Sustainability of miners' well-being, health and work ability in the Barents region

GUIDEBOOK ON
COLD, VIBRATION, AIRBORNE EXPOSURES AND SOCIOECONOMIC INFLUENCES IN OPEN PIT MINING

MineHealth

Sustainability of miners' well-being, health and work ability in the Barents region – a common challenge

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COLD, VIBRATION, AIRBORNE EXPOSURES AND SOCIOECONOMIC INFLUENCES IN OPEN PIT MINING

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PREFACE

Airi Paloste & Ahti Rönkkö

The Barents region has a wealth of natural resources that have fostered its growth and development. In the past, the discovery of these resources resulted in major population migration and rapid growth for formerly remote regions of the countries. Mining continues to provide the foundation for local economies in a manifold of areas.

The rapid growth of the mining industry is a challenge since it is hard to get enough skilled workers. The demographic change in the Barents region is similar to change in the whole Europe with a decreased proportion of the population available in the labour market. It has been expected that this will not automatically and in the short run result in a shrinking workforce, because at the same time, female employment rates as well as the employment rates of older workers are expected to rise. In recent years mining work has been marketed more to females, resulting in an increased number of females working especially in the Swedish mines. The increasing numbers of females in the mining sector influences the work communities in many ways.

Extraction of the resources and finding new deposits are the tasks of the mining industry. The metal ore mining industry segment covers the extraction of metal ores, primarily nickel, gold, silver, iron, copper, lead, chromium and zinc. The non-metallic mineral mining and quarrying industry segment covers a wide range of mineral extraction like phosphate minerals, especially apatite. Mining techniques can be divided into two common excavation types: surface mining and sub-surface (underground) mining. Heavy machinery is needed in mining to break and remove rocks of various hardness and toughness. Today, huge trucks, excavators, bulldozers and drills are employed in the mining industry.

In developed countries, the close links between the work environment and sustained human health is taken for granted. However, the mining industry is one of the most hazardous industries in the world and working as a miner is still associated with an increased risk of poor health, resulting in increased costs for companies and society. Examples of factors hazardous to miners' health are accidents, airborne exposure (such as radon, asbestos, silica dust, diesel exhaust) and physical exposure (for instance vibration, noise, cold and physical overload of the musculoskeletal system).

In this guidebook, the main focus is on cold exposure, vibration exposure, airborne exposure and their responses to miners' health and ways to prevent harmful effects. The wider socioeconomic effects of the mining industry and wellbeing of individuals and society are also briefly discussed.

◂ Boliden AB, Aitik Mine

ABOUT THE MINEHEALTH PROJECT

BACKGROUND

The Barents region has many natural resources that promote growth and development. New mines are opening in several locations, and old mines are being expanded or reopened. Working as a miner is still associated with the risk of poor health with individual suffering and increased costs for enterprises and society.

New topics and challenges are emerging in the mining industry in the region. Increased mining activity in the sparsely populated area is a challenge since it is hard to get enough skilled workers. Mines are increasingly recruiting females, raising gender-related issues in the mining industry.

AIMS OF THE PROJECT

The overall objective is to provide long-term sustainability of well-being, health and work capacity among workers in the mining industry. This is achieved by increased and updated knowledge of how to cope with the environment and to adopt preventive measures for working in the mining industry in the Barents region. The project includes several work packages. Learn more about them here.

FOCUS ON THE WORK IN THE ARCTIC ENVIRONMENT

The project focuses on the unique work environment of mining in the Barents region, which is characterised by work in cold conditions. The exposures to be addressed are cold, airborne dust, diesel exhaust, whole-body and hand-arm vibration, ergonomics and physical strain.

Information will be collected through work environment measurements, clinical examinations, interviews, questionnaires and physiological measurements, clothing and ergonomic evaluations as well as from experimental laboratory studies.

IMPACT ON WORKERS, INDUSTRY AND SOCIETY

The project will address the impact of the mining industry on the local societies, employment rate, income, the environment, young employees, the indigenous people and gender issues.

The studies give possibilities to compare different mines, regions and countries and show the possibilities to implement a good socio-economic practice in the local community.

◂ Boliden AB, Aitik Mine

▼ Sternøya, Norway

A challenge for the mining industry in northern regions is to attract skilled workers, who use safe working practices. One way to achieve safe working practices is to provide training material for continuous learning in occupational safety and health related to mining work.

PUTTING THINGS INTO PRACTICE

The outcome will include learning material and education plans/programmes as well as technical and administrative actions and optimisation of arctic miner's clothing and personal protective equipment. The outcome from the project will also have relevance outside the Barents region, as in other mining communities in the circumpolar region. The outcome is aimed at promoting well- being, work capacity and health and preventing sick leave. Consequently, the outcome can lead to lower costs for enterprises and society, and increase productivity and profitability in the mining industry in the Barents region.

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RISK MANAGEMENT IN THE MINING INDUSTRY

Ahti Rönkkö

The mining industry is more dangerous and unhealthy than other industries. Globally this is true, but in Nordic countries, for example, accident frequencies in the mining industry are on average lower than in all the industry sectors.

