

## **EMFO - Abstracts of projects approved in the spring 2005**

### **Prediction of Engine Noise from Gas Pressure**

Body conducting the research: Scania CV AB

Project duration: 2005-2008

Environmental issues are the driving factor in the development of diesel engines for commercial vehicles. The engines should be more fuel efficient and have reduced noise and pollution levels. From a combustion perspective, there is unfortunately a conflict between low pollution levels, good fuel economy and low noise levels. As an example, a clean and fuel efficient combustion process often becomes noisy. The aim of combustion development is to find the best trade off between these three properties.

During combustion development an engine with one cylinder is commonly used. The pollution and fuel consumption that results from this single cylinder is easily scaled up to a multicylinder engine. However, combustion noise may unfortunately not be scaled up from a one cylinder engine to a multi cylinder engine. The goal of the project is to develop a method with which a transfer function may be constructed. This transfer function enable us to make fast predictions of the total sound power of the complete multi cylinder engine from gas pressure curves that are measured on a one cylinder test engine.

### **Traffic generated inhalable wear particles: Formation processes, emission factors and occurrence from the viewpoint of measure**

Body conducting the research: IVL Svenska Miljöinstitutet AB

Project duration: 2005-2008

The aim of the project is to improve knowledge regarding formation, properties, emissions and occurrence of inhalable traffic-generated wear-particles, and propose cost-effective measures aiming at reaching compliance with PM air quality guidelines.

The project is carried out in collaboration between IVL, VTI, LTH/LU and SU/City of Stockholm, and comprises of four workpackages:

1. Dedicated sampling/measurements of PM<sub>10</sub>, PM<sub>2.5</sub> and PM<sub>1</sub> in street canyons, urban and regional background in Stockholm and Malmö.
2. Data-broadening geographically through utilisation of existing particle samples from e.g. the Swedish Urban Network.
3. Studies of properties, formation processes and emission factors of wear-particles under controlled laboratory conditions, to improve knowledge of the importance of the various factors that affect road wear and the emissions of various particle fractions.
4. Dissemination, modelling and synthesis of the results from WP1-3. The contributions from road traffic to occurring ambient air concentrations of particles are quantified and cost-effective measures to reduce concentrations are elaborated.

### **Powertrain noise**

Body conducting the research: Marcus Wallenberg Laboratoriet för Ljud och Vibrationsforskning, Inst. för Farkost och Flyg, KTH

Project duration: 2005-2008

## *a research programme on emissions*

For road traffic in cities and areas where the speed is less than 70 km/h the power train is the dominating source of noise. This is in particular the case during acceleration (intake/exhaust noise) and at low speed and stand still when cooling fan noise increases significantly. The trend to enclose different noise sources on vehicles will increase the importance of aerodynamic noise from the intake/exhaust system and the cooling fan. The main objective of this project is to investigate and develop more efficient solutions for these systems that can meet stricter noise regulations combined with demands on reduced weight/volume and emission of fibers.

The expected main results of this combined research and development project are:

- improved methods for acoustic design of compact intake systems based on source data for engines coupled to linear acoustic models;
- new solutions for “compact mufflers” for active control of low frequency exhaust noise;
- new solutions for damping of air-borne sound based on non-fibrous materials, e.g., micro-perforated panels with application to cooling fans and mufflers.

### **Nanoparticles from tyre- and road wear?**

Body conducting the research: VTI

Project duration: 2005-2007

In experiments where wear particles from tyre and pavement have been studied, it has been shown that a very small (a few tens of nanometres) fraction of particles is formed. Coarser particles are formed almost exclusively when using studded tyres, but this fine fraction seems to appear to an equally great extent when friction winter tyres are used. Since research has shown that smaller particles seem to be stronger related to some health effects than coarser particles, it is important to study the source and formation of these nano-particles.

The aim of this project is to

1. study different tyres types' generation of nano-particles during wear on a single pavement
2. study these particles physical and chemical properties and relate them to tyre properties like friction, pattern and construction
3. identify the particles' occurrence in a street environment
4. calculate particle emission factors and test these in a dispersion model.

### **Determination of noise emission from heavy lorries for use in new prediction methods**

Body conducting the research: SP Sveriges Provnings- och Forskningsinstitut

Project duration: 2005

The project aims to validate and improve the source model for propulsion noise from heavy vehicles developed within the frame of the European HARMONOISE project. The project is performed as cooperation between SP and Volvo Trucks. Measurements will be performed on trucks in different driving situations that partly are not yet included in the HARMONOISE model. These data will be used to adapt and to develop the calculation model to new situations.

The project results in new possibilities for better optimisation of noise reduction on trucks or along the propagation path truck – receiver (=annoyed person) and additionally, to more accurate calculation of road traffic noise in general and of maximum sound pressure levels indoors in particular.

