PC37.100.7 Working Group: Performance Evaluation of Sulfur Hexafluoride Alternatives

Tuesday, May 5, 2020 Web meetings 08:00 to 09:45 and 10:15 to 12:00 (CDT)

### 4th Meeting, Spring 2020

Chair: Daniel Schiffbauer Vice Chair: George Becker Secretary: Victor Hermosillo

# Session #1. Tuesday May 5<sup>th</sup>, 2020, 08:00 to 09:45

### Agenda

- Introductions
- IEEE copyright and patent slide review
- Review and vote on approval of fall 2019 MOM
- Chapter personnel updates
- PC37.100.7 guide schedule
- Review of working draft
- Closing remarks

### Call to order: 08:00

Chair called to order.

#### Introductions:

Chair used the attendance feature in Skype and asked those identified by phone number only to introduce themselves.

#### IEEE copyright and patent slide review:

Secretary reviewed the IEEE copyright and patent slides.

#### Approve October 2019 Minutes:

Motion: Paul Leufkens Second: Sushil Shinde

# Personnel Updates:

Stephanie Montoya (SCE) has moved to another position and will not continue with PC37.100.7 – we thank her for her work. Carl Kurinko (ABB) has agreed to lead chapter 9 "Continuous current performance" going forward.

#### Minutes of Meeting PC37.100.7 Working Group: Performance Evaluation of Sulfur Hexafluoride Alternatives

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### Schedule:

Chair presented the project schedule. PAR expires December 2022.

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# Draft Review:

Progress on document draft was presented by each chapter lead. Latest contributions were incorporated.

Chapter 7 – Switching and Short Circuit Performance Javier Mantilla

Review of the chapter on switching and short-circuit performance. Thermal volume pressure curves, short line fault di/dt versus pressure rise and post-arc current shape and duration graphics were shown. Charts of reignition times and thermal clearances were presented. ITRV considerations included.

Chapter 4 – Gas Characteristics

# Dan Schiffbauer

Table 1 contains gas characteristics for individual components of the various mixtures currently considered for use in switchgear. Figures have been prepared with saturation curves with respect to temperature in °K for single gas and gas mixtures. Kelvin degrees will be used for the charts to accommodate low temperature range. Minimum gas composition discusses as related to testing. Table prepared with consumption rates of gas mixtures depending on breaking accumulated energy.

Chapter 5 – Environmental Performance Dave Johnson

GWP calculation for various individual gases. Life Cycle Assessment process diagram included. LCA comparison between SF6 and CO2/O2 mixture in dead-tank circuit breaker. Results of LCA vary greatly depending on assumptions. Need to complete update on proposed national and international regulations.

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# Session #2. Tuesday May 5<sup>th</sup>, 2020, 10:15 to 12:00

Chapter 6 – Health and Safety

Li Yu

Includes Acute Toxicity Estimation with tabulated values for different categories as well as comparison between different toxicity classifications around the world. Discusses classification of mixtures depending on components. Presented LC50 calculation procedure and other hazard classification aspects. Toxicity estimations shown for individual gases and some mixtures. Effects of electrical arcing on gases, partial discharge and breaking conditions and species formation for individual gases and some gas mixtures. Figure 15 shows fault duty versus toxicity. Chair asked chapter leader to change color gradient, yellow and red to be replaced with other color choices since they may give the impression of high toxicity. Example for LC50 after interruption test included in Table 15. Reach registration provided for SF<sub>6</sub> and some gases used in mixtures.

Chapter 8 – Dielectric Insulation Performance Sushil Shinde

Topics to be covered include: dielectric strength versus density, influence of composition, statistical breakdown behavior, influence of voltage duration (impulse compared to power frequency), polarity effects, behavior under uniform/non-uniform fields and effect of surface roughness. Statistical behavior based on Weibull plots of breakdown probability. Charts prepared comparing dielectric strength versus pressure for SF<sub>6</sub> and some alternative gas mixtures. Need to indicate specifics of mixture. Particle sensitivity section to be expanded with some available information comparing SF<sub>6</sub> to other gases.

Chapter 9 – Continuous Current Performance Carl Kurinko

Table comparing temperature limits according to IEC, IEEE and Japanese standards. Section included with validation of contact stability with temperature. Contact aging discussed. Considerations during validation tests for contact systems. Heat transfer characteristics comparing SF<sub>6</sub> with alternative gas mixtures. Thermal overload capability to be covered and compared with existing equations (IEC, IEEE) for estimations.

