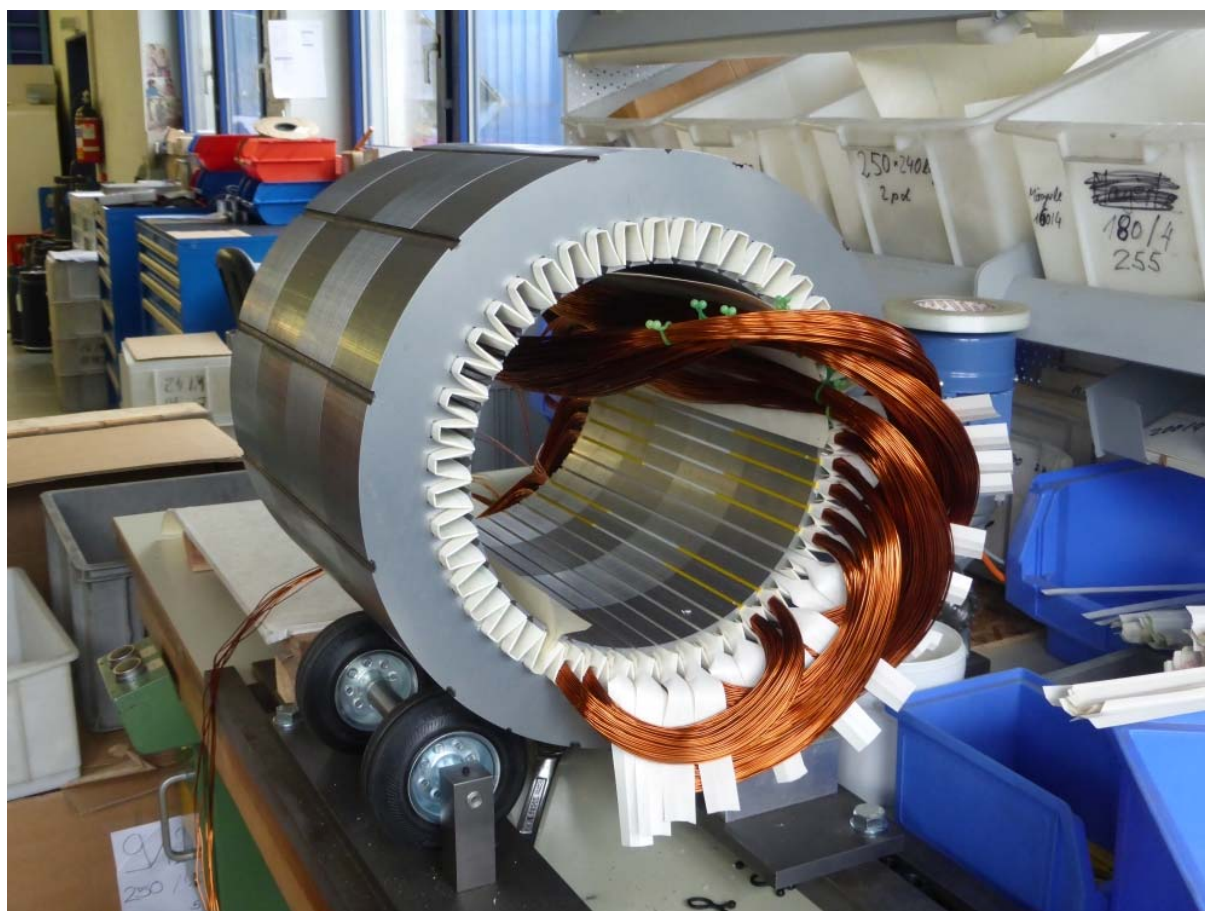




Final report, 8 April 2019

IEA 4E Electric Motor Systems Annex

Swiss contribution





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The author of this report bears the entire responsibility for the content and for the conclusions drawn therefrom.



