Norwegian Water Resources & Energy Directorate

Svartisen Subglacial Laboratory (SSL)

Human Risk Assessment

Report Revision 08
22. May 2012
Summary:

Svartisen Subglacial Laboratorium is in this report called SSL for short. SSL is operated periodically all year round with participants from many countries.

Upgrading of safety installations and further safety measures have been performed and finalized in March 2012. Extensive description of SSL has been performed.

The objectives of the risk assessment are to ensure the safety of any persons present in the SSL, to protect property and equipment, to ensure continuous research operation and to minimize interruptions due to incidents. All known risk of incidents have been addressed and assessed. Incidents are characterized by probability of incidents, consequences for life and health, consequences for the environment and consequences for loss of values. The applied risk matrix is shown. Every identified possible incident has been ranked according to this matrix. Detailing of possible incidents has been performed.

The safety of SSL complies with all Norwegian relevant legal safety provisions.

NVE has stated a risk matrix with limits for their acceptance.

<table>
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<th>Date</th>
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<th>Prepared by</th>
<th>Approved</th>
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<td>22.05.2012</td>
<td>Final report last revision</td>
<td>Ole A. Westberg</td>
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<td>00</td>
<td>10.12.2010</td>
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<td>Ole A. Westberg</td>
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1 ABSTRACTION OF THE RISK ASSESSMENT REPORT

This human safety chapter is an abstraction of the Risk Assessment Report. It is printed out separately for daily use at SSL.

1.1 Introduction

SSL is operated periodically all year round, with participants from many countries. However, most activity, especially melting out ice tunnels, takes place between October and April.

Safety measures have been performed from 2007, through 2012 and finalised in February 2012.

A detailing of possible incidents has been performed. Relevant Norwegian legal provisions are listed in Norwegian. Words, expressions and abbreviations used are listed. Reference documents are listed.

1.2 Words and abbreviations

Svartisen Subglacial Laboratory is abbreviated to SSL.
It has been decided to state all proper nouns in Norwegian.

1.3 Safety Philosophy

Persons staying in any area of the SSL will be early warned in case of a fire/smoke outbreak. A number of fire detectors are mounted in all areas where fire might break out. Smoke detection will be initiated within seconds in order to make escape possible before the fire develops into severe stage. All persons bring with them escape masks all time. The escape into one of the two safe rooms takes maximum 10 minutes from anywhere in SSL. The safe rooms have escape mask for the evacuating to the next safe room or to the SSL exit.
1.4 Safety Objectives

Risk definition, risk level and limitations have been stated. The owners of the tunnel system, Statkraft, and local fire protection authorities have been informed.

The objectives of the risk assessment are to ensure the safety of any persons present in the SSL, to protect property and equipment, to ensure uninterrupted research activity, to minimise interruptions due to incidents and to raise the organisation’s awareness regarding safety.

1.5 Human Risk comply with legal provisions

The risk for humans to stay and work in SSL complies with all relevant Norwegian legal provisions:

1. Regulations related to fire prevention and inspection. (FOBTOT- Brannforebyggende-forskriften).
2. Systematic health, environmental and safety activities in enterprises (Internkontrollforskriften).
3. Regulations relating to contingency planning in the power supply system. (BfK Beredskaps-forskriften).

1.6 Addressed danger and incident event types

Fourteen incident event types have been addressed:

1. Accident on the way to and from SSL on foot.
2. ATV driving accident.
3. Accident on the way to and from SSL with helicopter.
4. Injuries by falling.
5. Accident by rock falls.
6. Fire outbreak in a lighting fixture in the upper part of Adkomsttunnelen.
7. Hot water boiler rupture.
8. Fire outbreak in Laboratoriet.
10. Tunnel flooding.
11. Fire outbreak in one of the electrical cabinets outside buildings.
12. Fire outbreak in the ATV.

1.7 Probability and Consequences of incidents

Each addressed incident is characterised by probability of the incident, consequences for life and health, consequences for the environment and consequences for loss of value. Every risk is shown in a risk matrix. Preventive conditions as premise for the risk assessment results are: No oil cables are installed, no mineral oil in any transformers, all inflammable materials stored in a safe location in Adkomsttunnelen, all rooms in buildings are equipped with fire detectors, all areas are equipped with warning sound/light devices and satisfactory admittance procedures are implemented.
1.8 Probability and consequences of addressed incidents

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<th>PROBABILITY</th>
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<tr>
<td>1 Accident on the way to and from SSL on foot.</td>
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<td>2 Accident on the way to and from SSL with helicopter.</td>
<td>1</td>
<td>4</td>
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<td>3 ATV driving accident. (ATV=All-terrain Vehicle).</td>
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<td>3</td>
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<tr>
<td>4 Injuries by falling.</td>
<td>3</td>
<td>3</td>
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<tr>
<td>5 Accident by rock falls.</td>
<td>2</td>
<td>3</td>
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<tr>
<td>6 Fire outbreak in a lighting fixture in the upper part of Adkomstunnelen.</td>
<td>4</td>
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<tr>
<td>7 Hot water heater rupture.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>8 Fire outbreak in Laboratoriet.</td>
<td>3</td>
<td>1</td>
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<tr>
<td>9 Fire outbreak in Boligkvarteret.</td>
<td>3</td>
<td>1</td>
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<tr>
<td>10 Tunnel flooding.</td>
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<tr>
<td>11 Fire outbreak in one of the electrical cabinets outside buildings.</td>
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<td>1</td>
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<tr>
<td>12 Fire outbreak in the ATV. (All-terrain Vehicle).</td>
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<td>13 Secondary oil mist explosion outside Transformer No 2.</td>
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<tr>
<td>14 Sabotage.</td>
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1.9 NVE stated acceptable risk levels

NVE has stated a risk matrix, as shown below, with limits for their acceptance. Caution required means acceptable, but requires special attention to specific threats during operations in or to/from SSL.
1.10 **Safe Rooms**

In order to fulfil escape and evacuation requirements, safe rooms have been built.

The safe rooms are equipped with compressed air in bottles to create an overpressure in the room. The first person who arrives at a safe room shall open the bottle valve and enable air flow of 5 litres per second to stream into the room.

![Safe room 1](image1)

![Safe room 2](image2)

1.11 **Rescue equipment**

SSL is equipped with rescue equipment such as Escape masks, Fire hoses, Hand-held extinguishers, Stretcher, First Aid equipment, and fire blankets.

1.12 **Fire alarm equipment in Boligkvarteret**

![Diagram of fire alarm equipment](image3)
1.13 Fire alarm equipment in Laboratoriet

![Diagram of Laboratoriet with marked escape routes]

Escape routes marking

All escape routes are equipped with marking plates.

2 DEFINITIONS, ORGANISATION AND LIMITATIONS

2.1 Safety Philosophy

The safety installations in the SSL were upgraded in 2010/11 according to a superior Safety philosophy plan because:

1. Persons staying in any area of the SSL will be early warned in case of a fire outbreak. A number of fire state-of-art fire detectors are mounted in all areas where fire might break out within seconds in order to make escape possible before the fire develops into severe stage.
2. All persons carry or bring with them escape masks all time.
3. The escape into one of the two safe rooms takes maximum 10 minutes.
4. The safe rooms have escape mask for the evacuating to the next safe room or to the SSL exit.
2.2 Risk definition, risk level, limitations

2.2.1 Risk definition
The risk analysis approach employs two fundamental elements: the probability of an incident occurring and the consequences if the incident should occur. Risk is therefore the probability of an incident related to the consequences of the incident. Risk covers personal risk, contamination of the outer environment, material damage/destruction and loss of production.

2.2.2 Risk level
The risk of incidents will always be present in the SSL. It is not possible to operate any research facility such as SSL without human risk. However, this human risk assessment process has contributed to measures to bring the human risk to a satisfactory level and in accordance with Norwegian laws and regulations.

2.2.3 Risk is not an exact matter
Risk analyses and assessments can never give an exact measure of the risk potential in SSL. However, this assessment has been performed based on theoretical skills, knowledge and experience from previous incidents, newly gained knowledge, joint discussions and analysis during several meetings.

2.2.4 Limitations and assumptions
This human risk assessment is based on the following limitations and assumptions:
1. Risk assessment is prepared on a predominantly qualitative basis.
2. Risk assessment is based on single incidents only.
3. Risk assessment is limited to hazards originating from the SSL. with associated operations and activities.
4. Risk assessment is limited to operations of SSL only.
5. It is assumed that SSL is sufficiently protected and secured against intruders.

2.3 Organisation and progress

The Human Risk Assessment Working Group has been established. The composition of this committee represents responsible leadership and expertise covering all aspects to SSL.

Findings and conclusions have been discussed in the Working Group as part of the risk assessment process.

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**Progress of the assessment work:**

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<td>6 May 2011</td>
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<td>3 May 2011</td>
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<td>20-23 September 2010</td>
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<tr>
<td>01 June 2010</td>
<td>Oslo</td>
<td>Project meeting</td>
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</table>

It has been close contact among the working Group and other parties during the reporting period.

### 2.4 Authorities

The following authorities are relevant:

1. DSB - region Nord-Norge, PO Box 217, N-9482 Harstad, Visitor address: Håkons gate 4.
2. Glomfjord Fire Municipality, Gammelveien 5, N-8150 Ørnes. Contact Mr. Per Arne Engamo, Fire Inspector.
3. Direktoratet for arbeidstilsynet i Nord-Norge, PO Box 4720 Sluppen, N-7468 Trondheim.

### 2.5 Contractors

Upgrading works from autumn 2010 to February 2012 was performed by the following contractors:

1. Electrical works: El-Team AS, Ørnes. Contact: Mr Magne Olav Pedersen
2. Civil works: Norluft AS, Bodø. Contact: Mr Rolf Grytvik
2.6 Matters particularly discussed in the risk assessment meetings

The following matters have been subject to particular discussion in the risk assessment group:
1. Living Quarter inside or outside the Tunnel.
2. Escape routes.
3. Escape marking.
4. Safe Rooms.
5. Lighting.
7. Fire alarm system.
8. Safety equipment
9. Number of persons present inside the tunnel system simultaneously.

2.7 Objectives

The objective of the risk assessment process is to minimise the risk level concerning explosions and fires in order
1. to ensure the safety of any persons present in the SSL,
2. to protect property and equipment,
3. to ensure uninterrupted research activity,
4. to minimise interruptions due to incidents,
5. to raise the organisation’s awareness regarding safety,
6. to confirm measures to optimise the safety of the SSL,
7. to confirm measures to optimise the organisation and operational safety and
8. to comply with the public regulation.