▲ Loading ongoing

▲ Loader at work in cabin

"Working conditions in mines can be unusual and sometimes dangerous. Workers in surface mines are subject to rugged outdoor work in all kinds of weather and climates, though some surface mines and quarries shut down in the winter because snow and ice covering the mine site make work too dangerous. Surface mining, however, is usually less hazardous than underground mining. In underground mining operations, unique dangers include the possibility of cave-in, mine fire, explosion, or exposure to harmful gases. In addition, dust generated by drilling in mines still places miners at risk of developing either of two serious lung diseases: pneumoconiosis, also called "black lung disease," from coal dust, or silicosis from rock dust. These days, dust levels in mines are closely monitored and occurrences of lung diseases are rare if proper procedures are followed."

In Nordic countries and Northwest Russia, coal mining does not exist, so the accident situation is better but other mining risks such as noise, vibration, dusts, gases, PAH, climate conditions, darkness, poor ergonomy and rock falls are about the same globally.

◂ Boliden AB, Aitik Mine

▼ Cleaning the tunnel from falling rocks

BASIC OSH MANAGEMENT PRINCIPLES IN THE MINING INDUSTRY

These principles are of course much the same in all the industrial sectors. Special concerns compared with other sectors concern working underground (both physical and mental stress and working alone), working in coal mines (underground and open pits), working outdoors in a cold arctic climate, asbestos and siliabout Special problems in OSH are connected with co-operation between the mining company, contractors, subcontractors and others involved. Problems like lack of information between partners, lack of competence, equipment and PPEs, and problems in the supervision of work and discipline can of course be solved but this needs patience and continuous work. If a good level is reached, maintaining it needs continuous work from all partners but especially from the mining company with overall responsibility.

▸ Drill rig

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Boliden AB, Aitik Mine
Typical open pit mine terrace

IMPORTANT TO KEEP IN MIND

Employer's genuine commitment to OSH

- CEO's role is crucial

OSH policy definition and commitment to it

- employer's responsibility but employees should be involved in the early stage

Goals or/and tasks in OSH should be clearly defined

- there is a discussion of whether numerical goals are needed in OSH
- however the real tasks to improve conditions are important and they will achieve good results sooner or later
- at the bottom high quality and up-to-date RA are needed
- clear prioritising after RA is needed and the focus must be on basic things
- in mining work, OSH must be understood as basic vocational skills in all tasks

Good and real co-operation between the mining company and contractors as well as between employer and employees

- clear contracts between partners
- definition of responsibilities
- positive discipline is always needed

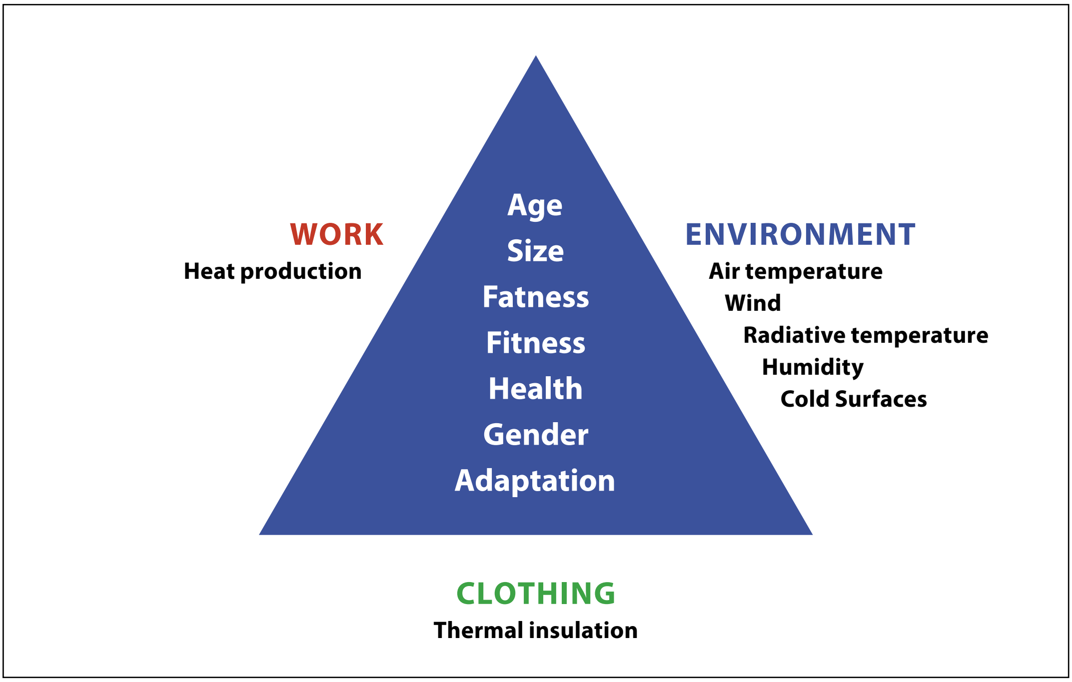

0
°C

COLD

*Hannu Rintamäki, Juha Oksa, Kirsi Jussila,
Satu Mänttäri & Sirkka Rissanen*

Winter (daily average temperature below 0 °C) is the longest season in the Barents region. For example, in Northern Finland the length of the winter is 150-200 days per year. The limit of cold work is considered to be +10 °C, below which fingers start to cool in light work.

The cooling of the human body depends not only on ambient temperatures but also on clothing (thermal insulation between the skin and environment) and physical activity (producing heat which replaces the heat lost to the environment).



Components of body heat balance.

▼ Checking the drill holes before charging in Kevitsa

Weather forecasts and cold warnings: national meteorological institutes provide local weather forecasts, which are useful for the planning of work.

