Brandforsk

1 PERSONUPPGIFTER

1.1 Huvudsökande

Sökande

Förnamn: Francine

Efternamn: Amon

Akademisk titel: Dr.

Tjänstetitel: Forskare

Genus: Kvinna

Födelsedatum: 1960-12-05

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Mobiltelefon: 0705545166

E-post: francine.amon@ri.se

Organisation

Organisationsnamn: RISE Research Institutes of Sweden

Org. Nummer: 556464-6874

Hemsida: ri.se

Institution: Safety

Gatu/Boxadress: Box 857

Post nr: 50115

Postort: Borås

1.2 Firmatecknare/ansvarig

Förnamn: Michael

Efternamn: Rahm

Tjänstetitel: Sektionschef BRd

1.3 Projektledare

Projektledare är: Den Huvudsökande

CV - Projektledare

Max 2 sidor 2017-09-26 12:06:32 Sidor: 2 447,3 kb

2. PROJEKTINFORMATION

2.1 Ansökningstyp

Ansökan avser

Återremitterad ansökan

Ansökningsnummer

BF16-0009

2.2 Problemområden

1. Värdering av brandskyddsåtgärder ☑
2. Samspelet mellan människa, teknik, organisation och samhälle ☐
3. Brandskydd i byggnadsverk ☑
4. Brandskydda i transportmedel ☐
5. Aktiva brandskyddssystem ☑
6. Brandsskydd och risker i industriell verksamhet ☐
7. Brand och miljö ☑

2.3 Projekttid

Periodens startdatum

2018-01-08

Periodens slutdatum

2019-07-08

Sökta medel

600 000

2.4 Återrapporteringar

Underlag för Infoblad på svenska och engelska ☑

Slutrapport ☑

Planerade seminarium, specificera

2 st workshops, en uppstart, en mot slutet

Planerade vetenskapliga artiklar, specificera

en vetenskaplig artikel (peer review)

Annan

Artiklar i branchtidningar och presentationer på branchdagar

Annan

Demonstration av verktyget på RISE hemsida

2.5 Projektinformation

Projekttitel

Miljöpåverkan från brand i byggnad

Projektbeskrivning (max 1000 tecken)

Lokala och nationella myndigheter är ansvariga för att förhindra eller begränsa skador för människor, egendom och miljö enligt LSO. När vårt samhälle förändras genom begränsade resurser, måste dessa organisationer överväga vilka strategier som är mest effektiva samtidigt som de negativa konsekvenserna på människor, egendom och miljö tas i beaktande. När det gäller brand i byggnad är det särskilt svårt att uppskatta hur olika beslut kommer att påverka hållbarheten och miljön. Det främsta målet med det föreslagna projekt är att vidareutveckla ett verktyg som skapades för bränder i varuhus eller lagerlokaler för National Fire Protection Association (NFPA) och tillämpa den på andra typer av byggnadsbränder. Den föreslagna utvidgningen av verktyget kommer att ge användaren relevant information om risker för miljön som härrör från olika byggnadsbränder. Exempelvis, när är det bäst att låta byggnaden brinna upp?, eller, vilka är de miljömässiga effekterna av ett sprinklersystem?

3. MEDSÖKANDE / SAMARBETSPARTNERS

Förnamn

Marcus

Efternamn

Runefors

Universitet / Organisation

Lund Universitet

Funktion

Lektor

E-post

marcus.runefors@brand.lth.se

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Förnamn

Robert

Efternamn

Jansson McNamee

Universitet / Organisation

Brandskyddslaget

Funktion

Forsknings- och utvecklingschef

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robert.mcnamee@brandskyddslaget.se

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4. BUDGET

4.1 Budget

Personal	Timmar	Kost/h.	Sökt	Total
RISE	343	1 220	200 000	418 460
LTH	230	1 220	200 000	280 600
Brandskyddslaget	230	1 220	200 000	280 600
		Summa	600 000	979 660