2.8 Risk Assessment scope

This risk assessment report states the risk level as follows:
1. Address all known risk elements.
2. Identify possible causes of incidents.
3. Identify and quantify the consequences of possible incidents.

2.9 Type of risks addressed

This present risk assessment report has focus on the following types of risk
1. Fires
2. Explosions
3. Rock falls
4. Injuries by falling
5. Tunnel flooding
6. Sabotage
7. ATV accidents
8. Accidents on the way to and from SSL (by helicopter or on foot).

2.10 Not included in the risk assessment

Works involving removing bars to open the horizontal research tunnel, dismantling the vertical research shaft, use of power tools including chainsaw etc. are not included in this report.
2.11 Human Risk comply with legal provisions

The risk for humans to stay and work in SSL complies with all relevant Norwegian legal provisions:

1. Regulations to fire preventive measures and inspections (FOBTOT-Branntforebyggende-forskriften).
2. Systematic health, environmental and safety activities in enterprises (Internkontrollforskriften).
3. Regulations relating to contingency planning in the power supply system. (BfK Beredskaps-forskriften).

3 DESCRIPTION

It has been decided to state all proper nouns in Norwegian.

Grey area: The Svartisen glacier
The SSL consist mainly of the Laboratorium (Laboratory), the Forskningsstunnelen (Research Tunnel), the Boligkvarter (Living Quarter) and a connecting tunnel system.

Vinterinngangen (winter entrance) is accessible all year and the main entrance for personnel. A helicopter can land close to this entrance when conditions are favourable.

3.1 Transportporten

Transportporten (Transport Gate) consists of a double door that opens outwards for heavy or large equipment. Transportporten is accessible only in the summer due to snow and ice conditions.

3.2 Laboratoriet

Laboratoriet (Laboratory) is located 1450 m inside Vinterinngangen. It consist of nine rooms in a 50m long building along the tunnel. The building has three doors into the tunnel and two doors into the opposite side of the tunnel. All rooms and exits have escape markings into the Adkomsttunnel.
3.3 Forskningsområdet

Forskningsområdet (Research Area) is located inside Forskningstunnelen. 23 m from Forskningstunnelen a staircase with a total of 79 steps leads to Forskningsområdet. At the front is a horizontal opening to the glacier closed by aluminium bars. To the right it is a 6 m long tunnel to a structure which enables vertical access to the glacier.

In Forskningsområdet measurements and experiments are performed, and samples are collected for further examination in Laboratoriet.
3.4 Boligkvarteret

Boligkvarteret (Living Quarter) is located 265 m inside Vinterinngangen. It consists of four double bedrooms, kitchen area, shower room, toilet and cloakroom. The building has three exits.
3.5 Sedimentkammeret

Sedimentkammeret (Sediment Chamber) belongs to Statkraft Power System and is part of the headrace of Svartisen power plant. It enables the removal of sand and sediment and has a threshold into Kilviktunnelen (ref 3.10.5) and a manually controlled opening into Spyletunnelen (ref 3.10.2), which can be opened only by Statkraft.

Statkraft has a container next to the gate with power supply and control boards. A lighting fixture, connected to the tunnel lighting circuit, and power point is installed outside the container.

3.6 Svalbardrøret

Svalbardrøret is a 45 m long closed steel tube with access to the open air through a steel door set into a concrete wall at Vinterinngangen.
3.7 Tunnel system

SSL consists of a tunnel system partly under Svartisen as illustrated in the above drawings.

3.7.1 Adkomsttunnelen
Adkomsttunnelen (Access Tunnel) is 1550 m long from Transportporten at level 514 up to Bjelkestenglet/Laboratoriet at level 609 and further to the junction with Fonndalstunnelen.
Bjelkestenglet (Beam blocks) consists of light, aluminium elements which can be removed.
Adkomsttunnelen is coarsely excavated and is a dirt road with a variable and partly rough surface. In some places channels with running water cross the roadway. The surface is easy for walking and driving by ATV between Bjelkestengslet and Transportporten. Cable bridges are mounted at one side of the tunnel at a height of approximately 3m. The bridges carry high voltage, low voltage and communication cables.

3.7.2 **Spyletunnelen**

Spyletunnelen (Flushing Tunnel) is 875 m long from the bottom gate at Sedimentkammeret out into open air. At its upper end, Spyletunnelen ends in a ca. 5 m high rock wall at the spill-over threshold from Sedimentkammeret. The escape from Sedimentkammeret to Spyletunnelen is difficult and therefore not part of an escape route. Spyletunnelen is divided into two parts. The inner part from Sedimentkammeret to Tverrslaget is 625 m long. The outer part from Tverrslaget to open air is 250 m long and covered by stones and partly by ice in the winter.

When the unit valve (gate in Kilvik) in Svartisen power plant is closed, Kilviktunnelen (Ref 3.10.5) will be filled up with water which causes overflow from Sedimentkammeret into Spyletunnelen. When the water flow in the headrace tunnel system is greater than the tunnel capacity flow, there will be over-flow into Spyletunnelen as well.
Due to the possibility of changes in the water flow in the tunnel system without adequate warning to personnel in the tunnel system, it is not recommended that Spyletunnelen is considered as part of an evacuation route.

3.7.3 **Sedimentkammertunnelen**
Sedimentkammertunnelen (sediment chamber tunnel) is a 20 m long access to Sedimentkammeret from Adkomsttunnelen.

3.7.4 **Tverrslaget**
Tverrslaget (Cross Cut) is a 50 m long tunnel between Adkomsttunnelen and Spyletunnelen. At this location both aligned tunnels change their directions approximately 30 degrees. The entrance from Adkomsttunnelen is closed but accessible with a door that opens towards Spyletunnelen. Ice may cover the ground and walls year-round.

3.7.5 **Kilviktunnelen**
Kilviktunnelen is the water diversion tunnel from the threshold in Sedimentkammeret to a gate in Kilvik above Svartisen power plant. The tunnel collects water from a number of river intakes between Engabreen and Kilvik. This gate can be remotely closed by Statkraft.

3.7.6 **Tverrtunnelen**
Tverrtunnelen is the short tunnel between Bjelkestengslet and Vanntunnelen. Rock and large stones cover the ground that makes it difficult to walk. 20 m from Bjelkestengslet is a turn to the left leading to Forskningsstunnelen (Ref. 3.10.7) and Forskningsområdet.
A wooden footbridge is mounted along the tunnel wall in order to have access to the cat-walk over Sedimentkammeret.

3.7.7 Forskningsstunnelen
Forskningsstunnelen (Research Tunnel) is a 23 m long tunnel from Tverrtunnelen to the stairs leading to Forskningsområdet.

A wooden footbridge is mounted along the tunnel in order to have access from the Bjelkestengsel area into Spyletunnelen.

3.7.8 Fonndalstunnelen
Fonndalstunnelen is the 5850 m long water diversion tunnel originating in Fonndalen and collecting water from a number of intakes on its way to Sedimentkammeret. It passes the exit Engabreen Syd ca. 1900 m from Sedimentkammeret. Even in winter when discharge is low the tunnel has running water that can be deep in places.

3.8 Footbridge
A footbridge (cat-walk) is constructed from Bjelkestengsel through Sedimentkammeret for measuring water depth and sediment accumulation in Sedimentkammeret.

However, this walkway can be difficult and not recommended as an escape route.
3.9 Internal transport

An ATV (All-terrain Vehicle) and a trailer are available for internal transport in Adkomsttunnelen and Sedimentkammertunnelen. It is powered by 95 Octan Petrol.
3.10 Access to SSL

Helicopter transport is the safest, fastest and easiest way to access the SSL. The trip from Kilvik to SSL takes five minutes. The smallest helicopter rented takes four persons or 800 kg cargo, partly in a small cargo compartment at the rear. The helicopter landing place is usually right outside the Vinteringangen. Helicopter transport requires satisfactory visibility and is thus very weather dependent. Vinteringangen is accessible all year.

Walking up to the SSL is possible almost all year. It takes approximately 90 minutes up and 70 minutes down in optimal conditions, but can take 4 hours or more. The main risks are snow avalanches and icy conditions on bare rock, and exhaustion when conditions are difficult.

3.11 Electrical installations

All electrical installations belong to Statkraft. SSL has access to all low power installations. Only authorised personnel have access to the high voltage installations.

The electrical single line diagrams are available at the SSL.
3.11.1 High voltage system
Meløy Energy in Ørnes is the owner of the 22 kV supply up to the last mast outside Vinterinngangen.

From the last mast a TXSP earth cable brings the 22 kV supply to Svalbardrøret and further into Adkomsttunnelen to one transformer outside Boligkvarteret (T1) and two transformers outside Laboratoriet (T2, T3).

Each of the three transformers feeds its low voltage distribution including protection. T1 feeds the Boligkvarter including tunnel lighting. T2 feeds the boiler with four circuits and T3 feeds Laboratoriet and surroundings.

3.11.2 Transformer T1
T1 is a 50 kV dry insulated transformer located outside Boligkvarteret. It is an Electromeccanica Valdagnese in a Simast 315 S L6-99004. The transformer was delivered by Malthe Vinje in 1996. Normal load is 15% of nominal load.

3.11.3 Transformer T2
T2 is a 630 kVA dry insulated transformer located outside Laboratoriet. It is an Electromeccanica Valdagnese in an Interpower container. The transformer was delivered by Malthe Vinje in 1994. Normal load is 100% of nominal load.
3.11.4 **Transformer T3**
T3 is a 50 kVA silicon oil insulated transformer located outside Laboratoriet. It is a Møre Trafo in Simast housing with the number L6-99004. The transformer was delivered by Møre Trafo in 1994 and was installed in 1999. Normal load is 30 % of nominal load.

3.12 **Cable bridges in the tunnels**
Cable bridges are fastened in the rock walls at approximately 3m height in Adkomsttunnene, Fonndalstunnene and Sedimentkammertunnelen. The bridges carry high voltage cables. Low voltage cables and fibre optic cables/Cupper cables for telecommunication. All bridges are in good condition with excess capacity. Except for two areas, where a ladder is necessary, the bridges are accessible by use of short bench or low ladder.

3.13 **Lighting in Adkomsttunnene and Svalbardrøret**
39 lighting fixtures are mounted under the cable bridge in Adkomsttunnene and two fixtures are fastened on conduits in Svalbardrøret.

The two fixtures in Svalbardrøret and the eight fixtures from Svalbardrøret up to Boligkvarteret will not be switched off at night. In order to reduce their fire risk they have normal 70 W bulbs and the reactors are disconnected.

