

CMCFinland Responding to Emergencies

MANUAL FOR COLD CONDITIONS



CMCFinland
Kriisinhallintakeskus
Crisis Management Centre



Swedish Civil
Contingencies
Agency



THE COLD CONDITIONS MODULE has been developed by the Crisis Management Centre Finland (CMC) and the Swedish Civil Contingencies Agency (MSB) with the financial contribution of the European Union Preparatory Action on an EU Rapid Response Capability.

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FOREWORD

This manual is a product of the Cold Conditions Module project. The project is funded by the European Commission and implemented by the Crisis Management Centre of Finland (CMC) in cooperation with the Swedish Civil Contingencies Agency (MSB).

The need for the Cold Conditions Module project stems from the limited experience of civil protection personnel to operate in extreme weather conditions. Such conditions require special equipment and knowledge of the impact of cold on human beings and rescue facilities.

Due to the harsh winters and changes in weather conditions, Finns and Swedes have gained experience on cold conditions; this knowledge has been adapted by the project for the use of the civil protection responders.

The project is a development effort aiming to enhance Finland's international rescue and emergency response capacities. The funds have been used for provision of training and equipment, development of standard operation procedures as well as this manual, which outlines the impact of cold and advises how to protect personnel and equipment when operating in such conditions.

The manual provides the know-how collected with the Commission's support throughout the project, and will be freely available for the participating states or any other interested party.

Sam Back, Anu Haveri, Mikko Keltanen, Ari Keski-Säntti, Elja Kivikoski, Marko Nieminen, Jukka-Pekka Patoluoto, Jussi-Matti Roitto and Christer Rose have generously extended their expertise on issues covered in this manual and thus made this publication possible.

LIST OF ACRONYMS

CCM	.....	Cold Condition Module
CMC	.....	Crisis Management Centre Finland
CPR	.....	Cardiopulmonary resuscitation
EADRCC	.....	Euro-Atlantic Disaster Response Coordination Centre
ECG	.....	Electrocardiography
EU	.....	European Union
EUCPT	.....	European Civil Protection Team
FRF	.....	FinnRescue
HNS	.....	Host Nation Support
HQ	.....	Headquarters
HUSAR	.....	Heavy Urban Search and Rescue Module
ICT	.....	Information and Communication Technology
INSARAG	.....	International Search and Rescue Advisory Group
LCD	.....	Liquid Crystal Display
LPG	.....	Liquefied Petroleum Gas
MSB	.....	Swedish Civil Contingencies Agency
MST	.....	Medical Support Team
Mol	.....	Ministry of the Interior of Finland
MSB	.....	Swedish Civil Contingencies Agency
MUSAR	.....	Medium Urban Search and Rescue Module
NATO	.....	North-Atlantic Treaty Organisation
PS	.....	Participating State
USAR	.....	Urban Search and Rescue
UN OCHA	.....	United Nations Office for the Coordination of Humanitarian Affairs

INTRODUCTION

Several natural disasters have recently taken place in areas of extreme weather conditions. Therefore, the need to develop preparedness for rescue operations in cold climates has increased.

In Finland thermal winter begins in October or November and ends in April or May. Thermal winter is defined as the season of the year during which the average daily temperature is under zero Celsius degrees. In addition to the cold air, the factors affecting the operations include the amount of snow, which varies from year to year from 5 cm to 100 cm, depending on the region.

In the south of Finland, there may be no snow at all during winter, while in the north, the amount of snow may increase to up to 150 cm. Due to the geographical location of the country, Finns have plenty of experience from rescue operations in extremely cold conditions and thus the Finnish rescue

services operate efficiently throughout the country in cold, wintry, and arctic conditions.

The rescue services must consider the cold weather conditions from the perspective of the rescue equipment, rescue techniques, staff equipment and training, as well as the victims to be rescued. For this reason it is only natural that when it comes to international rescue services, Finland has the ability and desire to share its competence and skills with the other countries taking part in the international rescue service operations.

Operations in cold conditions are extremely challenging and thus present great demands to clothing, nutrition, tools and personnel. Experience plays a significant role in adapting to extremely cold conditions, which is why training for the operations is essential, as is careful preparation for the various conditions. Cold conditions may significantly hinder or slow down various tasks and assignments, in comparison to carrying out the same

tasks in so-called normal conditions. Sometimes rescue operations are required in cold conditions where the temperature may drop under zero degrees Celsius, but it is important to know that even a drop to +10 degrees Celsius may create disadvantages to the operations. Hence, it is very important that the equipment and staff training of the rescue teams enable operations in such conditions. Consequently, the importance of practise in a cold environment is highlighted for a successful rescue operation should the future demand it.

It is important to note that cold conditions can be found in both northern and southern areas, in warm countries during the winter months, and at high altitudes in mountain areas. In addition, great temperature variations from high temperatures during the day to sub-zero temperatures during the night pose challenges for the rescue staff and the victims alike. The lack of sleep resulting from cold nights alone can radically reduce the

functional abilities and efficiency of rescue service personnel. It is equally important to acknowledge that a cold climate is defined differently in different countries.

Together with the Swedish Contingencies Agency (MSB), the Crisis Management Centre of Finland (CMC) and FinnRescue have developed and established the Cold Conditions Module (CCM) with funding from the European Commission. This manual is one output of the project. It is intended to serve as a support document for rescuers who have already acquired basic information on cold conditions. The manual seeks to describe special requirements of cold conditions and advice how to prepare and protect oneself against it. The manual tackles issues related to the conditions in camp, issues on personal well-being, impact of cold on equipment and use of search dogs in extreme weather, and above all, it intends to stress the extent to which cold impacts every aspect of a rescue operation from the preparation phase to its completion.



URBAN SEARCH AND RESCUE OPERATIONS

Urban Search and Rescue operations (USAR) refer to searching for and helping disaster victims in difficult disaster conditions. In USAR operations, victims are located, rescued and treated in disaster situations, resulting from earthquakes, floods, or explosions. The rescue conditions are often demanding and may even put the rescuers at great risk. In the operation of USAR teams, these risks have been extensively considered in comparison to the so-called normal rescue missions. In addition, the other special characteristics of the target areas, such as the risk of external violence or the continuation of the natural disaster, must be considered in these operations.

The Finnish Ministry of the Interior may, at the request of another state or an international organisation, such as the European Union (EU), United Nations (UN), or the North Atlantic Treaty Organization (NATO), decide to send help abroad from the rescue services in Finland.

Help can be sent to protect people, property, or the environment. Situations calling for such assistance include natural disasters, environmental disasters, political or military conflicts, or damage caused by terrorism.

International requests for assistance are usually mediated by European Union

Civil Protection Mechanism (Monitoring and Information Centre, MIC), United Nations Office for the Coordination of Humanitarian Affairs (OCHA), or NATO's Euro-Atlantic Disaster Response Coordination Centre (EADRCC).

The international taskforce of the Finnish rescue service, FinnRescue (FRF), may be sent abroad to help. The CMC Finland (Crisis Management Centre), operating under the Ministry of the Interior in Kuopio, is responsible for the foundation and maintaining of FRF as well as organising the required training.

FinnRescue (FRF) is a taskforce made up of rescue professionals and experts of various fields, ready to be sent on international assignments all over the world on very short notice. The assignments include major catastrophes as well as other humanitarian aid and support tasks.

The FRF USAR teams are capable of self-sustaining operations in a disaster area, including management relations, communications, paramedics, catering, and accommodation. In the actual rescue operations, the rescue team has access to specially trained crew and equipment for surveying the area, search missions in collapsed structures, clearance missions, support of unstable structures, rescue from heights and low places, and first aid.

The FRF USAR team was created in accordance with the INSARAG Guidelines by The International Search and Rescue

Advisory Group (INSARAG), operating under the UN, can be mobilised either as a Heavy Urban Search and Rescue (HUSAR) taskforce or Medium Urban Search and Rescue (MUSAR) teams, as required. The FRF HUSAR team consists of approximately 64 members, including a management and support unit, four rescue teams and a dog unit. The FRF MUSAR taskforce consists of the management and support unit, two rescue teams and a dog unit. If necessary, certain modules of the units can be sent to the disaster area to be joined with USAR teams of other countries.

The training and competence of the FRF USAR team can be divided into the following areas: team leadership, logistics/camp, tactical search, technical search, breaking and breaching, shoring, rope rescue, paramedics and dog search.

The team leaders strive to create the optimal operational requirements for their team in the operation area. The general management, operational planning, operational management, safety, logistics, communications with other operators, information and communication technology, as well as media relations are a part of the expertise of the team leaders. In



addition, medical care, catering, and maintenance management are a part of the essential competences of the leaders.

Logistics and camp maintenance are the vital part of the operations of the team, enabling the quick deployment of the rescue team by keeping the equipment constantly on standby in Finland.

Well-organised logistics to and at the target area play a key role in the execution of the operations.

Tactical search operations refer to the reconnaissance, charting and locating of the scenes of accident in the disaster area using GPS positioning devices, maps and special marking systems.

Technical search aims at locating the victims of the disaster or accident in collapsed buildings and structures. Victims are searched by using sound detection devices, remote controlled cameras, and search dog units. The activities aim at verifying the results of the search with all possible methods in order to find the exact location of the victim.

At times, victims are located under heavy and sturdy structures. Breaking and breaching gives the rescuers access to the target and allows them to rescue the victims safely from otherwise inaccessible locations. The FRF equipment can be used to break and breach heavy-duty concrete structures.

