NATUR VÅRDS VERKET

Miljöforskningsnämnden
Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram

Forskningsprogram
SNAP ■ **REPROSAFE** □ **FLIPP** Inriktning: Ekonomiska styrmedel □
Inriktning: Informationssystem och indikatorer IPP □

Projekttitel (svensk):
Experimentell metodik för karakterisering av brandgenererade partiklars hälsopåverkan.

Projekttitel (engelsk):
Experimental methods for characterising health impact of fire generated particles.

Huvudsökande

Efternamn:	Förnamn:	Födelseår:	Kvinna □ Man ■
Hertzberg	Tommy	1958	

Organisation:	Institution:
SP Sveriges Provnings och forskningsinstitut	Brandteknik

Adress:	Postnr:	Ort:
Box 857	501 15	Borås

Telefon:	E-post:	Tjänst:
033-165046	Tommy.hertzberg@sp.se	Forskare

Medsökar

Efternamn, förnamn, tjänst, organisation, institution:		
Gunnar Skarping, Instititutionen för arbetsmiljökemi, Stockholms Universitet		
Telefon:	E-post:	Kvinna □ Man ■
0451-385251	Gunnar.skarping@anchem.su.se	

ammanfattning på **svenska** strukturerad enligt följande: 1) Projektets betydelse för programmet 2) Miljörelevans och förväntad betydelse för miljöpolitiken 3) Mål och hypotes 4) Metodik och genomförande 5) Kommunikationsinsatser i relation till programmet:

1. Hälsofarligheten hos små luftburna partiklar visades under 90-talet genom statistiska samband mellan variationer i en befolknings hälsotillstånd/mortalitet och halten partiklar i luften. Undersökningar har även visat att speciellt de minsta partiklarna (< 100 nm) är hälsofarliga då de kan transporteras djupt ner i lungorna Sådana partiklar bildas i mycket stor mängd vid bränder. Brandrök innehåller även andra mycket toxiska ämnen vilka kan komma att absorberas och anrikas på ytan av partikelfasen. Även om mekanismerna för små partiklars hälsopåverkan inte är helt kända har det föreslagits att likartade respiratoriska problem hos dem som lider av ökad partikelhalt i luft också kan hittas hos människor som utsatts för brandrök. Projektet syftar till att ta fram diagnostiska verktyg som beskriver lungpåverkan av brandgenererade partiklar och att generellt öka förståelsen av interaktionen mellan partiklar och lungvävnad.
2. Det finns ett stort behov av att klarlägga hur brandgenererade ämnen påverkar hälsan på såväl kort som lång sikt. Vid en brandolycka har ofta räddningspersonalen otillräcklig information för att korrekt bedöma tänkbara hälsorisker för insatspersonalen och för människor som bor eller vistas i brandens närområde. Detta medför bl. a svårigheter för att avgöra huruvida utrymning är nödvändig. Det finns också ett behov av att klarlägga vilka material som utgör störst hälsorisk vid en brand. Sådan information kan sedan kopplas till regelverk/rekommendationer som styr användande av byggmaterial.
3. Projektet syftar mot att studera och utveckla två olika experimentella tekniker för att diagnostisera och studera brandgenererade partiklars/gasers hälsopåverkan:

- Studie av utandningsdiagnostik (Exhaled Breath Analysis, EBA) för att söka efter biomarkörer som kan indikera kort och långtidseffekter på andningsorganen av brandrök. Denna del av projektet utförs i samarbete med Centrum för yrkes och miljöallergi, Laboratoriet för klinisk biokemi och Allergiforskningsgruppen samt Institutet för invärtes medicin, vid Bergens Universitet, Norge.

  -Mål: att utveckla en standardprocedur, ett 'protokoll, för att karakterisera brandröks påverkan på andningsorganen. Syftet är att utveckla en metod som skall kunna användas dels vid rutinmässig hälsokontroll av personer som i sitt arbete ofta konfronteras med bränder, exempelvis brandmän, men även för att kunna diagnostisera personer som utsatts för enstaka höga doser av brandrök.
- Mekanismstudier av brandröks lungpåverkan genom att nyttja en teknik baserad på isolerade och perfunderade marsvinslungor. Denna del av projektet genomförs i samarbete med Institutet för Miljömedicin, Karolinska Institutet.