A cold environment (low temperature of air) increases heat loss, which cools the body. Wind is the worst companion of cold air, because the movements of cold air increase heat loss by carrying away warm air from the skin and clothing and replacing it with cold air. Wind chill index (WCI) describes the combined effect of cold and wind, as shown in the figure.

Also contact with cold objects, especially metal surfaces, greatly increases the risk of frostbite, because local heat loss can be extremely high in contact cooling.

At work, cold also affects machines, materials and tools. Moreover, ice and snow increase the risk of slipping. Walking on snow markedly increases energy consumption compared to walking on solid ground.

Wind, m/s	Air temperature, °C 0	-5	-10	-15	-20	-25	-30	-35	-40	-45
1	-1	-7	-12	-18	-23	-29	-34	-40	-45	-51
2	-3	-8	-14	-20	-26	-32	-38	-43	-49	-55
4	-4	-11	-17	-23	-29	-35	-41	-47	-54	-60
6	-6	-12	-18	-25	-31	-37	-44	-50	-56	-63
8	-7	-13	-19	-26	-32	-39	-46	-52	-58	-65
10	-7	-14	-20	-27	-34	-40	-47	-54	-60	-67
12	-8	-14	-21	-28	-35	-41	-48	-55	-62	-68
14	-8	-15	-22	-29	-35	-42	-49	-56	-63	-70
16	-9	-16	-23	-29	-36	-43	-50	-57	-64	-71
18	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72
20	-9	-17	-24	-31	-38	-45	-52	-59	-66	-73

Very cold — Risk of frostbite — Great risk of frostbite

Wind chill index

▾ Climbing into the truck

▾ Sternøya, Norway

HUMAN RESPONSES TO COLD

Exposure to cold stimulates the cold receptors in the skin. The message from the cold receptors is evaluated in the brains and, as a result of this interpretation, we get thermal sensations. At the same time, our behaviour and physiological responses are changed. The most important physiological effect is the dramatic reduction of circulation in the skin, arms, hands and fingers as well as in feet and toes.

The decrease in circulation aims to decrease heat loss and conserve a good temperature in the internal body parts. Unfortunately, at the same time the reduction in circulation speeds up the cooling of hands and feet. Therefore, good thermal protection of the body is needed in the cold to prevent the reduction in circulation.

Cold also increases blood pressure and therefore the work load of the heart. The cooling of the body also stimulates heat production by causing shivering and, at least in some persons, by brown adipose tissue. Shivering starts in the trunk muscles and may extend to the limbs, too, if cooling is severe.

At first the shivering is sensed only as an increased stiffness in the muscles but, in a more severe cooling, shivering becomes a visible tremor and shaking.

Physiological adaptation to cold takes about two weeks. Thereafter, cold is less stressful, and shivering starts later and is weaker. Moreover, circulation is reduced less in cold after adaptation. This particularly evident in the hands, which stay warmer in cold-adapted persons – “fisherman’s hands” are developed. Physiological adaptation to cold must be acquired at the beginning of every cold season, as it disappears in the warm season. The only permanent adaptation is experience and knowledge, which help a lot in observing correct behaviour in the cold.

In mining work, about 25% of workers generally experienced a cold thermal sensation in their fingers and toes at -20…-10°C, and 11% in the whole body. At higher temperatures, sensations of cold were very rare. The cooling of fingers takes about 30 minutes. When coming back indoors, rewarming took 20-30 minutes in fingers and toes.

▼ A huge loading machine

▼ A truck Boliden AB, Aitik Mine

RISK PREVENTION

In mining work, personal protective equipment (PPE), such as protective clothing, helmet, protective shoes, hearing and eye protectors are all necessary. It should be possible to use all necessary PPE at the same time and therefore their compatibility should be optimal. The primary preventive method against the cold is protective clothing, which should provide protection against cold, windy and damp conditions. The optimum protective work wear must be selected based on the ambient conditions and physical activity. The weight, thickness, bulkiness and stiffness of the clothing and the friction between the layers increase the physical work load and energy expenditure.

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Wear layers in the cold

Layered clothing provides higher thermal insulation due to insulating air layers between the garments than single thick fabrics. The layered clothing enables adjustment of clothing depending on the work and ambient temperature. The structure and functions of layered winter clothing are:

- THE INNER LAYER keeps the skin dry and warm. It transfers moisture from the skin to the outer layers. Suitable materials are wool (WO), silk (SE), polyester (PES), polypropylene (PP), and two-layer materials.
- THE MIDDLE LAYER adjusts the thermal insulation of clothing depending on the weather or work load. Suitable materials are wool, fleece and synthetic fur. 1-3 mid layers of clothing are sufficient.
- THE OUTERMOST LAYER protects against external exposures, e.g. cold, wind, moisture and dust. The garments should be loose-fitting so that the layers underneath are not pressed and there is enough air inside the clothing. Visibility is enhanced by using reflective colours and reflectors.

Cold-protective clothing is evaluated according to standard EN 342 and is then marked with a pictogram of snowflake. The most important properties of the cold-protective clothing are thermal insulation and air permeability. In heavy work or in moist ambient air, water vapour permeability and resistance to water penetration are important properties. Cold-protective gloves are evaluated according to European standard EN 511.