The eight fixtures between Svalbardrøret and Boligkvarteret were installed in 2010. Tunnel HID from DEFA Lighting with 70W QL Lamps.
31 fixtures between Boligkvarteret and Laboratoriet were mounted in 1993. They have yellow halogen bulbs and separate reactors and fuses.

The ten first lighting fixtures between Vinterinngangen and Boligkvarteret and 60 metres further up are controlled by a switch located at Vinterinngangen. All other lights in Adkomsttunnelen are switched on and off by a switch located outside Telecontainer at Boligkvarteret. This switch shall as part of the safety instructions by switched off after all persons have left Laboratoriet and the upper part of the tunnel.

3.14 Emergency lighting

Emergency lighting fixtures are placed in relevant rooms over doors and in the Adkomsttunnelen at Tverrslaget
3.15 Boiler

Hot water is used as part of the ice investigations in Laboratoriet. The boiler has 600 kW nominal power and is in operation a few times a year. The boiler is embedded by plates and 50 mm insulated plates. Thermo elements are built in between boiler and the protecting sheets. The boiler casing was manufactured by Glomfjord Blikk and installed by Halsa sveiseverksted in November 2007. High voltage is fed from T2.

3.16 Pumps:

Two Grundfos high pressure pumps in parallel operation supply Forskningsområdet with hot water from the Boiler. The pumps are fed by transformer T3.

3.17 Telecommunication

The present telecommunication system has a limited bandwidth that excludes internet and other broadband services.

3.17.1 Telephone equipment

There is installed a multi communication cable with twisted pairs in the Adkomstunnelen for telephone purposes. At Vinterinngangen is a rack with GPRS router for Ethernet, Ethernet switch and DLS Modern. The telephone equipment with manual exchange and 10 numbers belongs to Statkraft but is fully available to SSL.
3.17.2 **Fibre cable installation**
A fibre optical cable with 8 fibres is drawn between terminals in Vinterinngangen and Boligkvarteret/Telecontainer and between Boligkvarter/Telecontainer and Laboratoriet. Two of the fibres are allocated to the fire alarm systems communication.

3.17.3 **Mobile communication**
Both Netcom and Telenor operate mobile networks in the area covering Vinterinngangen, Svalbardrøret and approximately 50m along the Adkomstunnel. There is no mobile communication possible in other parts of the tunnel system.

3.17.4 **Communication potential**
Fibre cable and terminals along Adkomstunnelen opens for high bandwidth communication in the future. A radio link between Vinterinngangen down to Braseth will have free line of sight.

3.18 **Fire alarm equipment**
An automatic fire detection and alarm system is installed in Boligkvarteret, Laboratoriet and Forskningsområdet (alarm only). Control panels are put up in Boligkvarteret and in Laboratoriet. The panels are identical and interconnected by fibre communication.
The system is intelligent analogue addressable. The detectors are optical smoke point detectors, heat point detectors and manual call points. Some of the detectors are equipped with a buzzer in order to warn persons inside the buildings. To warn persons outside the buildings, Flashni lights are mounted in Forskningsområdet and in Adkomstunnelen and Roshni sirens are mounted at the Laboratoriet and Boligkvarteret. The flashni lights also include sirene sound.

Any detector release will activate the fire alarm in all buzzers, all Flashni lights and sirens.

All relevant rooms are covered by fire detectors in order to achieve early warning. Early warning is the premise to have enough time to escape. In the two fire panels it will be possible to get information about where the fire is located and the extent of the fire situation.

The panels are equipped with two rechargeable sealed lead acid batteries type FLAME. FG 21803. Weight 12 kg. The batteries have to be replaced every five year.

3.18.1 **Fire detection in Boligkvarteret**
In Boligkvarteret there are four smoke detectors with buzzer, three detectors without buzzer, two heat detectors and two manual call buttons, as shown in the drawing.

One flashni light is mounted under the cable bridge in front of the Boligkvarteret. This light gives sirene sound as well.

One Roshni siren is mounted on the wall outside Boligkvarteret in order to warn people in Adkomstunnelen.
Fire alarm panel in Boligkvarteret
Smoke detector with buzzer
Flashlight at Boligkvarteret
3.18.2 **Laboratoriet**

In Laboratoriet there are three smoke detectors with buzzer, six detectors without buzzer and two manual call buttons, as shown in the drawing.

Strobe lights are mounted under the cable bridge at Sedimentkammertunnelen, on the cable bridge at Bjelkestengslet and in Forskningsområdet.

One Roshni siren is mounted on the wall outside the Laboratorie building in order to warn people in Adkomsttunnelen.

![Diagram of Laboratoriet with smoke detectors and strobe lights](image)

**Fire Panel in Laboratoriet**

**Smoke detector with buzzer in Laboratoriet**
3.19 Storage of flammable materials

In Adkomsttunnelen 100m up from Boligkvarteret there is a recess (alcove) useful for storage of petrol, oil, lubricants, chemicals, etc. In this location there are no ignition sources and little possibility of fire breaking out.

3.20 Ventilation

There is no ventilation equipment in the tunnel system. Due to tunnel openings, the gradient of Adkomsttunnelen and the normal wind conditions in the area, the exchange rate of the air inside SSL is sufficient for a satisfactory environment and can handle exhaust from the ATV.
3.21 Safe rooms

In order to fulfill evacuation requirements, safe rooms have been built in Adkomsttunnelen. Safe Room 1 is mounted at the corner Adkomsttunnelen/Sedimentkammeretunnelen and Safe Room 2 at Boligkvarteret. The safe rooms are equipped with compressed air in bottles to create an overpressure in the room. The first person who arrives at a safe room shall open the bottle valve and enable air flow of 5 litres per second to stream into the room. The inward opening doors are equipped with mechanical door closers in order to keep the room closed to ensure over-pressure. Ten escape masks are stored in each safe room. The safe rooms are equipped with light and emergency light.

3.22 Rescue equipment

SSL is equipped with rescue equipment suitable to residence in the tunnel and usual tasks there.

3.22.1 Escape masks

There are 31 escape masks available in SSL in order to enable escape to the nearest Safe Room and from there to the exit at Vinteringangen.

According to Safety Instructions, all persons leaving Boligkvarteret or Laboratoriet for duties are obliged to carry one escape mask. Er varslingsanlegget godt nok til at masker kan lagres på faste steder?
The escape mask contains pressured air for about 15 minutes escape.

3.22.2 **Fire hoses**

One fire hose is located in the Cloakroom in the Laboratoriet.

3.22.3 **Hand-held fire extinguishers**

The hand held fire Extinguishers are located as shown in the table.

<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
<th>Type</th>
<th>Size</th>
<th>NVE Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boligkvarteret - Cloakroom</td>
<td>1</td>
<td>ABC Powder</td>
<td>6 kg</td>
<td>NVE 6</td>
</tr>
<tr>
<td>Boligkvarteret Kitchen entrance</td>
<td>1</td>
<td>ABC powder</td>
<td>12 kg</td>
<td>NVE 13</td>
</tr>
<tr>
<td>Boligkvarteret Kitchen Room</td>
<td>1</td>
<td>Foam</td>
<td>9 litre</td>
<td>NVE 12</td>
</tr>
<tr>
<td>Boligkvarteret Corridor</td>
<td>1</td>
<td>ABC powder</td>
<td>6 kg</td>
<td>NVE 10</td>
</tr>
<tr>
<td>Safe Room 2 (Boligkvarteret)</td>
<td>1</td>
<td>ABC Powder</td>
<td>6 kg</td>
<td>?</td>
</tr>
<tr>
<td>Laboratoriet Close to Boiler</td>
<td>1</td>
<td>CO₂</td>
<td>2 kg</td>
<td>NVE 2</td>
</tr>
<tr>
<td>Laboratoriet Close to Boiler</td>
<td>1</td>
<td>ABE Powder</td>
<td>1 kg</td>
<td>NVE 1</td>
</tr>
<tr>
<td>Laboratoriet Tool Room</td>
<td>1</td>
<td>ABC Powder</td>
<td>12 kg</td>
<td>NVE 5</td>
</tr>
<tr>
<td>Laboratoriet Instrument Room outside Entrance</td>
<td>1</td>
<td>91 AFFF Foam</td>
<td>12 kg</td>
<td>NVE 6</td>
</tr>
<tr>
<td>Laboratoriet inside</td>
<td>1</td>
<td>ABC Powder</td>
<td>12 kg</td>
<td>NVE 4</td>
</tr>
<tr>
<td>Laboratoriet Grovlab inside</td>
<td>1</td>
<td>CO₂</td>
<td>5 kg</td>
<td>NVE 3</td>
</tr>
<tr>
<td>Laboratoriet Grovlab inside</td>
<td>1</td>
<td>ABC Powder</td>
<td>6 kg</td>
<td>NVE 7</td>
</tr>
<tr>
<td>Laboratoriet Lounge</td>
<td>1</td>
<td>ABC Powder</td>
<td>6 kg</td>
<td>NVE 8</td>
</tr>
<tr>
<td>Safe Room 1 (Laboratoriet)</td>
<td>1</td>
<td>ABC Powder</td>
<td>6 kg</td>
<td>?</td>
</tr>
</tbody>
</table>

3.22.4 **Stretchers**

One stretcher is located in the Cloakroom in Boligkvarteret.

3.22.5 **First aid equipment**

One first aid set is located in the Grovlab in Laboratoriet and in Kitchen in Boligkvarteret.

3.22.6 **Fire Blankets**

One fire blanket is hanged up in the Kitchen in Boligkvarteret and one in the Grovlab in Laboratoriet.

3.23 **Operations of SSL**

SSL is operated periodically all year round with participants from many countries. Most activity takes place between October and April.
4 SAFETY MEASURES PERFORMED 2007 TO 2010

Safety measures were performed before the inspections and present risk assessment in 2010 as follows:

4.1 2007 and 2008:

1. Inspection of the HV and LV electrical system. Some repairing works performed.
2. Inspection of the hot water pumps.

4.2 2010:

1. 14 escape masks provided.
2. A number of hand held fire extinguishers provided.
3. Two fire blankets provided
4. Simplified escape route marking.
5. Safety instructions completed.

5 ESCAPE POSSIBILITIES

5.1 Escape routes

In a critical situation (fire) inside SSL with risk of death or personal injury, the evacuation assembly point is outside Vinterinngangen. The longest escape route is from Forskningsområdet at 1530 metres.

Walking speed along Adkomstunnelen is estimated as 100 metres per minute and on stony ground, as in Tverrtunnelen, 30 metres per minute.

