and increases the risk of accidents. This study aimed to quantify the problem of cold hands in Arctic open pit mines.

Methods The questionnaire study was carried out in four open pit mines in Russia, Finland, Sweden and Norway. Moreover, skin temperatures as well as thermal sensations were recorded in Kevitsa (Finland) and Aitik (Sweden) open pit mines among 14 male and 2 female mine workers with duties consisting mainly of outdoor work.

Results The questionnaire study (n = 1323) revealed that experienced cold problems were negligible at ambient temperatures above −10 °C. However, at −10 – −20°C, 25% of workers estimated that their prevailing thermal sensation was "cold". Skin temperature measurements showed that finger skin temperatures were below 15°C (a threshold for sharp performance decrement) for 21% of the working time.

Conclusions The questionnaire study and skin temperature measurements suggest unequivocally that hands/fingers are so cold that manual performance is markedly decreased in more than 20% of workers/working time. Such a decrease in manual performance increases the risk of accidents. It should be noted that during the skin temperature measurements ambient temperature was never below −16°C. Improved cold protection should be directed to cold sensitive workers and tasks especially at ambient temperatures below −10°C.

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393 THERMAL AND VISUAL PROBLEMS WHILE USING FAN-ASSISTED RESPIRATOR IN THE COLD

[1]Sirkka Rissanen, [2]Merethe Larsen, [2]Eva Kramvik, [2]Morten Skandfer, [1]Satu Mänttäri, [1]Hannu Rintamäki. *[1]Finnish Institute of Occupational Health, Oulu, Finland; [2]University Hospital of Northern Norway, Tromsø, Norway*

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Background Respirators protecting against airborne particles and gases are also needed in cold environments. However, low temperature causes special problems such as freezing of exhaled moisture in the respirator, increases respiratory resistance and hampers communication. Fan-assisted respirators aim to solve the problem of respiratory resistance. However, there are a lot of complaints that the high and continuous air flow inside the face shield cools the face and eyes. This study aims to quantify the cooling problem and seeks solutions.

Methods Fan-assisted respirator with the face shield together with the battery-powered fan and filters was used. Air flow rates were 170 and 240 l/min. Exposure temperatures were −10, −20 and −30°C. Under the face shield the face skin was either unprotected or protected by a facemask (balaclava with a ventilator). Five male volunteers participated in the study. Face skin temperatures were measured at forehead, cheek, nose and lower lip. In the exposure temperature the subjects were standing, stepping and lifting for altogether 30 min.

Results Face skin temperatures were between 5 and 17 °C and thermal sensation was "cold" without the facemask. While the facemask was used skin temperatures were between 17 and 30 °C and thermal sensation was "slightly cool". Fogging of the visor started from the sides in 10 to 15 min (exercise started) and humidity started to freeze soon after, regardless of the use of the facemask.

Conclusions The flow of air inside the fan-assisted respirator decreased skin temperatures to uncomfortable level within 5 −10 min without the facemask. The lowest temperature was measured in the lower lip. The use of facemask kept the skin temperatures in comfort/acceptable level. Freezing of exhaled moisture in the face shield was a marked problem without and with the facemask. It seriously restricted the eyesight causing a critical safety issue. Further development is needed for the respiratory protection in the cold.

394 SMART PROTECTIVE SOLUTIONS FOR WORK IN THE COLD

Kirsi Jussila, Sirkka Rissanen, Hannu Rintamäki. *Finnish Institute of Occupational Health, Oulu, Finland*

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Background Human and industrial activities are increasing in the Arctic. Several countries are involved in Arctic business e.g. through oil and gas, mining, fisheries, tourism, as well as technology suppliers and developers for those fields. Year-round activity in the area involves challenging climate for the industries as well as workers' performance and occupational safety. In the cold, thermal comfort, work capacity and productivity decrease and the risk of mistakes, errors and accidents increase. Peripheral or uncovered body parts, like hands, are the first to cool when humans are exposed to cold resulting in reduced manual and psychomotor performance.

Recently started SmartPro-project (Smart protective solutions for industrial safety and productivity in the cold) aims to assure productivity and occupational safety in cold by developing proactive auxiliary heating solutions for protective clothing and gloves.

Methods The project is organised in three work packages (WP). WP1 develops an algorithm for monitoring cold stress for workers, WP2 creates novel gloves which have new design and optimal thermal insulation supported by auxiliary smart heating system, and WP3 is for project management and dissemination.

Results This project will develop novel solutions for interactive heating systems for the hands and early warning systems of critical levels of cold. Smart solutions, such as wireless sensors, wearable computing and auxiliary heating together with material solutions, will be integrated into a protective workwear jacket and novel designed gloves.

Conclusions The SmartPro-project will lead to smarter and safer work in several industries, where workers are frequently exposed to harsh weather environment. Integrating wireless sensors in protective clothing and gloves will provide, together with the knowledge from the thermal environment, an early warning mechanism of critical level of cold exposure on work site and on an individual level in real time.