Open-pit mines do not have natural shelter against wind, so cold-protective clothing should include tightening straps or similar in the jacket hem, waist, neckline, sleeve and leg ends, to counter the effect of wind.

Moisture in clothing decreases thermal insulation and increases the evaporative heat loss from the body. If clothing gets wet during work, it should be dried between work shifts.

Protection of extremities

Workers in open-pit mines felt that fingers and toes were most often the coldest parts of the body. Gloves are often removed during tasks requiring manual dexterity, and about 60% of workers in open-pit mines felt that bare-hand contact with cold objects was a problem in the cold. The principles of extremity protection against the cold are:

- HAND PROTECTION consisting of different layers. Wear thin gloves underneath and thicker ones on top, so that you never need to have bare hands. Mittens give more protection than gloves. Take an extra pair of gloves with you so that you can change them if they get wet.
- FEET PROTECTION is most effective when you wear two pairs of socks. Wear socks made of synthetic materials underneath, and woollen socks that have good thermal insulation on top. Cotton is not a suitable material in cold weather because of its cooling effect when wet.
- WINTER SHOES should be one size larger than summer shoes. A thick outsole protects against heat transfer from the feet to the ground and a high leg protects the ankles. Insulation can be increased using insoles/insocks made of felt or other insulating material.
- HEAD PROTECTION is important in cold weather, as most heat is lost from an uncovered head. It should protect the ears and face because they get cold most easily. Adjust your headgear using a scarf, hood or face guard.

DRESS CORRECTLY IN THE COLD

Wear layers

The inner layer keeps the skin dry
Good materials are:
- Wool (WO), Polyester (PES), Polypropylene (PP)
- Clean clothing is warm!

The mid layer gives thermal insulation
Good materials are:
- Woollen knits, Fleece, Flannel
- 1-3 layers

The outermost layer protects against external hazards

TIPS FOR COLD PROTECTION

Improve protection against wind by tightening:

- Jacket hem
- Waist line
- Neckline
- End of the sleeves and legs

Dry your clothing between work shifts

Choose outer clothing that is one size larger than normal.

HEALTH AND SAFETY

The mildest negative effects of cooling are unpleasant thermal sensations and thermal discomfort. Further cooling may result in changes in muscles, circulation, respiration and hormones, which decrease physical and mental performance.

Cooling affects health through at least two mechanisms:

- Cooling has direct negative effects on blood pressure, respiratory tracts, stress hormones, muscles and joints. Frostbite and non-freezing cold injuries also result.
- A cold-induced decrease in the capacity for work means that workers have to do the same work with smaller resources, which causes higher stress in work.

Typical cold exposure in winter increases blood pressure by 20-60 mmHg. The older a person is, the higher the increase. Face cooling alone is already enough to increase blood pressure. Blood pressure is highest when standing still or doing heavy work. Light exercise decreases blood pressure.

Breathing cold air may constrict the upper airways in sensitive persons. During heavy work, when breathing is intensive, the risk of airway constriction (“wheezing of breath”) is increased. Simple heat and moisture exchangers are helpful.

Muscle and joint pains are common in people working in the cold.

Frostbite can develop at any temperature below 0 °C but the level of frostbite increases sharply below -25 °C. Wind and metal contact increase the risk of frostbite.

Any kind of sickness decreases cold tolerance.

Optimal safety is achieved at thermoneutral temperatures. The cooling of skin, muscles and nerves together with cold-induced discomfort impair capacity for work and make workers more susceptible to accidents. Heavy protective garments, which are absolutely necessary in the cold, may impair the senses of touch, sight and hearing and reduce functional capacity, all of which may also increase the risk of accidents.

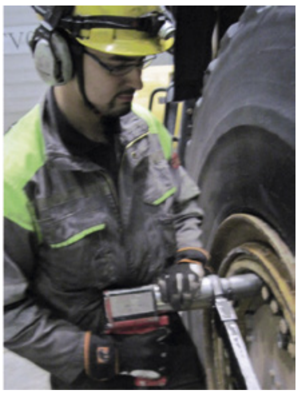
A winter environment with slippery surfaces, snow and ice as well as darkness may also increase the risk of accidents and injuries.

VIBRATION

Lage Burström, Bodil Björ, Anna Aminoff,
Ingemar Rödin, Marte Thomassen & Morten Skandfer

Many workers in the mining industry experience work-related vibration. For example, maintenance workers use hand tools that create vibration and truck driver are exposed to vibration in their vehicles. Operators of hand tools experience vibration in their hands and arms and vehicle operators experience vibration in their whole body. Therefore, occupational exposure to vibration is subdivided into two main categories: hand-arm vibration (HAV) and whole-body vibration (WBV).

Acceleration is the magnitude usually used to describe exposure to vibration (unit m/s2). The exposure time, the total time during which the vibrations occur, is highly significant when assessing effects on humans. Therefore, daily exposure to vibration is expressed by means of the vibration magnitude and daily exposure time as the daily A(8). The daily exposure (A(8)) is used for comparison with stated governmental exposure limit values and action values for vibration.



◂ Exposure to hand-arm vibration

▸ Exposure to whole-body vibration

▸ Picture of "White Fingers" after prolonged exposure to hand-arm vibration.

HUMAN RESPONSES TO VIBRATION

Human response to vibration can be divided into acute or permanent. The acute effects are temporary and usually arise immediately when exposed to vibration and disappear after they cease. Permanent effects lead to various injuries and may arise after prolonged exposure.

