Instituut Fysieke Veiligheid

Exchange of Experts 2018
November 12th - 16th
Realistic Training
FSE and real fires

Short Report

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Content

Preface

Arnhem, 25 November 2018

This year it is the third time that the Fire Service Academy (IFV) organized an exchange of experts in the Netherlands. The exchange was combined with the international Fire Safety and Science congress, and in that way provided in a very international program. Combining on the one hand science and practice and on the other hand fire suppression and fire prevention.

The main objective of these exchanges is to share knowledge and look for research topics to collaborate on. In that sense, we still consider these exchanges a first step towards a more comprehensive and durable network of researchers and practitioners who conduct practical research for the fire service, who are willing to share this knowledge and can translate it to practice. Starting from this network, we are working together to achieve this objective.

During the first exchange in 2016 we determined a list of topics of general interest, and at the exchange in 2017 we updated this list. This year we primarily shared knowledge about two topics on that list: realistic training and simulation modelling in order to understand real fires. This year, funding from EU was not available, and we are very happy that still we were able to meet with a great group of people to continue working on our collective goal.

Judging by the positive reactions from all participants, the meeting was again a success!

The network that is formed is a very strong one, and growing. I am really happy with that, and we will continue to organize the exchange. Next year the program will be more open, in order to leave more time to discuss research results with each other.

I want to thank you, participants, for your active interaction, your presence and input, and hope to meet you again next year. A special thank you I would like to express to my colleagues that made a big effort to organize this exchange: Jan Maarten, Monique and Deborah. Without you, this exchange would not have been such a success!

Ricardo Weewer

Professor of fire service science
Fire Service Academy (IFV)

1 Objectives

'The most difficult thing at this moment is knowledge to practice: to make firefighters understand and use science.'
Participating expert

Exchanges of Experts are important means in answering experts' need of sharing practical and scientific knowledge on an international level and on actual topics. At the Exchange in 2017 at the IFV, experts reviewed and added to the list of mutual topics of interest which they had outlined at the exchange that took place in 2016. All experts expressed the desire to keep organizing exchanges. Proposed topics for Exchanges of Experts are:

1. Exchange results of experiments into fire spread in family dwellings. This subject is of continuous interest for those institutes that actually conduct experiments.
2. How to conduct measurements in practical experiments. The subject was discussed this year, but may be a continuous topic for those countries that conduct experiments.
3. The use of drones for size up. This topic is still of interest, next year Denmark or the Czech Republic may organize an exchange on this subject.
4. *Fire safety engineering, modelling in combination with practical experiments. This subject is still of interest, and the Netherlands proposes to make this a topic for next year in Netherlands*
5. *The impact of smoke (contaminates and toxins) on firefighters and PPE (occupational health issue).*
6. The Human factor in command and control. This year the Netherlands organized an exchange, a follow-up may be organized next year by Catalonia or Denmark.
7. Gas cooling by the fire service (effects, possibilities, measurements) and water mist (effects on fire, application in the home, especially for elderly people). This subject has been addressed.
8. *Foam as an extinguishing medium (use, chemicals and environmental aspects).*
9. *Batteries (what are the dangers and how to construct large battery installations to enable firefighters can do their work?). This is a very important topic since it is a new risk for society, and many countries are working on it, but not together. The Netherlands organizes an exchange on this subject in spring 2018*
10. *Realistic training. Participants think that this will be a new way of learning and gaining knowledge. Knowledge can be exchanged on the process as well as the outcomes.*
11. *Gas explosions (looking into case studies, do they actually occur?). This has become one of the biggest risks for fire fighters nowadays and more research and knowledge has to be collected and exchanged.*

This Exchange had two objectives:

> Exchange (finished, ongoing, planned) research and find topics to collaborate upon
> Exchange practical knowledge on topics no. 4 and 10 (mainly), and also on no. 5, 8, 9 and 11.

A total of 20 experts participated in this Exchange, two of which also had a keynote or workshop during the FSS Conference.