Shoring collapsed buildings or buildings at a risk of collapsing enables safer working conditions for the rescuers and prevents any additional damage and victims. Special shoring equipment sets or wooden, specially built structures can be used for assistance. Rope rescue operations enable the rescuers to access the site and ensure the safe rescuing of victims in highly

inaccessible locations. Those can be at heights, deep inside structures, or otherwise difficultly inaccessible, such as bottoms of ravines. The team has access to versatile rope rescue operation equipment.

The teams of paramedics are primarily meant to provide medical care to the team members. However, they naturally provide first aid to victims whenever necessary. The fact that the disaster area may be located anywhere in the world, in any kinds of environment and climate, sets special requirements for the medical staff. Special factors to consider include the local fauna, epidemics, pollution, and the versatile spectrum of injury mechanisms. The paramedics are also responsible for the basic health care of the team's search dogs.

Search dogs are very efficient at locating and searching for victims. Dogs can detect victims extremely deep within collapsed structures. The collaboration of dogs and their handlers is a highly demanding area of expertise, and training takes a long time. Moving the dogs between countries is also a challenge for the organisation.

CAMP IN COLD CONDITIONS

When assembling a camp, the effects of the climate, direction of wind, and any piling up of snow in storms and blizzards must be taken into consideration. The points and shape of the terrain, as well as any protective locations in the terrain, such as hills and buildings, should be considered in the selection of the site for the accommodation and service tents whenever possible.

SPECIAL REQUIREMENTS FOR CAMPS IN COLD CONDITIONS

Camp assembly in cold conditions must be made as simple as possible. Everything must be doable "gloves on". The way the different materials conduct cold must also be considered, for instance in the selection of tools. Using snow for anchoring the tents must also be taken into account when setting up the camp. Snow is shovelled into sufficiently sturdy PE plastic bags in order to start the anchoring. The tents must be insulated carefully. The amount of air in the inflated fabric arches of tents must be checked when the temperature drops under -5 degrees Celsius, or in higher temperatures, twice a day. The snow load on tents and other structures must be inspected several times every day. The camp should be equipped with a sufficient number of snow tools, such as snow pushers, shovels and brushes.

When using snow machinery, particular care must be paid for not to damage the tent anchoring, heating devices, or any other objects that may be covered by snow. When taking down the camp, all equipment should fit in the same packages that were used for transporting them to the camp in the first place.

For the duration of setting up and taking down the camp, a sufficient amount of dry foods where only water needs to be added should be reserved. This serves to ensure that the meal chain does not break. In cold conditions, the human body needs more energy than in normal conditions.

The camp should offer a possibility for drying clothes and equipment separately on designated racks in tents set up for maintenance purposes. Snowy, wet, and damp equipment cause extra humidity in the accommodation tents, causing humidity problems inside the tent. Humidity reduces the temperature inside the tents. It must be ensured that snow cannot get inside any tents to cause humidity problems. This can be prevented for instance by having one pair of shoes for outdoor use and another pair for indoor use. Shoes should be kept in the entrance tent in a designated rack, which is kept off the floor.

ACCOMMODATION

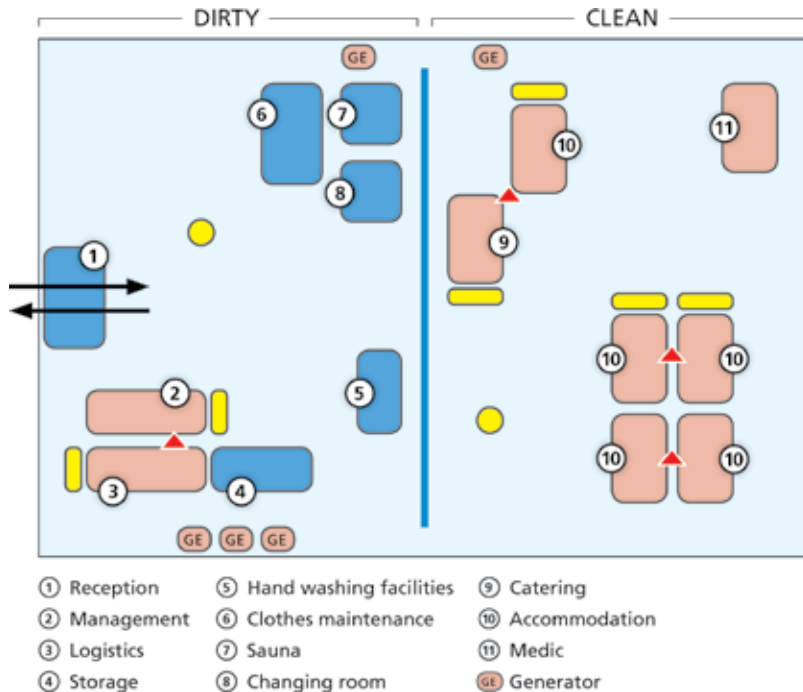
Quantitatively and qualitatively sufficient rest is crucial for ensuring the long-term ability to function in cold conditions. The quality of sleep suffers both in too low and too high temperatures. Protecting the feet in particular when sleeping in cold conditions is very important, as the temperature drop in feet and toes can distract sleep.

A tired crew is very vulnerable to the effects of frost. Lack of sleep reduces the ability to observe and the level of performance, which increases the risk of frostbite and

other damage caused by the cold. Lack of sleep is first visible in tasks requiring precise manual dexterity. In long-term operations, the rotation of breaks must be planned so that the operations are not interrupted. Approximately 90 per cent of people can work with three to five hours of sleep for approximately nine days, if the sleep is uninterrupted and the conditions are stable.

TENTS

Before checking out on an assignment, the crew must know how to use and erect a tent so that resting time need



not be used for getting to know the equipment in the cold and dark. A tent offers protection from the weather as well as an opportunity to rest and to dry clothes and equipment. The heat source in a tent is a stove or a similar piece of equipment. Stoves use wood, peat, or gasoline/diesel for burning.

TEMPORARY SHELTER

Temporary shelter refers to an emergency accommodation solution with the purpose of providing protection from the impacts of weather. A temporary shelter can be made of snow, it can be

a lean-to, or it can be located under the thick branches of a snow-topped pine or spruce. Snow provides good thermal insulation, but when staying overnight in a snow cave, for instance, particular attention should be paid to sufficient ventilation. The sufficiency of the ventilation can be monitored with a burning candle. No wet clothes or equipment should be taken inside a snow shelter, and in order to avoid moisture from forming, a camp cooker should not be used for cooking inside a snow shelter.



TECHNICAL CAMP FUNCTIONALITY IN COLD CONDITIONS: THE LOCATION OF MATERIALS

HYGIENE AND SANITARY FACILITIES

The waste management and toilet equipment should be placed so that they will not disappear in the snow. The operation of the toilets must be ensured for instance by enabling the washing of hands in a warm facility, where there is no risk of freezing. The cold resistance of hand disinfectants must be taken into account in selecting them. Certain hand disinfectants may freeze even in low sub-zero temperatures. The toilet waste must be sorted, if possible. Faeces are collected into a durable bag, and urine in canisters, or buried into a safe spot in the ground. Waste must be collected either in a plastic barrel or a closable metal barrel. When selecting the hand washing location, ensure that neither the water used for washing the hands nor the waste water can freeze. In addition, it should be ensured that waste water cannot freeze routes or tents, for example.

WATER

The freezing of water must be considered in the storage of water. Water is stored

either in water bottles designed for drinking water, or in designated canisters. If snow is melted for drinking water, it should be considered that it does not contain a sufficient amount of minerals. Minerals available in sports drinks or hypotonic tablets should be added to any water melted from snow to ensure sufficient supply of minerals. In addition, chemicals and tablets intended for purifying water can be used, but their operation in cold conditions must be verified from the product description. Cooking water ensures microbiologically clean water, but the cooking capacity and the kettles must be significantly larger than in the summer. A large coffee pot is ideal for melting snow, as it is safe to use for filling Thermos flasks and drinking water bottles. The kitchen supply box must be equipped with appropriate equipment for handling hot water, such as pot holders and oven mittens.

FUEL

The camp must be equipped with multi-fuel camping stoves that operate at different temperatures. A thing to consider when using these is that the different fuels from gas to petrol use nozzles of different sizes.

Warm rubber gloves suitable for fuelling must be used when filling in fuel. A spill mat should be available in order to keep the fuel from staining clothes or polluting the environment. Fire-fighting equipment must be placed so that it cannot be buried in snow.

In the selection of liquefied petroleum gas (LPG), the proper ratio of propane and butane must be noted for ensuring operation in cold conditions. The higher the propane content in the LPG, the better it works in cold conditions. The boiling point of propane is -45 degrees Celsius.

HEATERS

In the placing of the heaters, the safety distance to the tents must be considered, as well as the fact that the heating tubes of the heaters warm the ground. The fuel containers of the heaters must be set on a level surface where there is no risk of melting to prevent the fuel containers from falling over and causing environmental damage.