Chapter 10 – Mechanical Performance Dan Schiffbauer

Mechanical performance to include: pressure vessel proof test, contact resistance measurement after mechanical endurance test and pressure relief under internal arc. More work needed in this section.

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Chapter 11 – Low Temperature Performance

Mike Crawford

Comparison between low temperature behavior of SF<sub>6</sub> and mixed gas. Pressure change smaller for minor components of the mixture. Need to associate dielectric recovery with gas behavior during loss of power section of low temperature test. Possible to make assessment of dielectric characteristics for variations in gas mixture and relate them to composition measurement taken during the test.

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# Attendance: [51 members, 26/51 members attending (51%), 53 total attending]

Last Name	First Name	5/5/2020		Company
Aldakka	Qais		Member	Los Angeles Department of Water and Power
Almeida	Edwin		Member	Southern California Edison
Aristizabal	Mauricio		Member	ABB
Baker	Daniel		Member	LADWP
Bannink	Herman		Guest	KEMA Netherlands
Barbera	Steven		Guest	Arizona Public Service
		v	Vice-Chair	
Becker	George	<u>X</u>		POWER Engineers Inc.
Beseda	David	Х	Member	S&C Electric Co.
Bisewski	Bruno		Guest	RBJ Engineering Corp
Boulus	Michael		Guest	PSE&G
Boyce	Russell		Member	Eaton
Brown	Steven		Guest	Allen & Hoshall
Bufi	Arben	Х	Guest	Hitachi T&D Solutions, Inc.
Burse	Ted		Guest	Powell Industries, Inc
Byron	Eldridge	Х	Member	Schneider Electric
Cary	Stephen		Guest	Eaton
Chhabra	Mohit		Guest	S&C Electric Company
Chiodo			Member	
	Vincent			HICO
Chovanec	Andrew	Х	Member	GE Power
Cleaveland	Charles		Guest	Cleaveland/Price Inc.
Collette	Lucas	Х	Guest	Duquesne Light
Collette	Dave		Guest	Mitsubishi Electric
Connor	Brad		Corresponding Member	Xcel Energy
Cosby	Bianca		Member	San Diego Gas & Electric
Crawford	Michael	Х	Member	Mitsubishi Electric
Crist	Daniel		Guest	Siemens Industry, Inc.
				Eaton
Culhane	Michael		Guest	
Cunningham	Jason		Guest	Southern States, LLC
Darko	Kennedy	Х	Member	G&W Electric Co
Dhawan	Anil		Guest	ComEd
Di Lillo	Patrick	Х	Member	Consolidated Edison Co. of NY, Inc.
Di Michele	Federico		Guest	CESI S.p.A.
Door	Jeffrey		Guest	The H-J Family of Companies
Duncan	Kirk		Guest	Hitachi T&D Solutions
Dwyer	Bernie		Guest	PECO
	Ken			
dwards			Guest	FirstEnergy Corp.
dwards	Doug	Х	Guest	Siemens Industry, Inc.
Eftink	Emily		Guest	Burns & McDonnell
Evans	Aaron		Guest	HICO America
Fender	Karl		Guest	Southern States LLC
Fennell	Howard		Guest	Nashville Electric Service
Frazier	Raymond		Guest	Ameren
French	Christopher		Guest	Eaton Corporation
Frye	Richard		Guest	Eaton
	Brian	х	Member	
Gerzeny				Powell Electrical Systems Inc
Glaesman	Peter		Member	PCORE Electric Company, Inc.
Glinsky	Ilya	Х	Guest	Southern California Edison
Grahor	Lou		Guest	Eaton Corporation
Hall	John	Х	Corresponding Member	Tennessee Valley Authority
lastreiter	Christopher		Guest	Eaton
Heiermeier	Helmut	Х	Member	ABB
Heintzelman	Travis		Guest	Burns & McDonnell
lensberger	Jeremy	х	Guest	Mitsubishi Electric Power Products Inc.
Hermosillo	Victor	x	Secretary	GE Grid Solutions
		٨		
lester	Edward		Guest	Entergy
lu .	Jingxuan (Joanne)		Guest	RBJ Engineering Corporation
Hunter	Jennifer		Guest	MEPPI
Hutchins	Roy		Member	Southern Company Services
lyjek	Katarzyna		Guest	DTE
rwin	Todd	Х	Corresponding Member	GE Grid Solutions
acobs	Allan	Х	Guest	ABB Inc,
agadeesan	Bharatwaj		Corresponding Member	
ain	Rahul	х	Member	S&C Electric Company
		X	Member	
arnigan	Christopher	٨		Southern Company Services
asinski	Joseph		Guest	ITC Holdings Corp.
ohnson	David	Х	Member	HVCB
ohnson	Travis		Guest	Xcel Energy
ung	Wolfgang	Х	Corresponding Member	Siemens AG
Keels	Thomas		Member	kEElectric Engineering
lim	SangTae		Member	HICO America
tim	jungdae		Guest	hyosung
lowalik				, 0
	Peter	Y	Guest	Cleaveland/Price Inc.
lurinko	Carl	Х	Member	ABB Inc.
anning	Scott		Member	S&C Electric
avrinoff	Benedict	Х	Guest	Kinectrics Inc
eccia	Brad		Guest	Eaton
.EE	CHANG HOON		Guest	HYOSUNG Heavy industries
.EE	JOOHYUN		Guest	HYOSUNG
			Guest	PECO/Exelon
Lemmerman	David	х		