  -Mål: att undersöka direkt lungpåverkan av komponenter i brandrök samt att ta fram en generell metodik för att testa brandröks direkta toxicitet.

4. Projektet syftar till en långsiktig kunskapsuppbyggnad inom området förbränningsgenererade partiklar-hälsa och innefattar ett omfattande interdisciplinärt samarbete. Följande institutioner deltar i projektet:

SP Sveriges Provnings och Forsknings Institut, avd.för Brandteknik	*(Borås)*
Stockholms Universitet, avd. för Arbetsmiljökemi	*(Hässleholm)*
Karolinska Institutet, Institutet för Miljömedicin	*(Stockholm)*
Centrum för yrkes och miljöallergi, Yrkes medicinsk avdelning	*(Bergen)*
Laboratoriet för klinisk biokemi och Allergiforskningsgruppen	*(Bergen)*
Bergens Universitet, Institutet för invärtes medicin	*(Bergen)*

   De inblandade institutionerna har lång erfarenhet inom de berörda specialområdena. En betydande del av det vetenskapliga arbetet utförs inom ett doktorandprojekt med gemensam handledning från flera berörda institutioner.
5. Resultat från projektet kommer att publiceras i vetenskapliga tidskrifter från skilda vetenskapliga fält samt att presenteras vid olika konferenser och i form av en avhandling.

Miljöforskningsnämnden
Ansökan om projektbidrag inom Naturvårdsverkets forskningsprogram

	År 2004	År 2005
Summa sökta medel per år i kr:	1 290 000	1 290 000

Sökta projektmedel fördelade på kostnadsslag	År 2004 (kr)	År 2005 (kr)
Personalkostnad inkl. soc. avgifter * Lön doktorand: (x) 400 000/år Lön handledning: (Doc. Gunnar Skarping) 40 000/år Projektledning: (Dr Tommy Hertzberg) 250 000/år	690 000	690 000
Övriga omkostn exkl moms (förbrukningsmtrl, analyser, resor etc)** Försök, EBA i Bergen: 200 000/år Försök, perfunderade lungor, Karolinska Institutet: 200 000/år Rökgasanalys, SP+arbetsmiljökemi: 250 000/år	600 000	600 000
Delsumma av ovanstående poster:	1 290 000	1 290 000
Förvaltningspåslag: ..... %		
Totalsumma per år: (införs sid. 1):	1 290 000	1 290 000

*) Specificera namn, tjänst **) Specificera

Samtliga övriga miljörelaterade projekt för vilka de sökande har beviljats anslag eller söker anslag för 2004-2006. OBS Även EU-finansiering.

Projekttitel	Finansiär	Tidsperiod	Sökt kr	Beviljat kr
Metodik för karakterisering av brandröks inverk på miljö/hälsa	MISTRA	2003-2006	6 000 000	
Ny metod för småskalig toxicitetsmätning	Brandforsk	2004-2005	500 000	

Miljörelaterade projekt för vilka sökande har beviljats anslag för 2000-2003
OBS Även EU-finansiering

Projekttitel	Finansiär	Tidsperiod	Beviljat Kr
Partiklar vid bränder	Brandforsk	2002-2003	600 000

Datum och sökandes underskrift, vilken samtidigt ger Naturvårdsverket tillåtelse att publicera sökandes namn på sin webbplats:	Datum och underskrift av prefekt eller motsvarande med namnförtydligande: M. SIMONSON

Ansökan skall bestå av detta formulär jämte högst sex sidor lång projektbeskrivning på **engelska** (strukturerad som den svenska sammanfattningen samt en redovisning av kunskapsläget). Referenser till egna publikationer ges med sifferhänvisning till CV. Andra referenser ges i löpande text. Sökandes och eventuell medsökandes CV får omfatta högst två sidor. Inga bilagor kommer att beaktas vid bedömningen. Ansökan (max 10 A4-sidor, 12 punkters teckenstorlek) skall inlämnas i **original + 15 kopior samt elektroniskt** till ansok@naturvardsverket.se. Häfta ihop ansökan och använd hålat papper. Ansökan skall ha inkommit senast den 15 oktober 2003 till Naturvårdsverket, Forskningssekretariatet, 106 48 STOCKHOLM.