Material / utrustning	Sökt	Total
-	0	0
Summa	0	0

Resor	Sökt	Total
Projektresor	0	60 000
Summa	0	60 000

Övrigt	Sökt	Total
2 * Workshop	0	20 000
Summa	0	20 000

Summering av budget sökt och totalt	Sökt	Total
Summa av samtliga kostnader för hela projektet		1 059 660
Summa av medel som sökes från Brandforsk	600 000	

5 ÖVRIGA ANSLAGSKÄLLOR

5.1 Medel erhållna från andra finansieringskällor för projektet

Anslagskälla	Summa
NFPA	160 000
RISE/LTH/Brandskyddslaget	300 000
Summa	460 000

5.2 Medel sökta från andra finansieringskällor

Anslagskälla	Summa
-	0
Summa	0

5.3 Medel som planeras sökas från andra finansieringskällor

Anslagskälla	Summa
-	0
Summa	0

6. BILAGOR

Projektbeskrivning	**Max 20 sidor**	**2017-09-29 08:22:28**	**Sidor: 8 612,5 kb**

Övriga bilagor

Stöd från NFPA	**Max 5 sidor**	**2017-09-26 12:23:15**	**Sidor: 1 68,6 kb**

7. EXAMENSARBETE

Lägg till eventuella examensarbeten, dock minst två.

Titel

Using the Enveco tool for estimating the environmental damage of enclosure fires

Syfte

Urval och analys av fallstudier med verktyget som utvecklas i projektet.

Handledare

Robert Jansson McNamee

Antal studenter

1

Kort problembeskrivning

Framtagen modell appliceras på ett antal fallstudier.

Kommentarer (ex behov av ytterligare samverkans partners)

Samverkan genom LTH.

Titel

Compilation of environmental contaminants from contents of burned enclosures

Syfte

Uppbyggnad av LCA modell med fokus på utsläpp från inneslutna bränder.

Handledare

Francien Amon

Antal studenter

1

Kort problembeskrivning

Studenten ska hjälpa till och ta fram indata till- och att utveckla LCA modellen med avseende på utsläpp från inneslutna bränder.

Kommentarer (ex behov av ytterligare samverkans partners)

Samordnas genom LTH.

Measuring the impact of fire on the environment

Purpose

Local and national authorities are responsible for responding to accidents or imminent danger of accidents, such as building (enclosure) fires, and to prevent or limit the damage incurred by people, property or the environment (see Civil Protection Act 2003:778[1]). As our society changes, and as resources become scarcer, these organisations must consider which response strategies are most effective while minimizing the negative consequences on people, property and the environment. In the case of enclosure fires, it is especially difficult to estimate how different decisions will impact resource sustainability and the environment. Enclosure fires contribute to contamination of air and possibly also to surface water, groundwater, sediment, and soil [1-3] in the natural and built environments. In some cases studied previously performed, it was found that replacement of the materials damaged by fire in warehouse fires had a much higher environmental impact than all other aspects of enclosure fires combined, by far [4]. This result has severe implications for the sustainability of materials used in the construction of buildings as well as the building contents.

The impact of responding to enclosure fires, including both tactics and use/choice of suppression media, can also have a negative effect on the environment [5]. Fire debris and ash often contain many harmful constituents, depending on the fuel and burning conditions of the fire [6]. While much research has been devoted to characterizing the contaminants found in fire effluent (discussed in the following section), very little work has been done to bring this complex body of knowledge to organisations such as responsible authorities and responders in a form that enables them to understand the environmental consequences of choices made to protect people and the environment from enclosure fires. A methodology is needed for understanding the potential environmental advantages and disadvantages of decisions regarding which type of response is appropriate to use for a particular type of fire incident. Responsible authorities must adapt to fire safety risks that are shifting due to development of new materials, fire protection systems, construction codes and regulations, etc. Improved understanding about whether the environmental damage incurred by an enclosure fire will be reduced, remain unchanged, or be increased by fire protection decisions will help authorities, fire protection engineers and builders fulfill their obligations to the Civil Protection Act.