### **Valuation of ecosystem effects of emissions from road transports**

*a research programme on emissions*

Body conducting the research: Centrum för miljöstrategisk forskning - fms, KTH  
Project duration: 2005-2006

In infrastructure planning, cost-benefit analysis is used, where environmental effects of traffic emissions are valued in monetary terms. Ecosystem effects from pollution is today valued by the cost of cutting down the emissions to a certain level. This project aims at estimating values for ecosystem effects of sulphur dioxide and nitrogen oxides based on available valuation studies using willingness-to-pay methods, so-called damage costs. The resulting values will then be compatible with the values for health effects from air pollution. The values are calculated using a new method for benefit transfer where a utility function is estimated from the results of WTP studies. Swedish studies will be used as far as possible. A comparison will be done between the new WTP-based and the avoidance cost-based estimates, as well as an analysis of the implications for their use. The results can be used in several environmental systems analysis tools, e.g. life cycle analysis, together with available values for health effects, either as monetary values or as unitfree weights.

**TESS – Traffic Emissions, Socioeconomic valuation and Socioeconomic measures**

Body conducting the research: VTI  
Project duration: 2005-2008

In TESS we will implement the approach for economic valuation that has been developed in the EU-funded ExternE-projects. The project will focus on particle emissions with local and regional impact. In part one we will investigate the relationship between exhaust particles and NO<sub>x</sub> to establish whether or not NO<sub>x</sub> can be used as an indicator for this kind of particles. In addition we will gather knowledge on the health impact of particles that are found in ambient air. The knowledge collected in part one will be an input into part two. In part 2 we will calculate the costs related to particles that local emissions (from traffic and other sources) generate on a local and regional scale using Stockholm as a case study. Based on the information on costs for various sources we will analyze what reductions measures are likely to be efficient from an economic point of view.

**Optimal national economic measures in order to reduce emissions from non-road mobile machinery**

Body conducting the research: Sveriges lantbruksuniversitet, institutionen för biometri och teknik  
Project duration: 2005-2007

The purpose of the present work is to, from a national economic perspective, derive the costs for different measures to reduce the emissions, both gaseous and noise, from non-road mobile machinery in Sweden.

For example, the amount of particulate matter in the exhaust can be substantially reduced by installing a diesel particulate filter on the vehicle while the amount of nitrogen oxides hardly is affected at all. Other measure such as replacement of whole vehicles or engine repowering affects both the fuel consumption and several pollutants at the same time. However, the investments related to these measures differ.

Within the project, the accumulated costs for different measures will be calculated and related to the achieved reduction in emissions. Furthermore, the most cost effective methods to reduce a defined amount of emissions will be studied and how those solutions are influenced by the time period studied and different pollutants attributed.

## **Minimization of emission from heavy duty vehicles by information enabled**

Body conducting the research: Volvo Technology AB

Project duration: 2005-2008

The project will investigate the potential of decreasing the emissions of carbon dioxide and other emissions (including noise) for heavy duty vehicles by using information enabled control. External information may be given in the form of geographic positioning by GPS, traffic information or by sensors on the vehicles. Data may also be collected on the vehicles during normal operation for use in estimating future events.

The first part of the study will estimate the potential for several different systems, such as diesel hybrid vehicles, exhaust aftertreatment systems and auxiliary systems on the vehicle. The main part of the study will make a more detailed analysis on the most interesting applications. In addition to estimating the potential for information enabled control, the project will also produce guidelines and algorithms for implementation in a vehicle. The project will also develop tools for simulation in cooperation between the university and industry.

## **Emission, dispersion and health effects of air pollutants and community noise in Scania - an integrated study on road-, railway-, air- and sea traffic and industries**

Body conducting the research: Avd för Yrkes- och miljömedicin, Lunds universitet

Project duration: 2005-2008

The use of geographical information system (GIS) is central in this project. Detailed emission databases are used for modelling of exposure to air pollutants and noise from various sources – road traffic, railway, air and sea transport, industry for the total population in Scania. The covariation between these emissions and socioeconomic and sociodemographic factors is described.

Epidemiologic studies focusing on respiratory and cardiovascular disease (mortality, morbidity) and complaints and disturbances are performed. Dose-response relationships are evaluated.

Indoor and outdoor measurements are performed for validation of the modelled exposures. Empirical data obtained within the project are used for development of GIS and epidemiological methods within environmental medicine. The cost of illness in Scania due to traffic is calculated.

## **Comparing health effects due to local and regional pollution in Stockholm**

Body conducting the research: ITM Stockholms universitet

Project duration: 2005-2007

More and more studies confirm the strong link between people's health and particulate matter in ambient air. But there are a number of questions that need answers in order to identify the most efficient abatement strategies to reduce health effects.

This project focus on the difference in health effects due to locally (fresh) generated particles compared to secondary particles (from long-distance transport). The analysis will also include other air pollutants like ozone, to see if air pollution episodes with a certain mix are more toxic than others. In Stockholm we have unique possibilities to study this problem since the long-distance episodes are relatively easily identified and appear frequently throughout the year, but with quite different relations between different pollutants.

*a research programme on emissions*

The project is a co-operation between Stockholm university, the Karolinska institute, Environment & Health Protection Administration of Stockholm and Swedish Meteorological and Hydrological Institute.