2 General program

The Exchange of Experts took place in Arnhem, in the Netherlands and was organised by the Institute of Physical Safety (IFV). The program of the Exchange consisted of four days. From November 12-16, experts came together at the IFV. Following last year, the Fire Safety Science (FSS) Congress was integrated in the program of the Exchange. In preparation of the Exchange, all experts were asked to provide specific input for the program. This resulted in an approval of the main topics proposed by the host: Realistic training and FSE in relation to real fires, as well as several other topics. These topics were discussed during the different sessions. Additionally, all experts prepared a concise presentation on their current research (findings/programs), developments and challenges regarding (inter)national Fire and Rescue Services. A detailed program of the Exchange is presented in chapter 5. The Exchange ended with summarizing and evaluating the gained experiences.

Participants

The participants were invited by approaching the existing and growing network consisting of:

> European Fire Service Academy Association (EFSCA) members
> The Arnhem Group, participants from last year's exchange
> Participants from other Exchanges.

This network was approached to send their experts on the specific subjects.

3 Report

3.1 Monday 12-11-2018

After arrival at the Institute of Safety (IFV), participants were welcomed by Ricardo Weewer, professor of Fire Service Science, at the Netherlands Fire Service Academy. The experts then individually shared their recent research results, ongoing research and research agenda in their national reports. After lunch, the experts immediately went on to discuss on the use of foam on ignited batteries, the use of (advanced) drones and realistic training.

3.1.1 Session 1 l National reports

Experts one by one shared a short presentation on their current research (findings/programs), developments and challenges regarding (inter)national Fire and Rescue Services.

Martin Thomsen (Head of College at Danish Emergency Management Agency (DEMA) Emergency Services College, DK)
DEMA works under the responsibility of the Ministry of Defence. There is a political agreement on the budget for DEMA for the next six years. Attention towards emergency services in Denmark have grown over the years. DEMA offers different training programs to incident (sub-) commanders in the fire service, firefighters, police and health authorities. Trainings also involve e-learning. Some of the latest research involves the practical use of drones (since 2014), simulation-based training and thrownness: what happens when emergency services get into an incident in which they get overwhelmed?

All other experts indicate that drones are also used (by means of pilot) by the fire and rescue services in their countries. In most countries, a clear and usable regulation on the use of drones by the emergency services is still lacking.

Nils Johansson (Associate senior lecturer at Division of Fire Safety Engineering, University of Lund, SWE)
The University of Lund has an International Master of Science in FSE, together with Belgium. Forest fires in 2014 instigated a Rescue Service Investigation. The investigation initially focust on emergency services actions and capacity regarding these forest fires, but the report expanded to answer even questions such as: Which ranks to use throughout the country? When can the government come into a crisis and take over? It also resulted in the fact that you do no longer have to be a FSE engineer, to be a fire chief. FSE is taken out of the basic training.
Pending research proposals are: Efficient fire service in a changing world. Modeling, large scale evacuations.
Nils highlighted what he thought to be a worldwide problem: How to explain and use scientific knowledge?

Lee Johnston (Central Group Manager, West Sussex Fire and Rescue Service, UK)
Lee is the group manager of 9 fire brigades. He advocates evidence-based firefighting, on which he wrote an important report. This report will be used to enhance the existing manuals, which date back to the late 90's and often are more tradition-based. Lee and his

colleagues are now investigating whether they can use evidence-based training material from other (international) colleagues or that they have to do a study on their own.
They also started research on the physiology of firefighting. This is a longitudinal study, involving ear sensors, taking blood and other physiological measurements.

Picture 3.1 Marko Hassinen (presenting) on the research guidelines for rescues services in Finland

Marko Hassinen (Research Scientist at Emergency Services College, FIN)
Marko and his colleagues (of which only four permanent) at the Pelastusopisto Institute by law are responsible for coordinating the research of the emergency services. For instance, they write guidelines and strategy plans on which projects to fund. Marko is intrigued by the question: How to prepare our firefighters for (all changes in) the future? Marko is working on a project on utilizing drones with more advanced sensors in emergency services. Other research focuses on exposure of firefighting clothing to asbestos and what type of clothing, breathing protection and tools to use during forest fires. He is also preparing a project on a new manual on road operations, involving also electrical cars and other alternative fuels.