Hand-arm vibration (HAV)

When using hand-held vibrating machines, acute effects could be numbness, fatigue or pain in the finger and hands immediately after the exposure. The time it takes before we regain normal sensation varies depending on the vibration level and exposure time. The reduction may vary between 10 and 60 minutes.

HAV can permanently affect the blood vessels of the fingers so that blood supply decreases causing typical symptoms of finger blanching called "white finger". White fingers usually start at the tip of the finger and, if the exposure continues, become larger on the affected areas of the fingers. White fingers are triggered mainly by damp and cold, especially when the body is cooled. Vibration can also damage the nerves and muscles of the fingers and hands and cause discomfort in the arms and shoulders. Numbness, loss of sensation and having trouble fastening buttons are examples of nerve effects.

	Acute effects	Permanent injuries
Hand-arm vibration	Numbness, stress, reduced temperature, fatigue in the hands and arms.	Vascular, nerve, muscle and joint/bone injury.
Whole body vibration	Motion sickness, impaired motor skills, impaired vision, reduced performance, increased risk of fatigue.	Neck/back injury.

▸ Working with angle grinder

Whole body vibration (WBV)

Exposure to whole body vibration could acutely affect heart rate, blood pressure, balance and breathing and cause fatigue. Whole-body vibration can also cause symptoms such as headache, dizziness, nausea, perspiration and vision problems. WBV in mining vehicles, for example, can also act soporifically and reduce attention, posing a security risk. Vibration can thus impair performance. During prolonged sitting, whole-body vibration can cause an increased risk of pain in the lower back, shoulders and neck. It is often difficult to distinguish the effect of whole body vibration from the impact of other factors like bad and twisted postures, heavy lifting or prolonged sitting without interruption.

People with increased sensitivity and pregnant

It is not known how other diseases may be affected by vibration exposure or if vibrations can accelerate an already known vascular or nerve disease. There is still reason to show special care by isolating such people from vibration. For example diabetes could be worsen by simultaneous exposure to vibration. It is inappropriate for persons with innate propensity for white finger, or for those who already have nerve damage, to expose to vibration.

Pregnant women should not be subjected to shock or whole body vibration. Work with whole body vibration often include ergonomic and physical stress that is not good in pregnancy, e.g. noise, unfavourable locked posture, prolonged sitting in the same position. These factors need to be risk assessed according to employee’s pregnancy

▾ Drilling underground.

▾ A truck cabinet

RISK PREVENTION

Regardless of the type of work, it is important to work continuously with vibration issues and make them into a natural part of daily work. These four steps could be helpful in the prevention of vibration:

1. Examine the working conditions.

The employer is obliged to investigate working conditions and assess the risks that may arise if a worker is subject to vibration. The degree of detail of the study will vary but it is important to take into account all the risks linked to vibration. In the examination, the daily vibration exposure for each worker should be estimated.

2. Assess the risks.

The employer is required to assess the risks of damage or accidents as a result of vibrations the worker is exposed to. Risk assessment should be carried out regularly and updated as changes in operations occur or when medical checks show that it is needed.

3. Resolve and make an action plan.

If there is a risk of vibration injury, steps must taken to investigate and minimise risk and to minimise vibration exposure and the risk of injury.

4. Follow-up.

Follow up actions in collaboration with employees and safety personnel and find out if the measures were adequate. If necessary, develop a new action plan.

READ MORE
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▼ Boliden AB, Aitik Mine

▼ Kirosvk OAO APATITY Central Mine

HEALTH AND SAFETY

WHO has classified exposure to mechanical vibration as an occupational disease. This classification is intended to improve labour safety and health surveillance as well as compensation. In 1977, the International Labour Office (ILO) listed vibration as an occupational hazard and recommended that measures be taken to protect employees from vibration and that the responsible authorities must establish criteria to determine the danger.

The European Union has approved a directive that covers minimum health and safety requirements regarding the exposure of workers to risks arising from vibration. Employers are obliged to assess and, if necessary, measure the levels of mechanical vibration to which the workers are exposed.

In the directive, two exposure values are stated: daily action value and limit value (Table). If the action value is exceeded, the employer should establish and implement a programme of technical and/or organisational measures intended to reduce to a minimum exposure to vibration and the attendant risks. Moreover, workers exposed to vibration in excess of the action value are entitled to appropriate health surveillance. In any event, workers must not be exposed above the exposure limit value. If the exposure limit value is exceeded, the employer should take immediate action to reduce exposure below this value.

The exposure limit value

	Daily action value (m/s^2)	Daily limit value (m/s^2)
Hand-arm vibration	2.5	5.0
Whole-body vibration	0.5	1.15

AIRBORNE EXPOSURE

The airborne exposure assessment of workplace hazards in both open pit and underground mines have shown that the principal air pollutants in the breathing zone of miners are aerosols with a low content of silicon dioxide, nitrogen oxides, carbon monoxide and trinitrotoluene frequently exceeding occupational exposure limits.

One of the health risks from working in the mining industry is that of exposure to fine dust containing crystalline silica (otherwise known as quartz). Quartz is found in almost all kinds of rock, sand, clay, shale and gravel. Workers exposed to fine dust containing quartz are at risk of developing a chronic and possibly severely disabling lung disease known as "silicosis". It usually takes a number of years of regular daily exposure before there is a risk of developing silicosis. Silicosis is a disease that has only been seen in workers from industries where there is a significant exposure to silica dust.