Summary

The goal of the International Energy Agency's Technology Collaboration Programme Energy Efficient End-Use Equipment Electric Motor Systems Annex (IEA 4E EMSA) is to help the participating countries (Australia, Austria, Denmark, Netherlands, Switzerland and USA) design and implement successful policies for the market transformation of efficient electric motor systems mostly used in industry. EMSA builds an information platform for policy and technical exchange and is actively involved in the international standardization process.

The project serves to stimulate the alignment of international standards for energy efficient electric motor systems. It is part of the IEA 4E EMSA and has successfully brought competent EMSA members as experts into decisive IEC standardization bodies in ACEE, TC 2 and SC 22G who are working on energy efficiency principles, efficiency classification and testing methods for motors and converters. The attention in IEC is slowly shifting away from conventional and well-defined testing and classification standards of fixed speed motors to variable frequency applications and motor driven units. The standards deal now with converter-fed motors and the converters themselves (first edition of IEC 61800-9-2, published in 2017). The findings of the 4E EMSA report "Policy Guidelines for Motor Driven Units - Part 2: Recommendations for aligning standards and regulations for pumps, fans and compressors" (published 2018), start to influence international standards, both in ISO and IEC. In IEC ACEE a special Task Group 6 was launched to deal with the alignment of IEC and ISO standards for Motor Driven Units, based on its Guide 119 on system standards published in 2017.

In the framework of the next EMSA program period, a key element is the testing program "Round Robin for Converter Losses" (separate project) which EMSA leads in collaboration with IEC SC 22G/WG 18. It will inform the revision for the second edition of IEC 61800-9-2.

Résumé

L'objectif du Programme de collaboration technologique de l'Agence internationale de l'énergie (AIE 4E EMSA) est d'aider les pays participants (Australie, Autriche, Danemark, Pays-Bas, Suisse et États-Unis) à concevoir et à mettre en œuvre des politiques opérantes pour la transformation sur le marché des systèmes de moteurs électriques efficaces utilisés principalement dans l'industrie. L'EMSA construit une plateforme d'information pour l'échange politique et technique et participe activement au processus international de normalisation.

Le projet vise à stimuler la coordination des normes internationales relatives aux systèmes de moteurs électriques à haut rendement énergétique. Il fait partie de l'AIE 4E EMSA et fait participer des membres compétents de l'EMSA en tant qu'experts au sein d'organismes de normalisation décisifs de la CEI en ACEE, TC 2 et SC 22G, qui travaillent sur les principes d'efficacité énergétique, la classification du rendement et les méthodes d'essai pour moteurs et convertisseurs. L'attention de la CEI s'éloigne lentement des normes d'essai et des classifications conventionnelles et bien définies des moteurs à vitesse fixe au profit des applications à fréquence variable et des unités motorisées. Les normes traitent maintenant des moteurs alimentés par convertisseurs et des convertisseurs eux-mêmes (première édition de la CEI 61800-9-2 publiée en 2017). Les conclusions du rapport 4E EMSA "Policy Guidelines for Motor Driven Units - Part 2 : Recommendations for aligning standards and regulations for pumps, fans and compressors" (publié en 2018), commencent à influencer les normes



internationales, tant à l'ISO que la CEI. Au sein de la CEI ACEE, le groupe de travail spécial 6 a été créé pour traiter de l'alignement des normes CEI et ISO pour les unités d'entraînements, sur la base de son Guide 119 sur les normes de systèmes publié en 2017.

Dans le cadre de la prochaine période de programme de l'EMSA, un élément clé est le programme d'essais "Round Robin for Converter Losses" (projet séparé) que l'EMSA dirige en collaboration avec la CEI SC 22G/WG 18. Il servira de base à la révision de la deuxième édition de la CEI 61800-9-2.

Zusammenfassung

Das Ziel des Technology Collaboration Programme Energy Efficient End-Use Equipment Electric Motor Systems Annex (IEA 4E EMSA) der Internationalen Energieagentur ist es, die teilnehmenden Länder (Australien, Österreich, Dänemark, Niederlande, Schweiz und USA) bei der Entwicklung und Umsetzung erfolgreicher Strategien zur Markttransformation von effizienten Antriebssystemen zu unterstützen, die hauptsächlich in der Industrie eingesetzt werden. EMSA bildet eine Informationsplattform für den politischen und technischen Austausch und ist aktiv am internationalen Normungsprozess beteiligt.