Experimental methods for characterising health impact of fire generated particles.

Background

The impact of small airborne particles was demonstrated in the early 90's through statistical correlations between variations in health/mortality in a population and the amount of airborne particles[1,2]. Further investigations have shown that in particular the smallest particles (< 100 nm) are dangerous as they might be inhaled and transported deep into the respiratory system[3]. Such small particles are generated in huge amount in fires as a result partly of evaporation and condensation mechanisms, partly from soot generation. Fire smoke also contains many other toxic substances and it has been shown that the mixture of small particles and toxic gases enhance the toxicity of the smoke[14,4].

Traditionally there has been a focus on the acute toxic substances (carbon monoxide, hydrogen cyanide) in smoke. However, there is also a number of other very dangerous substances[5, 6, 7, 8, 9, 10] in fire smoke; substances that might have both a short and a long term impact on the survivability and of the quality of life for a fire victim after the fire accident.

Even if the mechanisms for the interactions between particulate materials and humans are not fully understood, it has been suggested[14] that pulmonary problems similar to those found in people who suffer from increased atmospheric pollution can be found in surviving fire victims.

Generally, the cost for pulmonary diseases in the population is huge and increasing. In the year 2000 the cost in Sweden alone was approximately 7 billion SEK[11] (only asthma, and chronic obstructive pulmonary disease) and there is a need for developing efficient diagnostic tools that can be used to measure the health status of the pulmonary system.

It has been demonstrated[10, 12, 25] that rescue personnel might be exposed to fire gases even when using advanced protective equipment. There is a need to develop techniques for measuring the fire gas impact and relate this to the functionality of the equipment for protection.

There are only a few reports on the mechanisms for how particulate material might influence our health, part from asbestos. As for the particularities of fire generated particles where toxic substances (aromatic compounds, isocyanates, dioxin, metals) are likely to be absorbed on the particle surface, even fewer reports are available [3, 10, 12, 13, 14, 15]. There is a need for further research.

There is a need to clarify how fire generated substances influences human health both on a short term and a long-term basis. During a fire accident it is often difficult for rescue personnel to know the impact of the fire smoke on fire fighters and on the people living in the vicinity of the fire. This makes it difficult to decide whether an evacuation is necessary or not. More data is needed.

1. The project in relation to Snap

The basic concept for the proposed project is to develop standardised methods and test-protocols for evaluating the interaction between lung-tissues and fire generated smoke. Testing technologies for evaluating pulmonary effects on people exposed to fire smoke will be developed. This includes measuring and estimating the impact of very well defined particulate material on lung tissues and the pulmonary system. Knowledge from the project as well as the understanding and development of the tools suggested will enhance the basic understanding of the health impact of particulate materials in general and of combustion generated particles in particular. The project will be run in co-operation between Swedish and Norwegian scientists and experts from different fields.
The project concept requires expertise and skills from several scientific diciplines:

- Fire technology expertise
- Chemical expertise
- Medical expertise
- Toxicological expertise

Within the project information relating to the following sequence will be obtained: Generation of toxic substances from fires - toxicological test of substances – exposing of rescue personnel and others - diagnostic test - appearance of pulmonary disease.

The character of the project is very much an interdisciplinary co-operation where the institutions involved have a long experience within their particular fields. Much of the work will be done as part of PhD-diploma works.