The primary goal of this proposed project is to further develop a tool that was created for warehouse fires as part of a feasibility study for the National Fire Protection Association (NFPA) [4] and apply it to other types of enclosure fires. The proposed expansion of the tool will take it from the prototype stage to a level that provides useful information to stakeholders/users about risks to the environment resulting from enclosure fires. This information can be used for pre-planning and training so that emergency responders can answer questions about the environmental risks at a particular type of enclosure fire. For example, when is it best to let the fire burn? What are the environmental trade-offs regarding the type of suppression media used?

Also, a future sustainable society will benefit from knowledge about the environmental consequences of fire suppression systems such as sprinklers and the effects of new construction techniques/materials. An additional goal of this work is to use the results of the tool to populate a database that can be used for training and fire protection purposes to increase the general understanding of the environmental impact of enclosure fires.

[1] See https://www.msb.se/en/About-MSB/Legislative-areas/ for more information.

Background

Fire effluents from burning enclosures and various contents or furnishings have been characterized by many researchers, see [7] for a review of this research. Räddningsverket commissioned a large project in which fire effluents to air, soil, and water from large fires were analyzed [8]. These studies have provided much useful information about species such as polyaromatic hydrocarbons (PAH), flame retardants (FR), volatile organic compounds (VOC), acid gases, halogenated compounds, metals, dioxins and furans, and other toxic compounds that have short and long term impacts on the environment.

The environmental consequences of fighting enclosure fires are related to the fire size, degree of ventilation, and burning contents, which affect the type and amount of contaminants in the fire effluent and residue. Also, the choice of suppression media and how it is applied, contained, and disposed of is a very important factor when considering environmental impact [9-12].

The state of the art methodology for understanding the impact of contaminants is life cycle assessment (LCA), which is typically used to evaluate the potential environmental impacts of a product, process, or activity (usually referred to as a system). LCA is a comprehensive method for assessing impacts across the full life cycle of a system, from materials acquisition through manufacturing, use, and end of life. A formal procedure for conducting an LCA has been standardized by the International Organization for Standardization (ISO) in ISO 14040 and ISO 14044 [13, 14]. In general, LCA-based environmental impact methods can be used to assess a wide range of environmental impact categories, for example: global warning, eutrophication, resource depletion, ecotoxicity of soil and water bodies, etc, depending on which impact assessment method is considered important for the goals of the LCA. LCA-based assessment methods generally require specialized knowledge that most fire brigades and authorities do not have.

In the previously mentioned feasibility study for NFPA [4] a prototype tool (the Enveco tool) was developed that enables the fire service to estimate the environmental and economic savings to communities resulting from warehouse fires in industrial parks using water as the suppressant. The goal of this preliminary work was to determine whether it is possible to simplify the complex calculations needed for estimating environmental and economic costs/savings so that meaningful results can be produced by users without specialized knowledge. The environmental assessment methodology used in the Enveco tool is based on simplified LCA models and fire effluent measurements conducted at RISE [15-20] and found in the literature referenced above.

NFPA have released the Enveco tool to several US and Canadian fire service organisations for evaluation and feedback from them has been incorporated into this proposal. NFPA will plan future work in this area, primarily on the economic assessment; meanwhile this proposed project will expand the functionality of the environmental assessment part of the tool.

Project presentation

This proposed project will extend the environmental functionality of the Enveco tool such that it can also be applied to enclosure fires in Swedish conditions. Given a minimal amount of information about the enclosure and size of the fire, the tool will provide estimates of environmental damage from fire effluents to air, water, and soil, and also the environmental impact of replacing the enclosure and contents/furnishings. The Enveco tool will compare the impact of different choices that could be made with respect to handling an enclosure fire. This concept is illustrated in Figure 1. After an incident, the tool will allow users to compare the results if different response decisions had been made. For example, should the fire have been allowed to burn to completion (while the surroundings are protected) or should a more active role have been taken, thus causing potential pollution from fire water run-off or foam? How would these decisions affect clean-up and restoration of the site?

