88/963/NP

NEW WORK ITEM PROPOSAL (NP)

PROPOSER:	DATE OF PROPOSAL:
Secretariat	**2023-06-15**
DATE OF CIRCULATION:	CLOSING DATE FOR VOTING:
2023-06-23	**2023-09-15**

IEC TC 88 : WIND ENERGY GENERATION SYSTEMS

SECRETARIAT:	SECRETARY:
Denmark	Mrs Christine Weibøl Bertelsen
NEED FOR IEC COORDINATION:	PROPOSED HORIZONTAL STANDARD ☐
TC 8, SC 8A, TC 82	Other TC/SCs are requested to indicate their interest, if any, in this NP to the TC/SC secretary

FUNCTIONS CONCERNED:

☒ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

TITLE OF PROPOSAL:

Wind energy generation systems – Part 27-3: Structure and validation procedure of frequency domain models for harmonic propagation studies

☒ STANDARD	☐ TECHNICAL SPECIFICATION	☐ PUBLICLY AVAILABLE SPECIFICATION

PROPOSED PROJECT NUMBER: 61400-27-3

SCOPE
(AS DEFINED IN ISO/IEC DIRECTIVES, PART 2, 14):

IEC 61400-27-3 contains normative specifications for validation of frequency domain models of converter-based units, subsystems or components. The application range for IEC 61400-27-3 is limited to 0-9kHz, i.e. sub-synchronous emission as well as harmonic emission, interharmonic emission and emission above harmonic range up to 9kHz as defined in IEC 61000-4-7.

The model validation procedure specified in IEC 61400-27-3 is applicable to converter-based units which are used in renewable power plants, i.e. active power generation units like wind turbines and PV systems, energy conversion units like battery and electrolyser systems, and units with reactive power capability such as STATCOMs.

The specifications in IEC 61400-27-3 includes definitions, specification of model structure, specification of a model validation procedure, and specification of limits in the applicability of the models.

The model structure defines inputs to and outputs from the model. Balanced as well as unbalanced components are included in the model structure specifications, enabling the unit models to include couplings between frequency components and between sequence components.

The model validation procedure provides quantitative measures for the model accuracy based on comparison of model outputs to measured values.

The first edition of IEC 61400-27-3 does not include validation procedure for frequency domain models at plant level, but good practices for how to use validated unit models in plant level modelling will be described in an informative annex.

IEC 61400-27-3 does not specify generic frequency domain models of converter-based units but specifies the model structure in terms of inputs and outputs of black box frequency domain models.

IEC 61400-27-3 does not specify test procedures for frequency domain tests of wind turbines or renewable power plants but refers to tests specified in the IEC 61400-21 series.

IEC 61400-27-3 does not specify procedures for conformity assessment of model validation. Conformity assessment for validation of electrical, mechanical and other models is harmonized in IECRE, based on model validation procedures like the one specified in IEC 61400-27-3.

IEC 61400-27-3 does not specify procedures for grid compliance evaluation of renewable power plants. Grid compliance evaluation of renewable power plants is in the scope of IEC TC 8, IEC SC 8A and other legal entities.

PURPOSE AND JUSTIFICATION

INCLUDING THE MARKET RELEVANCE AND WHETHER IT IS PROPOSED TO BE A HORIZONTAL STANDARD.

MARKET RELEVANCE SHOULD BE ADDRESSED BY INDICATING THE NEED FOR THE CORRESPONDING STANDARDS WORK AND ITS GLOBAL RELEVANCE (SEE ISO/IEC DIRECTIVES, PART 1 ANNEX C)

IF PROPOSED AS A HORIZONTAL STANDARD, IDENTIFY AS POSSIBLE, THE CORRESPONDING APPLICABLE GUIDE(S) AND ASSOCIATED ADVISORY COMMITTEE(S) (SEE GUIDE 108).

The purpose of the proposed standard is to ensure properly validated frequency domain models of converter-based units which are used in renewable power plants. Traditionally, grid operators have analysed power system stability based on quasi-static and dynamic fundamental frequency models, often referred to as RMS models. But today, frequency domain models and EMT models are requested by several grid operators to be able to assess the impact of converter-based renewable generation on the stability and power quality in converter dominated power systems. Thus, ENTSO-E's Expert Group Interaction Studies and Simulation Models (EG ISSM) concludes the need for validation of mainly 3 types of models: RMS time domain models, EMT time domain models (real time and non-real time), and frequency dependent harmonic impedance models.

The global energy transition is expected to increase rapidly the share of converter-based renewable generation in power systems. Therefore, the current request from grid operators for validated frequency domain models is propagating rapidly internationally and become a generally accepted requirement to renewable plant developers for obtaining grid connection. With the present and expected future request for validated frequency domain models in mind, standardization is an efficient mean to reduce the financial resources and manpower involved to ensure the credibility and ease the applicability of the models.