5.1.1 Fire alarm in Forskningsområdet

Fire alarm break out by two Flashni Lights combined with a very strong persistent siren sound. Action: Immediately escape from Forskningsområdet.

5.1.2 Escape from Forskningsområdet

From Forskningsområdet 59 steps lead continuously down to a platform. From there seven steps to another platform and 11 steps down to the stony ground in Forskningstunnelen that is 15 metre long and ends in Tverrtunnelen. To the right it is 15 metres to Bjelkestengslet and Adkomstunnelen. In Adkomstunnelen the escape route passes Laboratoriet and it’s a further 130 metres to Safe room 1. In the Safe room it is possible to exchange escape masks. Further evacuation is to walk down Adkomstunnelen and out through Vinterinngangen.

Escape along the wooden footbridge in Tverrtunnelen and along the cat-walk in Sedimentkammeret to Sedimentkammertunnelen is not recommended.

Estimated walking time for 225 metres to Safe Room 1 is 5 minutes and from Safe room 1 to Vinterinngangen 13 minutes.
On the way, Laboratoriet may burn and Adkomsttunnelen can be filled by dense smoke. Further down, Boligkvarteret may burn.

5.1.3 Fire alarm in Laboratoriet

Fire alarm light flashes by one Flashni Light combined with a very strong persistent siren sound at the Bjelkestengsel and one Flashni Light outside Safe Room 1. Also, the Roshni Siren outside the Laboratorie Building sounds very strong. Action: Immediately escape from Laboratoriet down the Adkomsttunnelen (Access Tunnel).

5.1.4 Escape from Laboratoriet

The escape in Adkomsttunnelen passes Safe room 1 after 130 metres. It is possible to enter this safe room in order to calm down and exchange masks. Further evacuation is by walking along Adkomsttunnelen and out through Vinterinngangen. Estimated walking time for 130 meters to Safe Room 1 is 2 minutes and from Safe room 1 to Vinterinngangen 13 minutes.

On the way, Boligkvarteret may burn and Adkomsttunnelen may be filled by dense smoke.

5.1.5 Fire alarm in Boligkvarteret

Fire alarm breaks out by one Flashni Light combined with a very strong persistent siren sound at the Cable bridge outside the Boligkvarteret. Also, the Roshni Siren outside Boligkvarteret sounds very strong. Action: Immediately escape from Boligkvarteret.

5.1.6 Escape from Boligkvarteret

Normal escape is out of the building and into Adkomsttunnelen and out. If anybody is in the vicinity, for instance in Laboratoriet, and Laboratoriet is on fire, Safe room 2 can be utilised.

Way out is 285 meters. Estimated walking time is 3 minutes.

5.1.7 Escape from Sedimentkammeret

Fire Alarm in the Flashni Light outside Safe Room 1 will be seen and caught sight of in Sedimentkammeret. The escape in Sedimentkammeret tunnel passes Safe room 1 after 20 metres. It is possible to enter this safe room in order to calm down and exchange masks. Further escape is to walk down Adkomsttunnelen and out through Vinterinngangen.

Estimated walking time 20 metres to Safe Room 1 is 1 minute and from Safe room 1 to Vinterinngangen 13 minutes.

On the way, Boligkvarteret may burn and Adkomsttunnelen can be filled by dense smoke.

5.2 Escape markings

All escape routes are equipped with luminescent and reflective escape marking plates.

5.3 Escape marking plate type 1

Under the wooden bridge in Tverrtunnelen.
Size is 15 cm x 30 cm, luminescent and reflective.

5.4 Escape marking plate type 2

In Tverrtunnelen outside the door to Adkomstunnelen.
In Adkomstunnelen at Sedimentkammertunnelen on opposite tunnel wall.
At Boligkvarteren opposite Adkomstunnelen wall.
In Adkomstunnelen at Transportporten.

Size is 15 cm x 30 cm, luminescent and reflective.

5.5 Escape marking plate type 3

<table>
<thead>
<tr>
<th>Type</th>
<th>Figure</th>
<th>Locations</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>130</td>
<td>T2 Container 130 metre from Safe rom 1</td>
<td>1</td>
</tr>
<tr>
<td>3.2</td>
<td>1150</td>
<td>Adkomstunnel under cable bridge</td>
<td>1</td>
</tr>
<tr>
<td>3.3</td>
<td>850</td>
<td>Adkomstunnel under cable bridge</td>
<td>1</td>
</tr>
<tr>
<td>3.4</td>
<td>650</td>
<td>Adkomstunnel under cable bridge</td>
<td>1</td>
</tr>
<tr>
<td>3.5</td>
<td>400</td>
<td>Adkomstunnel under cable bridge</td>
<td>1</td>
</tr>
<tr>
<td>3.6</td>
<td>200</td>
<td>Adkomstunnel under cable bridge</td>
<td>1</td>
</tr>
<tr>
<td>3.7</td>
<td>100</td>
<td>Adkomstunnel under cable bridge</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>SUM</td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>
Size is 20 cm x 20 cm, luminescent and reflective.

5.6 Escape marking plate type 4

Adkomsttunnel at Safe room 1

Size is 20 cm x 20 cm, luminescent and reflective.

5.7 Escape marking plate type 5

Adkomsttunnel at Safe room 2

Size is 20 cm x 20 cm, luminescent and reflective.

5.8 Escape marking plate type 6 - Door marking

<table>
<thead>
<tr>
<th>Type</th>
<th>Text</th>
<th>Locations</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Exit</td>
<td>Boligkvarter Kitchen Door out</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Exit</td>
<td>Boligkvarter Hall Door out</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Exit</td>
<td>Laboratorium Door out</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Exit</td>
<td>Laboratorium Door out</td>
<td>1</td>
</tr>
</tbody>
</table>
Size is 10 cm x 60 cm, luminescent and reflective.

5.9 Line Marking Floor

50 mm tape Size is 10 cm x 60 cm, luminescent and reflective.

<table>
<thead>
<tr>
<th>Marking</th>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>Boligkvarter Cloak Room, Hall, Kitchen</td>
</tr>
<tr>
<td>Floor</td>
<td>Laboratorium including lounge and kitchen</td>
</tr>
<tr>
<td>SUM</td>
<td></td>
</tr>
</tbody>
</table>

Boligkvarteret.
In Laboratoriet:

6 RISK ASSESSMENT

There are no relevant statistics for incidents related to tunnel systems such as SSL, neither in Norway nor elsewhere in Europe. There have been a few incidents in tunnel systems that resulted in death or personal injury. In 2009 a rock fall and flooding in Svandalsflona tailrace tunnel caused 2 casualties. A number of fires in road tunnels have caused many dangerous situations.

Although the probability of incidents is very low to low, the consequences of the incidents are analysed.

6.1 Preventive conditions as premise for the risk assessment results

The following conditions as premise:
1. No oil cables are installed.
2. No mineral oil in any transformers.
3. All inflammable material stored at a safe location in Adkomsttunnelen.
4. All rooms in the buildings are equipped with fire detectors.
5. Satisfactory admission procedures are implemented.

6.2 Preventive operational measures implemented as premise for the risk assessment results

The following routine measures are implemented in the normal operation of SSL. supported by instructions, by training and by practice:
1. All Safety Procedures and Instructions will be complied.
2. Stated access procedures will be complied.
3. All inflammable materials will be reduced to a minimum.
4. Routines by hot repair work and maintenance are implemented.

6.3 Types of risks assessed

The following incidents are addressed:
1. Fires
2. Explosions
3. Rock falls
4. Injuries by falling
5. Tunnel flooding
6. Sabotage
7. ATV accidents
8. Accidents on the way to and from SSL (by helicopter or foot).

6.3.1 **Fires**
Fires may occur in all parts of SSL. They are
1. Oil fires.
2. Open fires from other burning materials.
3. Smouldering fires from compact materials

Fire sources are the following:
1. Fires from reactor driven lighting fixtures.
2. Fires from electrical boilers
3. Vehicle fire (ATV)
4. Cable fires.

When physical and chemical conditions are suitable, fire can break out in every room in the buildings, and in all areas. Smouldering fires and open fires cause different types of smoke.

The insulation material in cables and other components may catch fire normally from heat development in conductors caused by electrical failures combined with protection malfunction. In many cases components encased in cabinets and cubicles develop so called cubicle fire.

Insulation materials employed in all areas will most probably result in self-extinguishing fires that will be easy to handle and not lead to serious personal threats, property damage or production loss. It cannot be disregarded that a small amount of insulation components developing corrosive gases and halogen has been used.

Oil fires may break out in used paper towels and oil receptacles. Dangerous oil fires are not probable in SSL. No transformer contains mineral oil. T2 contains synthetic oil with a high ignition temperature.

Oil fires can occur in Adkomsttunnelen due to accidents when driving ATV or malfunction when parking.

Most of the possible fires that may break out in the buildings will immediately be detected and identified by the high-grade smoke and fire warning system installed.

Fire incidents also arise from careless maintenance and high-temperature repair work, particularly angle grinding and welding.

6.3.2 **Risk of electric arcs in dry insulated components**
Electrical faults are, directly or indirectly, the predominant cause of incidents such as pressure build-up, explosions and fires. Minor or insignificant failures may also develop or may cause incidents. Spark-over and short circuit faults in high voltage circuits and dry insulated components will result in electric arcs that cause overpressure. Particularly high-risk areas are power transformers, connectors, cabinet installations, etc. Component failures are normally the result of lack of maintenance, lack of inspection and defects due to aging.

However, the over-pressure will be greatly limited due to large open areas around the components.

6.3.3 **Secondary oil mist explosion**
Transformer T2 is filled with synthetic oil that may cause secondary oil mist explosion in case of tank rupture. The operation of the transformer is unfavourable: most of the time it has no load.
For short periods, when the boiler is working, the transformer runs on nominal load. However, we consider the probability of tank rupture as very little. As a consequence of tank rupture, the
probability of secondary oil mist explosion exists. The explosive pressure is estimated to be limited due to large air volume in the Adkomstunnelen outside the transformer. No oil fire will occur due to the synthetic oil with high ignition temperature.

6.3.4 Risk of battery gas explosion in the battery room

In Telecontaineren there is a compartment with battery bank. If leakage of battery gas coincides with an ignition source, a limited explosion may occur in Telecontaineren. The risk is extremely small, but does exist. The probability of persons present in Telecontaineren at the time of explosion is negligible.

6.3.5 Rock falls

Rocks and stones can loosen from the tunnel ceiling or walls and fall down and hit someone. Such incidents are highly improbable but may happen. Normally, all persons shall carry a helmet that might protect them from serious injury.