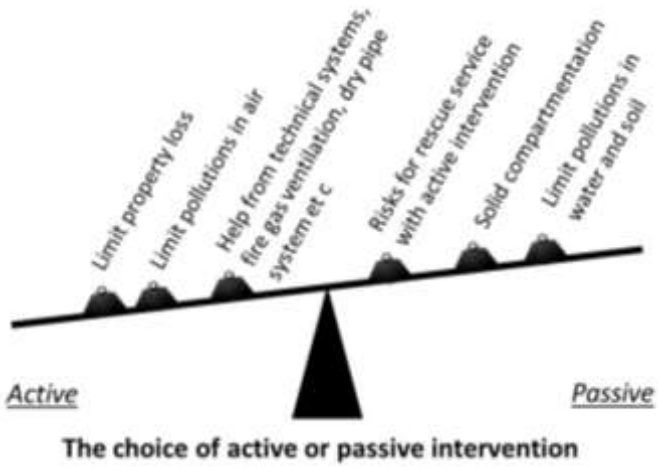

Figure 1. Examples of factors that can influenc the choice of active or passive intervention.

A variation of the tool will also evaluate the environmental trade-offs associated with fire protection systems. Sprinkler systems will be studied to evaluate the environmental impact of a theoretical requirement to install them in houses compared with the fire damage if no sprinkler systems existed, as shown in Figure 2. The tool will also be used to analyse other types of fire protection systems if resources and statistical data allow.

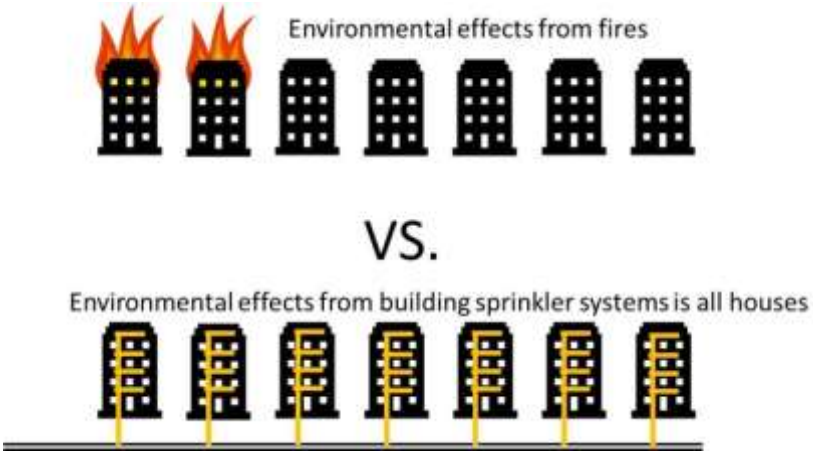

Figure 2. Comparison of environmental impact of sprinklers vs. impact from burning buildings.

Ultimately, this knowledge will help to improve the accuracy of the thousands of fire risk evaluations that are performed each year. The framework for a repository of results will be created so that the knowledge is available for training purposes to prepare users for responding to enclosure fires and as input for risk assessments and planning activities.

Project structure

WP 1: Definition of case studies (Leader: RISE)

- ***Interactive process with the reference group***
- ***Definition of enclosure materials and configurations***
- ***Definition of active tactics***
- ***Sprinkler case predefined***

A reference group that includes representatives of potential end users, e.g. responsible authorities, the fire service, and property developers, along with technical experts will be formed early in the project and a kick-off meeting will be scheduled to introduce the project, determine the level of interaction needed throughout the project, and refine the needs of the end users. Specifically, the reference group will provide guidance with respect to the enclosure fire situations that are most challenging from an environmental decision-making perspective, suggest fire protection systems to

evaluate, and to identify case studies for analysis with the tool. The reference group will also be asked how they see future changes in fire risks affecting their current standard operating procedures.