Das Projekt dient dazu, die Koordination der internationalen Normen für energieeffiziente Antriebssysteme zu fördern. Es ist Teil des IEA 4E EMSA und hat erfolgreich kompetente EMSA-Mitglieder als Experten in die entscheidenden IEC-Normungsgremien von ACEE, TC 2 und SC 22G gebracht, die an Energieeffizienzgrundsätzen, Effizienzklassifizierung und Prüfverfahren für Motoren und Umrichter arbeiten. Die Aufmerksamkeit in der IEC verlagert sich langsam von konventionellen und klar definierten Prüf- und Klassifizierungsstandards für Motoren mit fester Drehzahl hin zu Anwendungen mit variabler Frequenz und ganzen Antriebssystemen. Die Normen befassen sich nun mit umrichtergespeisten Motoren und den Umrichtern selbst (erste Ausgabe der IEC 61800-9-2 aus dem Jahr 2017). Die Ergebnisse des 4E EMSA-Berichts "Policy Guidelines for Motor Driven Units - Part 2: Recommendations for aligning standards and regulations for pumps, fans and compressors" (veröffentlicht 2018) beginnen, internationale Normen sowohl in ISO als auch in IEC zu beeinflussen. In IEC ACEE wurde eine spezielle Arbeitsgruppe 6 eingesetzt, die sich mit der Angleichung der IEC- und ISO-Normen für Antriebseinheiten befasst, basierend auf dem im Jahr 2017 veröffentlichten IEC Guide 119 zu Systemnormen.

Im Rahmen der nächsten EMSA-Programmperiode ist ein Schlüsselement das Prüfprogramm "Round Robin for Converter Losses" (separates Projekt), das EMSA in Zusammenarbeit mit IEC SC 22G/WG 18 leitet. Es wird wissenschaftliche Grundlagen für die Überarbeitung in der zweiten Ausgabe der IEC 61800-9-2 liefern.



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List of abbreviations

4E	Energy Efficient End-use Equipment
ACEE	Advisory Committee for Energy Efficiency in IEC
CES	Comité Électrotechnique Suisse
ECI	European Copper Institute
EEMODS	International conference on Energy Efficiency in Motor Driven Systems
EMSA	Electric Motor Systems Annex in 4E
ExCo	Executive Committee in 4E
IEA	International Energy Agency
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MEPS	Minimal Energy Performance Standard
SEAD	Super-Efficient Equipment and Appliance Deployment initiative
SFOE	Swiss Federal Office of Energy
TC	Technical Committee in IEC and ISO
TCP	Technical Cooperation Programme in IEA
TK	Technische Kommission in CES
U4E	United for Efficiency
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Programme
VFD	Variable Frequency Drive
WG	Working Group in IEC and ISO



1 Introduction

International standards for electric motors and some additional components (Variable Frequency Drives (VFD), pumps, fans, compressors, etc.) serve as a prerequisite for setting national Minimum Energy Performance Standards (MEPS). MEPS can save an important part of electric energy by prohibiting the sale of inefficient products.

Switzerland is charged within the Electric Motor Systems Annex (EMSA) of the IEA Technical Cooperation Programme 4E to lead the Task "International Standards". Switzerland coordinates the work of EMSA members in IEC and ISO standard developments.

In addition, Switzerland together with the EMSA Operating Agent, Maarten van Werkhoven at TPA advisors in the Netherlands, is responsible for the coordination of the EMSA program with Rita Werle, EMSA Program Coordinator. Furthermore, Switzerland leads with Rita Werle the Task EMSA Outreach. These activities are covered under a separate agreement.

This report summarizes the completed tasks and achieved results for the period between November 2017 and end of February 2019 (the so called "Mini-Extension") under the EMSA Task "International Standards".

