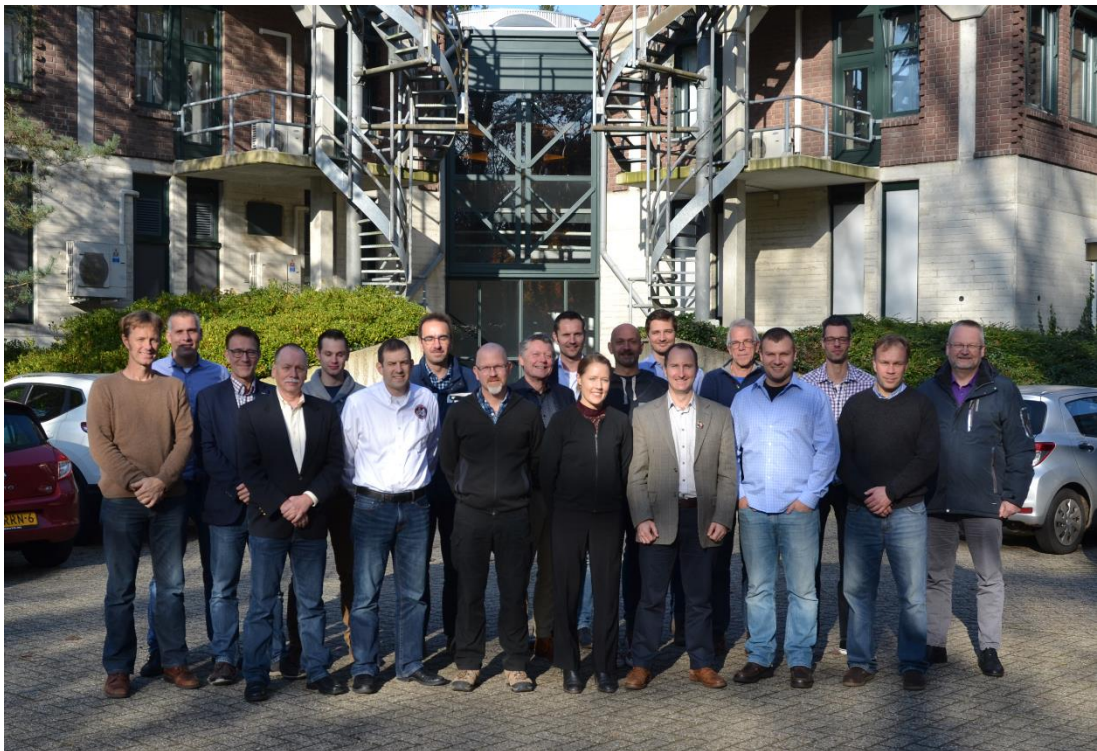


# Exchange of Experts EX551 November 5<sup>th</sup> - 10<sup>th</sup> 2017 Gas cooling and Experiments & Measurements Field Report



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# 1 Objectives

*'Research and development is not a short term commitment.'*

Participating expert

Fire researchers today face more challenges than ever before. Ever-growing differentiation in compositions of combustible products, innovative construction materials and new technological possibilities to attack fires, add to the complexity of the firefighting practice and confront fire researchers with new questions about firefighting strategy and tactics, but also present health and environment related questions. Conducting experiments and (applied) research is vital in finding answers to these questions and questions alike. As fire research represents a very specific area of scientific research, internationally exchanging ideas and knowledge can contribute greatly to overcoming practical problems and gain new insights to conduct further research upon. Hence, Exchanges of Experts are important means in answering experts' need of sharing practical and scientific knowledge on an international level and on actual topics.

During the Exchange of Experts in November 2016 at the IFV, the experts agreed on two important statements: (i) Structural Exchanges of Experts form very important contributions to knowledge sharing on an international level, and (ii) there should be a regularly revised list of topics of interest which can be used to provide input for future exchanges. At the time, stock-taking resulted in the following list of topics:

1. Exchange results of experiments into fire spread in family dwellings.
2. How to conduct measurements in practical experiments.
3. The use of drones for size up.
4. Fire safety engineering, modelling in combination with practical experiments.
5. The impact of smoke (contaminates and toxins) on firefighters and PPE (occupational health issue).
6. The Human factor in command and control.
7. Gas cooling by the fire service (effects, possibilities, measurements) and water mist
8. Foam as an extinguishing medium (use, chemicals and environmental aspects).

Earlier this year the topics Occupational Health (Finland) and Human Factors (Netherlands) were addressed during an Exchange of Experts. The current exchange aimed to predominantly delve deeper into two specific topics on this list, namely Measurements & Experiments and Gas cooling (no. 2 and 7).