The scope of the new Enveco tool will be focused with help from the reference group and a preliminary list of assumptions and parameters will be discussed. Considerations for determining the scope will include preferences expressed by potential end users and availability of fire statistics and other data upon which to base the environmental impact calculations. If possible, the tool will be made available online for the reference group and others to use hands-on. During the development of the tool, end users will also be asked to use it on recent fire incidents they have experienced. This work is part of WP4 – Case studies.

A video teleconference near the end of the project will be scheduled in which the reference group will be given a demonstration of the tool and give feedback for improvements. The feedback will be evaluated and incorporated into the tool if feasible and appropriate.

WP2: Develop enclosure fire scenarios for the chosen case studies (Leader: Lund)

- **With or without rescue service intervention**
- **With or without sprinklers**

In this WP the scope of the Enveco tool is extended to include occupancies other than warehouses, based on guidance from the reference group in WP1. A hypothetical set of scenarios will be developed for a case without rescue service intervention. The probability of different outcomes (e.g. fully engulfed room/enclosure) is estimated based on a few parameters about the building (e.g. size, fuel load) and the fire (e.g. object of first ignition). This is done by a combination of statistics and fire dynamics calculations. This set of scenarios, and their respective probability, will be used to calculate an expected (average) environmental impact. This can be compared with the environmental impact of the actual scenario to estimate the environmental benefit or detriment of rescue service intervention. Further, the tool will be expanded to calculate the environmental benefit/detriment of fire protection systems. Within this project, the scope is limited to sprinkler systems, but it will also include an outlook to other fire protection systems that might be possible in future tool extensions.

WP3: Data collection and model development (Leader: RISE)

- ***LCA inventory data for materials***
- ***Data on environmental effects of extinguishing media***
- ***Design of user interface and selection of input parameters***

The type of enclosures used by the new Enveco tool will be limited initially to the most prevalent materials and configurations used in Sweden. A selection of 3 – 4 enclosure configurations (single floor, two floors, multi-floors, with/without basement) will be offered as choices. Outer wall materials will also be limited to 3 – 4 choices. These enclosure materials, configurations and contents will be based on previous work [8, 18, 20], along with input from the reference group. The literature will be searched for LCA inventory data for new structural and furnishing materials, such as insulation and flame retarded materials. All of the collected inventory data will incorporated into the LCA models upon which the tool is based.

The extent of the inventory data collected for the LCA models will be expanded with the help of a student. The student project could be entitled “Compilation of environmental contaminants from contents of burned enclosures”.

WP4: Case studies (Leader: Brandskyddslaget)

- **Evaluation of environmental impact of fire protection systems**
- **Evaluation of environmental impact of active tactics**

A range of case studies will be used to exercise the tool and optimize its value to end users and fire protection assessments. The case studies will cover a range of potential severities and will be chosen by the project staff with input from the reference group, see WP1.. The reference group will also be

invited to use the tool on actual enclosure fires and their feedback will be used to modify the tool as necessary to make it as useful possible.

To further validate and develop the tool, a student project is proposed in which case studies are collected and analyzed using the tool. This work could be entitled "Using the Enveco tool for estimating the environmental damage of enclosure fires".

With this tool, the environmental consequences of including fire suppression systems such as sprinklers and the effects of new construction techniques/materials can be evaluated. The results of these case studies will be analyzed and, if they are consistent across the range of enclosure fires selected in WP1, will form the basis of a compilation of generalized conclusions that can be used by the fire safety community and others as guidelines for the types of enclosures included in this project.

WP5: Implementation and dissemination (RISE)

This work will be implemented initially through the end users in the reference group that used the tool in WP4. A demonstration of the tool will be available online at RISE's website. A RISE report and articles in Brandposten will document the development and testing of the tool. An article based on the report will also be submitted to a peer reviewed journal. This work will be presented at a national conference, such as Brandskydd. The main language for dissemination to the users will be Swedish, but a RISE report and international article will be available in English.