▲ Testing of sample in mine laboratory

In addition to silicosis, there is now evidence that heavy and prolonged workplace exposure to dust containing crystalline silica can lead to an increased risk of lung cancer. The evidence suggests that an increased risk of lung cancer is likely to occur only in workers who have developed silicosis.

It should also be noted that excessive long-term exposure to almost any dust is likely to lead to respiratory (breathing) problems.

Particularly important is that many aerosols carry particles with an aerodynamic diameter below 100 nm, which mostly originate from fuel combustion processes in diesel engines widely used in mining machines. An increase in the morbidity and mortality of the population exposed to airborne nano-size particles has been proven to be associated with cardiovascular diseases rather than with pulmonary disorders. Little is known about why the cardiovascular system is apparently vulnerable to ultrafine particle exposure.

There is a lack of information on the health risks to specify which levels of control are required in the presence of ultrafine particles in air and cold, and thus to provide guidance on the choice of proper control measures.

▼ Loading on going in artic open pit mine

HUMAN RESPONSES TO AIRBORNE EXPOSURE

The increase in morbidity and mortality of the population exposed to airborne nano-size particles has been proved to be associated with cardiovascular diseases rather than with pulmonary disorders. There is little known about why the cardiovascular system is apparently vulnerable to ultrafine particle exposure. It is currently assumed that inhaling such particles may result in systemic inflammation as determined by higher levels of acute-phase reactants in serum. Work in a cold environment creates an extra stressor to the cardiovascular system of miners, reducing its functional reserves and contributing to processes of its dysadaptation and decompensation. Nevertheless, the combined effect that takes place in a cold climate and high humidity constitutes an increased risk of developing bronchopulmonary diseases and an increase in morbidity and mortality in cardiovascular diseases. There is a lack of information on the health risks to specify which levels of control are required in the presence of ultrafine particles in air and cold and thus to provide guidance on the choice of proper control measures.

The adverse health effects on the population exposed to air pollution of CO, NOx, elemental carbon (EC) and other particulate matter constituting the main health hazards of diesel exhaust (DE) have been known for years. As for occupational settings, especially in open pit mining operations air concentrations of these contaminants may well reach levels significantly exceeding occupational exposure limits (OELs) that, in a large number of documented instances, could pose the risk of acute poisoning in miners.

The cold-induced modification of exposure and related health effects caused by diesel exhaust will be further evaluated in an epidemiologic study planned in the framework of the above-mentioned MineHealth project.

▼ Kirosvk OAO APATITY Central Mine

◀ Drilling ongoing

RISK PREVENTION OF AIRBORNE EXPOSURE

The basis of airborne exposure risk prevention is good and up-to-date risk assessment, the main principles of which are as follows:

Where risks to workers cannot be prevented, control measures should be applied to remove or reduce the risks to workers' health. The following control hierarchy should be followed:

Design work processes and controls, and use of adequate equipment and materials to reduce the release of dangerous substances.

Apply collective protection measures at the source of the risk, such as ventilation and appropriate organisational measures.

Apply individual protection measures including using personal protective equipment (PPE). By law this is the last resort, and should only occur where exposure cannot be adequately controlled by other means. Where PPE is given to workers, they must be trained in its use.

The number of workers exposed should be reduced to a minimum, along with the duration and intensity of exposure and the amount of dangerous substances used. Appropriate hygiene measures should also be adopted.

Employers are also obliged to provide workers with information on the risks posed by hazardous substances, and training in how to use them safely. Regulations apply both to marketed products and to the waste and

▼ Dusty work in refining plant

by-products resulting from production processes.

For many, but not all chemical products, legislation also establishes standards on classification and labelling, so that users can understand the substances they are dealing with. EU law covers the provision of clear, standardised safety labels, risk symbols and Safety Data Sheets (which chemical manufacturers and suppliers must provide, giving information on the properties of substances, the hazards associated with them, and guidance on storage, handling, protection, etc).

Edited by Airi Paloste and Ahti Rönkkö from the material produced and presented by the project colleagues

HEALTH AND SAFETY

Dangerous substances – meaning here mainly dusts and different gases and fumes like diesel exhausts poses a risk to miners' health and safety – can be found in nearly all mines.

According to recent research, 19 % of EU workers report being exposed to toxic vapours for a quarter or more of their working time, while 15 % of workers have to handle dangerous substances as part of their daily work.

If the risks of using dangerous substances are not properly managed, miners' health can be harmed in a variety of ways, with effects ranging from mild eye and skin irritations to asthma, reproductive problems and birth defects, and cancer. This can be through a single short exposure, or multiple exposures and long-term accumulation of substances in the body.

Employers must protect their workers from being harmed by dangerous substances in the workplace. Employers must carry out risk assessments, and act on them. Legislation also governs the identification and labelling

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Picture from Kirovsk open pit mine in late spring

of the thousands of different substances that are registered in the market.

Reducing the risks of working with dangerous substances is not just a moral and legal imperative – there is a strong business case for it as well. Organisations can suffer when things go wrong through lost productivity and reputation as is well known also in Nordic countries!

Fortunately, a large amount of guidance is available for employers and workers in dealing with dangerous substances. And across Europe, there are many examples of good practice to learn from.