2 Goal of Project

The goal of EMSA is to help governments develop and implement successful policies for energy efficient motor systems. This is achieved inter alia through national Minimum Energy Performance Standards based on international standards. EMSA is coordinating in its Task International Standards global efforts in IEC and ISO to align testing standards and energy efficiency classification for Motor Driven Units and to propagate systems efficiency with well-coordinated components.

3 Work undertaken and findings obtained

Global standards for efficiency classification and testing of electric motors are treated in the International Electrotechnical Commission (IEC), in the Technical Committee (TC) 2 on rotating machines and its Working Groups (WG) 12, 28 and 31. More recently, with the energy efficiency benefit of load control, new standards are being developed by the IEC Subcommittee (SC) 22G and its WG 18 for energy efficiency testing and classification of Variable Frequency Drives (VFD) and their interaction with motors. EMSA members in IEC TC 2 and IEC SC 22G include Conrad U. Brunner (Impact Energy/Switzerland), Andrew Baghurst (CaITest/Australia) and Sandie B. Nielsen (Danish Technological Institute/Denmark). Since September 2017 Andrea Vezzini (Bern University of Applied Sciences) has joined EMSA and the international standards team. He was officially accepted as Swiss national expert in the above-mentioned IEC TCs and WGs on 4 November 2017.

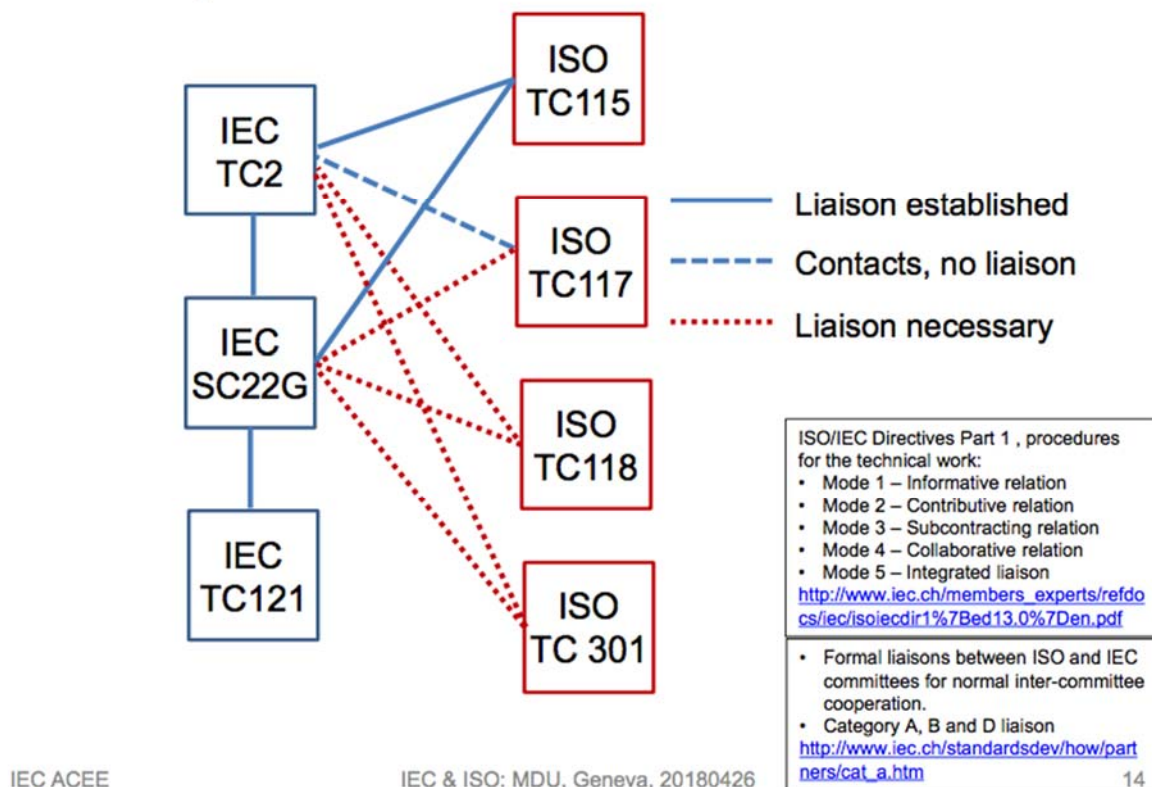
The IEC Advisory Committee on Energy Efficiency (ACEE) and its EMSA member Conrad U. Brunner (Impact Energy/Switzerland) has been actively involved in developing the following case study, based on the recently published new guides 118 and 119:

- IEC ACEE 02: Case Study Electric Motors (July 2018)

Its goal is to explain the application of the guides to a specific area, namely motor driven units.



Cooperation to be established



Motor control		Motor	Mechanical equipment		Driven application			
IEC TC 121	IEC TC 22 SC 22G	IEC TC 2	ISO TC 41	ISO TC 60	ISO TC115	ISO TC 117	ISO TC 86	ISO TC 118
Switchgear & controlgear	Adjustable speed drive	Rotating machinery	Pulleys & belts	Gears	Pumps	Fans	Cooling-Compressors	Air-Compressors
1927	1934	1911	1947	1947	1964	1964	1957	1965

Figure 1 Overview of TCs from IEC and ISO involved in motor systems

ACEE launched Task Group 6 (Conrad U. Brunner, TG leader, Kirk Anderson/NEMA, Franco Bua/CEI), Maarten van Werkhoven/EMSA, Benno Weis/Siemens) to deal with the "Coordination and alignment of the system standards for Motor Driven Units by ISO and IEC". Maarten van Werkhoven, EMSA Operating Agent, is as Dutch national expert new member of IEC ACEE since 2019.

The following 8 international meetings of the IEC WGs were held during the reporting period (brief meeting summaries in Appendix 1) and attended by EMSA members:

1. IEC SC 22G WG18, 26 - 28 February 2018, Tampa FL, USA (report no 31)
2. IEC ACEE, 25 - 26 April 2018, Geneva, Switzerland (report no 32)
3. IEC TC2 WG28, 21 May 2018, Shanghai, CN (report no 33)
4. IEC TC2 WG 31, 22 May 2018, Shanghai, CN (report no 34)
5. IEC TC2, 23 May 2018, Shanghai, CN (report no 35)
6. IEC TC2 WG12, 24 May 2018, Shanghai, CN (report no 36)



7. IEC ACEE, 29 - 30 August, Quebec, Canada (report no 37)
8. IEC TC2 WG 12, 9 November 2018, Prague, CZ (report no 38)
9. IEC SC 22G WG18, 19-21 February 2019, Melbourne, Australia (report no 39)
10. IEC ACEE, 3-4 April 2019, London UK (report no 40)

In the following draft standards Switzerland, Australia and Denmark are directly involved in the writing of the text, in comments and in the continuous revision:

1. IEC 60034-1, Rotating electrical machines - Part 1: Rating and performance, next edition: Conrad U. Brunner provides draft chapter 10: rating plates (including QR code to link with technical data on motor manufacturer's company server)
2. IEC 60034-2-3, Rotating electrical machines - Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC induction motor: preparation of edition 2 with improved testing method, substantial comments by Andrew Baghurst.
3. IEC 60034-31: Rotating electrical machines - Part 31: Selection of energy-efficient motors including variable speed applications - Application guide, next edition: Conrad U. Brunner provides draft chapter 9 on system performance and optimization.
4. IEC 61800-9-2: Adjustable speed electrical power drive systems - Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications - Energy efficiency indicators for power drive systems and motor starters. Conrad U. Brunner, Sandie B. Nielsen and Andrew Baghurst provided input and criticized insufficient testing and calculation methods.