**Traffic related particles relative and absolute impact on quantifiable health endpoints**

Body conducting the research: Umeå universitet  
Project duration: 2005-2006

The aim of the project is to quantify exposure-response functions for several specific particle indicators, including black carbon ("soot") and different well defined health endpoints using time-series analysis. These analyses will be performed with a uniform approach and focus on the Greater Stockholm population to achieve comparability. The project will also estimate impact in terms of cases per year that can be attributed to different types of particle pollution such as vehicle exhaust particles, road dust and secondary PM, using new indicators. We also intend to develop easy-to-use tools for health impact assessment. As a basis for the epidemiological analyses we will use air pollution data with different spatial resolution. The aim is to build a 5 year long database with air pollution data that can be used to evaluate the exposure-response relationships due to local traffic related particles and regional secondary pollution. Especially the associations with particulate carbon will be studied in more detail. The importance of vehicle exhaust, domestic wood burning and long-range transport on carbon levels will also be evaluated. Another objective is to evaluate how black carbon (BC) correlate with NO<sub>x</sub> and particle number concentrations (PNC), in order to do retrospective modelling as have been done in the PASTA-project for PNC, and to better understand causality in the exposure-response relations found in epidemiological studies.

**Determination of highly carcinogenic dibenzopyrenes in vehicle exhausts**

Body conducting the research: Stockholms universitet, Institutionen för Analytisk kemi  
Project duration: 2005

The aim with the project is to develop a chemical method for identification and determination of highly carcinogenic dibenzo(a,l)pyrene and dibenzo(a,h)pyrene in particulate emissions from vehicles.

**Cardio-vascular and respiratory effects of vehicle exhaust**

Body conducting the research: Umeå Universitet  
Project duration: 2005-2008

The present research project is based upon almost two decades of experimental air pollution research. The long-term intent is to increase the detailed knowledge of adverse health effects of engine exhaust and other types of air pollution.

In the present programme the investigators intend to further characterize the biomedical effects of new and older diesel engine technology during different running conditions. The efficacy to intervene with exhaust particle filters is studied. Interactive effects of the common air pollutant ozone with that of diesel exhaust are characterised.

In order to increase the understanding of health effects associated with diesel engine exhaust, additional studies are performed on the local vascular and respiratory effects, through sampling locally within the organ systems. Detailed mechanistic studies are included to learn further on by what means exhaust is initiating and propagating adverse biomedical events.

## **Interaction between noise and air pollution from road traffic for development of myocardial infarction**

Body conducting the research: Institutet för Miljömedicin, Karolinska Institutet

Project duration: 2005-2007

Buller och luftföroreningar från vägtrafiken är utbredda miljöproblem som berör ett stort antal människor, särskilt i tätorter. Under senare år har misstankarna stärkts att exponering för buller och luftföroreningar kan påverka hjärt-kärlsystemet. Underlaget är dock osäkert då det gäller hjärtinfarkt, som är den vanligaste dödsorsaken i vårt land. I projektet studeras samverkans effekter mellan buller och luftföroreningar från vägtrafiken vid uppkomst av hjärtinfarkt. I studiepopulationen ingår 1600 fall av hjärtinfarkt och drygt 2100 kontrollpersoner från Stockholms län. En mycket detaljerad kartläggning görs av exponering för buller och luftföroreningar vid undersökningspersonernas bostäder under flera decennier. Information om andra riskfaktorer insamlas via enkät. I analysen kommer eventuella effekter av buller och luftföroreningar att särskiljas och samverkans effekter kommer även att belysas. Studien är den första i sitt slag i världen och resultaten kan få stor betydelse för riskbedömningen.

## **Reduction of exterior noise from diesel propelled passenger cars**

Body conducting the research: Saab Automobile AB

Project duration: 2005-2008

The objective with the work is to develop methods for reducing radiated sound power from powertrain and driveline including intake and exhaust systems for diesel propelled passenger cars.

This requires;

1. An increased understanding of the influence of absorbents and shields in engine compartment/bay with respect to effects for external noise (primarily high frequency combustion and transmission noise).
2. A comprehensive understanding of basic physical phenomena of noise sources and propagation of noise in intake and exhaust systems (low frequency order noise and high frequency flow noise).

Measures will be used to show the potential of noise reduction of diesel propelled vehicles in urban environment.

The project focuses also on establish and develop applied experimental and virtual competence and methods based on the physical phenomena of powertrain and driveline related noise sources including intake and exhaust systems as well as propagation of noise in engine compartment/bay to external receivers. In addition, the development tools and methods used in industry will be improved. These objectives will be reached by using frequency response function based sub-structuring technique on a system level, while in the case of high frequency engine noise apply the usage of statistical energy analysis (SEA) and in the case of intake and exhaust systems apply advanced CFD methods on typical complex three dimensional topologies. The results will be transferred into sub models for direct usage in state of the art industrial development tools. The developed models will then give increased possibilities to quickly examine different measures to reduce radiated sound power from primarily powertrain and driveline but also from intake and exhaust systems for diesel as well as petrol propelled passenger cars. It should be emphasised that the final solution is a compromise between many engineering disciplines where NVH is one.