This Exchange had six objectives:

- a) Form a network/community of practical researchers in Europe
- b) Exchange research subjects and find topics to collaborate upon
- c) Exchange practical knowledge about conducting practical experiments
- d) Exchange knowledge gained from practical experiments in general
- e) Exchange of knowledge about the effects and principles of gas cooling techniques in fire fighting
- f) Take stock of the need for a pan-European network

A total of 19 experts participated in this Exchange, 5 of which were sponsored by the Exchange of Experts 551 program.

## 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 five days. From November 5 – 10, experts came together at the IFV. Following last year, the Fire Safety Science (FSS) Congress was integrated in the program of the Exchange (objective 1). 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: Measuring & Experiments and Gas cooling (derived from common topics of interested articulated during the Exchange in 2016), as well as several other topics. These topics were discussed during the different sessions (objectives 2, 3 and 4). Additionally, all experts prepared a concise presentation on their current research (findings/programs), developments and challenges regarding (inter)national Fire and Rescue Services (objectives 2 and 4). A detailed program of the Exchange is presented in chapter 6. The Exchange ended with summarizing and evaluating the gained experiences and discussing possible topics to discuss during future Exchanges of Experts. This list of topics can be found in chapter 4.

### 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.



*Lieuwe de Witte (IFV) engaging the audience in his workshop on the refreshed view on firefighting using FSE, at the FSS Congress.*

# 3 Report

## 3.1 Monday 6-11-2017 | Sessions

After arrival at the Institute of Physical Safety, participants were welcomed by Ricardo Weewer, professor of Fire Service Science, at the Netherlands Fire Service Academy. The experts then immediately went on to discuss how to conduct experiments, which parameters to measure and how to accurately measure them. In the afternoon, the experts held individual presentations.

### 3.1.1 Session 1 | Experiments & Measurements

The session started off with a presentation of Lieuwe de Witte and Rijk van den Dikkenberg (IFV) who presented results of and methods used in some of their experiments on the use of different nozzles. They outlined which parameters they measured, which measurements they reported and which measuring devices they used. This led to a very broad discussion, treating each of these topics and more. The overarching question was one of validity: How do researchers measure what they want to measure? During the session especially the applicability, sensitivity, pros and cons of plate radiation sensors versus water cooled radiation sensors, various types of thermocouples and gas concentration sensors were discussed. There seemed to be a general understanding of these pros and cons which was very interesting to exchange knowledge about.

Overall conclusions were (i) think carefully about the set-up and devices you use during experiments. What do you want to measure and how can you get accurate results? Choose devices that can help achieve your aim, but be aware of their downsides. (ii) Technological advancements should support the firefighter on the fire ground, not replace him or her. To develop useful tools, data from real fires is essential. With technology advancing, it is now possible to collect more data from the fire ground (e.g. physiological monitoring, body cameras). Nevertheless, full scale experiments are needed in order to test possible answers to the diverse problems experienced in practice in a realistic and reliable manner.

### 3.1.2 Session 2 | Individual presentations

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

#### **Lotta Vylund (Researcher at Research Institute of Sweden – Fire Research, Sweden)**

RISE aims to be an international leader on innovation. One of their topics is Fire and Safety, further subdivided in tunnels, first responders, fuel storage, CFORT. Among others, Lotta and her colleagues are working on tests for battery fires in vehicles on laboratory scale<sup>1</sup>, tests on how to extinguish fire with less water, residential sprinklers, attacking fire in tall timber buildings and a tool for incident commanders to help reduce the effects of incidents.

#### **Martin Thomsen (Head of College at Danish Emergency Management Agency (DEMA) Emergency Services College, Denmark)**

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<sup>1</sup> See; [www.vehicleresearch.com](http://www.vehicleresearch.com)



DEMA offers different training programs to (sub-) commanders in the fire service, firefighters, police and health authorities. Next to finishing the construction of a brand new full scale practice and experimental environment, Martin is quite progressive in exploring the use of drones in firefighting. He highlighted some of the many possibilities of drones in fire situations, which DEMA explored through research. Martin concluded that drones can add to a more effective and efficient firefighting practice, for instance because a drone is able to fly close to burning tanks to do a reconnaissance, or stream live footage of a fire site to a secured website. DEMA also offers an education for drone pilots in a special training domain.