395 WINTER TYRE TYPE AND TRAFFIC SAFETY

[1]Mikko Malmivuo, [2]Juha Luoma, [2]Heikki Kanner. *[1]Innomikko Ltd, Finland; [2]VTT, Finland*

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Background The winter tyre type have various effects on traffic safety. These effects have been analysed in three separate studies published between December 2014 – December 2015.

Methods The main questions of the 3 studies were a): what's the safety difference between studded tires and studless tires and b) how can we promote traffic safety connected to winter tires? The

study number 1, "Studded and studless tires in fatal wintertime road accidents" was based on accident data analysis. The study 2, "The socio-economical consequences of Ice grip approval" was based on literature analysis. The study 3, "The winter tyre type effects on the grip and wear of packed snow and ice" was a field test study.

Results

- In Finland, 12% of the traffic exposure of passenger cars and vans in winter is driven by studless winter tires. If everyone in Finland would use studded tires, we would have one deadly accident per year less.
- There is no ice grip demands for the winter tires used in Finland. If such demand will be deployed today, there will be 0.5 million € yearly societal savings per year. If the use of studless tires increase as planned, the effects of ice grip approval will be multifold.
- Studded tires have an external safety effect, they make ice more rough. According to tests in test field, 50% of studded tires ensured good friction conditions for all kind of winter tires.

Conclusions Use of studded tires offer still remarkable traffic safety benefits in winter time. Because there seem to be need to decrease the proportion of studded tires in large cities (studded tires may promote air quality problems), it's still important to understand, how we can minimise the negative traffic safety effects of this decrease. By deploying ice grip demands, we can be assured, that the approved studless tires meet the winter traffic demands. It's also important to remember, that if the proportion of studded tires will fall below 50%, there is high risk for increasing slipperiness.

396 ACCEPTANCE AND IMPACTS OF A REAL TIME REINDEER WARNING SERVICE

Elina Aittoniemi, Pirkko Rämä. *VTT Technical Research Centre of Finland*

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Background About 4000 reindeer die each year in traffic, causing significant costs. This study investigated the acceptability of a real-time reindeer warning service and its potential impacts on driver behaviour, foresight and traffic safety.

Methods Professional heavy goods vehicle drivers participating in the field test on two main roads in Northern Finland received real time warnings based on sightings of reindeer on or near the road. The information was provided by the same group of drivers and a group of reindeer herders.

The warning system was a simple smart phone application and was designed to be easy to use. When a driver saw reindeer near the road, he touched a circle on the screen of a smart phone installed in their vehicle, sending the warning to all nearby drivers using the application. The warnings were in effect within an area of radius 500 m from the initial warning for the following 2–4 hours.

Results The impacts of the service were evaluated by driver questionnaires and interviews. The drivers were interviewed twice, after about 6 and 12 months use of the service. 23 drivers participated in the interviews. In addition, also driving companies, reindeer herders and other stakeholders and experts were interviewed. The majority of drivers assessed the service useful. They especially liked the possibility to foresee unexpected situations. Drivers valued service simplicity. It was estimated that, if installed in every vehicle, the service could lead to a decrease in reindeer accidents by 9.7–17.8%, corresponding to a reduction of 395–725 accidents annually. Regarding all injury accidents in the area, the service was estimated to cause a reduction of 0.76–1.52% corresponding to 2–4 injury accidents annually.

Conclusions The service worked well and was well received by its users. The results of the trial were promising.

397 SNOWMOBILE-RELATED INJURIES IN U.S. EMERGENCY DEPARTMENTS 2001–2013

Christopher Peterson, Charles Jennissen. *Department of Emergency Medicine, University of Iowa Carver College of Medicine, USA*

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Background Snowmobiling is a popular form of winter recreation, but adverse events can lead to significant injury. Our objective was to determine the demographics and risk factors for snowmobile-related injuries seen in Emergency Departments (EDs).

Methods ED visits related to snowmobile operation were identified in the National Electronic Injury Surveillance System (NEISS) database, which collects information from a national probability sample of U.S. hospitals. Descriptive and statistical analyses were performed.

Results From 2002–2013, 1,944 snowmobile-related injuries were identified in the NEISS database. This corresponds to a national estimate of 135,032 snowmobile-related ED visits during the study period. There was a trend of decreasing injuries over time with a national estimate of 12,862 in 2002 and 9,270 in 2013 (average decrease of 499 per year, 95% CI: 89.9–907.7). Most commonly injured were 19–29 year olds, accounting for 30% of the total; 19% were paediatric patients. About three-fourths were male. The most common mechanisms of injury involved falling off (22%), striking a stationary object (16%), and rolling the vehicle (13%). Mechanisms that had the greatest admission rates included events involving a drop-off (50%), ejections (25%) and motorised vehicle collisions (22%). Helmets were reported as being used in 11.4%. Patients wearing a helmet had a 63% reduced odds of requiring inpatient admission compared to those without ($p = 0.03$). Speed was reported in only 7% of cases. A higher proportion of those operating at speeds estimated $\geq$35 mph were admitted (24%) as compared to those with lower speeds (15%).

Conclusions Snowmobilers without helmets were more likely to require hospital admission. Snowmobilers should be especially wary of terrain changes, other vehicles in the area, and being ejected, as these mechanisms had injuries requiring higher rates of inpatient treatment.