Robin Zevotek (Lead research engineer at UL Firefighter Safety Research Institute, US)
After 9/11 there was more funding available for apparatus, education, but little for fire research. UL annually conducts many research projects. Robin and his colleagues are confronted with the question from the field: Could you not only do research and write reports, but also translate it into practical language?
Some insights from recent research are: ‘close before you dose’, ‘if you know where to put it, you do not need a lot of water’ and the weight of the fuel is directly related to the released

energy. The latter insight means for training that different types and amounts of fuel can be used to equal the same heat release rate as real fires, such as car fires of couch fires etc. enhancing realistic training. Additionally, UL researched whether one is able to see (post-fire) whether electrical wires were charged at the event of the fire. Results indicate that it is not possible to see this.

Peter McBride (Division Chief - Safety & Innovation, Ottawa Fire Services, CAN)
In the province of Ontario, “competency” is defined under health and safety law as, knowing the law, knowing the dangers in the work and being able to supervise the dangers in the work. Peter related that his main focus is danger in the work and how to supervise it. He gave an overview of Defence Research Development Canada’s, Fire Community of Practice, and the Community’s goals in supporting research and leveraging the work of 14 different communities of practice. Peter listed a wide range of research interests such as smoke movement and control, firefighter hygiene and rehabilitation practices, tunnels, hybrid vehicles and energy systems, tall wood buildings and the implications of material science within the built environment. According to Peter, ‘firefighting is art informed by science.’
He challenged the group to reimagine the fire service as F for firefighting, I for instruction, R for research, E for engineering and proposed a U.N. Declared International Year of the Firefighter.

Picture 3.2 Peter McBride during the introduction on his national report.

Ricardo Weewer (Professor of Fire Service Science at the Netherlands Fire Service Academy, NL)
The Dutch Fire Service Academy provides input for training programs of all firefighters, all ranks. It also does fire research including literature reviews, practical experiments, data collection and analysis, community of practice and action research. Ricardo indicated that areas of most interest are now: climate change, sustainability, information technology, demographic developments and global safety in relation to fires and firefighting. This for instance results in ongoing or future research on smoke gas explosions, the quadrant model, human factors in decision-making and volunteers.

3.1.2 Session 2 l Foam as an extinguishing agent

Alexander Schaberg (M.Sc. Chemie, Fakultät für Maschinenbau und Sicherheitstechnik, Bergische Universität Wuppertal, GER) and Prof. Roland Goertz presented on the use of fire fighting foam and battery fires. Results of small experiments show that:

> High concentrations of ions tend to have an adverse effect on foam building.
> CAFS is (nearly always) preferable over NAFS.
> For sealing, high stability foam with prescribed concentration should be used, in any other fields, the foam concentration doesn't need to be as high – for battery fires, wetting agents in water should be considered.
> Nevertheless, lower concentrations tend to stabilize the foam by using the Marangoni effect.
> Effectiveness is most dependent on the foaming system, less on the agent.
> The more ethanol in gasoline, the higher the application rate need.

On a side note: the water used in typical tests does not resemble normal water (salt nor sweet).

Additionally, Roland and Alexander are looking into a new way of thinking about the fire service: Fire service as a system element. Driver of looking into this is the (lack of) fire brigade capacity.

3.1.3 Session 3 l Realistic training I - Advanced drones

Marko Hassinen stated that in Finland there mostly are procedures and trainings for a team of six firefighters, but that in practice, mostly four firefighters are on the team. Because of this, the Pelastusopisto Institute has developed educational material (also many videos, with very long Finnish titles) for teams of various size: 1-6 firefighters. Marko also is looking into the question: When is it useful to deploy a drone? There have been tests with incident commanders, asking them during and after exercises whether they thought the use of a drone was practical or not.
Drones are developing. Advanced sensors in drones, such as hyperspectral vision, add another dimension to a drone. Marko is trying to use this tool to identify forest fires or to find spilled hazardous fuels that went airborne. Marko explained how this vision works and how drones can be used in practice.

3.1.4 Session 4 l Realistic training II

Lee Johnston mentioned that in the UK they are building a realistic training facility. However, what is reality? There are so many different scenario's, what to train for? Lee states that firefighters are losing skills because they are practicing to little. However, one cannot train every possible scenario. There are limitations in time, safety, law and others. Although training can never really approach reality, Lee advocates a better training of firefighters in the UK, by better translating scientific insights into understandable knowledge. Lee is also opting for the use of VR to better prepare the firefighters for the real deal and to be able to show them various types of fires.