### **Marko Hassinen (Research Scientist at Emergency Services College, Finland)**

Marko and his colleagues at the *Pelastusopisto Institute* have researched the use of handheld extinguishers (e.g. backpack, throwing extinguisher etc.) by the fire service, in comparison with the use of hoses. They concluded that in some specific scenarios, handheld extinguishers can be just as effective as and quicker than the use of hoses. However, it is far from a universal tool. Another research project examined the physical burden of firefighters, such as blood pressure and muscle strength. Results showed that fighting fires is a physically tough job. New and ongoing research topics are: remotely piloted aircrafts in fire and rescue services, noise exposure and hearing protection, exposure to asbestos and cleaning of personal protective equipment (PPE) after an incident, new Standard Operating Procedures (SOP's) for chemical incidents, and new SOP's for traffic incidents. Pelastusopisto Institute organized an Exchange of Experts on Occupational health in spring this year.

### **Alex Rhodes (Team Lead for Research and Development Function at Chief Fire Officers Association (CFOA), UK)**

Due to his position, Alex is closely connected to the firefighting practice, research and policy-making. The CFOA's goal is to enable firefighters to make more evidence-based decisions. Alex and his colleagues therefore aim to collect and conduct as much relevant research as possible on a national level and translate it into comprehensible guidelines for firefighters. Some of the research (to be) conducted by Alex and his colleagues focuses on PPE & contaminants, waste fires, the EXIT-project in fundamental research, audibility of safety signals, physiological monitoring and environmental monitoring in industrial research.



*Stefan Svensson elaborating on the societal role of the fire service*

**Stefan Svensson (Associate professor/Docent at Lund University – Division of Fire Safety Engineering, Sweden)**

Stefan has been researching fires and firefighting practice for about 20 years. The amount of research conducted by him, colleagues and (PhD) students at Lund University is considerable. Research projects they conduct are small, medium or large scale. They also provide qualitative testing. In the recent past, Stefan has delved into the topics of smoke ventilation, smoke filling, and high pressure/low flow versus low pressure/high flow water-based firefighting systems.

**Robin Zevotek (Lead research engineer at UL Firefighter Safety Research Institute, US)**

UL annually conducts many research projects. To name a few, Robin and his colleagues have been researching burn patterns, how to attack basement fires (14 experiments), the cardiovascular and chemical risks of firefighting (12 full scale experiments), interior versus exterior extinguishing and the use of different nozzle types (25 full scale experiments), as well as PPE exposure and laundering (expose and wash over 40 times, different decontaminations). Additionally, they have been occupied with promoting a close-the-door-campaign in the US.<sup>2</sup>

**Ricardo Weewer (Professor of Fire Service Science at the Netherlands Fire Service Academy, Netherlands)**

The Dutch Fire Service Academy provides input for training programs of all firefighters, all ranks. This provides the main incentive of the research department to conduct research. Ricardo and his colleagues have recently conducted research on the quadrant model, incident command, a learning model for firefighters (KEI-model) and the culture of fire services. Ricardo's goal is to aid firefighters in making (difficult) decisions, often under pressure.<sup>3</sup>

## 3.2 Tuesday 7-11-2017 | Sessions

Tuesday morning was spent discussing gas cooling intensively. In the afternoon, there were three individual contributions and plenary discussions. Lotta Vylund presented some of her research findings on the use of combining methods (e.g. coldcutters) to extinguish fires. Alex Rhodes stressed the importance of evidence-based firefighting tactics, whereas Stefan Svensson pinpointed some remaining challenges in fire research and facilitated an exchange of ideas for future research topics.

### 3.2.1 Session 3 | Gas Cooling

Lieuwe de Witte, Rijk van den Dikkenberg and Ricardo Weewer (IFV) introduced this topic to the other experts by taking their recent experiments on gas cooling as an example. Their objective was to create a reproducible situation in which they are able to create a smoke gas explosion. To them, the foremost goal of gas cooling is to create a safer working environment for firefighters. Apart from that it is observed that smoke explosions seem to occur more often than before. An important question is how to recognize situations in which gases (in other rooms than the fire room) can ignite? One of the experts mentioned that in his country, cooling gas alone is not done: They cool the entire environment, including walls, ceiling etc.

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<sup>2</sup> For more information see: <https://www.ul.com/>

<sup>3</sup> For more detailed information see: <https://www.ifv.nl/Paginas/Institute-for-Safety.aspx>



He stated that the probability of explosion (i.e. the presence of an ignitable mixture of pyrolysis gases, oxygen and temperature) is generally low and so far has been impossible to recreate in experiments. That fact could make researchers wonder whether what firefighters believe to be a gas explosion, may be something else (e.g. ceiling coming down, mixing up gases). Whether firefighters are taught to cool the gas including surfaces or not, differed greatly between the expert's countries. Moreover, influencing the mixture is a challenge, as many of the elements that together can create fire gas ignitions are extremely difficult to influence.