Grid operators need models at the plant level which is supported by the informative annex with good practices for how to use validated unit models in plant level modelling included in the scope. The good practices will consider impacts of correlations between units emission and the impact of the power collection system, referring to research advancement in this area, for instance German NetzHarmonie - Electrical Power Systems (hsu-hh.de).

IEC 61400-27-3 is intended to replace IEC 61400-21-3 Wind turbine harmonic model and its application. With this change, the division of scopes of the 61400-21 series and 61400-27 series is consolidated with IEC 61000-21 series focus on test procedures and the IEC 61400-27 series focus on modelling and model validation. TC88 is also planning to develop a PAS for model validation which is expected to provide generic requirements as well as the mathematical details for model validation and thus will act as an umbrella for the validation standards in the IEC 61400-27 and other TC88 series.

IEC 61400-27-3 is proposed by TC88 to complete the existing IEC 61400-27 electrical simulation model series for wind energy generation systems. WG27 includes experts from wind power industry and academia with most advanced experience on modelling of converter-based wind turbines and other converter-based units. Other technology units such as STATCOMs to extend reactive power capability and storage units to enhance generation flexibility and reserve capability are already used in several wind power plants. Hybrid power plants combining wind, solar and storage technologies is also a growing solution which enables connection of more renewable to the existing grids. The growing grid operator request for frequency domain models and EMT models suggest supplementing the existing IEC 61400-27 series standards for fundamental frequency models with the proposed IEC 61400-27-3 standard for validation of frequency domain models and a proposed IEC 61400-27-4 standard for validation of EMT models.

However, other technical committees are working with other converter-based technologies than wind turbines, and the standard is relevant for conformity assessment in IECRE and for power system stability in IEC TC8. Therefore, IEC 61400-27-3 is horizontal and relevant for the following committees:

- IEC TC8 System aspects of electrical energy supply
- IEC SC8A Grid Integration of Renewable Energy Generation
- IEC TC82 Solar photovoltaic energy systems
- IEC TC120 Electrical Energy Storage (EES) Systems
- IECRE System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications.

Standardization and best practice for frequency domain and harmonic modelling is also ongoing outside IEC. The following working groups will be considered:

- Cigré WG C4.49 Multi-frequency stability of converter-based modern power systems
- IEEE PES Task Force on Harmonics Modeling, Simulation and Assessment

PLEASE SELECT ANY UN SUSTAINABLE DEVELOPMENT GOALS (SDGS) THAT THIS DOCUMENT WILL SUPPORT. FOR MORE INFORMATION ON SDGS, PLEASE VISIT OUR WEBSITE AT HTTPS://WWW.IEC.CH/SDG/

☐ GOAL 1: No Poverty	☐ GOAL 10: Reduced Inequalities
☐ GOAL 2: Zero Hunger	☐ GOAL 11: Sustainable Cities and Communities
☐ GOAL 3: Good Health and Well-being	☐ GOAL 12: Responsible Consumption and Production
☐ GOAL 4: Quality Education	☐ GOAL 13: Climate Action
☐ GOAL 5: Gender Equality	☐ GOAL 14: Life Below Water
☐ GOAL 6: Clean Water and Sanitation	☐ GOAL 15: Life on Land
☒ GOAL 7: Affordable and Clean Energy	☐ GOAL 16: Peace, Justice and Strong Institutions
☐ GOAL 8: Decent Work and Economic Growth	☐ GOAL 17: Partnerships for the Goals
☒ GOAL 9: Industry, Innovation and Infrastructure	

TARGET DATE(S)	FOR FIRST CD: 2025-03-01	FOR PUBLICATION: 2027-03-01	
ESTIMATED NUMBER OF MEETINGS	FREQUENCY OF MEETINGS	DATE OF FIRST MEETING	PLACE OF FIRST MEETING
6	3 per year	Precise date TBD	DTU Risø Campus, Roskilde, DK

RELEVANT DOCUMENTS TO BE CONSIDERED:

- IEC TR 63222-100 ED1. Power quality management – Part 100: Impact of power quality issues on electric equipment and power system. 8/1648/DTR 2022-12-02. IEC - TC 8 Dashboard > Projects / Publications: Work programme, Publications, Stability Dates, Project files
- ENTSO-E Expert Group Interaction Studies and Simulation Models (EG ISSM). FINAL REPORT 01.10.2021. Expert Group Interaction Studies and Simulation Models (EG ISSM) (windows.net)
- CIGRE Technical Brochure 766. Network modelling for harmonic studies. April 2019.
- Ziemann, Larissa & Edalati, Omid & Rauch, Jens & Muehlberg, Marko & Klosse, Rainer & Safargholi, Farhad & Hoven, Max & Vennegeerts, Hendrik & Meyer, Jan & Domagk, Max & Malekian, Kaveh & Santjer, Fritz & San, Su. (2019). Improved procedures for determining harmonics - findings of the German research project NetzHarmonie. 18th Wind Integration Workshop. Dublin, Ireland. October 2019.
- Kaveh Malekian , Farhad Safargholi, Wolfgang Schufft, Thomas Dreyer, Jair Cassoli, Stephan Adloff, Florian Ackermann, Hasanali Moghadam, Soenke Rogalla, Gesa Kaatz, Marc Florian Meyer, Sascha Mueller, Issam Athamna, Sven Daniel, Rainer Klosse, Fritz Santjer, Bernd Weise. Harmonic model validation of power generation units. IET Renewable Power Generation, September 2020. Harmonic model validation of power generation units - Malekian - 2020 - IET Renewable Power Generation - Wiley Online Library
- Nouri, B., Kocewiak, L. H., Shah, S., Koralewicz, P., Gevorgian, V. & Sørensen, P. Generic Multi-Frequency Modelling of Converter-Connected Renewable Energy Generators Considering Frequency and Sequence Couplings. IEEE Transactions on Energy Conversion. 37, 1, p. 547-559. 2022.
- Nouri, B., Kocewiak, L. & Sørensen, P. Frequency and Sequence Couplings in Type 4 and Type 3 Wind Turbines. Proceedings of the 19th Wind Integration Workshop. Energynautics GmbH 2020
- 61000-4-7. Electromagnetic compatibility (EMC) – Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto. Second Edition 2002-08.

N. Hatziargyriou *et al.*, "Definition and Classification of Power System Stability – Revisited & Extended," in *IEEE Transactions on Power Systems*, vol. 36, no. 4, pp. 3271-3281, July 2021, doi: 10.1109/TPWRS.2020.3041774.

RELATIONSHIP OF PROJECT TO ACTIVITIES OF OTHER INTERNATIONAL BODIES:

- Cigré WG C4.49 Multi-frequency stability of converter-based modern power systems

- IEEE PES Task Force on Harmonics Modeling, Simulation and Assessment

LIAISONS WITH INTERNATIONAL BODIES:	NEED FOR ISO COORDINATION:
IECRE	

DOCUMENT MATURITY:

☐ A DRAFT IS ATTACHED FOR COMMENT* ☒ **AN OUTLINE IS ATTACHED**

* Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

CONCERNS KNOWN PATENTED ITEMS (SEE ISO/IEC DIRECTIVES, PART 1) ☐ YES ☒ NO

PATENT DESCRIPTION:

RECIPIENTS OF THIS DOCUMENT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY LOCAL REGULATIONS OR TECHNICAL REASONS THAT MAY EXIST AND SHOULD BE CONSIDERED SHOULD THIS PROPOSAL PROCEED, RECOGNIZING THAT FAILURE TO ADDRESS SUCH REQUIREMENTS COULD RESULT IN THE NEED FOR "IN SOME COUNTRIES" CLAUSES.

CONCERNS LOCAL REGULATIONS OR TECHNICAL DIFFERENCES (SEE AC/22/2007) ☐ YES ☐ NO

DESCRIPTION:

WE NOMINATE A PROJECT LEADER IN ACCORDANCE WITH ISO/IEC DIRECTIVES, PART 1

LAST NAME:	FIRST NAME:	E-MAIL:	COUNTRY:
Sørensen	Poul	posq@dtu.dk	Denmark

COMMENTS AND RECOMMENDATIONS FROM TC/SC OFFICERS:

WORK ALLOCATION:

☐ NEW PROJECT TEAM ☐ NEW WORKING GROUP ☒ **EXISTING WORKING GROUP:** **WG 27**

IF APPROVED, THE NEXT STAGE SHOULD BE:

☒ **CD** ☐ CDV

REMARKS FROM TC/SC OFFICERS:

The proposal was announced and presented at the TC 88 plenary meeting on 24 and 25 April 2023. TC 88 welcomed the proposal.

IEC national committees with P-membership status wishing to participate in the development of this new project are invited to appoint/confirm experts.

APPROVAL CRITERIA

- Approval of the new work item proposal by a 2/3 majority of the P-members voting;
- At least 4 P-members in the case of a committee with 16 or fewer P-members, or at least 5 P-members in the case of committees with more than 17 P-members, have nominated or confirmed the name of an expert and approved the new work item proposal.