3.1.5 Session 5 l Realistic training III

Siemco Baaij drew a picture of a Dutch firefighter's mindset: they state they know their skills, train realistically, train as the fight and have learned enough through the years. But are they right? Not always. Siemco stated there are still many challenges in realistic training in the Netherlands and proposed ways (of which a name just a few) to go about these challenges:

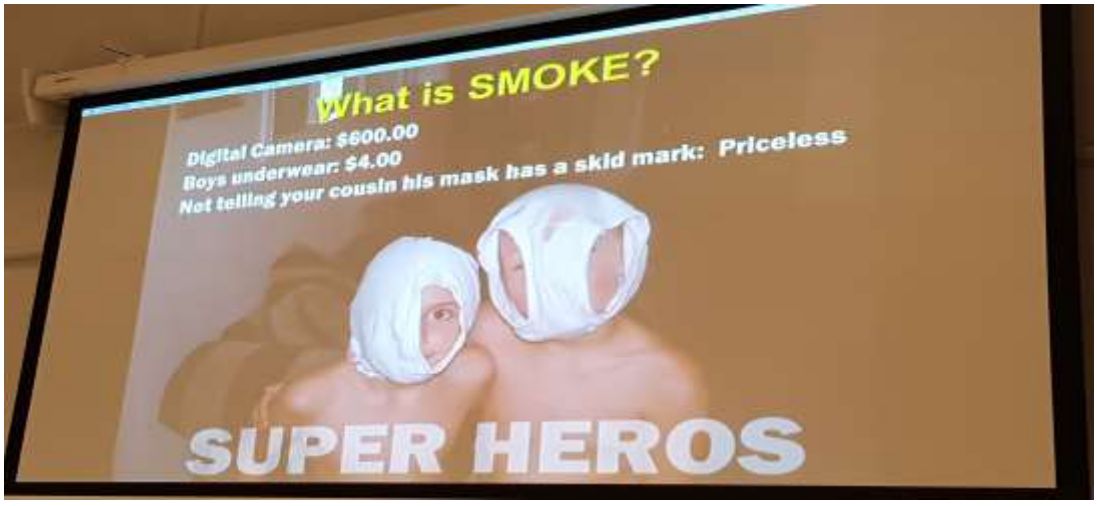
> Tell students that they are training with simulations, not reality.

> Apply science in practice.
> Set learning goals for exercises and work towards those.
> Instructors should teach students the same.
> Instructors should function more as a mentor to students.

Picture 3.3 Siemco Baaij identifying gaps in 'realistic' training of Dutch fire fighters.

3.1.6 Masterclass I Exposure to smoke

The scientific evidence for a relation between firefighting and cancer is increasingly troubling. Firefighters are regularly exposed to contaminants from fires that are known or suspected to cause cancer. A number of recent studies have provided insights on the possible mechanisms and pathways of exposure and their effects. Peter provided an overview of nanotechnology lexicon/terminology, unique properties, inherent hazards, societal benefits and risks, and controls fire service should consider in managing the risks associated with nanotechnology and current/common operational practices. Attendees heard first-hand of the Ottawa Fire Service experience and their efforts to reduce the dose through research, education, and action.



Picture 3.4 One of Peter McBride's more humorous slides during his masterclass on the

(hidden) dangers of exposure to smoke. Humour aside, Peter wants the fire service to develop a similar cultural aversion to smoke and implement hygiene controls for this danger!

3.2 Tuesday 13-11-2018 l Sessions

3.2.1 Session 6 l FSE and real fires I

Dutch firefighters often think they have a lot of knowledge, but they turn out to also lack a bunch. Why? Because new fuels are introduced and building and building methods have changed. Lieuwe de Witte introduced FSE as an analytic tool by mentioning four case studies, drawn from the (Dutch) book by the Fire Service Academy *Trends to learn from*, which he analysed using FSE:

Case 1: Toilet bowls. Three cars in an underground parking garage.
Case 2: Mobility scooter fire. Immense soot, yet small fire (1,5 Mw).
Case 3: Use of a cobra cutter on a home store.
Case 4: Army dump store: eliminating doors, windows etc. to create openings to let the smoke out, to be able to see the fire and put it out. Also to avoid pressure build up and fire spread.