GENERATORS

When placing the generators, sufficient air supply must be ensured by making sure that the air inlets cannot be clogged by snow during a snow storm. In cold conditions, the power loss of generators is approximately 0.1 to 0.2Kw at a temperature of -5 degrees Celsius. The initial temperature of the generators is $+20$ Celsius degrees. When the outside temperature is -20 Celsius degrees, the power loss of the generator is approximately 0.8–1.6Kw, depending on the model of the generator. When placing the generators, it must be ensured that the generators cannot be buried in snow and that they can be fuelled and serviced safely and quickly. The pour point of diesel used as a generator fuel must also be taken into

account. Different diesel types have different filterabilities, which affects their operation in cold conditions. Diesel types designed for cold conditions are available via separate orders, or, during the cold season, from the gas stations in cold areas. The pour points are -15 , -34 and -44 degrees Celsius. In everyday use, the different diesel fuel types are known as summer, winter and arctic diesel fuel types. As the filtering temperatures drop, paraffin, which is used as an additive in diesel, may cause various problems in the filters of machines and equipment. The generator should be also winterized by replacing the lubricants and removing water residue from the fuel system.

ELECTRICITY

When using electric cables, the connectors must be water-tight. For the safe transmission of electricity, the water-proofness of any electric cables used at the camp must comply with the applicable standards and the cables must be sufficiently strong. This means cables of 2.5mm² at minimum. The cables must be marked with separate sticks or other markings so that they can be easily located under the snow. This marking will also act as a warning for hazard of electric shock.

The outdoor lights used at the camp must be weather-proof. The designated smoking area must be located at a sufficient distance from the fuel storage place.

PERSONAL EQUIPMENT AND WELL-BEING

PHYSIOLOGY AND COLD

In cold climates, the prerequisites for being able to function include good physical fitness, sufficient training related to the weather conditions, and suitable clothing and equipment. All operations require individual activity and initiative.

Cold air reduces the ability to perform and increases blood pressure. In addition, it directly burdens the breathing and cardiovascular system and makes the cold protection equipment heavy and stiff. Cold reduces strength production as well as flexibility and coordination, as the contraction ability and flexibility of frost-bitten muscles disappear in the cold.

In order to understand our body's built-in warning signals and how different frostbite symptoms appear, it is important to understand the body's build and functions. The body's normal temperature is +37 degrees Celsius. It tolerates about 0,5° difference before the body's function starts to fall. That is why too cold or too warm feels uncomfortable.

The body acts as a temperature regulator. To do this, it needs energy. The energy comes from food, muscles, and body fat. The heating occurs in the body by

metabolism. Metabolism is the amount of energy (calories) the body burns to maintain itself. The heat is transported around the body by blood. At rest, the greatest heat production comes from our heart, liver, kidneys, brain, etc. In order to get maximum heat output one has to use the muscles. This means, that when feeling cold, one needs to move the body. When moving or working, the body needs energy. This energy should be taken from food (carbohydrates, fat and protein), not the muscles and body fat.

Heat loss occurs through the convection, conduction, radiation and evaporation. Convection means that the air next to the skin becomes heated and consequently lighter and rises up. New cold air flows into your clothes. Wind accelerates the heat loss. Heat loss by conduction often occurs through contact with cold surfaces. Be sure to insulate yourself against the cold surfaces. Heat loss by radiation happens when one is standing too close to large cold objects, such as cold stones, concrete blocks, large rocks or big trees etc. A large part of the body's heat is used to heat the inhaled cold air. At minus 18 degrees about 25% of the heat the body produces is needed to warm it up.

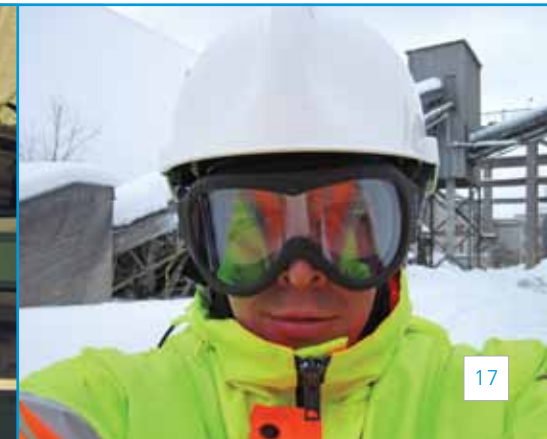
In the cold, the best protection for skin is the skin's own oil; creams and ointments on the other hand increase the risk of frostbite. For example, washing the face should be avoided if the exposure to cold is constant.

How is the body's outer shell - the skin - made up? The cells are surrounded by water. If these fluids freeze, different types of frostbite occur. Knowledge and experience on the body's heat regulation is very important to determine how to survive in winter conditions. When cold, the muscles under the very thin outer layer - the skin - and the blood vessels (capillaries) pull themselves together. This leads the body to reduce its blood circulation in its outer tissues and increases blood volume in the internal organs. Reduced supply of heat, oxygen and nutrients in the muscles result in less muscle power. The increased cooling, which occurs results in shivering that could turn into heavy shaking. This increases the energy metabolism in our muscles, which is about 4-5 times greater than at rest. The growing energy consumption leads to faster decrease of the energy reserves. When working hard, heat increases the flow of blood to the outer vessels, which cools the body. Sweating is the body's way to increase cooling. The evaporated liquid produced by the skin, uses a large quantity of heat. Wet skin loses heat 25 times faster than dry skin.

The points of the body where very superficial blood vessels are located - the head, neck, groin, wrists and ankles are called ventilation points or freezing points.

The most significant factor limiting operations in the cold is the human itself. The personnel performing operations in cold conditions should be in good physical health; good aerobic fitness in particular facilitates coping with the cold. The heat production at the basal metabolic rate may increase by 10–20 per cent during long-term exposure to cold. Involuntary fibrillation may more than triple the heat production and oxygen demand, and sweating is reduced to a minimum (depending on the clothing). The ratio between the surface and mass of the limbs is uneconomical, which exposes the extremities to freezing and increases the risk of local frostbite.

Compared to men, women have a larger amount of subcutaneous fat, which protects them from the cold. However, as women's heat production capability is approximately 25 per cent smaller than men's, women's long-term cold resistance is lower.



CLOTHING

When the human body produces as much heat as it gives out, it is in thermal balance. The heat produced (from work or exercise), the environment (temperature, wind, humidity), clothes, and individual properties all affect the thermal balance.

The performance of tasks in a cold climate requires the person carrying out the task to be able to function both physically and mentally. This, on the other hand, requires that the thermal balance stays within certain limits in a controlled manner. As a rule of thumb, sweating should be avoided. If this is not possible, the sweaty layer of clothes closest to the skin must be changed.

Dressing in layers is an efficient way of protecting the body from harmful exposure to cold. Several thin layers of clothing is better than a couple of thicker layers, as layers can always be added and taken off to adjust to the strain of the task and the prevailing weather conditions. The purpose of the layer of clothes closest to the skin is to transfer moisture from the skin to the outer layers.

General recommendations on clothing:

- Wear three or four layers of garments, which are easy to put on and take off to allow you to take off a layer or two when working hard;
- Use fabrics that transport the sweat away from your body;

- Make sure that the temperature of the outer layer is zero. If not, ice starts to develop inside the clothes. This will disturb the membrane of Gore-Tex, if that is worn. The ice will stop the ventilation and keep the moist inside your clothes,
- Try to build up air in and between your layers. Do not tighten belts etc.;
- Avoid metal, steel or any other cold materials in your clothing.

FIRST LAYER

Often, the thighs are easily exposed to the wind and rain, if the layers are too thin or few. The pants are in direct contact with the thighs. A pair of underwear with long legs will provide a better protection to the legs.

Garments with very good moisture transportation should be worn closest to the body. Wool or some kind of functional material next to the skin is highly recommended, as the skin should be kept as dry as possible. Remember that moist skin conducts heat about 25 times more than dry. Thicker inner layers provide better insulation needed in extreme cold. Fabrics with odor and fungal prevention also exist.



SECOND LAYER

The second layer can vary in thickness. The material is the key. Good materials are wool and all climate adjusted functional fibers.

FEET

When working for prolonged time periods in cold conditions, feet are the first to freeze. The shoes must have enough room for wiggling the toes, even when wearing several layers of socks. Winter shoes should be one or two sizes larger than summer shoes. When selecting footwear, their thermal insulation capacity against the cold ground, moisture resistance, and drying properties in field conditions should also be considered. Gore-tex shoes, for example, are sensitive to strong direct heat, such as heat from a stove or a camp fire. When warming the feet by a camp fire or stove, the shoes should always be removed in order to prevent the sweating of the feet which may result in frostbites. When warming the feet by the fire, the feet can be covered by snow in order to prevent sweating.

The boots always become damp from condensation after some period of use. This allows the feet to "loosen" up and become more at risk for abrasions, etc. The only way to avoid this is to change

the socks and insoles and dry the footwear. Wet footwear combined with damp or wet socks are very dangerous in winter conditions, as this will lead to frostbite injuries. It is recommended to use socks, which are mostly wool. The wool binds moist very well - up to 35% of its own weight and helps to keep feet dry. Wool has also good insulating properties even when damp. Synthetic materials are included to the natural materials used for socks to make them more durable.

On a normal day a male secretes about five centilitres of sweat from his feet. In order to reduce the risk of damage, one should have at least two pairs of socks on and another two pairs to change with.

It is important to recognize, that a foot is a very complicated structure and it can be difficult to fit the same type of footwear to all. Whatever kind of footwear is chosen - winter shoes or cellular rubber boots - one should always carry two sets of felt shoes and insoles to keep the boots and feet as dry as possible.

In the cold and wet environments the rubber boots are ideal. Warmth can be added to the rubber boots by using removable felt shoes inside. These need to be at least six millimeters thick with good insulation properties. The best feature of the felt shoes are that they will absorb the moisture from your feet and socks and keep them dry. The felt shoe moves moisture away from the foot to the outside surface of the

felt shoe and inside of the boot itself. This allows easy removal of moisture from the inside surface of the rubber boot with a paper towel for example.