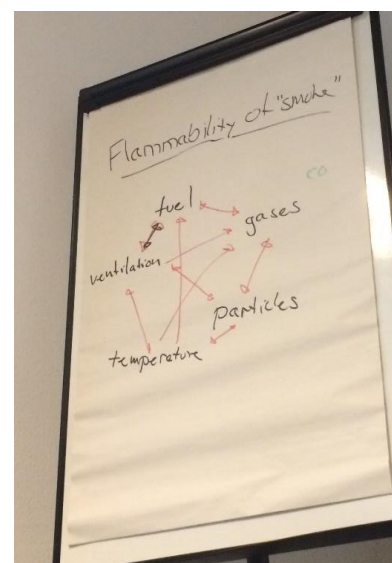


*Ricardo Weewer introducing the topic of Gas Cooling to the experts*

Stefan Svensson at this time presented some of his thoughts, derived from his own research and expert-knowledge on this topic, about the working elements in gas cooling. Svensson highlighted that in theory indeed some of the elements (gases, particle shape/size, temperature, ventilation and fuel) are not easy to influence, making it harder to alter situations that have a high risk of smoke gas explosions. Also, when interfering with one of the elements, other elements will possibly change in for instance volume or composition. Stefan continued with a presentation he prepared on this topic, stating at least five effects of water as an extinguishing agent:

1. Gas phase cooling: including hot gases as well as flames
2. Oxygen depletion: production of steam
3. Wetting and cooling of fuel surface
4. Radiation attenuation: physical blocking, water molecules absorbs infrared
5. Kinetic effects: adding of water stir things around

To control all these effects, the experts agreed, is extremely hard if not impossible. To what extent one can successfully control or prevent gas explosions, depends on the balance of an array of interrelated elements. Additionally, in the Netherlands, steam on the fire ground is perceived as dangerous to the firefighter. However, this is far less an issue in other countries. This may be due to the fact that in



*Stefan Svensson's notes on flammability of smoke*

other countries, the fire services use more water so there is not enough time for much steam to develop in the first place, or to differences in construction materials of buildings and experimental set-ups (e.g. concrete/steel/cardboard/wood).

Concluding, experts appeared to hold different opinions on what exactly is meant by the term gas cooling, how gas cooling can most effectively and efficiently be accomplished, and which are the determining factors in gas explosions. They agree that it is a difficult subject and that there may be differences between countries because of differences in building types between e.g. UK, Sweden, Netherlands and US. Agreement existed also on the fact that there may be too much emphasis on gas cooling, and that putting water on the fire still is the best way to fight fires. The term gas *changing* was opted to replace gas *cooling*, as cooling is not the only effect of gas cooling methods such as inerting or creating steam. The Netherlands plans to conduct further research into this subject.

### 3.2.2 Session 4 | Combining methods in extinguishing fires

Lotta Vylund presented and discussed some real life examples from the fire practice in which a mixed-method approach was used to attack the fire, from either the interior or exterior of the building. One of her conclusions was that the cold cutter might be useful in small rooms which contain a high temperature, but are less effective in attacking fires in bigger spaces. However, it might be advantageous to protect a non-burning part of the building with water mist from a cold cutter. Vylund and the experts' most significant conclusion was that a mixed-method approach (e.g. nozzle, droplet size and pressure) might be effective when tailored to the right momentum.

### 3.2.3 Session 5 | Evidence-based firefighting

Alex Rhodes went on to discuss with the experts how the firefighting practice can become more evidence-based, one of the goals of the CFOA. There is a lot of professional evidence which is (not) yet supported by scientific evidence. Firefighters and researchers should be aware of the difference between experience and scientific evidence. Concluding, both sources of knowledge are important, and scientific evidence findings should be translated to practical terms and guidelines: 'Most firefighters carry hoses, not PhD's'.



Alex Rhodes discussing evidence-based firefighting

### 3.2.4 Session 6 | Foods for thought

Stefan Svensson highlighted that there are several research questions that have to be further addressed by researchers in the future. How does the built environment interact with firefighting operations, specifically technical aspects regulated through building codes? How does the fire service use such technical aspects (escape routes, surface linings, structural integrity, building components and building materials) for supporting operations? How to create a training environment which is realistic, safe and environmentally friendly? Perhaps there lie possibilities in augmented reality and gaming. There is still little knowledge on how to attack fires in large spaces. Svensson also signals a knowledge gap on firefighting tactics. For instance, can researchers answer the question what is the difference between ventilation-suppression and suppression-ventilation?



