chromium (CrR, CrU), and chromium in whole blood and in erythrocytes (CrBl, CrEry) in welders.
Methods Respirable welding fume was collected in 241 welders during a working shift. Blood samples and spot urine samples were collected after the working shift. The content of CrR in the welding fume was determined using inductively coupled plasma mass spectrometry. CrU, CrBl and CrEry were measured by means of graphite furnace atom absorption spectrometry. Linear regression models were applied to model exposure to chromium. A multiple imputation approach was chosen to account for values below the limit of quantitation (LOQ).
Results Median concentrations of CrR were <3.80 g/m^3, with about 23% below LOQ. Major determinants of the CrR were the chromium content in the electrodes or base material in addition to the type of welding. Airborne exposure was higher when welding was performed under inefficient ventilation. CrR correlated strongly with CrU (Pearson's correlation r = 0.61). Median concentrations of CrU were <1.20 g/m^3, and 44% of CrU measurements were below LOQ. CrU exposure decreased by a factor of 0.66 when a respiratory mask was used. Most measurements of CrBl and CrEry were below LOQ. All 15 welders with a measurable concentration of CrEry had high chromium contents in the materials (above 5%).
Conclusions CrR was mainly influenced by the chromium content in the materials and the welding process. Welding in confined space increased exposure to CrR. Efficient local exhaust ventilation and the use of respirators decreased exposure. Airborne Cr concentration was a good predictor of urinary Cr exposure.

236 AIR MEASUREMENTS OF BENZENE AND OTHER ORGANIC COMPOUNDS IN THE NORWEGIAN PETROLEUM INDUSTRY 2007–2009: A REVIEW OF INDUSTRIAL HYGIENE REPORTS

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Objective Description of current exposure levels of benzene and other organic compounds among workers in the petroleum industry.
Materials A total of 2578 air measurements taken by 12 oil - and service companies were evaluated and summarised in a database. The data includes personal full-shift samples and measurements on specific tasks.
Results Most samples were from offshore installations (70%). 93 chemical agents were detected in the samples. Of these, 11 agents were measured in 100 or more samples including aromatic hydrocarbons (benzene n = 853, toluene n = 1014, xylene isomers n = 987, and ethylbenzene n = 939) and alkanes (n-hexane n = 856, oil vapour n = 130, oil mist n = 132). 66% of the chemical agents were measured in less than 11 samples. In total, 299 work tasks were described in the reports.

Generally, personal exposure levels of full-shift samples of benzene (median = 0.005 ppm), toluene (median = 0.005 ppm), ethylbenzene (median = 0.001 ppm), xylene (all isomers) (median = 0.005), and n-hexane (median = 0.003) were low compared to Norwegian 12-hour time-weighted average occupational exposure limits of 0.6 ppm, 15 ppm, 3 ppm, 15 ppm, and 12 ppm, respectively.

The highest personal air levels were reported when performing tasks such as cleaning of tanks, opening of processing units, changing of filters, and sampling from the petroleum stream.

Conclusion Although much of the monitoring data has been conducted for control evaluation and compliance, they provide a basis for industrial hygienists and exposure assessors to identify work tasks and jobs where exposures are likely, and provide an overview of current exposure levels. This work also shows that for most agents the exposure data is extremely sparse and therefore there is a need to measure chemical exposures in this industry.

237 THE WHAT-ME STUDY: RELATIONSHIPS BETWEEN WORK PRACTICES AND URINARY METAL CONCENTRATIONS AMONG WOMEN WORKING IN NON-TRADITIONAL TRADES

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Objectives The WHAT-ME cohort is a prospective study of reproductive health among Canadian women in non-traditional trades. The goal of this sub-study was to investigate associations between the exposure questionnaire and urinary metal concentrations.
Methods Women registered in welding, boilermaking, steam fitting/pipefitting ('welders') or electrical trade apprenticeships since 2005 were invited to join the cohort. Participants in the Alberta sub-study mailed-in a urine sample at 6 months. Correlations between urinary metals (by ICP MS) were investigated and principal components extracted. Relationships between individual metals, component scores and work practices (from exposure questionnaires at 6 months) were investigated.
Results 183 urine samples were collected. Analysis was limited to 108 subjects (57 welders, 51 electricians) who had completed trade-specific work since enrolment. Smokers (38%) had significantly higher urinary concentrations of cadmium, cobalt and lead. Metal concentrations were more strongly correlated in welders than electricians. In welders, the first principal component explained 46% of the variability in metal concentrations but for electricians only 23%. Geometric mean of each of the 12 metals measured was higher for welders than electricians: only chromium reached significance (0.51 vs. 0.16 ug/g-creatinine, p<0.001). Among welders, tungsten inert gas (TIG) welders tended to have lower metal concentrations while those doing manual metal arc welding had significantly higher zinc concentrations ($p < 0.05$). Preliminary analyses of work practices suggest that both personal protective equipment and local exhaust ventilation were related to urinary metal concentrations; supplementary analyses will also include data on consumables and base metals.
Conclusions Urinary metal concentrations tended to be higher and more strongly correlated among welders compared with electricians. Welding tasks, materials and controls associated with urinary metal concentrations will guide strategies for exposure reduction in the welding trade.