Participants

SP Swedish National Testing and Research Institute, Fire Dynamics	(Borås, Sweden)
Stockholm University, The dep. of Work Environment Chemistry	(Hässleholm, Sweden)
Karolinska Institutet, The Institute of Environmental Medicine	(Stockholm, Sweden)
Dep. of Occupational Medicine Haukeland University Hospital	(Bergen, Norway)
Laboratory of Clinical Biochemistry Haukeland University Hospital	(Bergen, Norway)
Bergen University, Institute of Internal Medicin	(Bergen, Norway)

2. Project relevance to environment policy

The understanding of the health impact of small airborne particles is important not only for medical reasons. In order to be able to prevent and minimise risks related to particles, it is necessary to be able to quantify the dangers related to different particles in our environment. Much of the smallest particles are generated from combustion sources and if the impact of well-defined particles can be measured and quantified through the suggested techniques, it will be possible to prevent generation of particularly dangerous particles from controlled fires, e.g. particles from heat/power plants, by avoiding the combustion of certain materials or by increasing the demand for flue gas cleaning. It will also be possible to minimise the generation of dangerous particles from uncontrolled fires, e.g. in buildings, by requiring the use of appropriate building materials.

3. Project targets

Main targets of the project is:

- Develop standardised methods for characterising and chemically define/describe fire generated particles and smoke
- Develop test protocols for gas/particle-lung interaction
- Develop test protocol for pulmonary diagnosis on smoke-exposed persons
- Develop standardised test equipment for pulmonary diagnosis

Fire smoke generation

Below are described two different methods and approaches for investigating the effect of fire smoke on the pulmonary system. Method I requires a very well defined fire smoke, which will be provided using a small-scale standardised experimental method[16]. The gas/particle ensemble will be analysed and defined using a variety of instruments available mainly at SP and at Stockholm University. Equipment for studying exhaled breath in method II will be constructed during the project.

Method I: Effects on lung-function- A study with isolated perfused guinea pig lungs

A well-established method[17,18] for isolating and perfusing guinea pig lungs has been developed at the Institute of Environmental Medicine, Karolinska Institutet[19]. The method is based on a technique to remove the hart-lung system from the animal and use it in an artificial thorax where various substances can be introduced in order to investigate the influence and mechanisms of lung-substance interaction.

It has been demonstrated that guinea pig lungs have a reaction pattern very much like human lings. The isolated perfused lung-model therefore is an excellent method for investigating irritating and acute effects on the lung function[20, 21, 22, 23]. Effects on the lung function, such as conductance (movability of air in the upper airways) and compliance (the elasticity of the lower part of the lung) will be measured. The model also allows detection of biological mediators released from the lung, e.g. histamine, thromboxane and leukotrienes. These substances are important indicators of a malfunctioning or irritated/inflamed lung.

This part of the project aims at investigating the direct influence on the lung by different components of the fire smoke but also to develop a standardised technique and method (a protocol) for investigating and testing toxicity of different fire smokes.

Method II: Analysis of exhaled breath from people exposed to fire smoke

A method that recently has obtained a lot of interest for its potency of providing information on various pulmonary diseases is analysing the exhaled breath[24] on patients. This analysis is done directly on the exhaled breathe but can also be performed indirectly by cooling the breath and study the condensate. A number of biomarkers are used today to indicate acute airway injury and diseases such as asthma, bronchitis, cancer, etc. The markers used are pH, CO, nitrogen oxide (NO) and specific marker of inflammation such as leukotriene C_4 and D_4, and specific markers of oxidative stress. Most important are H_2O_2, glutathion, 8-isoprostane and malonyldialdehyde (MDA). The method is non-intervening and therefore simple and pain free for the patient. However, it is necessary to have a sufficient amount of experimental data in order to evaluate and diagnose the health condition correctly. A large part of the project will therefore be to analyse exhaled breath on people exposed to fire smoke and compare the result to reference material already existing at the Haukeland University Hospital, Bergen Norway. Through comparisons, hopefully it will be possible to find and define biomarkers for pulmonary effects of fire smoke.

This part of the project aims at developing a standard procedure for testing the pulmonary impact of having been exposed to fire smoke. The idea is to obtain methods for testing on a routine basis, people frequently exposed to fire situations (e.g. rescue personnel) but also to be able to diagnose someone that have been exposed to large amounts of smoke on a single occasion. The method should also be usable to indicate effectiveness of protection equipment (gas masks etc.) by testing people using such protection gear during smoke exposure[25].