*Stefan Svensson articulating several foods for thought*

### 3.3 Wednesday 8-11-2017 | FSS Congress

On Wednesday and Thursday the program was integrated with the Fire Safety Science (FSS) Congress, held at the IFV in Arnhem, the Netherlands. The following descriptions contain a selection of the events. For a complete overview of the events see chapter 6.<sup>4</sup>

**Keynote: What we've learned from 10 years of research with the Fire Service**  
(Robin Zevotek, Underwriters Laboratories, US)

Zevotek presented what he named the ten most important lessons learned from fire research over the last ten years. Among others, he mentioned closing windows and doors is an important lesson that people and firefighters keep forgetting. It proves that one can stay fairly safe behind a closed door, while a fire is going on in an adjacent room. Furthermore, Zevotek stressed the realization that scientific research is essential in understanding the dynamics of fire development.

<sup>4</sup> Keynotes and Workshops have been recorded. You can find all clips on:  
[https://www.youtube.com/playlist?list=PL\\_YhRx\\_IrMn0\\_yYmmrNo2D3pJl30faoc](https://www.youtube.com/playlist?list=PL_YhRx_IrMn0_yYmmrNo2D3pJl30faoc)

## **Keynote: The refreshed view on firefighting: an update**

(Ricardo Weewer, IFV, Netherlands)

In his presentation, Weewer stated that fire (service) researchers have effective theories for



attacking fires. However, these theories are not always applied in practice. He concluded that it is therefore important to stimulate collaboration with fire fighters, so science can really *Ricardo Weewer (left) and Robin Zevotek (right) discussing with their public during Keynotes*

become applied science. To conclude, Weewer presented the 'Refreshed view on firefighting: an update', a part of which is the Quadrant-model. This model supports the choice of tactics in attacking a fire inside a building.

After the Keynotes participants exchanged knowledge with colleagues during the workshops which were English spoken. Subjects on Wednesday were:

### **1. Cooling capacity of water; the different views**

Ruud van Liempd, Fire Service Brabant-Noord (Netherlands)

### **2. Data-analysis during and after fire**

Florian Vandecasteele, University of Gent (Belgium)

### **3. Understanding Fire Attack; interior, exterior, transitional**

Keith Stakes, UL (United States)

### **4. Practical experiments on the effectiveness of fire safety measures in care complexes (VIPA-study)**

Pieter Poppe, ISIB (Belgium)

### **5. Gas explosions in practice**

René de Feijter, Efectis (Netherlands)



## 3.4 Thursday 9-11-2017 FSS Congress

### **Keynote: Understanding fires by statistics and case studies**

(Patrick van Hees, Lund University, Sweden)

By providing real examples from fires in Swedish schools, construction fires and residential fires, van Hees explained how fires can be explained and their effects minimized, by using a combination of statistics and case studies. Whereas statistics can provide a good vantage point for research, they do not offer clear explanations for how and why fires occur and develop. Additionally analysing separate cases can provide a more holistic image and help gain understanding.



*Patrick van Hees outlining the importance of his topic during his Keynote*

### **Keynote: Changing building characteristics, changing indoor fires?**

(Ruud van Herpen, Eindhoven University of Technology, Netherlands)

Do the current building regulations in the Netherlands (and elsewhere) also offer solutions to societal changes, such as an ageing population and an increase in the part of the population which is less self-reliant? Perhaps certain concepts used in designing escape routes in residential buildings should be replaced by stay-in-place concepts? These and other questions were coined by van Herpen, who questioned if building regulations in their current form are fit to answer such changes.

After the keynotes participants could exchange knowledge on the follow subjects during workshops:

#### **1. The refreshed view on firefighting: case study using FSE**

Lieuwe de Witte, IFV (Netherlands)

#### **2. Update on the Study of the Fire Service Training Environment: Safety, Fidelity and Exposure**

Robin Zevotek, Underwriters Laboratories (United States)

### **3. Tactical firefighting; a modern approach**

Dan Moore and Bernie Higgins, Northampton Fire & Rescue Service (United Kingdom)

### **4. Reliability of fire-resistant separations**

Annemarie Weersink, Saxion University of Applied Sciences and  
Ruud van Herpen, Eindhoven University of Technology (Netherlands)

### **5. The efficiency of CAFS in comparison to other extinguishing agents**

René Erdt & tobias Knorr, Berliner Feuerwehr (Germany)

The day concluded with a networking buffet.