As the rubber boots are flexible and waterproof, it is important that the sole takes up all “sharp” pressure from small rocks, etc. When the boots are fitted, one should stand on a small ball or similar to check that the pressure cannot be felt through the sole. If the pressure can be felt clearly, another pair should be chosen. The sole should absorb the pressure. An advantage of the rubber boot is that it is easy to put on and take off. They allow a good movement of the feet. It is recommended to bring two pairs of insoles and inner felt shoes along to the missions in cold conditions.

HANDS

The ability of the hands to function is reduced in the cold as the temperature of the hands decreases, as this reduces the sense of touch, muscular strength, and the mobility of the joints. Layering applies to hands as well. The layer closest to the skin should be a glove made from a thin fabric that enables short tasks requiring manual dexterity. One or two pairs of mitten-type gloves should be worn over the under glove, according to the required thermal protection. Wearing under gloves also prevents any accidental touching of cold metal. The ability to dry the gloves easily in the field is as important in gloves as it is in footwear.

Use of a shell glove and reinforcement gloves over it is recommended. Muscular work produces a lot of body heat and therefore, only one pair of gloves is needed to protect hands against wind and cold during work. However, an extra pair should be carried to be changed with, when needed. Wet gloves inside the reinforcement gloves should not be used. Thickness of the gloves is irrelevant, if the wrists are not protected. The wrist has very superficial veins and it is important to protect them well too.

HEAD

In order to survive the cold without frostbite, protection of the peripheral body parts is essential. The principles of layering also apply to the protection of peripheral body parts. Plenty of heat evaporates through the head due to its dense peripheral vascular system. For example, at a temperature of –20 degrees Celsius up to 80% of the heat production of the body evaporates through the head. When working in the cold, wearing a face mask in addition to other headgear is recommended. When estimating the effect of the cold, the wind index, which will increase the bite of the frost, must also be taken into account.

In minus degrees, protection of the face is very important also in order to heat the breathing air. Breathing in cold air (–20°C) under hard strain may result in permanent damage to the lungs. Using protective frost cream for protecting the face is not

recommended, as the majority of the creams contain water, which will freeze into a film on the face. Sweat cannot evaporate from under the film, and frostbite may occur.

Up to 75% of your body heat can be vented out from the head. A headgear will act as a lid to this ventilation. The size and shape of a hat is important. A hat needs to cover the forehead, but it is not allowed to press against the capillaries that supply blood to the forehead and thus brings heat to the head. Also the reinforcement cap should be big enough and windproof, since the headgear does not consist of multiple layers.

The head has small blood vessels that cannot be drawn together as in other parts of the body. This is because the body will not impair blood circulation to the head (brain). As the capillaries in the face will not tighten, the face does not need as much protection as the head. Therefore, most of the body heat is lost through the head. At minus 15 degrees about 75% of the body heat is lost through your head, if no hat is worn.

An adjustable helmet is needed in cold conditions, as protection is needed underneath. Goggles and ear protection are also needed when working on rescue mission. In winter time, goggles need to have UV protection.

THE THIRD AND FOURTH LAYER

The reinforcement garments are used as the fourth layer and should only be used to retain heat. They should not be used during physical activity.

When the garments get wet, it is essential that in field conditions they can be dried as quickly as possible. The outer gear should be loose to allow air to build up between the layers. There should also be room for some extra clothing under your jacket and trousers. Examples of extra clothing are heating jacket, thick sweater, winter hat, and semi long fiber trousers with zippers on the sides of the legs. The advantages of such pants are that the side zippers allow you to add or remove clothes without the need of taking off the boots and trousers. The extra layers should bind much air and thus provide good insulating properties, and are easy to compress. This saves in weight and volume when travelling.

The quality of kneepads is highlighted in cold conditions, as they provide more kneeling time while working in cold ground.

The outer shell garments should have been marked with one of the below listed European standards:

- EN 471 – High Visibility
- EN 342 – Protection against cold
- EN 343 – Protection against bad weather
- EN 531 – Protection against flames
- EN 1149 - Protection against static electricity

PERSONAL WELL-BEING

FOOD

Active operations in cold conditions may double the energy consumption of the body. During active operations in cold conditions, the staff should eat warm, easily digestible meals that contain plenty of carbohydrates several times a day. Even though a diet with a high fat content increases the basal body temperature the most, such meals are not as easily digested and should therefore be eaten only before going to sleep. The risk of dehydration is great, and therefore, one should regularly drink warm liquids that contain sugar even when not feeling thirsty. Smoking reduces peripheral blood circulation and increases exposure to frostbite. Alcohol expands the vascular system, and

therefore significantly increases heat loss. Cold makes the body to consume more energy. Carbohydrates give “high octane” fuel, which is good when working. Proteins build and repair cells and tissues. Fat has a high calorific value and should be used in order to increase your endurance and stamina. Extra fat should be added at least every three days, if on dried food diet. Never eat frozen food in cold and be sure to heat the food. When engaged in heavy physical labour in winter conditions, one should eat something at least every four hours.

WATER

Fluid balance as a prerequisite for the ability to function is equally important in both hot and cold weather conditions. In the field, dehydration poses a real risk. In a cold climate, the environment and heavy clothing increase the consumption of energy, which, in turn,

increases dehydration. Strenuous work causes sweating, and the nutrition consumed in the winter is often dry in order to prevent it from freezing.

Drinking should be done ‘pre-emptively’, in other words, long before feeling thirsty. The human body can absorb approximately 0.6 litres of fluid per hour through the stomach. Drinking cold or icy water should be avoided, as it may increase the blood circulation in the stomach as the body tries to warm the water. This reduces the peripheral blood circulation, which in turn increases the risk of frostbites in the fingers, toes, and face.

Keeping the required fluid unfrozen requires planning and constant control. One possibility is to keep the drinking water container (canteen or a Thermos flask) inside the clothing where the liquid will stay unfrozen. However, this amount of fluid is not sufficient for long-term

consumption. In extremely strenuous work, the human body needs up to five litres of fluid per day. Using a drink water reservoir bag (such as CamelBak reservoirs) under the clothes is not recommendable, as the bag may break or the valve may leak, making all clothes wet.

The need for liquids increases in the winter conditions, as in cold kidneys function faster and produce more urine. Four to five litres of water per day is needed. When working, it is better to drink little and often, and never to swallow snow or drink cold liquids. Should one drink cold drinks, they should be heated at least in the mouth before swallowing. Otherwise cold drink can cause diarrhea, vomiting or an upset stomach. Yellow and foul-smelling urine is a warning for dehydration.



GRAB BAG

Grab bag should always be near in case of any emergency. It should include:

- Ration food (Dry Tech or similar) for at least 24 hours;
- Emergency kit;
- Maps, GPS;
- Thermos;
- Extra clothes, socks, insoles, gloves etc.;
- Fire starter kit;
- Spork or similar;
- Extra flashlight, batteries etc.;
- Water.

GENERAL COOLING

When the body will gradually lose more heat than the body can produce, it is called general cooling. General cooling may occur in both plus degrees and minus degrees.

IMPACT OF WIND ON TEMPERATURE

The temperature is an important factor on the risk of getting frostbite. However, frostbite can occur at both plus and minus degrees, due to the wind chill factor. The wind chill factor lowers the real temperature compared to the air temperature. I.e. the more it blows, the colder it gets and the colder it gets the faster frostbite can occur.

Below diagram indicates how the wind chill factor impacts the air temperature at windy conditions. The wind chill factor should also be taken into account when a snowmobile, ATV or an open car is used.

HUMIDITY

Humidity in the air always feels colder than dry air even if the temperature is the same. This is because the body gives off about 25 times more heat to the water molecules than to air molecules. This is why cotton next to skin is to be avoided, as it binds moisture and stays wet for longer period.

		Air temperature in Celsius						
		+10	+5	0	-5	-10	-15	-20
Wind in m/s	2	+8	+2	-2	-7	-12	-17	-23
	7	+3	-4	-11	-17	-25	-32	-38
	11	0	-8	-16	-23	-31	-38	-46
	16	-4	-12	-19	-26	-34	-42	-49

The wind at 2 m/s is equal to 7.2 km / h.
The wind of 11 m/s is equal to 39.6 km / h.

HOW TO AVOID FROSTBITE IN VERY COLD CONDITIONS

- Cold, wind and water combined with duration can quickly lead to frostbite. Protect yourself;
- Control yourself and your partners;
- Attain knowledge on how to use your equipment in several ways;
- Pay attention to your body's signals;
- Learn to recognize and treat frostbite;
- Dress in multiple layers;
- Avoid sweating and pay attention to the body's ventilation points;
- Eat often and choose carbohydrate rich food;
- If you eat ration packs, try to add extra fat at least every third day;
- Drink often warm drinks at least 4-5 litres/day;
- Mind your hygiene;
- Stay in good physical condition.

CAUSES OF COLD DAMAGE

External causes of frostbite are temperature, wind, moisture, humidity and duration. Contributing factors to frostbite:

- Lack of knowledge;
- No or improper treatment of frostbite;
- Inadequate or improper clothing;
- Poor hygiene;
- Too little food and drink;
- Poor physical condition;
- Stress;
- Fatigue;
- Injury or illness;
- Lack of self-control and self-awareness.

SUPERFICIAL FROSTBITES

A superficial frostbite often arises in the face when exposed to the slipstream or at contact with steel etc. This type of injury is not dangerous, if it is treated immediately.