4. Methodology and project structure

The project will be co-ordinated by SP, Fire Dynamics. SP will provide equipment for smoke generation and smoke analysis. Responsible at SP is Dr Tommy Hertzberg, senior research scientist at the department of fire dynamics.
SP Fire Dynamics has the most modern fire lab in Europe with advanced equipment and facilities for small- and large-scale fire tests. The laboratory performs accredited fire tests and does a substantial amount of research within fire related areas. (www.sp.se/fire)

The dep. of Work Environment Chemistry, Stockholm University, will be responsible for much of the necessary chemical analysis involved in the project. This includes the fire smoke, lung tissues (method I) and exhaled breath condensate (method II). Responsible at the institute will be ass. Prof. Gunnar Skarping.
The Institute of Work Environment Chemistry is a modern laboratory at the Institute of Analytical Chemistry, Stockholm University. The department has a long experience of developing methods for isocyanate and amine measurements in the working environment. Methods for estimating metabolites in the human body have been developed at the department. (www.anchem.su.se/amk/)

Experiments according to method I will be performed at IMM, the Institute of Environmental Medicine, Karolinska Institutet. Responsible at IMM is Dr.med Lena Låstbom.
The Institute of Environmental Medicine is a particular branch at Karolinska Institutet and it has two different roles, one as a Swedish national expert body within the field of environmental medicine and the other as a traditional research institute at Karolinska Institutet. The activities include research, education and risk analysis. Research is done within the fields of toxicology, environmental medicine, epidemiology and physiology.
(www.imm.ki.se)

Tests according to method II will be performed in Bergen in cooperation with the department of Occupational Medicine and the Laboratory of Clinical Biochemistry, both at Haukeland University Hospital in Bergen and also the Institute of Internal Medicine at Bergen University.
Responsible for the work in Bergen is dr. Tor Aasen MD, MHA, Consultant Chest Physician and Head of the Department of Occupational Medicine, Haukeland University Hospital.
The department of occupational health is responsible for the region of west-Norway, with units in work-related neurology, dermatology, pulmonology, diving medicine and also responsibility as National centre of competence in hyperbaric medicine. Together with the laboratory for clinical biochemistry (LKB), is run the Centre of work and environmental allergy where senior physician and allergologist dr.med Erik Floorvaag is section leader. He is primarily related to LKB but also to the Institute of Internal Medicine at Bergen University. The Institute has an Allergological research group (Prof. Said Elsayed) with at thorough allergological competence and a particular experience in the research on reactive oxygen

species (ROS). Several research projects are running at the Centre with relation to exhaled breath condensate (EBC) techniques and also the effect of hyperbaric treatment on mediators and ROS in EBC. (http://www.helse-bergen.no/avd/yrkesmed)

5. Communication of results

Results from the project will be communicated through scientific papers in journals from different scientific fields, mirroring the interdisciplinary nature of the project. Further, results will be presented at conferences and through the thesis work of one or several Ph D students.

References

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CV Tommy Hertzberg

Adress: Vickervägen 2
352 53 Växjö

Family: Lotta, Alexander Niclas

Main education and employments

- 1979-84. M.Sc in chemical engineering at Chalmers/ and *l'Université de Technologie de Compiègne,* France.
- 1984-88. Development manager at Perstorp AB for a metal substrates group producing Cu-, Invar foils to the PCB market.
- 1988-97. Department of Chemical Engineering II, University of Lund. Licentiate 1994 ("Spectral resolution as a method for the simulation of a packed bed reactor"), PhD 1997 ("Simulation of Chemical Reactors")
- May-September 1997. Part time at the department of Numerical Analysis, Lund University.
- May 1997. ABB-fläkt, Växjö, as a research scientist at ATC (Air pollution control, Technology Center). Main activities in flue gas cleaning projects.
- March 1999. Part time at the Bioenergy Centre, Växjö University. Modeling of combustion processes. Teaching.
- May 2000. Researcher at SP Swedish National Testing and Research Institute, Borås, department of Fire Technology. Main activities as project leader for research tasks related to fire growth, fire extinguishment and to the generation and analysis of fire related aerosols (particles+gas phase).