When and if the methodology is expanded to include more enclosure types, sites, and situations it will become more useful to the fire safety community and could be implemented on a larger scale, for example in the form of an online service accessible to the fire service.

Expected results and their practical use

The result of this project will be a tool that can be used by people without specialized knowledge in environmental assessment to evaluate the environmental risks associated with enclosure fires. It will provide improved background knowledge for the thousands of risk evaluations that the fire and rescue brigade leaders (and others) perform each year. The benefits to the target audience are explained below:

- Impact to society, who will benefit*:*
  - ✓ The tool will help to inform policy makers, municipalities, and the public about the effects on the environment of enclosure fires.
- Protect people:
  - ✓ The tool will provide guidance on the expected sources of environmental pollution caused by fires. Thus, better preparation and training can help to reduce damage and protect people.
- Reduce insurance claim frequency or size of claim:
  - ✓ As with protecting people, better planning and preparation for responding to enclosure fires can improve efficiency and minimize damage.
- Improve firefighting:
  - ✓ There is high uncertainty in estimating potential risks to the environment caused by fire. This tool will reduce this uncertainty by giving users an opportunity to learn more about the environmental consequences of enclosure fires.
- Reduce the risk of firefighting:
  - ✓ Improved knowledge of the environmental impact of fire will help firefighters make safe and timely decisions that could prevent toxic exposures to themselves and the public, as well as to the surrounding environment.

Impact on authorities/organizations' rules, regulations, etc…

The tool can help to inform policy makers, municipalities, and the public about the effects on the environment of enclosure fires. The tool will also improve the fire service ability to consider the

environment when making strategic decisions to be able to fulfill their obligation to the Civil Protection ACT, 2003:778.

Further, the tool can contribute to a more sustainable futre, offering input to planning activities for new enclosures, material uses and the choice of fire protection systems.

How much will it cost and what is the timeline?

The applicants are requesting 600 000 kr from Brandforsk. In addition to this, NFPA has agreed to support this project with co-funding of $20 000 (approx. 160 000 kr), and Brandskyddslaget, Lund, and RISE have also agreed to support this project by contributing 100 000 kr each, if it is accepted.

Funding source	**Contribution (kr)**
Branforsk	600 000
NFPA	160 000 ($20 000)
Brandskyddslaget	100 000
Lund	100 000
RISE	100 000
Total (potential) project funding	***1 060 000***

The duration of the project is planned to be 18 months and the work is expected to be performed according to the schedule in Table 1.

Table 1. Timeline

WP	M3	M6	M9	M12	M15	M18
1						
2						
3						
4						
5						

Deliverables

1. A revised Enveco tool that can be used on enclosure fires other than warehouses to estimate the environmental impact of active intervention vs passive protection of surroundings.
2. A new tool capability to estimate the impact of installing fire protection systems compared with increased risk of fire.
3. A database or knowledge repository to allow dissemination of the results of case studies for training purposes.

Re-applied application (BF16-0009)

The feedback from the 2016 application “Environmental threat due to structure fires” was primarily that the tool should not be focused solely on the fire service as users and that there are other potential users that would benefit from using the tool to support their risk assessments and their general understanding of the environmental impact of fire. Mr. Gell also explained that the tool could not be used at a fire incident because the fire brigade is too busy doing other things. The current proposal is directed at a larger fire safety community, including not only the fire service (which would use the tool for preparedness and training purposes) but also responsible authorities, fire protection engineers, agencies that conduct risk/vulnerability assessments, building constructors, community planning organizations, etc. An additional function will be added to the tool in this proposal: the ability to compare the environmental impact of fire protection systems.

Applicant credentials

Francine Amon

Dr. Amon has led two projects at SP Technical Research Institute of Sweden specifically investigating the environmental impact of fire. The first project was a review of the effects of fire on the environment, funded by Brandforsk (project 700-121). The second project was the feasibility study for the Enveco tool, funded by NFPA. She has also used LCA methods for evaluating products containing nanomaterials (graphene and carbon nanotubes) developed in two large EU 7th Framework projects. She is active in the ISO working group entitled "Fire Threat to the Environment" (TC92/SC3/WG6).

