webb	ABB	Member
Jan	Weisker	Siemens Industry	Guest
Matt	Yarbrough	Hubbell Power System	Guest
Zhihong	Zheng	Drexel University	Member