238 STATISTICAL MODELLING OF PM10 AND PM2.5 EXPOSURES IN POULTRY BARNS, AND EVALUATION OF ELECTROSTATIC PRECIPITATORS TO CONTROL PARTICULATE EMISSIONS

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Objectives Particulate concentrations within poultry barns pose a potential occupational and environmental health concern. We

aimed to identify determinants of PM_{10} and $PM_{2.5}$ levels in poultry barns and evaluate the effectiveness of electrostatic precipitators (ESP) to reduce environmental air pollution.
Methods PM_{10} and $PM_{2.5}$ Harvard impactor samples were collected in "side-by-side" barns (one with an ESP, one without) at five poultry farms in British Columbia, Canada from 2008 to 2012. Measured particulate levels were analysed using multimodel inference and linear mixed-effects models after log-transformation. Random effects were added to account for clustering within farms, barns, and rearing cycles.
Results A total of 234 $PM_{2.5}$ and 230 PM_{10} valid samples were modelled. Geometric means of $PM_{2.5}$ and PM_{10} were significantly lower in barns with ESP control in place (151 and 427 g/m^3, respectively) compared to barns with no control (334 and 969 g/m^3), resulting in unadjusted % reductions of 47% and 50% respectively.

In statistical models, the fixed-effects explained 57% and 72% of the total variance in the $PM_{2.5}$ and PM_{10} measurements, respectively. The residual (i.e. within rearing cycle) and between rearing cycle variance were the most affected by adding the fixed effects structure. Strongest determinants in the models for both dust types were ESP use (i.e. approximately halving particulate levels for both $PM_{2.5}$ and PM_{10}), bird age (i.e. 10–30 fold increase in particulate levels depending on bird and particulate type), and type of bird (i.e. approximately a 2.5 fold increase for $PM_{2.5}$, and four fold increase in PM_{10} for turkey compared to chicken). Interactions were suggested in PM_{10} models between type of bird, bird age, and ESP use.
Conclusions The use of ESP resulted in significant reductions in in-barn particulate even after controlling for other determinants such as bird age, type of bird, ventilation, and date.

Session: 3. Electro magnetic fields and health

239 MEASUREMENTS OF OCCUPATIONAL EXPOSURE TO EMF EMITTED BY HIGH-SPEED MAGLEV TRANSPORTATION SYSTEM AND ITS HEALTH EFFECTS

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Objectives High-speed Maglev transportation system is an advanced technology using magnetic forces to propel, levitate, and guide the trian. Our study was to assess the EMF emitted by High-Speed Maglev Transportation System and the possible health effects of occupational exposure to the Maglev EMF.
Methods The static magnetic field of Maglev were measured by Narda ETM-1 magnetic field measurement system. The time-varying EMFs of Maglev were evaluated by PMM8053 EMF measurement system. 48 employees exposed to maglev EMF were selected as occupationally exposed group while 54 employees without any Maglev EMF exposure were selected as control. Questionnaires were sent to two groups. Complete blood count was done by haematology analyzer. Blood lipid level was detected by enzymatic method. Thyroid function related hormones was evaluated by chemical immune assay. Serum melatonin level was measured by an ELISA kit.
Results EMF strength of all Maglev sites was lower than the safety exposure limits of current international and Chinese national standard.

The symptoms of drowsiness, memory impairment, irritability, alopecia were related to occupational exposure to maglev EMF. Abnormal rate of cholesterol and high density lipid protein in exposed group were significantly higher than control. The blood cell counts, thyroid function, and serum melatonin level had no statistical difference between two groups.
Conclusions EMF emitted by the High-speed Maglev transportation system in different frequencies were lower than the exposure limits of current international and Chinese national standard.

Due to the population limits, we can not draw a conclusion that occupational exposure to Maglev EMF may have adverse health effects from the previous data. However, it may gives us a clue that occupational exposure to maglev EMF may result in the alteration of neuronal function and lipid metabolism.

240 NO INFLUENCE OF MAGNETIC RESONANCE IMAGING SCAN ON MALE REPRODUCTIVE HORMONES

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Objectives To investigate if magnetic resonance imaging (MRI) influences male reproductive hormones. The use of MRI is increasing around the world and the possible adverse effects on reproductive health of electromagnetic fields (EMF) in MRI are not previously studied. Previous articles have suggested that radio frequency (RF) electromagnetic fields may influence on male reproductive hormones follicle stimulating hormone (FSH) and luteinizing hormone (LH), and that this may cause reduced sperm quality.
Methods A randomised balanced cross-over study using real and sham MRI scan among 24 healthy male volunteers were conducted. Serum-blood samples of Inhibin B, testosterone, LH, FSH, sex-hormone binding globulin, oestrogen, prolactin and thyreotropine were taken immediately before and after the different scans and at a control session without any scan. Questionnaire data was gathered regarding possible confounding factors among the participants at each session. The RF EMF exposure caused by the MRI scanner was described as RF estimates for each sequence driven during the scan.
Results When investigating the hormone levels immediately before and immediately after the scan we found no differences, neither in the MRI scan setting nor in the sham setting. We also investigated if the hormones changed differently in the MRI setting versus the sham setting, but found no differences. We could neither find an effect after 11 days, which was the average number of days between the different sessions.
Conclusion EMF exposure during a MRI did not cause changes in male reproductive hormones. Adverse effects on other endpoints than male reproduction or possible chronic effect of multiple MRI scans have not been investigated in this study. To evaluate this, further studies should be carried out.

241 OCCUPATIONAL EXPOSURE TO EXTREMELY LOW FREQUENCY MAGNETIC FIELDS AND BRAIN TUMOURS IN THE INTEROCC STUDY

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