By taking appropriate action, miners can be kept safe while using dangerous substances.

Employers are also obliged to provide workers with information on the risks posed by hazardous substances, and training in how to use them safely. Regulations apply both to marketed products and to the waste and by-products resulting from production processes.

Edited from the material produced in the European Agency for Safety and Health at Work by Ahti Rönkkö

MINING AND SOCIETY

Leena Viinamäki & Seppo Kilpiäinen

ABOUT MINING AND SOCIETY

Socio-economic conditions also affect the mining sector, in addition to traditional economically quantifiable factors and factors, which are not easily measured but important such as health and safety issues, environmental impact, the regional distribution of added value, employment and other benefits arising from the industry.

Especially from the point of view of local and indigenous peoples, it is important to pay attention to the possible negative effects of mining activity like waste, pollution, noise and the attitudes of local society showing to pollutants connected to mining activity (HSE issues), and the response of mining management and regulating authorities to these attitudes.

Companies' recruitment strategies, rotation, work time arrangements and different working conditions are all elements in the socio-economic study and are incorporated into the health aspect. Other research shows that, over time, long hours and shift work affect the health of workers.

These questions will also be studied in the light of gender and answers can be given if problems or risks arise. It is possible to study the recruitment of a competent workforce and how this affects the migration to the municipality/rotation, composition of the population (infants, children, female) and municipal services needed for population growth (housing, schools, and kindergartens) as well as value-added activity in the society and how the company and its subcontractors contribute.

Socio-economic study gives possibilities to compare different mines, regions and countries and show the possibilities of implementing good socio-economic practice in the local community.

SOCIO-ECONOMIC RESPONSIBILITY

The socio-economic impacts of the mines can be divided into predicted and realisable positive and negative impacts from the viewpoint of individual citizens (income level and working possibilities) as well as mine localities (changes in economic structure with altered collected taxes). Mining companies are implementing periodic local industrialisation politics and the operating time is defined by the ore body and the world market price of ore. Even if there are ore bodies, if the global world market price is too low for the mining company, the company can close operations as unprofitable.

The actions of mining companies and mine start-ups in some localities reconstruct the

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community both indirectly and directly – both permanently and temporarily as a change in the demand and supply of welfare services, as an increase in working oppotunities, and as a change in the nature (especially open pit mines). There will also be changes in the population structure because of mine workers' age, occupational and educational factors. In the sociological structural research of mining localities, the focus has been on the research of the wholeness of local communities, and less attention has been paid towards interactive relations with the life changes of locals. In Northern Finland in particular, socio-economic and ecological questions are essential, because many localities have competing and even contradictory mining and tourism industries.

MINIMISING SOCIAL AND ECONOMICAL RISKS

In this part, we reflect on the socio-economic framework to see if there is tension between the inhabitants and authorities of Sodankylä and the representatives of the Kevitsa mine concerning the reshaping of the mine area socially, physically, culturally, emotionally and historically. Lapland UAS is responsible for this particular question, which is under inspection in the socio-economic part of the MineHealth project. The research is carried out through statistics, questionnaires and interviews. Furthermore, the question of social and ecological diversity, physical, psychosocial and cultural reshaping of environment as well as the challenges of local multicultural community is under inspection (see Matthies et al. 2001). We also reflect to see if there is any noticeable conflict between ecologically orientated health politics and growthbased welfare politics (vs. the discussion about green gross domestic product, economically sustainable welfare, humane development, sustainable society, happy years of life and indexes of happy earth, authentic development indicators, ecological footprints, national happiness accounting and gross national happiness; see Hoffrén et al. 2010). Figures 1. and 2.

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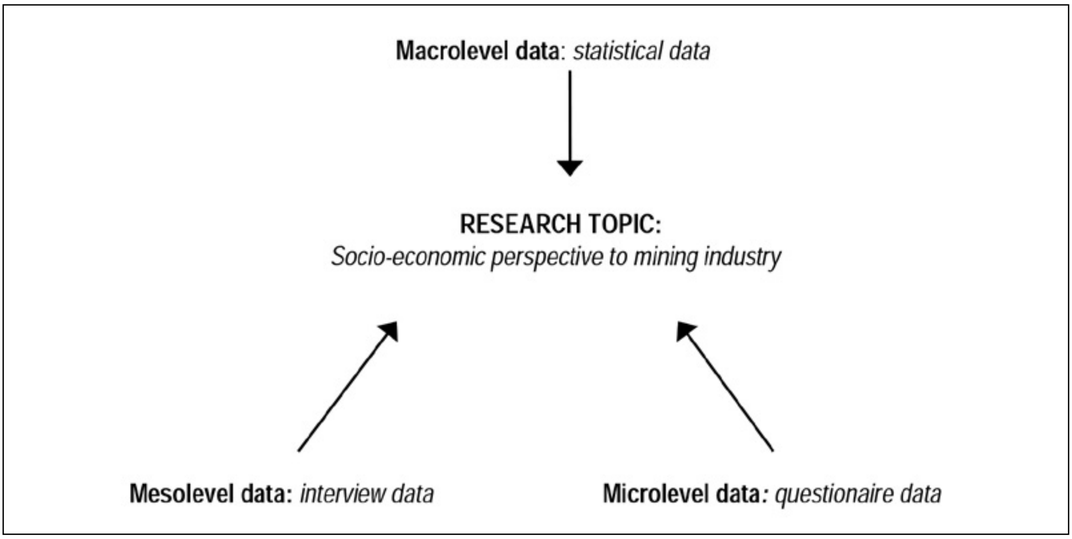