## **3.5 Friday 10-11-2017**

The concluding session took place on Friday morning. During this session, the experts looked back to the past week and drew some conclusions on the knowledge and experience gained. Subsequently they evaluated the goals, content and format of this exchange, as well as the functionality of exchanges in general. Lastly, experts discussed and put together a list of possible topics to discuss during future exchanges. An overview is presented in the subsequent chapter.



# 4 Conclusions

## 4.1 Evaluation

During the exchange and especially during the wrap up on Friday, experts evaluated the program and course of events of this exchange. Furthermore, they reflected upon the functionality of Exchanges of Experts in general.

### 4.1.1 Evaluation of objectives

- a) *Objective 1: Form and maintain a network/community of practical researchers in Europe*

Experts stated that this exchange benefited the international community of practical researchers. The overall program offered them the opportunity to gain new contacts, strengthen their ties with other experts, and contributed to the maintenance of the in 2016 established 'The Arnhem Group'. This is a first step towards a Pan-European network for knowledge sharing and development in the field of fire service. Objective achieved.

- b) *Objective 2: Exchange research subjects and find topics to collaborate upon*

The list of mutual topics of interest that was agreed upon in 2016 has been reviewed (see below). Certain topics have been added to the list. Additionally, one of the sessions was dedicated to discussing possible research subjects. Multiple experts will examine possibilities to organise or contribute to an Exchange of Experts on some of these topics. Objective achieved.

- c) *Objective 3: Exchange practical knowledge about conducting practical experiments*

Experts agreed that due to the technical nature of some of the topics and the in-depth discussions during the sessions, this objective has been achieved.

- d) *Objective 4: Exchange knowledge gained from practical experiments in general*

The main topics of this exchange were quite specific. On one hand this approach resulted in in-depth discussions. On the other, some experts of The Arnhem Group did not feel expert enough on the topics to join the exchange and/or could not find a suitable substitute. This effect should be taken into account for future Exchanges of Experts. Objective partially achieved.

- g) *Objective 5: Exchange of knowledge about the effects and principles of gas cooling techniques in fire fighting*

Participants were able to exchange their knowledge and opinions about the application, effects and limits of gas cooling techniques, which led to a general agreement that although it is a difficult phenomenon, there are some general principles. However, the effects might depend on building structures and needs some further research. Objective achieved.

- e) *Objective 5: Take stock of the need for a pan-European network*

Like last year, participants discussed common topics of interest for a pan European network, and also for next year. Objective achieved.

#### 4.1.2 General evaluation

##### *Sessions*

Experts unanimously concluded that the sessions were very successful and that the fruits of discussions are of practical use for current and future research projects. Among others, the sessions offered them the opportunity to exchange and pitch ideas and discuss solutions to practical research problems.

##### *FSS congress*

All experts agreed that the integration of the FSS Congress in the Exchange program adds value to the exchange. According to the experts, integration not only offers additional insights and ideas, but also opportunities to discuss a variety of topics and share knowledge with visitors (researchers, firefighters, police, insurance experts etc.) and other experts, and broaden their network.

##### *Exchanges of Experts*

Pointing back at the quote at page one of this report, recurring exchanges are deemed necessary by the experts to keep inspiring and supporting research and development on fires and fire services throughout Europe.

#### 4.2 Towards the future: Mutual topics of interest

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). Finland organized an exchange in spring 2017, next year a follow up will be organized by the Netherlands (IFV)
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/ learning. New subject. 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.

Experts thank the IFV for organizing and hosting this Exchange of Experts.

# 5 List of Participants

| Country                                  | Participant             | Email                            |
|--|-------------------------|----------------------------------|
| <b>Exchange of Experts project EX551</b> |                         |                                  |
| Denmark                                  | Martin Thomsen          | mth@brs.dk                       |
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| Sweden                                   | Lotta Vylund            | lotta.vylund@ri.se               |
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| <b>Exchange of Experts non-funded</b>    |                         |                                  |
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|  | Siemco Baaij            | sbaaij@cftb-nl.com               |