Other activities

- In 1989, Initiate a company 'Catator AB' at Ideon Research village, Lund. Main activities of Catator is development of catalysts and catalytic processes. Catator today (2003) employs 10 people and has a turnover of ~15 miljon SEK (www.catator.se).
- In 1999, took part in the initiation of the (still ongoing) particle and aerosol research project at Växjö University, through the application and acceptance of a STEM-sponsored (www.stem.se) ABB-Växjö University-Lund University joint aerosol research programme.
- In February 2000, opponent on a Licentiate thesis at NADA, KTH, 'Shape optimization of low speed airfoils using MATLAB and automatic differentiation'.
- In 2001, took part in the initiation of a national network, the 'Swedish Programme for Aerosol Research and Competence, SPARC', that will support and co-ordinate aerosol research in Sweden (www.sp.se/sparc). In 2002 we obtained funding from FORMAS to support part of the SPARC activities related to a research school. We have also obtained funding from several industries and we are currently (2003) discussing PhD-support with other funding institutions, such as the Swedish 'KK-stiftelse'.
- Consultant for ABB fläkt (today Fläkt Woods AB) since 2000 and Metfoils AB since 2002.
- Assisting PhD adviser at ABB and Växjö Universitet 1997-2000. Advicer for several master projects in Lund (1988-1997), Växjö (1997-2000) and Borås (2000-2003).

Curriculum vitae

Gunnar Skarping
Högalidsgatan 4
281 38 Hässleholm

Född den 18:e oktober 1950
Gift, 4 barn

Utbildning

Gymnasium	1969
Civ.ing.	1977
Tekn.Lic.	1983
Tekn.Dr.	1985
Docent	1990

Undervisning

Assistentundervisning vid avdelningen för Teknisk analytisk kemi, LTH	1977-1985
Handledare för ett flertal examensarbetare vid TAK och analytisk kemi (LU)	1977-1996
Lektorsundervisning inom framförallt Yrkes hyg. linjen	1985-
Doktorand-handledning och undervisning vid institutionerna för Analytisk kemi, Yrkes- och miljömedicin och Arbetsmiljöteknik samt Klinisk Kemi.	1987-

Har bl.a. handlett sex forskarstuderande till doktorsexamen, och fyra till licentiat-examen.

Anställningar

Assistent och forskningsassistent vid teknisk analytisk kemi	1977-1985
1:e Kemist/Chefskemist Yrk.Med Klin. Lunds Universitetssjukhus	1985-1998
Universitetslektor LU	1998-2002
Föreståndare för enheten för arbetsmiljökemi vid LU	2001-2002
Universitetslektor, Analytisk kemi, Stockholms Universitet	2003-

Övrigt

Deltagit i åtskilliga konferenser och seminarier 1977-
Konsult till masspektrometri tillverkare (1992-1995) rörande framförallt kemisk jonisation och programutveckling för masspektrometri. Konsult till Finnegan masslab 1994-1997 och Micromass avseende bestämning av framförallt lågmolekylära ämnen med LC-MS. Konsult till Metric Analys AB rörande mikro-LC.
Deputerad, 1973-1977, Ordf. internationella utskottet, 1973. TLTH:s Ordf.1974,. V. Ordf Lunds Studentkår 1975., Lunds Universitets konsistorium 1975-1977. Kemicentrums styrelse 1978-1980., SFS Doktorandråds Ordf. 1980., Fackliga uppdrag inom CF och SUHAF., Fullgjord militärtjänst som skyddstekniker, 1972, 15 mån, sgt. Anslagsinnehavare AMFO, AMF, AFA, RALF mm.

Annat

Har publicerat ett 100-tal uppsatser i internationella tidskrifter samt 1997 blivit förklarad professorskompetent vid tillsättningen av en professur i analytisk kemi vid Karlstads universitet