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	Wangpei		Guest	Eaton
Ling	Yingjie	х	Guest	GE
Liu	Hua Ying	х	Guest	Southern California Edison
Lo	Benson	х	Member	Toronto Hydro
Lopez	Leo		Guest	WIKA Instrument, LP
Ma	Chunming		Corresponding Member	Burns and McDonnell
Mannarino	Antonio		Guest	PSE&G
Marshall	Vincent		Guest	Southern Company Services
Martin	Donald		Guest	G&W Electric Co.
Marx	Benjamin		Guest	Sargent and Lundy
Marzec	Peter	х	Member	S&C Electric Co.
Mason	Douglas		Guest	ComEd
May	Steven	-	Guest	Southern Company
Meiners	Steven		Corresponding Member	
Methling	Ralf		Guest	Leibniz Institute for Plasma Science and Technology
Midkiff	Jacob			
			Guest	Dominion Energy
Montoya	Stephanie		Member	Southern California Edison
Moran	Ashley	Х	Guest	IEEE Standards Association (IEEE-SA)
Morris	Tim		Guest	Whitehead & Assoc
Mulakken	Nikil	_	Guest	Facebook
Natale	Anthony	х	Guest	HICO America
Nelson	Jeffrey	Х	Guest	Tennessee Valley Authority
Nelson	Jacob		Corresponding Member	HPS
ONeil	Brian		Member	RMS Energy
Owens	John		Member	3M
Palmer	Justin		Member	ELECTRONSYSTEM MD
Patel	Pathik	1	Corresponding Member	
Pattison	Mark	-	Guest	H-J Family of Companies
Pellerito	Thomas	-	Guest	DTE Energy
Perrin	Damian		Guest	
		-		Entergy Services, LLC.
Peterson	Mark		Guest	Xcel Energy
Phan	Lise		Member	Pacific Gas and Electric Company
Phouminh	John	_	Guest	PEPCO HOLDINGS, INC.
Polchinski	Craig	Х	Guest	MEPPI
Pruitt	Al		Guest	The Durham Company
Putman	Larry		Member	Powell
Reid	Laura		Guest	Hubbell Power Systems
Rich	Bobby		Member	Dominion Energy
Riley	Caryn	х	Corresponding Member	
Ringham	Grant	X	Guest	BC Hydro
Roberts	Brian	X	Member	Southern States, LLC
		<u> </u>	Member	
Rogers	Jon			Siemens Energy, Inc
Rohr	Richard	_	Guest	Powell Electrical Systems
Rostron	Joe		Guest	Southern States LLC
Ruebensam	James		Guest	S&C Electric Co.
Salinas	Alex	_	Guest	Director of Operations
Santos	Leonel	х	Guest	Schneider Electric
Savulyak	Victor		Guest	DNV GL KEMA Laboratory
Sazanowicz	Robert		Guest	Avangrid - United Illuminating
Schaben	Chase		Guest	Burns & McDonnell
Junaben	Daniel		Chair	Toshiba International Corporation
Schiffbauer		X		
	Carl	X	Member	American Transmission Company (ATC)
Schiffbauer Schuetz	Carl	X		
Schiffbauer Schuetz Schumann	Carl Jon	X	Corresponding Member	American Transmission Company
Schiffbauer Schuetz Schumann Sharma	Carl Jon Devki		Corresponding Member Guest	American Transmission Company Entergy
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