If parts of the tunnel ceiling and walls collapse, rock may block free access for people and ATV.

6.3.6 Injuries by falling

Falls from ladders, stairs or other situations may lead to injury. The risk is higher in SSL than other tunnels due to limited lighting and poor walking conditions.

6.3.7 Tunnel flooding

Parts from the rock and stones can loosen from the tunnel ceiling and enable substantial water flow into the tunnel. However, water flow that originates from the glacier will be limited and the consequences negligible.

6.3.8 Intentional acting - Sabotage

Uninvited visitors or intruders could sabotage parts of the installations and equipment. The likelihood of this kind of incident is negligible.

6.3.9 Accident by driving the ATV

ATV transport in Adkomstunnelen is comfortable but also risky. Trenches, stones and other obstacles may lead to overturn and injury of driver and passenger.

6.3.10 Accident on the way to and from SSL

The two transport options are not free from risk.

1. The helicopter may crash and all passengers die. Landing at the Vinterinngangen is most exposed, particularly combined with much snow and passengers with less routine.
2. The walk up and down to SSL may be exhausting and lead to injuries and death due to poor weather-, snow-, ice- and wind conditions

6.4 Risk probability/consequence matrix adopted

NVE – Preparedness section has recommended to the Norwegian power industry the implementation of a probability/consequence matrix stated in the preparedness regulations (Forskrift om Beredskap i Kraftforsyningen [8]) within the Norwegian energy law. This matrix has generally been adapted to the risk situation and implemented for Norwegian facilities in agreement with NVE. This matrix has been adopted in the present risk assessment process in a modified form. The modification applies the grade of probability according to the high grade of risk-reducing measures implemented in SSL.

Incidents can be characterised by:

1. Probability of incidents.
2. Consequences for life and health.
3. Consequences for the environment.
4. Consequences for loss of value.
6.5 Risk probability/consequence matrix adopted

The applied risk matrix is illustrated below. Every identified possible incident has been ranked according to this matrix.

<table>
<thead>
<tr>
<th>Probability of incidents</th>
<th>Consequences of incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>Improbable 1</td>
<td></td>
</tr>
<tr>
<td>Fairly improbable 2</td>
<td></td>
</tr>
<tr>
<td>Very slightly probable 3</td>
<td></td>
</tr>
<tr>
<td>Slightly probable 4</td>
<td></td>
</tr>
<tr>
<td>Probable 5</td>
<td></td>
</tr>
</tbody>
</table>

**Probability/consequence risk matrix**

6.6 Degree of probability for incidents at SSL

As stated previously, it is not reasonable to estimate probability levels in the quantitative way by figures developed from statistics. Even so, this has been attempted as far as possible in the table below.

<table>
<thead>
<tr>
<th>Degree of probability for incidents at SSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>
### 6.7 Degree of consequences for life and health

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Personal injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No consequences</td>
<td>No personal injury</td>
</tr>
<tr>
<td>2</td>
<td>Minor consequences</td>
<td>Minor personal injury. Absence &lt; 1 week</td>
</tr>
<tr>
<td>3</td>
<td>Dangerous</td>
<td>Serious personal injury. Absence &gt; 1 week</td>
</tr>
<tr>
<td>4</td>
<td>Critical</td>
<td>May result in loss of life</td>
</tr>
<tr>
<td>5</td>
<td>Disastrous</td>
<td>May result in substantial loss of life</td>
</tr>
</tbody>
</table>

### 6.8 Degree of consequences for outer environment

<table>
<thead>
<tr>
<th>Code</th>
<th>Degree</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No consequences</td>
<td>Insignificant effect on environment</td>
</tr>
<tr>
<td>2</td>
<td>Minor consequences</td>
<td>Minor effect on environment</td>
</tr>
<tr>
<td>3</td>
<td>Dangerous</td>
<td>Environmental pollution that can cause slight damage</td>
</tr>
<tr>
<td>4</td>
<td>Critical</td>
<td>Environmental pollution that can cause heavy damage</td>
</tr>
<tr>
<td>5</td>
<td>Disastrous</td>
<td>Environmental pollution that can cause permanent devastation</td>
</tr>
</tbody>
</table>

### 6.9 Degree of consequences for values

<table>
<thead>
<tr>
<th>Code</th>
<th>Degree</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No consequences</td>
<td>Insufficient loss &lt; 1,000 NOK</td>
</tr>
<tr>
<td>2</td>
<td>Small loss</td>
<td>Loss &lt; 10,000 NOK</td>
</tr>
<tr>
<td>3</td>
<td>Significant loss</td>
<td>Loss &lt; 100,000 NOK</td>
</tr>
<tr>
<td>4</td>
<td>Serious loss</td>
<td>Loss &lt; 1,000,000 NOK</td>
</tr>
<tr>
<td>5</td>
<td>Extremely serious loss</td>
<td>Loss &gt; 1,000,000 NOK</td>
</tr>
</tbody>
</table>

### 7 RISKS IDENTIFIED

All preventive design details and operational measures described above have been taken into account by the following risk assessment.
### 7.1 Possible incidents events identified

<table>
<thead>
<tr>
<th>Events</th>
<th>Probability</th>
<th>Worst Case Consequence of Incident</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Life and Health</td>
</tr>
<tr>
<td>Accident on the way to and from SSL on foot</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Accident on the way to and from SSL by Helicopter</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>ATV driving accident (ATV=All-terrain Vehicle)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Injuries by falling</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Accident by rock falls</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fire outbreak in a lighting fixture in the upper part of Adkomsttunnelen</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Boiler rupture</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Fire outbreak in Laboratoriet</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Fire outbreak in Boligkvarteret</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Tunnel flooding</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Fire outbreak in one of the electrical cabinets outside buildings</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fire outbreak in the ATV</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Secondary oil mist explosion outside T2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sabotage</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### 7.2 Detailing of the identified events

### 7.2.1 Accident on the way to and from SSL on foot

<table>
<thead>
<tr>
<th>Event description</th>
<th>Degree of Probability = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L</strong></td>
<td>Life and health</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>Pollution of outer environment</td>
</tr>
<tr>
<td><strong>V</strong></td>
<td>Loss of values</td>
</tr>
</tbody>
</table>

This event can be the worst one connected to the operation of SSL.

The helicopter transport will be the safest and preferred way to arrive at and return from SSL. The normal origin of the flights is at Kilvik, next to Svartisen power plant. The flight between Kilvik and SSL takes seven minutes.

Ones upon the time the helicopter will not be able to take off and land at SSL due to weather conditions. Normally, the visit at the SSL will be postponed or cancelled if the helicopter pilot decides that the flight cannot take place.

However, the weather conditions could have changed during peoples stay at SSL. If it should be necessary to leave SSL in spite of bad helicopter flight conditions, the way down on foot is the only possibility. All visitors have beforehand signed on the demands procedure that they are able to and willing to enter and leave the SSL on foot. It is also stated that nobody should set out on this walk without be accompanied by a local or by one of the NVE staff present.

Walking up to the SSL takes approximately 90 minutes and 70 minutes down in optimal conditions, but can take four hours or more when the conditions are severe. The difference in altitude between the boat landing place and SSL is 500 meters and the distance five km.

High level of snow, bad snow conditions, limited visibility, slippery surface, difficult tracks can be reasons to make the walk down difficult. Exhaustion and injuries can be the result that implies life and health risk.

The degree of probability is estimated to 2.
7.2.2 Accident on the way to and from SSL by helicopter

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Probability = 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L = Life and health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M = Pollution of outer environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V = Loss of values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Helicopter transport will be the safest and preferred way to arrive at and return from SSL. The normal origin of the flights is at Kilvik, next to Svartisen power plant. The flight between Kilvik and SSL takes seven minutes.

Standard helicopter flights to SSL normally carry six persons. All six persons can die in a serious crash.

The statistic graph below shows the probability of helicopter accidents in Norway the last years. An interpretation of the graph indicates worse case accident with death people every 60,000 flight hour (consequence degree = 4). Number of helicopter return flights to SSL is estimated to 10. Every single flight lasts 7 minutes. That means a probability of less than one incident per 25,000 years. I.e. probability degree 1.

In winter time, the landing and take-off conditions with handling of passengers may have an increased risk level. Taken this into consideration, the probability degree will not exceed 1.

![Innlands helikopter - ulykker og aktivitet](image-url)
### 7.2.3 *ATV driving accident*

**Event description**

<table>
<thead>
<tr>
<th>Degree of Probability = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>L = Life and health</td>
</tr>
<tr>
<td>M = Pollution of outer environment</td>
</tr>
<tr>
<td>V = Loss of values</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Driving the ATV in Adkomsttunnelen may lead to accident. Trenches, stones and other obstacles may cause overturn and injury of both driver and passenger.

### 7.2.4 *Injuries by falling*

**Event description**

<table>
<thead>
<tr>
<th>Degree of Probability = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>L = Life and health</td>
</tr>
<tr>
<td>M = Pollution of outer environment</td>
</tr>
<tr>
<td>V = Loss of values</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Falls from ladders, stairs or other situations may lead to injury. The risk is higher in SSL than other tunnels due to limited lighting and poor walking conditions.
### Accident by rock falls

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree of Probability = 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L</strong>: Life and health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M</strong>: Pollution of outer environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>V</strong>: Loss of values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rocks can fall from the tunnel ceiling and walls, and injure people. Such incidents are unlikely but may happen. Normally, all persons shall carry a helmet that may protect them from serious injury.

If parts of the tunnel roof and walls collapse, rock may block free access for people and ATV.
### Event description

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
</table>
| **Fire will not be extinguished manually**
Nobody present in the Laboratorium
Degree of Probability = 4

L = Life and health
M = Pollution of outer environment
V = Loss of values

Spark-over in the fixture reactor or other part of the fixture. High temperature causes smouldering- or open fire that spread to the low voltage cable under the bridge and damage parts of the other cables, including the 22 kV cable.

Black and dense smoke develops in the Adkomstunnelen that spreads in both directions.

Fire alarm will not be released before smoke reaches the boiler area where there is a smoke detector, probably after several minutes, depending on air flow strength and direction in Adkomstunnelen.

Persons in the Adkomstunnel, who are near the point of origin, will discover the fire. They have to get to the nearest point to take an extinguisher. Either in the Laboratorium or in Boligkvarteret. They will activate a manual call point in order to release fire alarm if the fire alarm has not been released by the smoke detector in the boiler area. With the extinguisher they have to move to the fire point and attempt to extinguish.

If no extinguishing effort has been achieved, people in all parts of the SSL escape safely according to the procedures.