Symptoms of superficial frostbites are:

- Stabbing pain that turns into numbness;
- The skin becomes white and cold (white spot);

Treatment:

- Seek shelter from the wind;
- Strengthening the clothing;
- Heat immediately with body heat i.e. skin to skin contact;
- Gently press your palm against the white spot. If you have problems with one hand place it in an armpit;
- If superficial frostbite is in the feet, place them in a companion's armpit. During the process one should ensure that the wrists and ankles are insulated against the cold;
- Drink warm beverages;
- Change to dry socks, insoles, etc. and dry your wet clothes;
- Move yourself to increase heat production;
- If you have not been able to regain feel in frostbitten area in 20-30 minutes, the injury may be a deep frostbite;
- Never rub against a white spot. It only destroys the frozen cells.
- Strictly only slow heating of the white spots.

HEALTH AND MEDICAL OPERATIONS IN COLD CONDITIONS

Cold can become lethal very quickly, and therefore, search and rescue missions play a crucial role in saving patients in cold conditions. Once the patient is found, the greatest challenge lies in the combination of the type of injuries and keeping the patient warm, especially if the patient is stuck between structures. First aid procedures also become more difficult than usual in cold conditions.

In addition to providing first aid to the rescued victims, the tasks of Medical Support Team (MST) include providing occupational health care to the rescue taskforce, producing first aid services to the rescue dogs and rescuers, ensuring the safety of the operation site, and providing medical evacuation for the rescue taskforce staff, whenever necessary.

OPERATIONS ON SITE

The outdoor temperature, humidity, wind, heat insulation of the clothing, and the warmth produced by muscular work all affect the thermal balance of the body of an appropriately dressed rescuer cooling down, such as the weakening

of manual dexterity, can be seen at a temperature of +10°C during light work.

The cold affects the operation of blood circulation, the respiratory system, the peripheral nervous system, and muscles, as well as the secretion of hormones. In addition, cooling down slows the biochemical reactions and the coagulation of blood, for example. Cooling down the entire body decreases the physical and/or cognitive abilities, thus increasing the work load. The functionality of hands is particularly prone to weakening in cold conditions. Heavy exercise associated with increased ventilation and consequent respiratory tract cooling and drying may cause constriction in upper respiratory tracts.

Adapting to cold conditions takes approximately two weeks, after which the physiological responses to cold are usually attenuated and cold exposure is experienced as less stressful. Once a casualty is found, the rescuer must expose their own hands in order to treat the patient. Often the rescuer must kneel or even lie down next to the patient in order to get sufficiently close, which increases the conduction of cold, as the insufficient movement and cold conducted from the structures affect the rescuer. For this reason, the rescuers' exposure to cold must be minimised by working in short shifts, as far as possible.



TREATMENT OF PATIENTS

The fundamental rules of action for injured and possibly hypothermic patients are: Rescue – Examine – Dry and insulate – Evacuate.

Patients should not be unnecessarily exposed to cold, and intravenous hydration may only be started if the fluid can be kept warm. The optimal temperature for the infusion fluid is +37 to +41°C. It is not recommended to infuse fluids with a temperature lower than +25°C. Giving cold fluids is particularly harmful to hypothermic patients who can no longer increase their heat production with their metabolism.

The background of cooled down or hypothermic patients must be clarified as well as possible. Questions about any illnesses and injuries, drugs and medications, food and fluid intake, possible injuries, and the duration of exposure must be asked. A warm and sweetened drink can be offered to conscious hypothermic patients: increasing calorie intake will fuel shivering which will, in turn, increase heat production. If intravenous fluid is given, it must be warmed to between +37 to +41°C. For conscious patients, electrocardiogram (ECG) should be recorded before and during transit. Violent shivering may make it difficult to achieve a readable tracing.

Hypothermic casualties must be handled with care and sudden movements that

might stimulate ventricular fibrillation should be avoided. As the patient warms up, the risk of hypovolaemia and rewarming shock increase, if the fluid replacement is inadequate.

A non-hypothermic casualty in the cold will soon be hypothermic, if counteractive measures are not taken. It is essential to recognise the risks affecting the development of mild hypothermia, and how quickly it can develop.

Mild insidious hypothermia has been termed the “umbles”: the patient fumbles, grumbles, and later mumbles. Fine motor skills, such as handling

zippers, decrease, and the patient withdraws and becomes less sociable.

Other motor skills are also affected, and the patient will start to stumble.

CASUALTY PROTECTION IN THE COLD

Protection is one of the most important elements in the treatment of a casualty in cold conditions. In addition to the physical benefits of maintaining the body heat of the patient, the psychological benefits are also significant. Wet, cold and windy conditions demand sustained pre-hospital effort to prevent hypothermia of a seriously ill or injured casualty.

Casualty protection in cold conditions requires adequate thermal insulation and waterproofing and low air permeability. If the casualty is wet, replace the damp or wet clothing with dry clothing if possible, set the casualty on a thermally insulated surface, and protect the casualty with windproof blankets and covers. Heat packs can be used for additional heat for cold or mildly hypothermic casualties. These can be applied to armpits, groins or over the thoracic region. In addition, the casualty and the rescuer may be kept warm by blowing warm air into where they are located with portable, fuel-operated additional heaters. A disadvantage of warming the location is that humidity may condense in the surrounding structures and, in the long term, snow may melt, making the rescue operations more difficult.

FOLLOW-UP TREATMENT

The basic principle is that the locally rescued casualty are treated and stabilised for transit as far as possible before handing them over to the local health authorities. If the local health authority does not have the resources to receive the rescued casualties, the treatment may be temporarily continued at the camp, where the possibilities to treat and monitor the patient are better due to the light, warmth, and equipment available. It should be noted, however, that operating room facilities and therefore life-saving surgery is not available.



OTHER TASKS

The main task of the medical staff is to ensure the safety of the operation site. This task includes the evaluation of the operation site in cooperation with the immediate superior of the rescue staff, as well as monitoring the working methods and working conditions of the rescue staff. If a casualty is saved at the site, the medical staff will participate only in case the professional competence or license of the rescue staff is insufficient.

COLD WEATHER-RELATED INJURIES

FROSTBITE

In the cold, the surface blood circulation is reduced in the extremities of the body in particular in order to prevent heat loss, which results in reduced circulation and cooling down in these areas. Frostbite occurs when the tissue freezes as its temperature drops under -2 degrees Celsius. Fingers, toes, ears, nose, and cheekbones are particularly vulnerable to frostbite. Similar tissue damage may occur in the lower extremities (so-called trench foot) also at temperatures of 0 to -10°C , due to long-term immobility, moisture, or clothes that are too tight.

Checking yourself and others at extremely cold temperatures (buddy check) is extremely important, because frostbite often starts insidiously and

once it occurs, it may lead to long-term loss of the ability to function and even create permanent damage.

When the first symptoms of frostbite occur, the affected area should be immediately warmed with a warm hand. Do not rub the affected area, as this may result in even worse damage to the tissue.

Never warm frostbite directly on the camp fire or with the stove: the tissue is numb, and such heating may result in a burn. In addition, the loss of any more heat should be prevented, and the body temperature in general increased.

Severe frostbite always requires evacuation to the nearest facility that provides professional medical care. During the evacuation transport, the frostbitten area, such as a frozen leg, must be supported so that it cannot move, and slow melting must be prevented in order to prevent any further tissue damage. Extensively frostbitten areas should only be rewarmed at the facility providing follow-up treatment. Any blisters formed on the frostbitten area may not be burst due to a risk of infection. Do not offer alcohol, cigarettes, or coffee to a hypothermia patient, as these substances impair blood circulation.

BURNS

In cold circumstances, burns are most often inflicted when warming up or drying clothes. In addition, the numbness

of frostbitten hands may expose the hands to burns. The most important rule in treating burns is cooling down the skin, which may reduce the total skin area affected by the burn and prevent the burn from deepening. Make sure to cool the burn for a sufficient time period, approximately 10–20 minutes.

Cover the burns with the cleanest cloths or bandages available. Do not use any creams or puncture any blisters. During transport, keep the affected extremities of the patient with burn elevated and protect the patient from the cold.

HYPOTHERMIA

The symptoms of hypothermia include severe feeling of freezing and shivering. At the same time, the metabolism increases at first, but starts to gradually slow down as the body temperature drops. A patient suffering from hypothermia may become quiet and have difficulty in speaking or answering questions. The patient may appear apathetic and unresponsive. In addition, the patient may experience an unusual sense of well-being or seem confused. The patient's behaviour may be strange and even aggressive. Hallucinations are also possible. Once the core temperature drops to $+32 / +33$ degrees Celsius, the shivering stops. At approximately $+30$ degrees Celsius, unconsciousness ensues.

It is crucial that the medical staff recognise the symptoms of hypothermia as early as possible, in order to prevent the situation from becoming life-threatening. Hypothermia may develop quickly when falling into cold water. If the water temperature is close to zero, the victim will fall unconscious in less than 15 minutes and die in less than 45 minutes. Cold wind and moisture expedite hypothermia.

There are often frozen masses of blood in the extremities of a hypothermia victim, and careless moving of the victim, rubbing the legs and hands, or active external rewarming can release these into the central blood circulation and cause ventricular fibrillation in the heart. Moving a person suffering from hypothermia must be done very carefully: even turning the victim while removing the wet clothes may cause the cold masses of blood to move and result in the victim's death. Hypothermic patients are transported lying on their back; unconscious patients in the recovery position.