The results were helpful. Lieuwe's goal is identifying lessons of real cases through simulations after the fact: What happened and why? These lessons are useful for incident evaluations, better understanding practical experiments and data collection. Lieuwe believes using FSE in analysing real fires can help to get firefighters engaged in FSE and to fill the gap between knowledge and practice.

3.2.2 Session 7 l FSE and real fires II

Nils Johansson exemplified how FSE can be used to understand real fires, for instance by analysing (big) data on fires, as well as case studies using FSE. In Sweden, there have been many school fires. One percent of fires causes almost 50% of the costs involved in these fires. This led the Swedish Fire Research Board to identify patterns in school fires. Since 1998 there exists a database on all kinds of incidents. It now contains over 200.000 fire incidents, based on reports of commanders. Around 10-15% of those are arson fires, in school fires nearly 40% is arson fires. Data also showed that the origin of the fire is often outside of the building. Case studies showed more details: Arson often involves all kind of materials around the school or in bins or toilets, and combustible liquids. There also appeared to be a lack of detection systems and lighting. Nils tries to take case studies to a next step. He wants to use fire investigations to analyse fires more systematically. He does so by using statistics/interviews to help refine research questions and using data from fire investigations to find underlying factors. He uses a six step methodology. By means of this methodology Nils developed a fault tree analysis to investigate how certain fires grow to big fires and others are successfully managed.

Also see:

> Combining Statistics and Case Studies to Identify and Understand Deficiencies in Fire Protection", *Fire Technology*, 48, pp. 945–960, 2012
> "A case study of fires in structural elements", *MATEC Web of Conferences*, 2016

Picture 3.5 Nils Johansson on the use of FSE, data and case studies to come to fault tree analysis

3.2.3 Session 8 l Fire Dynamics Project

Peter McBride promoted and explained the Fire Dynamics Project, an impressive initiative of over 60 international parties to get scientific knowledge on fires and fire extinguishing between the ears of ordinary fire fighters: form knowledge to practice. According to Peter, only when understanding fires, firefighters are able to choose the right strategies and tactics in practice. Understanding science and the effect of their actions, therefore, is crucial. The educational material that this project produced is built up in tactical bricks, which allows for easy changes when new scientific insights surface. The material is freely accessible online, please visit: https://www.firedynamicstraining.ca/.

3.2.4 Session 9 l Combustible metal roof decks

Peter McBride presented on commercial roofs with combustible components, such as foam insulation, can lead to complex fires that are challenging to control while keeping firefighters safe. Various tactics have been developed for fighting fires in combustible metal roof decks (CMRDs), including cooling structural steel, trenching, deck washing, and thermal decoupling. Coupled with the complex fire there is a high degree of variability in tactical application due to the history of training, experiential learning, staffing and equipment. Peter presented preliminary results of research on CMRD and provided guidance on how to approach this type of fire based on repeated operational success by Ottawa Fire Services.

3.2.5 Session 10 l Battery Packs

Roland Goertz shared new fire research results on two types of primary Lithium-metal batteries: Li-$SOCl_2$ and Li-MnO_2. The first is very active. A little heat can trigger an explosion. One AA cell is already very corrosive too. If a Li-$SOCl_2$ cell explodes, chunks of lithium might be spread in the surroundings, leading to the possibility of further fire spread, especially when using water to extinguish the fire. A way of extinguishing can be the use of CAFS. LiMnO2 cells offer fewer problems.

In contrast to the primary batteries, secondary cells feature no reactive alkali metal inside, which is why water or wetting agent are best for extinguishing fires that involve these batteries. The oxygen potential of these batteries depend on cathodic materials. Mostly, only when the state of charge drops below 25%, it is impossible to get an exothermic reaction (thermal runaway). The upcoming challenge is when people are starting to use elements of primary and secondary batteries together. Re-use of batteries can be dangerous because the safety is often in the surrounding casing, which not seldom is removed for re-use.

3.2.6 Session 11 l Desktop flashover experiments

Rijk van den Dikkenberg highlighted some small-scale experiments into smoke gas explosions that the Dutch Fire Academy has performed recently, using propane gas burners. From the results it is hard to extract how smoke gas explosions come about. Research recommendations or references to research on this topic is more than welcome.

3.2.7 Session 12 l Research questions

Johanne Sørensen (Fire Safety Engineer and part time firefighter, DK) asked the experts for input on her master thesis on high rise buildings. Her goal is to integrate practical fire fighter needs into building designs, opposed to common practice: a building is designed using FSE (modelling), but without taking into account the real needs of firefighting practice.