# 6 Program

| Date              | Hour                   | Item  | Remarks                    |
|-------------------|------------------------|---|----------------------------|
| <b>Travel day</b> | <b>5/11 &amp; 6/11</b> | <b>Arrival</b>  |                            |
|                   |                        |   | Check-in - Hotel           |
| <b>First day</b>  | <b>6/11</b>            | <b>Exchange of Experts: workshops</b>   | dress code: casual         |
|                   | 09.00 h                | Breakfast   | Hotel                      |
|                   | 10.00 h                | Transfer Hotel - IFV  |                            |
|                   | 10.30 h                | Welcome to the participants (Ricardo Weewer, lector IFV)  | IFV – Institute for Safety |
|                   | 10.45 h                | Presentation working plan (Ricardo Weewer, lector IFV & Jan Maarten Elbers, trainee IFV)            |                            |
|                   | 11.00 h                | Session 1: Measuring and Experimenting (Robin Zevotek / Rijk van den Dikkenberg & Lieuwe de Witte)  |                            |
|                   | 12.30 h                | Lunch   |                            |
|                   | 13.30 h                | Session 1: Measuring and Experimenting (Robin Zevotek / Rijk van den Dikkenberg & Lieuwe de Witte)  |                            |
|                   | 15.00 h                | Break   |                            |
|                   | 15.15 h                | Session 2: Personal introduction & national report  |                            |
|                   | 15.15 h                | Sweden: Lotta Vylund<br>( <i>RISE Fire Research</i> )   |                            |
|                   | 15.30 h                | United Kingdom: Alex Rhodes<br>( <i>Station Manager Hampshire FRS</i> )                             |                            |
|                   | 15.45 h                | Denmark: Martin Thomsen<br>( <i>Danish Emergency Management Agency Emergency Services College</i> ) |                            |
|                   | 16.00 h                | Sweden: Stefan Svensson<br>( <i>Lund University</i> )   |                            |
|                   | 16.15 h                | Finland: Marko Hassinen<br>( <i>Emergency Services College</i> )                                    |                            |
|                   | 16.30 h                | United States: Robin Zevotek<br>( <i>Underwriters Laboratories</i> )                                |                            |
|                   | 16.45 h                | Netherlands: Rijk van den Dikkenberg & Lieuwe de Witte (IFV)  |                            |
|                   | 17.00 h                | Intervision of national reports   |                            |
|                   | 18.00 h                | End of day 1  |                            |
|                   | 18.00 h                | Return to hotel   | IFV                        |
|                   | 18.30 h                | Dinner  | Hotel                      |
| <b>Second day</b> | <b>7/11</b>            | <b>Exchange of Experts: workshops</b>   | dress code: casual         |
|                   | 08.00 h                | Breakfast   | Hotel                      |
|                   | 08.30 h                | Transfer Hotel - IFV  |                            |
|                   | 09.00 h                | Session 3: Gas cooling (Rijk van den Dikkenberg, Lieuwe de Witte & Ricardo Weewer)                  | IFV                        |

|                  |         |  |                            |
|------------------|---------|--|----------------------------|
|                  | 11.00 h | Break  |                            |
|                  | 11.15 h | Session 3: Gas cooling (Stefan Svensson)   |                            |
|                  | 13.00 h | Lunch  |                            |
|                  | 14.00 h | Session 4: Combining extinguishing methods (Lotta Vylund)  |                            |
|                  | 14.45 h | Session 5: Evidence based firefighting tactics (Alex Rhodes)   |                            |
|                  | 15.45 h | Break  |                            |
|                  | 16.00 h | Session 6: Food for thoughts – Interesting research results and challenges for future research (Stefan Svensson)   |                            |
|                  | 18.00 h | End of day 2   |                            |
|                  | 18.00 h | Return to hotel  | IFV                        |
|                  | 18.30 h | Dinner   | dress code: smart casual   |
| <b>Third day</b> |         |  |                            |
| <b>8/11</b>      |         | <b>FSS Congress– day 1</b>   | dress code: smart casual   |
|                  | 9.15 h  | Transfer Hotel - IFV   | Hotel                      |
|                  | 9.30 h  | Reception  | IFV – Institute for Safety |
|                  | 10.00 h | <b>Word of welcome</b><br>Leo Zaal, General Director IFV (Netherlands)   | <i>English</i>             |
|                  | 10.10 h | <b>Opening</b><br>Stephan Wevers, Director Fire Services (Netherlands)   | <i>English</i>             |
|                  | 10.20 h | <b>Opening speaker in celebration of the 10<sup>th</sup> anniversary of the FSS Congress</b><br>Rosita Thé, Dienst Centraal Milieubeheer Rijnmond (Netherlands)  | <i>English</i>             |
|                  | 11.05 h | Break  |                            |
|                  | 11.30 h | <b>Keynote: What we've learned from 10 years of research with the Fire Service</b><br>Robin Zevotek, Underwriters Laboratories (US)  | <i>English</i>             |
|                  | 12.15 h | <b>Keynote: The refreshed view on firefighting: an update</b><br>Ricardo Weewer, Fire Service Academy (Netherlands)  | <i>English</i>             |
|                  | 13.00 h | Lunch  |                            |
|                  | 13.45 h | <b>Workshops - Round 1</b><br><br><b>1. Cooling capacity of water; the different views</b><br>Ruud van Liempd, Fire Service Brabant-Noord (Netherlands)<br><br><b>2. Data-analysis during and after fire</b><br>Florian Vandecasteele, University of Gent (Belgium)<br><br><b>3. Understanding Fire Attack; interior, exterior, transitional</b><br>Keith Stakes, UL (United States) |                            |