Do not start compression cardiopulmonary resuscitation (CPR) in the field. If the hypothermic patient shows signs of blood circulation but is not breathing normally or at all, continue with standard CPR with artificial respiration 10 to 14 times per minute, until the patient begins to breathe or is taken to further medical care.

KEEPING THE PATIENT WARM AND TRANSPORTING THE PATIENT

A trauma patient in cold conditions causes quite a challenge for the medical staff. The patient is usually lying down, which means that cooling down begins immediately. Lying on a cold base, often in wet clothes, increases the heat loss. If the patient has been still for a long time and is possibly hypothermic, it must be considered that hypothermia reduces blood coagulation and therefore prolongs bleeding. Examining the patient usually requires removing the patient's clothes at least partially or cutting the clothes open. Some kind of protection element, such as a blanket, would be useful. When beginning treatment with intravenous fluids, the infusion bags must be warm so as not to worsen the potential hypothermia.

When evacuating a patient, the patient must always be kept warm during transport. Battery-heated vests or blankets as well as chemically activated heating bags can be used as additional heaters. Hot water bottles or other containers containing hot water can be used as substitute heaters.

IMPORTANT TO REMEMBER

- Practice in the conditions in which you will have to work;
- Knowing the theory is not the same as knowing what to do in practice;
- When operating in extreme conditions, members of the crew with limited skills are a safety risk, and reduce the performance of the entire team;
- As the conditions become worse, the significance of leadership increases;
- Routines are extremely important in all operations.



TRAINING IN COLD CONDITIONS

Before starting the practical training of the team in cold conditions, the trainees should have the basic knowledge and skills as well as some experience on the themes of the training. As training in cold conditions is in itself extremely demanding and challenging, there is a risk that the learning objectives are not met due to the harsh conditions, if the theme of the training is completely new to the trainees.

The trainees should be healthy and motivated when starting the training, and they should have the required equipment with them. Before starting the training, a health examination to verify the physical and mental condition of the trainees should be organised for example by the Medic group that participates in the training.

The training location should be carefully selected. It is not sensible to start the training by shovelling snow, for example, which will make the trainees sweat and tire them. After such hard work, tiredness may disturb their concentration and together with the sweating, increase the risk of frostbite and freezing. If possible, the training can be carried out in cold indoor facilities (storages etc.), in which there is no risk of damages caused by hard wind or heavy snowfall.

The training groups should be divided so that there is something meaningful to do for each member of the group. Through doing so, unnecessary standing around doing nothing can be avoided, which may expose the trainees to freezing.

On the other hand, if the group's size is too small and the work pace too fast, the quality of the training will suffer, and the problems caused by sweating and tiredness are emphasised. Attention should be paid to the group dynamics: the group should be as homogenous as possible, and the qualities of the individual members should strengthen and correspond to the qualities and skills of the others.

The trainer should pay special attention to occupational safety and intervene in any issues, even if they seem trivial; when working in cold conditions, occupational safety has a greater significance. The training should be organised in sequences so that there is a sufficient number of short breaks at regular intervals, during which warm liquid and whenever necessary, light nutrition, is consumed. This factor should be considered already when planning the logistics of the training event.

It should be made clear to the trainees that they must constantly observe the functions of their bodies. In case of any unusual symptoms arise, the operations should be stopped immediately and applicable actions taken. In addition,

each member of the group is obligated to observe the other members of the group and be actively interested in their physical and mental status.

Abnormal symptoms:

- Unreasonably strong exhaustion in relation to the level of strain;
- Dizziness, nausea;
- Numbness of legs or arms;
- Numbness or pricking sensations in the peripheral body parts;
- Strong headache;
- Chills, strong shivering due to the cold, strong trembling of muscles;
- Declined judgement or initiative;
- Visible frostbite;
- Hypothermia (core temperature below +35°C, measured from the rectum).

In terms of the training time, it might be most efficient to organise the formal, preparatory training in the summer or autumn, when the conditions for learning new things are most agreeable. The actual training in cold conditions should take place in January to March, when the natural cold adaptation of the trainees has taken place, and the readiness to operate in cold conditions are significantly better than in the beginning of the winter. Naturally, the constantly changing climate in the country poses its challenges, too.

COLD CONDITION TRAINING IN VARYING CONDITIONS

Once the training level, basic skills and routines of the team increase, various natural elements and elements created by the trainers can be utilised in increasing the challenge level of the exercises.

DARKNESS

Organising exercises in the dark provides a whole new perspective to training. Many familiar and even simple things become challenging once the lighting conditions change. As possible, operations in the dark could be practiced round-the-clock with the different training groups, for instance in an industrial hall with the windows covered to make it dark. Particularly in rope rescue training, this is often the safest option, as the risk of damage caused by wind and snowfall can be eliminated.

COLD

In Finland, the weather is usually sufficiently cold for organising challenging training events from December to March. The best time for extremely challenging conditions is probably the turn of January and February, when the temperature often ranges between -20 and -30 degrees Celsius. In these conditions, the trainees must already be



fairly experienced in the various working methods. An additional challenge can be created by arranging longer trainings, during which tiredness brings an added challenge to the training. In tasks of this type, the role of absolute work safety is emphasised, and the number of trainers must be sufficient to ensure the safe organisation of the training event.

STRUCTURES

Already in the beginning phase of the training, once the skills of the trainees are formally at a sufficient level, plenty of applied situations in different kinds of locations should be arranged for the trainees. These exercises can concentrate on one area of special expertise only (such as shoring) or stage a scenario that requires the flexible interweaving of several areas of expertise (such as shoring-breaking and breaching, lifting and moving or breaking and breaching-rope rescue-first aid). The exercises can be adapted and made more difficult or less difficult by facilitating certain activities, considering the prevailing weather conditions. This emphasises the role of the trainer and their ability to know the requirements of the situation - the trainer must be able to make changes quickly without compromising the exercise. The trainees' level of training skills also plays a major role in creating a successful training event: the exercise's level of difficulty should increase steadily, while the exercises should not be too challenging.

As in any training event, occupational safety is the most important matter. All training events should be safe for the participants despite the extreme strain and physical exertion they may impose. All training events and exercises should be planned carefully, and there must be a sufficient number of staff in the organisation in order to keep the total load from becoming too great.

TOOLS IN TRAINING

The equipment and tools used in cold training should be designed for operations in cold conditions. The tools must be maintained and inspected and a sufficient number of spare parts should always be available. The majority of the problems are caused by battery-operated or pneumatic tools, whose operations are significantly hindered by cold weather. Operations must be planned so that the batteries can be charged in a warm facility, and that the tools can be stored protected from the cold when not in use. Pneumatic tools should be kept warm and dry. Pneumatic hoses and connectors must be sufficiently large in diameter, and they must be designed for use in cold conditions. The personnel must know how to correctly use and service the tools.



EQUIPMENT IN COLD

BASIC PRINCIPLES ON EQUIPMENT IN COLD

Basic principle for equipment usage and maintenance in the cold is to avoid and prevent the equipment from freezing. If the equipment freezes it is usually rendered useless. Freezing can be avoided mainly by reducing condensation and removing snow and frost from the equipment.

Condensation, also called sweating, is water appearing on metal surfaces due to change of temperature from cold to

warm. Condensed water commonly appears on equipment when it has been moved indoors from cold or when the equipment has warmed during use. As condensation occurs on all metal surfaces, equipment can also freeze from inside. Condensation can be avoided easily by storing equipment outdoors, if possible, or in storages with lower temperatures thus reducing the temperature change. If the equipment is brought indoors for maintenance, the maintenance should be started only after approximately one hour, when the condensation water has dried.

If the equipment is wet due to condensation or melted snow or frost, it should be dried before exposing it to the cold. If the water in the equipment freezes, it can cause severe malfunction and damage to the equipment. Fuel systems malfunction, if there is water or ice inside. After the equipment is dry it should be treated with lubricants designed for cold and arctic temperatures. If these are not available for example some petrol products (e.g. kerosene/paraffin/etc.) can be used as a surface lubricant.

In cold conditions the equipment will very likely come in contact with snow. This on its own is not dangerous for the equipment, but if possible some insulation should be placed between the equipment and snow. It should also be taken care of that the snow does not get into critical parts of the equipment (non-covered electronics, engines, air-intakes, etc.). These parts should be covered and if necessary cleaned. Normal exposure to snow does not affect these parts but if the equipment is dropped or the snow is blown by the wind, these parts can be exposed and affected by snow.

MATERIALS

Cold affects all materials in some way and therefore, it must always be considered what materials are used in the tools and equipment brought to cold climates. Rubber and plastic can become brittle and for example rubber coated cables can easily break, if not

warmed before bending. Metals cannot withstand stress or a shock as much as in warmer conditions. Fabrics stay flexible if kept dry, but if they get wet and freeze, they will lose flexibility very fast.

As a general rule to prevent unnecessary damage to equipment, all items should be kept as dry as possible and should not be bended, twisted or stressed unnecessarily in the cold. If equipment can be warmed, even slightly, it should be done.

ELECTRONIC EQUIPMENT

Electronic equipment should always be protected from extreme cold and from the effects of ice and snow. The main difficulty with electronics in the cold is

the fast depletion of batteries and the lowered output of power sources. Also electronic equipment should be kept at a stable temperature. Often rapid changes of temperature are more damaging to electronics than mechanical equipment.