Figure 1. Triangulative research design in Work package 4

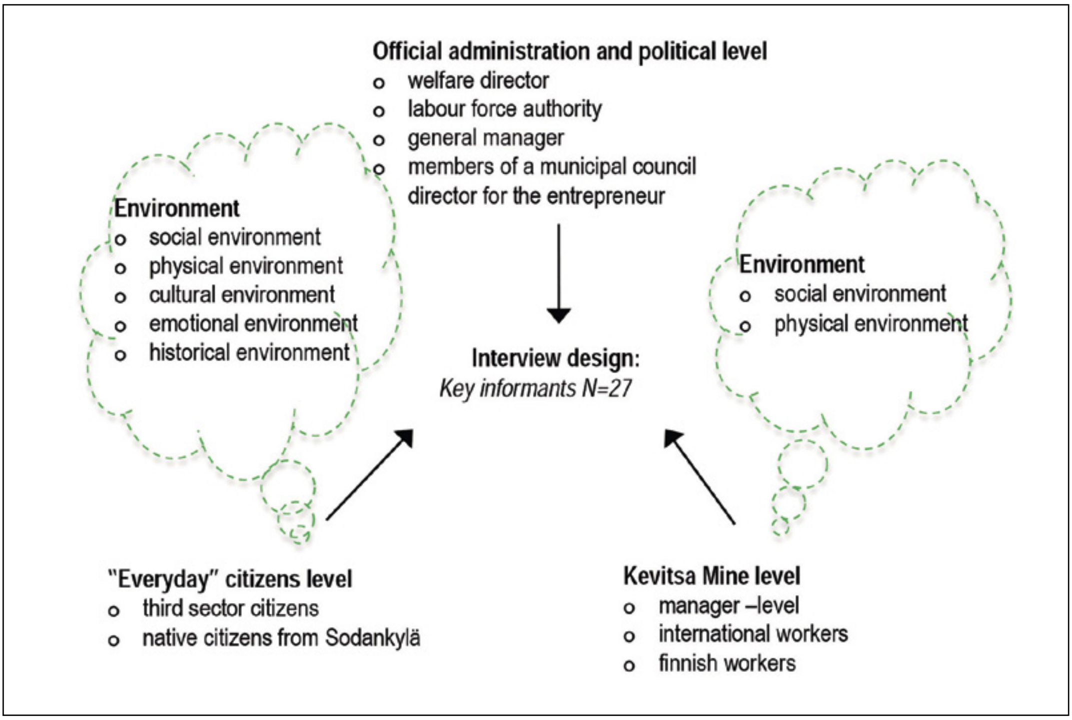

Figure 2. Multilevel evaluation idea in interview design.

▼ Boliden AB, Aitik Mine

▼ Kemi, Finland

WELL-BEING AND SOCIO-ECONOMICAL DIMENSIONS IN MINING ENVIRONMENT

When establishing a mine, there are always two essential dimensions. The other one is financial and the other one is societal / ecological. The financial part always comes from the national or international company that invests the capital in the stage of establishing the mine. The company takes into consideration the financial risk, which depends on the amount of ore, the richness of the ore and the current world market price of the ore. The other part is societal / ecological. In this part it is considered how the company has considered the rising questions of employment and environment.

The establishing of a mine in Sodankylä has many effects in the municipal economy. The salaries paid by the mining company also effects on the tax income and with this accrual the municipality is able to increase investments. On the other hand the municipality will receive costs from the socio-economical aspect. Internationally owned mining company brings workers from different countries and the municipality will have to offer services with various languages, for example day care, school, social services and health care. There are increasing costs also in land use planning, housing and logistic services.

In the stabling stage there are many other unpredicted costs besides the construction process, for example environmental protection. The financial and societal / ecological effects to the municipality and its environment can be calculated only until longer timespan. When effects are being viewed, the financial, socio-economical, health and ecological effects should be considered. Environmental protection is also an important issue of a municipality and the cooperation between the municipality and the mine is vital.

From the municipality's and mine's point of view the well-being in the area has increased and these two facets benefit from one another. The wellbeing and socio-economical dimensions of municipal and mine workers have been examined with the triangulative method in the MineHealth project.

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MineHealth

Sustainability of miners' well-being, health and work ability in the Barents region – a common challenge

The greatest challenge for the mining industry in northern regions is to attract personnel capable of safe working practices and to train them for the work in such a way that, despite the demanding mining tasks, they can sustain their work capacity. To ensure productive and safe mining operations, it is imperative to recognise the hazards in one's own work and to comply with instructions. The systematic identification of hazards and evaluation of the seriousness of the consequences, i.e., risk assessment, provide the foundation for safety management.

This Guidebook was developed for continuous learning in occupational safety related to mining work and to emphasise its role in the day-to-day work and professional skills required in the mining industry.

Thus, it is legitimate to claim that occupational exposure is a significant health risk within the mining industry in the Barents region. Therefore, there is a great challenge for the mining industry in northern regions to ensure highly productive, safe and healthy mining operations and to overcome the hazards related to exposure to vibration, cold and airborne particles. These challenges are prerequisites for attracting new personnel and keeping a substantial work force within this domain.

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