4 List of Participants

Country	Participant	Email
Exchange of Experts		
Canada	Peter McBride	peter.mcbride@ottawa.ca
Denmark	Martin Thomsen	mth@brs.dk
Denmark	Johanne Sørensen	jss@sj.dk
Finland	Marko Hassinen	marko.hassinen@pelastusopisto.fi
Germany	Roland Goertz	goertz@uni-wuppertal.de
Germany	Alexander Schaberg	schaberg@uni-wuppertal.de
Netherlands (Host)	Ricardo Weewer	ricardo.weewer@ifv.nl
Sweden	Nils Johansson	nils.johansson@brand.lth.se
United Kingdom	Lee Johnston	lee.johnston@westsussex.gov.uk
United States	Robin Zevotek	robin.zevotek@ul.com
Participants from the Netherlands		
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	Peter Krom	peter.krom@vggm.nl
	René de Feijter	rene.defeijter@efectis.nl
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(Host)	Rijk van den Dikkenberg	rijk.vandendikkenberg@ifv.nl
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	Siemco Baaij	sbaaij@cfbt-nl.com

5 Program

Exchange of Experts
12 - 16 November 2018
Arnhem (Netherlands)

Arnhem, The Netherlands

Date	Hour	Item	Remarks
Travel day	**11/11**	**Arrival**	
			Check-in - Hotel
First day	**12/11**	**Exchange of Experts: sessions**	dress code: casual
	08.00 h	Breakfast	Hotel
	08.30 h	Transfer Hotel - IFV	
	09.00 h	Welcome to the participants (Ricardo Weewer, professor IFV)	IFV – Institute for Safety
	09.15 h	Presentation working plan (Jan Maarten Elbers, researcher IFV)	
	09.30 h	Session 1: Personal introduction & national report	
	09.30 h	Denmark	
	09.50 h	Sweden	
	10.10 h	UK	
	10.30 h	Finland	
	10.50 h	Break	
	11.10 h	US	
	11.30 h	Canada	
	11.50 h	Netherlands	
	12.10 h	Intervision of national reports	
	12.30 h	Lunch	
	13.45 h	Session 2: Personal introduction & national report Germany / Realistic Training I - Training and education for civil firefighting services *(Alexander Schaberg & Roland Goertz, GER)*	
	14.15 h	Session 3: Realistic Training I – Advanced drones *(Marko Hassinen, FIN)*	
	15.15 h	Break	
	15.30 h	Session 4: Realistic Training II – (*Lee Johnston, UK*)	
	16.30 h	Session 5: Realistic Training III *(Siemco Baaij, NED)*	
	17.30 h	Dinner	IFV
	19.00 h	Masterclass: Exposure to smoke (*Peter McBride, CAN*)	IFV
	21.00 h	Return to hotel	

Second day	**13/11**	**Exchange of Experts: sessions**	dress code: casual
	08.00 h	Breakfast	Hotel
	08.30 h	Transfer Hotel - IFV	
	09.00 h	Session 6: FSE I - Case studies and Real fires *(Lieuwe de Witte, NL)*	IFV
	10.15 h	Break	
	10.30 h	Session 7: FSE III – Case studies and Real fires *(Nils Johansson, SWE)*	
	11.30 h	Session 8: Fire Dynamics Project *(Peter McBride, CA)*	
	12.15 h	Lunch	
	13.15 h	Session 9: Combustible Metal Roof Decks *(Peter McBride, CA)*	
	14.15 h	Session 10: Battery packs (*Roland Goertz, GER*)	
	15.15 h	Session 11: Desktop flashover experiments (*Rijk van den Dikkenberg, NL)*	
	16.00 h	Session 12: Research questions (*Johanne Sørensen, DK*)	
	16.30 h	Wrap-up	
	17.00 h	End of day 2	
	17.00 h	Return to hotel	IFV
	19.00 h	Dinner with FSS Speakers	dress code: smart casual
Third day	**14/11**	**FSS Congress**	dress code: smart casual
Fourth day	**15/11**	**FSS Congress**	
	18.30 h	Return to hotel	
	19.00 h	Diner with Euro FSA	Hotel