This incident will occur only in the daytime since all this type of lighting fixtures (with reactors) will be switched off at night. No people will sleep when a possible fire outbreak in the fixtures happens.

Damages on cables, lighting fixtures and bridges. Smoke and soot property damages in great areas.

Total damages about NOK 50,000.
### 7.2.7 Boiler rupture

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Probability = 3</td>
<td>Degree of Consequences</td>
<td>Degree of Consequences</td>
<td>Degree of Consequences</td>
</tr>
</tbody>
</table>

L = Life and health  
M = Pollution of outer environment  
V = Loss of values

The boiler is of great importance for operations of SSL.

Efforts have been provided in order to ensure safe operation and prolong life span.

Types of damages are:

- a. Water leakage (worst case). New boiler has to be installed.
- b. Heating elements defect. The elements have to be replaced.
- c. Contactor failures. Contactor has to be replaced.

Boiler rupture will have crucial importance on the research activity until the situation has been rectified.

Worse case damage will be limited to the boiler. Total damage costs: NOK 500,000.
### Fire outbreak in Laboratoriet

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
</table>
| **Fire will be extinguished manually**  
Degree of Probability = 3 | | | |
| *(Fire will not be extinguished manually)*  
Nobody present in the Laboratorium  
Degree of Probability = 2 | | | |

L = Life and health  
M = Pollution of outer environment  
V = Los of values

<table>
<thead>
<tr>
<th></th>
<th>Degree of Consequences</th>
<th>Degree of Consequences</th>
<th>Degree of Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Flame fire or smouldering fire from anywhere in one of the rooms probably caused by human error, by electrical fault or by overheating. Maintenance and repair work can also cause fire.

Fire alarm starts after few minutes when the fire has been developed and spread sufficient amount of smoke. All detector buzzers in Boligkvarteret and in Laboratoriet, as well as strobe lights in Forskningsområdet and in Adkomstunnelene will be activated.

Persons staying in Laboratoriet will discover the fire within a minute and probably extinguish it with one of the handheld extinguishers. If the extinguishing attempt does not succeed, the manual call point will be activated.  
Persons in Boligkvarteret will realise there is no fire there. On the fire panel they will be informed where and in what room the fire is in Laboratoriet.  
Persons in Forskningsområdet will not know where the fire has broken out and have to escape anyway.

Black and dense smoke develops in Adkomstunnelene that spreads in both directions.

Worst case is fire out of control. As soon as the fire alarm releases, all persons escape safely according to escape procedures.

This fire incident may break out in the night while people are sleeping in Boligkvarteret. Fire alarm detectors with buzzers are installed in every of the four sleeping rooms and will wake up all sleeping people by any outbreak of fire in the Laboratoriet.

Laboratoriet will burn down completely. Smoke and soot damages will hit great parts of SSL.

Total damages will be around NOK 500,000
### 7.2.9 Fire outbreak in Boligkvarteret

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire will be extinguished manually</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of Probability = 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Fire will not be extinguished manually)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nobody present in Laboratoriet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of Probability = 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L= Life and health</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>M=Pollution of outer environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V=Los of values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flame fire or smouldering fire from anywhere in one of the rooms probably caused by human error, by electrical fault or by overheating. Maintenance and repair work can also cause fire.

Fire alarm starts after a few minutes when the fire has developed and spread a sufficient amount of smoke. All detector buzzers in Boligkvarteret and in Laboratoriet, as well as strobe lights in Forskningsområdet and in Adkomsttunnlen will be activated.

Persons staying in Boligkvarteret will discover the fire within a minute and probably extinguish it, activating fire hose and handheld extinguishers. If the extinguishing attempt does not succeed, the manual call point will be activated. Persons in Laboratoriet will realise no fire there. On the fire panel they will be informed where and in what room the fire is in Boligkvarteret. Persons in Forskningsområdet will not know where the fire has broken out and have to escape in any case.

Black and dense smoke develops in Adkomsttunnlen and spreads in both directions.

Worst case is fire out of control. As soon as the fire alarm activates, all persons escape safely according to the escape procedures.

This fire incident may break out in the night while people are sleeping in Boligkvarteret. Fire alarm detectors with buzzers are installed in every of the four sleeping rooms and will wake up all sleeping people by any outbreak of fire in Laboratoriet.

Laboratoriet will burn down completely. Smoke and soot damages will hit many parts of SSL.

Total damages will be around NOK 500,000
7.2.10  **Tunnel flooding**

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree of Probability = 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L= Life and health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M=Pollution of outer environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V=Los of values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rocks can loosen from the tunnel roof and enable substantial water flow into the tunnel. However, water flow that originates from the glacier will be limited and the consequences negligible.

Excess water from the power plant headrace tunnel will flow out of Spyletunnelen.
### Event description

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Probability</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

**L= Life and health**  
**M=Pollution of outer environment**  
**V=Los of values**

Flame fire or smouldering fire can break out in one of the electrical cabinets located everywhere outside buildings caused by electrical fault or by overheating. Such cabinets are installed in Adkomsttunnelen, Telecontaineren, Sedimentkammeret, Forskningsområdet and Svalbardroret.

Fire alarm will not be released before smoke reaches the boiler area where there is a smoke detector, probably after several minutes, depending on air flow strength and direction in Adkomsttunnelen.

Persons in Adkomsttunnelen, who are not far away from the point of origin, will discover the fire. They have to get to the nearest point to take an extinguisher. Either the Laboratorium or Boligkvarteret. They will activate a manual call point in order to release fire alarm if the fire alarm has not been released by the smoke detector in the boiler area. With the extinguisher they have to move to the fire point and attempt to extinguish.

Persons staying or sleeping in Boligkvarteret, in Laboratoriet and in Forskningsområdet will respond when the fire alarm has been activated.

Limited amount of smoke develops in the cabinet that spreads to Adkomsttunnelen in both directions.

All tunnel lights will probably be cut off.

All persons escape safely according to the escape procedures.

This fire incident may break out in the night while people are sleeping in Boligkvarteret. Fire alarm detectors with buzzers are installed in every of the four sleeping rooms and will wake up all sleeping people.

The damages will on the whole be limited to the cabinet. Total damage costs: NOK 80,000
### Fire outbreak in the ATV

**Event description**

<table>
<thead>
<tr>
<th>Degree of Probability</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>L= Life and health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M=Pollution of outer environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V=Los of values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fire outbreak can occur in the ATV while the vehicle is in operation or still have hot engine. The fire will probably be limited to the ATV.

Fire alarm will not be released before smoke reaches the boiler area where there is a smoke detector, probably after some minutes, depending on air flow strength and direction in Adkomstunnelen.

Persons in Adkomstunnelen, who are not far away from the ATV, will discover the fire. They have to get to the nearest point to get an extinguisher, either Laboratoriet or Boligkvarteret. They will activate a manual call point in order to activate the fire alarm if the it has not been triggered by the smoke detector in the boiler area. With the extinguisher they have to move to the fire point and try to extinguish.

Persons staying in Boligkvarteret, in Laboratoriet and in Forskningsområdet will respond when the fire alarm has been released.

Limited amount of smoke develops in the cabinet that spread to Adkomstunnelen in both directions.

All people in Forskningsområdet escape according to the escape procedures.

If no extinguishing effort has been achieved, people in all parts of the SSL escape safely according to the procedures.

*The damages will be limited to the ATV. Total damage costs: NOK 120,000*
### 7.2.13 Secondary oil mist explosion outside T2

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Degree of Probability = 1</strong></td>
<td>Degree of Consequences</td>
<td>Degree of Consequences</td>
<td>Degree of Consequences</td>
</tr>
<tr>
<td><strong>L.</strong> = Life and health</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>M.</strong> = Pollution of outer environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>V.</strong> = Loss of values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Operating the boiler the T2 transformer is on nominal load. In this mode there is a risk of transformer break down and tank rupture.

The explosion pressure is limited to < 100mBarg due to large surrounding space in Adkomstunnelen. This overpressure will not cause any serious damage.

A limited amount of smoke will be developed. No oil fire will occur.

Very loud bang will scare people.

150 litre of synthetic oil will flow out of the transformer tank and spread into the ground.

Fire alarm will not be released before smoke reach the boiler area where there is a smoke detector, probably after some minutes, depending on air flow strength and direction in Adkomstunnelen.

It is not necessary to evacuate people.

The incident will have crucial importance on the research activity until a new transformer is in operation.

The damages will be limited to the transformer. Total damage costs: NOK 500,000
7.2.14 Break-in and sabotage

<table>
<thead>
<tr>
<th>Event description</th>
<th>L</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of Probability = 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

L= Life and health  
M= Pollution of outer environment  
V= Loss of values

Uninvited visitors and intruders sabotage and damage parts of the installation and equipment.  
Damage on the high voltage line up to the last power mast is not probable.  
Sabotage acts such as data hacking, data cracking, EMP-sabotage and destroying external communication cables are not relevant at SSL.  
The probability of break-in and sabotage at SSL is very little.
8 RISK ASSESSMENT BY NVE

NVE has stated a risk matrix, as shown below, with limits for their acceptance.

Caution required means acceptable, but requires special attention to specific threats during operations in or to/from SSL.

<table>
<thead>
<tr>
<th>Probability</th>
<th>Consequence</th>
<th>Dated 2012-03-07</th>
<th>Estimated repeat interval (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>Improbable</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
<td>Fairly improbable</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5, 1</td>
<td>Very slightly improbable</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3, 4</td>
<td>Slightly probable</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td>Probable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>None</th>
<th>Minor</th>
<th>Medium</th>
<th>Critical</th>
<th>Disastrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury</td>
<td>Injury</td>
<td>Loss of life</td>
<td>Loss of life</td>
<td></td>
</tr>
<tr>
<td>disables</td>
<td>disables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work &lt; one week</td>
<td>work &gt; one week</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk acceptance level:
- Acceptable
- Caution required
- Not acceptable

9 RELEVANT NORWEGIAN LEGAL PROVISIONS

The following Norwegian Legal Provisions are basis of the this risk assessment:

9.1 TEK - Forskrift om krav til byggverk og produkter til byggverk (ny bygningslov)


9.2 FEF - Forskrift om elektriske forsyningsanlegg

Gjeldende fra 01.01.2006. Fastsatt av DSB 20. desember 2005 med hjemmel i Eltilsylsloven. Myndighet: DSB.

9.2.1 Forskrift: Bygningsmessige krav til 22kV installasjoner

§ 4-7. Bygninger.