In all situations the connectors, switches and antennas of the electronic equipment should be kept dry and clean from snow. If large electronic equipment such as field radios is not stored and used in warm spaces, they should be placed in an insulated container. This preserves the charge on the batteries and power sources and reduces condensation.

The batteries used for the equipment should be either nickel-cadmium (NiCa)

or lithium sulfur dioxide (Li-SO₂) as they have better performance in cold conditions. Dry cell batteries are not recommended for cold temperatures.

Personal and smaller electronics (hand held radios, GPS-receivers, various measuring equipment) can be protected from the cold by keeping them inside the users clothes thus insulating the equipment alongside the user. Breathing directly at the equipment should be avoided as moisture from the breath will freeze on the equipment.

Some electronics are designed to be used in cold and arctic temperatures. In these cases the equipment is usually better shielded against the environment and may contain special design features (such as routing heat produced by the equipment through the LCD-display preventing the display from freezing). It should be noted that even this kind of equipment can rarely stand direct exposure to the elements for longer periods.

MECHANICAL EQUIPMENT

Mechanical equipment reacts to cold very much according to the principles described in chapter "Basic Principles". Condensation and freezing can be seen as the main problems for mechanical equipment. These can be prevented by regular maintenance, use of proper lubricants and protecting the equipment from the environment whenever possible.



Mechanical equipment can also suffer from sluggishness in cold climates. This is the result of the lubricants temperature dropping below its optimal and thus losing its liquid form. This can be prevented by using lubricants designed for cold and arctic climates. This kind of lubricants have significantly lower freezing point and thus they stay liquid much longer than lubricants designed for warmer climates.

As said, the equipment should be kept clean and dry. However, if the equipment freezes de-icing agents can be used to remove the ice from the equipment. If these kinds of agents are not available the equipment should be warmed gradually preferably indoors. After the ice has been removed the equipment should be cleaned and dried to prevent further freezing.

VEHICLES

In the winter, the driver must know how to protect their vehicle from the cold as well as any methods and tools needed for cold starting the vehicle. Incorrect actions may result in the failure to start or cause damage to the engine or other equipment of the vehicle.

Procedures to be carried out in order to ensure the working order of the vehicle include:

- Maintenance of the cold starting equipment;
- Maintenance and condition inspection of the batteries;
- Protecting the components and connectors of the electric system from moisture;
- Changing the oils of the engine and

the transmission gear to a fluidity that is suitable for winter conditions;

- Ensuring the frost resistance of the coolant;
- Removing water from the fuel system and refueling with a fuel suitable for winter or arctic conditions;
- Removing water from the pneumatic brake system every day.

When protecting a motor vehicle from the cold, the thermal energy stored in the engine and transmission gear components should be utilised by protecting the engine air inlets and outlets with cardboard sheets or covers. The effect of cold wind to the parked vehicle should also be considered.

When the temperature is below -10 degrees Celsius, the engine must be preheated before starting. One cold

start at a temperature of -20 degrees Celsius without preheating wears down the engine as much as driving 300 to 400 km. An engine block heater, a cold start pump, or an external heater powered by the vehicle's fuel can be used to assist in cold-starting the vehicle.

In case of an emergency, the engine sump can be heated with a blowtorch, for example. Cold starting can be made easier by running the engine regularly for a while in regular intervals. The warm-up running should be executed the more often the more the temperature drops. For example, at a temperature of -20°C , it should be performed every three to four hours, and at a temperature of -40°C , every one to two hours. Run the engine at least 15 minutes each time.



STANDARDS ON ENVIRONMENTAL EFFECTS ON EQUIPMENT AND MATERIAL

There have been several different standards employed to test equipment's endurance against various environments. Military organizations have created their own standards and these are commonly used also by civilian users. Most known are the United States Department of Defense's MIL-STD-series and the NATO standard STANAG. In the MIL-STD-series MIL-STD 810F Methods describe the different testing methods for what the equipment is exposed. For equipment used in cold climates the important methods of testing are 810F Method 503.4 (Temperature shock); 810F Method 521.2 (Icing, freezing rain) and 810F Method 502.4 (Low temperature). For NATO STANAG-series the determining standard is STANAG 2895 – Extreme climatic conditions and derived conditions for use in defining design and test criteria for NATO materials used by NATO forces.

These standards are useful when releasing a tender for equipment as these standards or parts of them (e.g. the climate designations) can be used to determine the properties of the required equipment. By using the standards it is also clear to the manufacturers and suppliers that what kind of equipment is needed.

It should still be noted that often manufacturers state that their products comply with MIL-STD 810F. This is physically not possible as the standard is a variety of different measures and no product is capable of complying with all criteria. Commonly the product claimed to comply with MIL-STD 810F is designed to pass one or more of the criteria but no actual measuring and testing has been conducted. If the product is complying with the standards the products manufacturer should be able to give the detailed method it has been tested with. Also as per the standard testing procedure the manufacturer should inform if the testing has been conducted internally or by an external testing company or organization.



INFORMATION AND COMMUNICATION TECHNOLOGY IN COLD CONDITIONS

An information and communication technology (ICT) module has been established as a part of the Finnish Cold Conditions Module (CCM). Its task is to manage the information and communication contacts of CCM and to produce the basic office services. The ICT module consists of computers, satellite phones, GSM phones, VHF radio phones, GPS devices, cameras, printers, various network components, and normal office supplies.

SECURING THE OPERATION CONDITION OF THE MANAGEMENT TOOLS

Communication equipment must be protected against cold, as it reduces the capability of power supplies to transmit and freezes the accumulators. Emergency power supplies should be stored under the clothing, for example. Any unnecessary moving of electronic equipment, from warm space to cold conditions in particular, should be avoided in order to prevent the humidity accumulated in the equipment from freezing. In low temperatures, the plastic parts and cable insulation become brittle and hard, and may freeze. Communication equipment may not be set directly on cold ground or snow, but sufficient insulation, such as a back bag, pine, spruce twigs

or similar, should be placed under them. Breathing or blowing in the connectors of communication equipment is forbidden, as the humidity created from the breathing may freeze the connectors. Connectors can be protected by taping, for instance. The microphones of radios and phones can be protected with a plastic film, for example.

SPECIAL REQUIREMENTS FOR THE ICT EQUIPMENT IN FIELD CONDITIONS

As the ICT module is a part of the CCM, all ICT equipment must endure extremely harsh conditions. In the selection of the equipment, the ICT module ensures that the equipment is very resistant to moisture, extreme temperature variations, dirt, and other problems arising of special conditions.

Equipment tested with well-known and widely used standards, such as the United States Military Standard MIL-STD 810 or the IP Code, should be favoured.

The IP Code is used in Europe to rate sealing electric appliances. The IP Code classifies and rates the degrees of protection in electric appliances against the intrusion of external environmental conditions, such as dust and water. In electronic appliances, a two-digit IP code is usually used. For example, the first digit of the code IP 54 indicates product's level of protection against the ingress of foreign objects or dust (Dust protected), and the second digit indicates that the

electric appliance is protected against water splashing onto the enclosure (Splashing water). Table 1 indicates the degree of protection in IP rating tests.

The MIL-STD-810 standard is a series of tests developed by the United States Army in 1965. The purpose of these tests is to define the applicability of equipment for many kinds of military use. The system is more accurate than the IP rating for defining the suitability of equipment for certain types of outdoor use, for instance. The tests are updated regularly, and at the moment, the standard MIL-STD 810G, first commissioned in 2008, is in use.

There are a total of more than 20 tests for various purposes of use, of which Table 2 shows the most popular tests for equipment used in civilian operations. The number affixed to "MIL-STD 810", such as 502.3, indicates the method used for testing the equipment.

For both standards, the manufacturer is responsible for deciding which rating or test to use for testing the equipment, after which an independent testing organisation will perform the test.

For example, the Panasonic CF-19 laptop computer has been issued the IP65 code for dust and water protections as well as the MIL-STD 810G 516.6 standard for protection against drops and vibration (included in the 516.6 test). The equipment used by the Finnish

ICT module are generally not MIL-STD 810 approved or IP rated, however, the GPS equipment, VHF radiophones, and some of the satellite phones fulfil some of these requirements.

EFFECT OF COLD CONDITIONS ON THE ICT EQUIPMENT

In cold conditions, most problems are caused by humidity and variations in temperature. The circuit boards and other components in the devices do not

tolerate humidity or great variations of temperature, especially when the internal temperature of the device changes rapidly.

All devices have been determined certain temperature limits within which the device should be used. Should the temperature rise above the recommended limit, the cooling down of the components will be a problem, eating away from the power and even damaging the components, if the cooling system is not sufficiently efficient. In cold conditions, the device

TABLE 1

IP 0x	Not protected	IP x0	Not protected
IP 1x	Protected against solid foreign objects with a diameter of 50 mm and greater (such as harmful touching by hand).	IP x1	Protected against vertically falling water drops (condensation).
IP 2x	Protected against solid foreign objects with a diameter of 12.5 mm and greater, such as tools and cables.	IP x2	Protected against vertically falling water drops when enclosure is tilted up to 15°.
IP 3x	Protected against solid foreign objects with a diameter of 2.5 mm and greater, such as fingers.	IP x3	Protected against sprayed water when enclosure is tilted up to 60°.
IP 4x	Protected against solid foreign objects with a diameter of 1.0 mm and greater.	IP x4	Protected against water splashed against the component from any direction.
IP 5x	Dust protected. Protected from the amount of dust that would interfere with normal operation or risk the other ratings of the appliance.	IP x5	Protected against water jets. Protected against water projected in jets from any direction.
IP 6x	Dust tight.	IP x6	Protected against water projected in powerful jets from any direction.
		IP x7	Protected against temporary immersion in water. (1 m, 20 °C and 30 min.)
		IP x8	Protected against continuous immersion in water, as specified by the manufacturer.

may, in theory, operate even faster than normal as no cooling down is required. However, the cold resistance of the components may become an issue. Equipment designed to be used in cold conditions are equipped with separate heaters that keep the components warm and ensure operation up until a certain temperature. If the device is battery-operated, the usage time of the device is reduced, as the heaters use the power of the battery.