The Task International Standards has also included a regular progress report on European plans and decisions concerning Ecodesign regulations for Minimum Energy Performance Standards:

EU: Ecodesign Directives					
- Fans no 327/2011 - revision pending - Circulators no 641/2009 - revision pending - Water pumps no 547/2012 - revision pending - Motors no 640/2009 - revision pending					
NEW DRAFT for Review					
General Regulation		no 640		no 640 (revision)	
Date decision		22.07.2009		open	
Date enacted		01.01.2015	01.01.2017	15.01.2021	01.07.2022
Requirements		tier 1	tier 2	tier 1	tier 2
Motors	Size kW	7.5 - 375	0.75 - 375	0.75 - 1000	0.75 - 1000 0.12 - 0.75
	Poles	2-/4-/6-		2-/4-/6-	2-/4-/6-/8-
	Efficiency class motor	IE3 (or IE2 & VSD)		IE3	IE3 IE2
	Benchmark	IE3 (or IE3 & VSD)			
VSD	Size kW			0.75 - 1000	
	Efficiency class VSD	no requirements		IE2	
	Benchmark			IE4	

Figure 2 Status of EU Ecodesign directives for motor systems, Revision of no 640: approved by regulatory committee in January 2019

The key element was the last review until 21 November 2018 of the European Commission draft



revision no 640 for motors and VFDs. Conrad U. Brunner, Maarten van Werkhoven, Konstantin Kulterer and Sandie B. Nielsen have actively contributed to the revision of this regulation as independent experts. The latest version of the draft, approved by the Regulatory Committee on 14 January 2019, was published in February 2019.

Two EMSA meetings were held during the reporting period, where the Task leader of "EMSA International Standards" reported on progress:

- 28 - 29 May 2018, Schaffhausen, Switzerland (before the 4E ExCo meeting)
- 12 - 13 November 2018 in Zurich, (before the Motor Summit 2018 International).

Both reports were also presented to the 4E ExCo by Roland Brüniger.

At the meeting in November in Zurich, the EMSA group thanked Conrad U. Brunner for his work within EMSA since the outset of the program and his contributions in the field of international standardization.

4 National cooperation

IEC work is based on National Committees (NC). In Switzerland the "Comité Électrotechnique Suisse" (CES) is managed by electrosuisse in Fehraltorf and is responsible for the Swiss National Committee (NC). The IEC groups are coordinated and supported by the Swiss National CES groups that mirror both IEC TC2 (TK2) and IEC SC 22G (TK22). Four CES meetings at electrosuisse in Fehraltorf/Switzerland were held and attended by Conrad U. Brunner (2017) and Andrea Vezzini (2017/2018):

- TK2 (mirror group for TC2), 3 November 2017
- TK22 (mirror group for SC 22G), 3 November 2017.
- TK2 (mirror group for TC2), 9 November 2018
- TK22 (mirror group for SC 22G), 9 November 2018

In all these meetings a brief report from the international work in IEC TC2, SC 22G and ACEE was given by either Conrad U. Brunner or Andrea Vezzini.

The 4E EMSA project is closely linked to the Swiss Topmotors program (www.topmotors.ch) and the Motor Summit (www.motorsummit.ch). The Motor Summit International was held in Zurich on 14 - 15 November 2018. As a side event, the task force for the global Round Robin for Converter (RR'C) losses staged a workshop on 13 November 2018. The RR'C program is reported in a separate report.



Figure 3 Group picture at the end of the RR'C Workshop on 13 November 2018 at the Motor Summit 2018 International in Zurich



On 30 November 2018 the second IEA Networking event Switzerland took place in Neuchâtel to encourage the exchange among TCPs with Swiss involvement. Rita Werle gave a presentation about EMSA: "Electric motor systems – standards and policy guidelines", Andrea Vezzini also attended the event.

Andrea Vezzini and Rolf Tieben (Impact Energy) are part of the "Trend watching group" organized by SFOE with regard to electric motor systems.

5 International cooperation

EMSA cooperates with other organizations and international initiatives active in the field of electric motor systems (e.g. inputs to IEA publications, SEAD, ECI, U4E, UNEP, UNIDO, UNECE, UNDP, etc.), to benefit from synergies and avoid duplications of effort.

The international cooperation includes presentations of the 4E EMSA team members at international conferences, like the Motor Summit 2018 International (14 - 15 November 2018 in Zurich, Switzerland) and the EEMODS conference (Energy Efficiency in Motor Driven Systems, organized by the Joint Research Centre of the European Commission).