"Bygninger og rom for høyspenningsinstallasjoner skal bygges og utstyres slik at de gir sikkerhet for personer i og utenfor anleggene. Adkomstmuligheter som dører og vinduer skal utføres slik at uvedkommendes adgang til anleggene effektivt hindres. Bygninger og rom skal være tjenlige for formålet og være slik at vesentlige materielle skader unngås ved feil. feilbetjening eller brann".
9.2.2 **Utdrag fra veiledning: Bygningsmessige krav til transformatorrom**

§ 4-7. Bygninger.


9.2.3 **Forskrift: Bruk av olje og liknende**

§ 4-8. Anlegg som det er vanskelig å evacuere fra.

"I anlegg som det kan være vanskelig å evacuere fra, som underjordiske anlegg, vindkraftverk, anlegg i fjell og lignende, skal det iverksettes tiltak for å sikre trygg evacuering ved brann eller ulykker".

9.3 **FOBTOT - Forskrift om brannforebyggende tiltak og tilsyn**


9.4 **Forskrift om systematisk helse-, miljø- og sikkerhetsarbeid i virksomheter (Internkontrollforskriften)**


9.5 **BfK - Forskrift til beredskap i kraftforsyningen. (Regulations relating to contingency planning in the power supply system). Reg. No. 1606 of 16th December 2002.**

Da dette anlegget ikke er registrert under KBO og ikke skal være det, er BfK i utgangspunktet ikke førende. Når det gjelder ROS, som skal gjennomføres for dette anlegget, er imidlertid BfK hensiktsmessig å følge fordi det er høyspente installasjoner i anlegget.

10 WORDS, EXPRESSIONS AND ABBREVIATIONS USED IN THIS REPORT

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATV</td>
<td>All-terrain Vehicle.</td>
</tr>
<tr>
<td>Bar</td>
<td>10 ton/m² = 100 kN/m².</td>
</tr>
<tr>
<td>mBar</td>
<td>0.001 Bar.</td>
</tr>
<tr>
<td>Barg</td>
<td>Bar gauge (Overpressure).</td>
</tr>
<tr>
<td>Bi/K</td>
<td>Norw. Regulation: Forskrift om Beredskap i kraftforsyningen. Regulations relating to contingency planning in the power supply system.</td>
</tr>
<tr>
<td>Energiloven</td>
<td>Norwegian Law: Energiloven: Lov om produksjon, omformning, overføring, omsetning, fordeling og bruk av energi m.m.</td>
</tr>
<tr>
<td>Eltilsynsloven</td>
<td>Norwegian Law: Lov om tilsyn med elektriske anlegg og elektrisk utstyr.</td>
</tr>
<tr>
<td>EN</td>
<td>European Norm.</td>
</tr>
<tr>
<td>Explosion</td>
<td>Fast combustion process that cause fast rise of Temperature and Pressure.</td>
</tr>
<tr>
<td>FEF</td>
<td>Norwegian Regulativ: Forskrift om elektriske forsyningsanlegg (ny pr. 1. januar 2006), beregning av sekundærksplosjon.</td>
</tr>
<tr>
<td>FOBTOT</td>
<td>Forskrift om brannforebyggende tiltak og tilsyn</td>
</tr>
<tr>
<td>HV</td>
<td>High Voltage</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electro technical Commission</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>KBO</td>
<td>Kraftforsyningens beredskapsorganisasjon (NVE).</td>
</tr>
<tr>
<td>kVA</td>
<td>Kilo Volt Ampere (Power)</td>
</tr>
<tr>
<td>NS</td>
<td>Norsk Standard (Norwegian Standard).</td>
</tr>
<tr>
<td>NVE</td>
<td>Norwegian Water Resources and Energy Directorate.</td>
</tr>
<tr>
<td>PBL</td>
<td>Plan og Bygningsloven</td>
</tr>
<tr>
<td>PHA</td>
<td>Preliminary Hazard Analyses (Groanalyse sannsynlighet/konsekvens)</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinylchloride. Develop hydrochloride Acid by combustion</td>
</tr>
<tr>
<td>Sectioning</td>
<td>Limited part of an area or building where an explosion and fire can occur without any damage or smoke spread or fire spread outside the part.</td>
</tr>
<tr>
<td>SINTEF</td>
<td>Norwegian Institute of Technology (Trondheim).</td>
</tr>
<tr>
<td>SSL</td>
<td>Svartisen Subglacial Laboratorium.</td>
</tr>
<tr>
<td>STATKRAFT</td>
<td>Norwegian State Power Company.</td>
</tr>
<tr>
<td>SWGS</td>
<td>Safe Way Guidance System</td>
</tr>
<tr>
<td>Svarptesen</td>
<td>Glacier in North of Norway.</td>
</tr>
<tr>
<td>TXSP</td>
<td>PEX insulated High Voltage Earth Cable.</td>
</tr>
</tbody>
</table>

11 REFERENCE DOCUMENTS

[2] Drawings
[9] Energiloven: Veilegding til forskrift om beredskap i kraftforsyningen
[12] Brannloven: Veiledning til FOBTOT
[13] Eltilsynsloven
[17] PBL: Teknisk Forskrift til plan- og bygningsloven
[18] PBL: VTEK - Veiledning til teknisk forskrift
[21] Forurensningsloven
[22] NS3926: Escape marking
[23] NVE: Temaveileder for utarbeidelse av ROS.

12 ATTACHMENTS

a) Site diagram.
b) Safety form for external visitors.
c) Arrival instructions.
d) Departure instructions.
e) Group instructions.
f) Fire drill.
g) Fire alarm test.

22 May 2012

Ole A. Westberg
Sikkerhetsinstruks for Svartisen Subglasiale Laboratorium (SSL)

Safety regulations for Svartisen Subglacial Laboratory (SSL)

Versjon datert 1. november 2009 / Version dated 1 November 2009

Denne sikkerhetsinstruksen omhandler aktivitet i Svartisen Subglasiale Laboratorium samt ovrig tunnelsystem i området ved Engabreen

The following safety regulations apply to all activities undertaken in connection with the Svartisen Subglacial Laboratory or any of the other parts of the tunnel system beneath Engabreen

1. Informasjon og forberedelse.

1. Basic safety information

1.1 Besøkende skal ha lest denne sikkerhetsinstruksen noye og skal har undertegnet en erklæring at de har gjort det.

1.2 Visitors must read these safety regulations carefully and sign a release form stating that they have done so.

1.2 Besøkende må være fjellvante slik at de kan ta seg opp til og ned fra SSL også under vanskelige værforhold på den aktuelle årsiden.

1.2 Visitors must be sufficiently fit and have enough wilderness experience to be able to handle the climb up to and down from the tunnel entrance in any of the various types of weather one is likely to experience at Svartisen. This includes, but is not limited to, deep snow, ice, high winds and heavy rain. Even under good conditions the climb is challenging as it is steep, often slick and with loose rocks, and with fixed ropes in places, and experienced mountaineers have found the conditions can be challenging on occasion. It is essential that each participant considers carefully whether they are able to make the journey up to and down from the tunnel unaided without being a safety risk to those travelling with them.

1.3 If upon arrival at Holandsfjord or starting the journey up the mountain a visitor is found insufficiently fit or otherwise unprepared to make the journey up to the tunnel, they are no longer the responsibility of NVE and will not be allowed access to the tunnel. NVE has the final decision in this matter.

1.4 If it is necessary to delay arrival or departure, visitors are responsible for any additional expenses for themselves and the tunnel guide. Visitors should be aware that although they may have planned to travel to or from the tunnel entrance by helicopter, sometimes it is necessary to make the trip by foot due to adverse weather conditions or other reasons for helicopter unavailability. If a helicopter is unexpectedly necessary due to illness, sickness or any other reason, visitors are fully responsible for this additional expense.

1.5 Visitors are responsible for providing their own equipment for this journey such as ice axe, crampons, rain gear and boots. If equipment is loaned from NVE for this trip and is then lost or damaged, it must be replaced in full.

1.6 Besøkende gruppe skal alltid ha med kjentmann (person som har vært i SSL. tidligere, som kjenner stedet og utstyre godt. og som tilhører NVE eller Statkraft).

1.7 Visitors must always be accompanied by an experienced tunnel guide, defined as someone who has been in the tunnel system before, is acquainted with the workings of SSL and the tunnel system, is fluent in Norwegian and is affiliated with either NVE or Statkraft.
1.8 Statkraft Stasjonsgruppe Glomfjord skal varsles på forhånd om besøk i SSL. Det skal informeres om hvem som er i SSL, tidsrom for oppholdet, og hvem som er kjentmann
Adresse: Stasjonslede
Statkraft Glomfjord, Fykan
8160 Glomfjord

1.8 **The Statkraft office in Glomfjord must be informed in writing before each visit to the tunnel system.** This notification letter should include the visitors’ names, the times of arrival and departure of each visitor, contact name and telephone number for each visitor (in case of accident) and the name of the guide.
**Address:** Stasjonslede
Statkraft Glomfjord, Fykan
8160 Glomfjord

1.9 **Adgang til tunnelsystem er på egen risiko!** Alle besøkere skal ha undertegnet en erklæring der de bekrefter å ha egen forsikring for skade som skyldes egen adferd eller uforutsette hendelser (steinfall og lignende), for de reiser til SSL. Dette skal sikre at skade ikke skal kunne lastes NVE eller Statkraft.

1.9 **Entry to the tunnel system is at the visitor's own risk!** All visitors must sign a release confirming that they have arranged for the appropriate insurance before coming to the tunnel system. Statkraft and NVE are not responsible for injuries that are the result of the visitor's own conduct or that are the result of "normal," unforeseeable tunnel conditions (rock pieces falling from the tunnel roof and similar).

1.10 Besøkende skal gjøres kjent med tunnelsystemets og de enkelte delenes funksjon og farepotensiale.

1.10 **Visitors will be given a tour of the tunnel, and be informed about the functions and potential hazards of the various parts of the system.** This is not always possible immediately upon arrival and access to certain parts of the tunnel system or equipment may then be delayed until such a tour has been completed.

1.11 Besøkende skal gjøres kjent med plassering av forstehjelpsutstyr.

1.11 **Visitors will be shown all locations where the first-aid kits are kept.**

1.12 Besøkende skal gjøres kjent med varslingsrutiner i forbindelse med ulykker, bruk av telefon og hvor telefoner er plassert. Ved ulykke skal varsling gjøres via Statkrafts Driftsentral i Narvik (døgnvakt) tlf. 76 94 20 08. Dessuten skal NVE varsles på tlf. 22 95 92 61 (seksjonssjef HBM) eller 99038868

1.12 **Visitors will be shown how to use the telephone system, and the locations of the various telephones within the tunnels.** In the event of an accident, contact Statkraft's Operation Center in Narvik (24 hours a day): 76 94 20 08. In addition, NVE should be notified at 22 95 92 61 (head, Glacier and Environmental Hydrology Section) or 99038868.