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|                   |         | <b>4. Practical experiments on the effectiveness of fire safety measures in care complexes (VIPA-study)</b><br>Pieter Poppe, ISIB (Belgium)   |                          |
|                   |         | <b>5. Gas explosions in practice</b><br>René de Feijter, Efectis (Netherlands)  |                          |
|                   | 15.00 h | Break   | IFV                      |
|                   | 15.30 h | <b>Workshops - Round 2</b>  |                          |
|                   | 16.45 h | Network event   |                          |
|                   | 17.45 h | Networking buffet   |                          |
|                   | 20.00 h | Return to hotel   | Hotel                    |
| <b>Fourth day</b> |         |   |                          |
| <b>9/11</b>       |         | <b>FSS Congress – day 2</b>   | dress code: smart casual |
|                   | 8.30 h  | Breakfast   | Hotel                    |
|                   | 9.15 h  | Transfer Hotel - IFV  |                          |
|                   | 9.30 h  | Reception   |                          |
|                   | 10.00 h | <b>Opening</b><br>Stephan Wevers, Director Fire Services Netherlands  | <i>English</i>           |
|                   | 10.10 h | <b>Keynote: Understanding fires by statistics and case studies</b><br>Patrick van Hees, Lund University (Sweden)  | <i>English</i>           |
|                   | 10.55 h | Break   |                          |
|                   | 11.25 h | <b>Keynote: Changing building characteristics, changing indoor fires?</b><br>Ruud van Herpen, Eindhoven University of Technology (Netherlands)  | <i>English</i>           |
|                   | 12.10 h | <b>IFV-VVBA Thesis Award: presentations by three nominated students and subsequently the award of the 6<sup>th</sup> IFV-VVBA Thesis Award</b><br>Paul Verlaan, jury chairman and member of the Scientific Council for Fire Services (Netherlands)  | <i>English</i>           |
|                   | 12.55 h | Lunch   |                          |
|                   | 13.45 h | <b>Workshops - Round 1</b><br><br><b>1. The refreshed view on firefighting: case study using FSE</b><br>Lieuwe de Witte, IFV (Netherlands)<br><br><b>2. Update on the Study of the Fire Service Training Environment: Safety, Fidelity and Exposure</b><br>Robin Zevotek, Underwriters Laboratories (United States)<br><br><b>3. Tactical firefighting; a modern approach</b><br>Dan Moore and Bernie Higgins, Northampton Fire & |                          |

|                  |              |  |       |
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|                  |              | Rescue Service (United Kingdom)<br><br><b>4. Reliability of fire-resistant separations</b><br>Annemarie Weersink, Saxion University of Applied Sciences and<br>Ruud van Herpen, Eindhoven University of Technology (Netherlands)<br><br><b>5. The efficiency of CAFS in comparison to other extinguishing agents</b><br>René Erdt & tobias Knorr, Berliner Feuerwehr (Germany) |       |
|                  | 15.00 h      | Break  |       |
|                  | 15.30 h      | <b>Workshops - Round 2</b>   |       |
|                  | 16.45 h      | Network event<br><br><b>Poster session</b><br>During congress, a great number of recent studies from the Fire Service Netherlands and the Eindhoven University of Technology is presented and explained by (among others) students.  |       |
|                  | 17.30 h      | Dinner   | IFV   |
|                  | 20.00 h      | Return to hotel  |       |
|                  |              |  |       |
| <b>Fifth day</b> | <b>10/11</b> | <b>Exchange of Experts: Wrap up</b>  |       |
|                  | 08.30 h      | Breakfast  | Hotel |
|                  | 09.00 h      | Wrap up (Ricardo Weewer, IFV)  | Hotel |
|                  | 12.00 h      | End of day 5   |       |
|                  |              |  |       |
|                  |              |  |       |