Since the start of the participation of EMSA members Andrew Baghurst (2010), Sandie B. Nielsen (2015) and Andrea Vezzini (2017) in the relevant IEC working groups, the effectiveness of the EMSA participation in the international standardization work has increased heavily. All three members have an independent testing laboratory for motors and converters that can help to understand testing methods for motors online and converter-fed, as well as the converter itself. They have contributed to advanced research. Results are regularly published at the international conferences EEMODS and Motor Summit. With the addition of Andrea Vezzini in 2017 and his independent laboratory at the Bern University of Applied Sciences, Switzerland increased the technical competence in the EMSA group.

Additionally, a specific series of tests on converter fed motors and converters have been undertaken by CalTest/Australia (Andrew Baghurst). A remarkable contribution to clarifying and improving testing methods has been made.

Maarten van Werkhoven, EMSA Operating Agent, also took part in the IEC ACEE meeting on 3-4 April 2019 in London UK (report no 40), as a new member of IEC ACEE and national expert for the Netherlands. He also took part in the U4E meeting in Paris on 26 March 2019, which aimed at discussing Model Regulation Guidelines for motors for emerging economies, referencing relevant IEC standards.

6 Conclusion and Outlook

During the reporting period, the study on the *"Policy Guidelines for Motor Driven Units - Part 2: Recommendations for aligning standards and regulations for pumps, fans and compressors"* was published in early 2018.

The report *"Round Robin of converter losses, results of phase 1"*, was published in March 2019. The work will continue with RR'C phase 2 to test some 60 converters and review the reference losses in IEC 62800-9-2, edition 1.

In 2017 a dissemination highlight was the Motor Summit Switzerland on 21 November 2017 in Zurich and in 2018 the Motor Summit International on 14 – 15 November 2018 in Zurich.

The current liaisons in IEC ACEE will be expanded and the necessary interaction to coordinate the different standards between ISO and IEC is under way. A side event at EEMODS 2019 which will take



place on 17 – 19 September 2019 in Tokyo, Japan is planned to discuss the procedure of this coordination with the 9 involved TCs and industry associations and regulators.

7 Publications

- Conrad U. Brunner: IEC standards for motor driven units, in: Motor Summit 2018, conference proceedings, 2018, Zurich, Switzerland
- Maarten van Werkhoven: International collaboration for efficient motor systems: Global Outlook and 4E EMSA, in: Motor Summit 2018, conference proceedings, 2018, Zurich, Switzerland
- Rita Werle: Motor systems today and tomorrow, in: Motor Summit 2018, conference proceedings, 2018, Zurich, Switzerland
- Sandie B. Nielsen: Global Round-Robin on Frequency Converters, in: Motor Summit 2018, conference proceedings, 2018, Zurich, Switzerland
- Andrew Baghurst: International converter efficiency measurements round-robin/feasibility study, in: Workshop Round Robin, Motor Summit 2018, Zurich, Switzerland
- Andrea Vezzini, Round Robin pilot study, in: Workshop Round Robin, Motor Summit 2018, Zurich, Switzerland
- Round Robin for Converter Losses, Report of Results of Phase 1, Zurich, March 2019

8 References

- [1] Maarten van Werkhoven, Rita Werle, Conrad U. Brunner (EMSA): IEA 4E Policy Guidelines for Motor Driven Units - Part 2: Recommendations for aligning standards and regulations for pumps, fans and compressors, Zurich Switzerland, May 2018
- [2] Konstantin Kulterer, David Presch (EMSA/Austrian Energy Agency): Energy Audit Guide for Motor Driven Systems, Recommended Steps and Tools, Zurich Switzerland, 2018
- [3] Motor Summit 2018, SFOE internal report 2018
- [4] IEA 4E Electric Motor Systems Annex, Swiss contribution, SFOE internal annual report 2018
- [5] Round Robin for Converter Losses, SFOE internal annual report 2018