Jonatan Gehandler

M. Sc. Jonatan Gehandler has been employed as a PhD student at RISE since 2010 within fire technology and risk management. Jonatan has participated in large European research projects such as iNTeg-Risk (Early Recognition, Monitoring and Integrated Management of Emerging, New Technology Related Risks). Recently he was responsible for the risk assessment part of the EnvEco tool developed for NFPA in the US.

Lotta Vylund

M. Sc. Lotta Vylund is educated as Master of Risk Management and Bachelor of fire protection engineering and has a one year senior officer training for fire protection engineers. She worked in a fire department and has participated in several research projects relating to fire rescue services, for example: "Brandskydd i flervåningsträhus", "Taktik och metodik vid brand i undermarksanläggningar" and "Storskadeproblematiken".

Marcus Runefors

M. Sc. Marcus Runefors is a lecturer at the division of fire safety engineering at Lund University. His research is primarily focused on residential fires from both a statistical and case study perspecitive. He is involved in several projects within the area such as MSBs large project on residential fires and Brandforsk project on happy fires.

Nils Johansson

Dr. Nils Johansson is associate senior lecturer at the division of fire safety engineering at Lund University. He has been involved in research projects on arson fires, residential fires and most recently in a project dealing with fire dynamics in the rescue service.

Robert Jansson McNamee

Dr. Robert Jansson McNamee is the R & D manager at Brandskyddslaget and has 15 years of experience form mainly fire resistance projects at SP. He has also worked with experiments and modeling of façade fires, fire dynamics of lightweight materials for boats, airplanes and trains (FireResist project) and measurement of thermal properties.

Markus Sandvik

Fire protection engineer Markus Sandvik is a fire protection consultant at Brandskyddslaget and has more than 20 years of experience of fire protection in built environments along with more than 10 years of experience as an on-scene commander within the Swedish municipal fire and rescue service.

References

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1 Batterymarch Park, Quincy, MA 02169-7471

Phone: 617-770-3000 Fax: 617-770-0700 www.nfpa.org

April 4, 2017

Thomas Gell
Secretary, Brandforsk

Dear Thomas:

I am writing in support of the application entitled ”Measuring the impact of fire on the environment”, submitted by Dr. Francine Amon to the 2017 Brandforsk call for proposals.

Understanding the effects of fire on the environment is important as a standalone topic. It is also a fundamental requirement for measuring the efficacy of new sustainable materials used to replace traditional nonrenewable materials and energy sources if the risk of fire is significant during their service life.

Life Cycle Assessment (LCA) is a growing field of science that provides a framework for estimating the impacts of fire on the environment. Unfortunately, LCA is a complicated process and is thus not accessible to most organizations that have an interest in reducing the environmental impact of fire on society. The LCA-based tool proposed in Dr. Amon’s application is based on a feasibility study commissioned by the National Fire Protection Association (NFPA) in 2015 to determine whether it is possible to create a simplified methodology that could be used by people who are not environmental experts. The work described in this 2017 proposal both expands the applicability of the tool and minimizes the data input necessary to use it.

A collaboration between Brandforsk and NFPA would make it possible to develop the tool from its current state (feasible for limited situations) to an essentially finished state. By doing this together, we could bring the ability to estimate the impact of fire on the environment to the people that make decisions regarding risk assessments for fire and environmental protection measures, and those that are involved in pre-planning activities for fire response.

As Vice President of Research, Data, and Analytics of NFPA, and as an early supporter of this work, I have an interest in seeing it succeed and hope that you will agree on the need to fund it. This letter is our commitment to add to our original 2016 investment of $87,500 in the prototype tool an additional $20,000 investment this year, if Dr. Amon receives your funding support.

I look forward to working collaboratively with Brandforsk on this project.

Sincerely,

Kathleen Almand
Vice President, Research