Examples of possible problems:

1) Moisture condensation inside the device: If the device is brought from the cold into a warm environment, moisture will begin to condense on the surface of the device and its internal components. If the device is started right away, the accumulated moisture causes a risk of short-circuit in the device, which may in the worst case damage the device beyond repair. The device should be left unused for a sufficient period of time in order for the moisture to evaporate and the risk of short-circuit to be eliminated.

2) Displays: The LCDs (Liquid Crystal Display) used in the modern devices are extremely sensitive to cold. The activity of the liquid crystals inside the display slows down as the temperature drops, and if the temperature drops sufficiently low, it stops completely. In devices designed for cold conditions and equipped with LCDs, the displays are equipped with heating.

3) Batteries: The service life and durability of the battery is quickly reduced by using it extensively in cold conditions. Batteries should always be charged at room temperature, never in cold conditions.

All electronic appliances that have not been specifically designed to be used in cold conditions require heating in order to avoid hardware failure. When using so-called normal equipment, their use within the CCM should be restricted to heated tents. When the equipment is used in the field, their temperature should be allowed to settle before starting them, especially when they are brought indoors or into warm facilities from the cold.

TABLE 2

MIL-STD 810G 516.6 (Shock)

The device is dropped onto each face, edge and corner for a total of 26 drops from a height of one meter. The device must remain intact after the test both internally and externally.

MIL-STD 810G 514.6 (Vibration)

Vibration and shock tests that ensure the durability of the device for instance in highly demanding military vehicle use (such as tanks).

MIL-STD 810G 506.5 (Spill resistance)

The spill resistance test ensures the protection of the ports and keypad of the device so that the device can be used for example in rain.

MIL-STD 810G 501.5 (High temperatures)

The device must endure storage at +70 C and operation at +60 C.

MIL-STD 810G 502.5 (Low temperatures)

The device must endure storage at -50 C and operation at -30 C.



SEARCH DOGS IN COLD CONDITIONS

SEARCH OPERATIONS WITH DOGS IN COLD CONDITIONS: BASICS

In the Nordic Countries and other cold areas, cold conditions are a natural part of the annual change of seasons for both dogs and people. Nevertheless, cold causes additional stress to dogs also during search missions. Snow and frost can make search operations challenging: moving becomes more difficult, everything smells different, and the minus degrees may impair the dog's ability to use its nose. The prevailing conditions should be observed both during the search mission and during breaks.

Several factors affect the dogs' cold resistance, and there is great variation between different breeds,

as well as between individual dogs. A dog that is used to living outside, for instance in a pen, has probably adapted to varying weather conditions and will cope with cold conditions better than dogs that live indoors.

WELL-BEING OF DOGS IN COLD CONDITIONS

Keeping a steady body temperature is necessary for maintaining the vital functions of the dog, as it is for any other warm-blooded mammals. The normal temperature varies between species and individuals, and cold adaptation does not change this temperature. For dogs, the normal body temperature is 38.9 ± 1 degrees Celsius.

In terms of heat economics, the body system can be divided in two: the core and the surface. The core consists of the brain, the abdominal cavity, and the

thoracic cavity, while the surface consists of the larger muscles and the limbs. The core temperature can be maintained level even though the temperature in the surface area might vary. Local temperature variations reduce the heat and energy loss of the body, enabling the dog to keep the temperature of the most significant body parts relatively stable.

However, keeping the body temperature stable requires plenty of energy. Temperature regulation takes place as a complex collaboration of various tissues and organs. Controlling the blood circulation, vibrationless heat production, trembling, piloerection, and panting are some of the methods dogs use for temperature regulation. Failure of the temperature regulation system in cold conditions causes hypothermia, a condition in which the core temperature of the body drops below the normal. The body emits more heat to the environment

than the heat production mechanisms are able to produce. In addition to extremely cold conditions, hypothermia can be caused by the combined effect of cold air and humidity, certain diseases that affect the basal metabolic rate, shock, or sepsis.

In cold conditions, the coat becomes even more important. The coat of arctic breeds has two layers. The undercoat is thick, soft, and downy, and operates as insulation, reducing the temperature drop in the surface areas. The fur in the topcoat is often coarser and more rigid, protecting the undercoat. Piloerection, i.e. erection of the hair, improves the insulation properties of the fur coat. The coats of dogs living outdoors and indoors are different.

The size of the dog is another factor affecting the way the animal can adapt to cold conditions. In small dogs, the ratio between surface area and volume



is greater than with mid-sized or large dogs, which means that heat loss is greater in small dogs than in large dogs.

In addition, the body shape, thickness of the fat layer, and the sex of the dog also affect its cold resistance. A fit dog has better chances of managing outside in the cold than ill, possibly medicated dogs. In addition, recovery from illness requires more energy in cold than in warm conditions. Also age plays a part: due to slower metabolism, older dogs freeze easier than young dogs.

Short-haired dogs are particularly prone to frostbite in extremely cold conditions. The ears, paws, groins, teats, foreskin, testicles, tail, and nose in particular are at risk of freezing. Dogs should be examined daily, and any damage should be treated. Wet dogs are very vulnerable to freezing. In cold conditions, dogs may suffer from limber tail syndrome, also known as cold water tail. The problem is painful, and the recommended treatment is rest and anti-inflammatory drugs. The first aid team should be prepared with the appropriate medication and equipment for injuries caused by cold conditions.

Different clothes can be worn on dogs – and this is in fact recommendable. A winter coat provides additional insulation. A thin wool or fleece blanket coat helps the dog to dry and keeps it warm – blanket coats can also be worn under winter coats. A blanket coat made from ceramic cloth (such as Back

on Track) reflects the body temperature back, thus reducing muscle tension and helping recovery and the maintenance of the dog's performance. If necessary, paws can be protected by fleece booties, such as those worn by sled dogs.

The dog should have a protected, warm place of rest with no draught, which could be a designated spot in a warm tent, equipped with an insulated bed, and if necessary, a sleeping bag.

Cooling liquids that contain toxic ethylene glycol to improve frost resistance pose a specific risk to dogs: ethylene glycol attracts dogs, and if



consumed, it may lead to intoxication which at worst causes fatal damage to the central nervous system or the kidneys. This should be considered in camp conditions by preventing the dogs' access to ethylene glycol.

THE OPERATIONS OF THE DOGS AND ITS HANDLER IN COLD CONDITIONS SEARCH CONDITIONS

The prevailing conditions should be observed both during the search mission and during breaks. The same basic principles for operations in cold conditions apply to both the dog and its handler.

Working in cold conditions increases water and energy consumption, which is why sufficient energy and water supply must be ensured. Eating snow is not a substitute for drinking even for a dog; there should be enough unfrozen water for example in a Thermos flask. If necessary, drinking water can be made more appealing to a dog by adding bouillon to the water, for example.

Moving about keeps the body warm and layered clothing is recommended. There is no use in unnecessarily sweating the dog, or getting sweaty yourself. A brief warm-up before a search mission reduces the risk of spraining the muscles both for the dog and the handler. It is equally important to remember to cool down after the search mission by walking and stretching.

Wind and humidity increase the effects of the cold, and a wet dog is more vulnerable to frostbite. The risk of slipping for instance on slanted surfaces should also be considered when working in cold conditions. Slipping may cause damage to the musculoskeletal system: skeletal muscles, tendons, ligaments, and joints are at risk.

THE EFFECT OF SNOW ON SEARCH MISSIONS

The snow situation and the terrain effect the search operation. Ample, soft snow is difficult to walk in without sinking, and if possible, crusted snow should be

utilised in the search operations. Heavy snowing can cause an avalanche risk on slanted slopes. Snow may also cover thin ice, or make dangerous or unstable structures more difficult to detect.

Clotted snow can make it more difficult for the dog to move, or even prevent using the dog in the search operation. The paws and body of dogs with thick or long hair gather clotted snow easily, particularly at thaw.

The passage of air currents may change according to the gathering and melting of snow, which should be considered in the plan for the search mission.

TRACKS AND TRAILS

Smells do not keep to snow as well as they do in the vegetation in the summer. Severe cold can evaporate the scent of the trail at a quick pace, but air scenting can be carried out even then. Ploughing the roads and snow melting can also make tracking and trailing more difficult. At the same time, the tracks left by the object of the search in snowy terrain are often visible, and can help in focusing the search into the right direction.

WORKING TIME FOR OPERATIONS IN COLD CONDITIONS

The working time suitable for the dog depends on the weather conditions as well as properties of the dog and the handler. The temperature limit for search and rescue missions is often set at -15°C when training, but in real situations dogs are worked at lower temperatures. Normally, cold affects the handler more than it does the dog.

Cold air is dry and strains the respiratory system. Furthermore, cold can reduce the optimum capacity of the dog's nose to some extent, but not significantly. Search missions should be carried out at a reasonable pace, with careful consideration, and avoiding unnecessary sweating. It is also very important to remember to warm up before the mission and to cool down after.



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