**2. Den enkeltes sikkerhet.**

**2. Individual safety.**

2.1 Hjelm skal alltid brukes i tunnelene p.g.a. faren for steinfall fra tak og vegger og fra breis.
2.1 **Always wear a helmet when in the tunnels.** Even a small rock falling from the roof can result in death or serious injury to an unprotected skull.

2.2 Ved ferdsel i tunnelsystemet skal alltid reserve lyskilde medbringes (lommelykt).
2.2 **Always carry two light sources when walking within the tunnel system, including a headlamp.** Each visitor is responsible for providing at least one headlamp or torch.

2.3 Dersom vannstanden overskriver ovre bjelkestengsel er det uklokt å bevege seg innenfor nedre bjelkestengsel ved breobservatoriet. Dersom ovre bjelkestengsel er brutt sammen eller att is fra inntaksområdet blokkerer tunnelen nedenfor bjelkestengsel så kan det føre til store mengder vann. I så fall skal tunnelsystemet evakueres.

2.3 **When discharge from the subglacial intakes is so great that water runs over the top of the innermost water-diversion barrier, it is inadvisable (if not foolish) to open the door in the**
closest water-diversion barrier (just past the SSL lab buildings). In the event that the innermost water-diversion barrier has failed entirely, or in case of ice blocking the tunnel downstream from it there will be abnormally high discharge behind the closest water-diversion barrier. In this case, the tunnel should be evacuated.

2.4 Ferdsel i spyletunnelen er forbudt unntatt etter klarering fra Statkraft Glomfjord.
2.4 The flushing tunnel from the sediment chamber is off limits, unless the Statkraft office in Glomfjord is informed beforehand, or in case of emergency and is used for evacuation from tunnel system.

2.5 Ferdsel i våttunneler oppstrøms sedimentkammeret skal kun forekomme i perioder med lav vannføring i vintersesongen etter vurdering av vær og tilsigsforhold.
2.5 The "wet" tunnel system upstream from the sediment chamber is off limits except during the winter (normally November-April) and only after evaluation of the weather and prior discharge levels.

2.6 Ferdsel i overforingsstunnel nedsstrøms sedimentkammeret er forbudt.
2.6 The "wet" tunnel system downstream from the sediment chamber towards the power station is always off limits, without exception.

2.7 Ferdsel under hengende is i tunnelene (der breis trenger inn i tunnelsystemet) må ikke forekomme.
2.7 Do not walk or crawl under hanging ice in the tunnel system.

2.8 Ved utsmelting av istunneler skal taket i istunnelen kontrolleres og renskes for løs stein før man går inn i istunnelen.
2.8 When melting ice tunnels, always inspect the ice in the roof for loose stones. These should be removed before entering the ice tunnel. Do not work alone in the ice tunnel. At least one other person should be nearby whenever work is carried out within the ice tunnel.

2.9 Ved fyring eller heising av instrumentbord i vertikal forskningssjakt må spesiell forsiktighet utvises. Ikke stå under bordet ved heising/fyring.
2.9 Use extreme caution when hoisting and lowering the instrument plate in the vertical shaft. Do not stand under the plate until the legs are secured.

2.10 Utkobling samt skifte av sikring i transformatoren ved SSL skal kun betjenes av kjentmann.
2.10 The fuses in the yellow transformer container near the SSL building should be serviced by trained personnel only. Any electrical work on laboratory equipment (e.g. hot water heater) is to be performed only by trained and authorised personnel.

3. Installasjonenes sikkerhet.
3. Facility security

3.1 Døren i bjelkestengsel ved NVEs bygninger skal alltid være stengt når det ikke befinner seg folk på innsiden av bjelkestengslet.
3.1 The door in the closest water-diversion barrier must always be kept closed when there is nobody working on the other side.

3.2 Inngangsdøren til tunnelsystemet skal være låst når stedet forlates.
3.2 The entry door to the tunnel system must be locked upon departure from the tunnel system.
Erklæring/Release form

Jeg herved erklærer at jeg har lest nøyde og vil slutte meg til sikkerhetsinstruks for besøkende til Svartisen Subglasiale Laboratorium. Videre bekrefter jeg at jeg har egen forsikring for skade som skyldes egen adferd eller uforutsette hendelser.

I hereby affirm that I have read and will adhere to the safety regulations for Svartisen Subglacial Laboratory. In addition, I confirm that I have the appropriate insurance for accidents occurring in the tunnel that are the result of my own conduct or that are the result of unforeseeable conditions within the tunnel.

Dato/Date_________ Sted/Location________________________

Underskrift/Signature________________________________

Navn/Name___________________________________________

Adresse/Address________________________________________
________________________________________________________
________________________________________________________
________________________________________________________

Affiliation ____________________________________________

Contact person (in case of accident) ______________________

Telephone number for above (incl. country code) ___________
Svartisen subglacial laboratory: Arrival instructions (2012-04-26)

These instructions list the tasks to be performed upon arrival at the Svartisen Subglacial laboratory.

**At the entrance:**

- Put spade from mast inside if necessary. Fasten straps to the mast - loose straps are distracting for helicopter pilot
- Turn on lights for lower tunnel
- Close the door when everything is brought inside
- Set up laminated personnel sheet at entrance, and cross off for those present in tunnel

**At the living quarters:**

- Disconnect the headlamp chargers from the timers
- Turn on battery for fire alarm system (see separate instructions). Check status is ok.
- Check the telephone works externally (inform Thorrud at Statkraft if not, 75 72 34 03, 75 72 34 00 or 4157 0752)
- Place escape masks in the safety room according to number of people in the tunnel
- Turn on lights for upper tunnel, but turn off overnight
- Ensure evacuation set is at the entrance
- Check pressure in fire extinguishers (needle on green) and shake a few times.

**At the lab area:**

- Set out escape masks in the safety room according to number of people.
- Open locked container (same key as entrance) and insert fuses/sikringer using safety helmet available there.
- Remove bubble wrap from in front of freezer room compressor
- Sump pump and sump pump hose should be set out with care. Sump pump should be attached with rope so it doesn’t get washed away. Sump pump should be set out so that there are no kinks. Motor for sump pump is set out on the catwalk.
- Turn on battery for the fire alarm system. Ensure status is ok.
- Turn on the freezer if there is a large quantity of food to be frozen
- Release air from the high pressure pumps when first turned on, if necessary (spanner size 9?)
- Confirm that the circulation pump is working by touch, and monitoring of relative temperature in hot water tank
- Set out halogen lamps on the catwalk and in the research shaft area
- Look for loose stones overhead when entering and leaving horizontal research tunnel.
Svartisen subglacial laboratory: Departure instructions (2012-04-26)

These instructions list the tasks to be performed upon departure from the Svartisen Subglacial laboratory.

At the lab area:

- Ensure all equipment removed from the research shaft.

  Ensure the door by the lab out to the unlit tunnel is CLOSED securely!

- Put back the sump pump and the sump pump hose. Be careful with the sump pump hose – there must not be any kinks in it.

- Replace the cone that fits in the hole beside the reservoir where the sump pump hose was (insert from opposite side to laboratory area).

- Turn off all the pumps, both high pressure pumps and circulation pump

- Turn off the hot water heater (kjelen).

- Remove the fuses/sikringer in the elektro-container) while wearing the safety helmet that is beside the equipment. Lock the elektro container (same key as entrance door).

- Check there is no food left in the freezer and turn it off. Replace the bubble wrap in front of the compressor and air intake.

- Take all rubbish and everything that must be retrograded to the entrance

- Empty the toilet (usually into the sediment chamber).

- Make sure everything is clean and tidy, and all tools have been put away. Sweep/vaccum floors, wash floors if dirty, clean benches and sinks.

- Turn down the temperature on all thermostats to 15°C

- Change the measurement interval for the pressure sensors, and confirm that the storage module is attached to the data logger (not the computer). Do not download data without first getting clear confirmation from check with Miriam first. If data is downloaded, save file to appropriate year folder and copy file to memory stick.

- Note any missing or broken equipment, and send details to Miriam (mja@nve.no)

- Drive the vehicle up to the lab area

- Check that fire extinguishers are on green not red. Shake fire extinguishers if more than two weeks since arrival. Put all fire extinguishers indoors.

- Move escape masks from the safety room into the lab building for storage

- Check that the door to Spyletunnelen is closed on the way past.

At the living quarters

- Turn off the lighting for the upper tunnel

- Check that all the headlamps are turned on, before being set into the chargers
- Plug the headlamp chargers into the time switches.
- Put helmets on the overhead shelf, with the helmet side down (not the plastic fasteners)
- Sort the food, disposing of perishables that will expire before the next visit, and do an inventory of remaining food
- Take remaining rubbish to the entrance to be retrograded.
- Make sure everything is clean and tidy, and all tools have been put away. Sweep/vacuum floors, wash floors if dirty, clean benches and sinks. Take dirty tea towels back to Oslo.
- Note any missing or broken equipment
- Collect the evacuation packs, and store at living quarters. Take any extra mobile phones back to Oslo.
- Put escape masks in the living quarters (not the safety room).
- Check that fire extinguishers are on green not red. Shake fire extinguishers if more than two weeks since arrival. Put all fire extinguishers indoors.
- Take all equipment to be retrograded to the entrance
- Place the trolley in front of the living quarters in a dry spot
- Turn down the temperature on all thermostats to 15°C

At the entrance:
- Cross everyone out on the personnel sheet on departure
- Turn off the lights
- Put a crowbar in front of the door after it is closed
- Fasten a spade securely to the mast above the door
- Lock the door
- Return tunnel key to Miriam
Svartisen subglacial laboratory: Group instructions (2012-04-26)

These instructions describe how the site manager is to organise group visits to the Svartisen Subglacial laboratory.

Before departure:

- Ensure all groups have received a copy of ‘subglacial lab_safetyform.doc’ and have signed and returned a paper copy before departure.

- Obtain list of names and dates for when people are in the tunnel, and contact information for next-of-kin. Information should be tabulated in a file of form ‘Engabreen personnel schedule mar 2012.xls’. This is submitted to Statkraft about one week before departure, and a copy is also given to the head of section (along with the signed safety forms).

- Work is planned such that the number of people in the tunnel is not above the maximum allowed for safety reasons (eight overnighting, ten during the daytime).

To tunnel on foot:

- Ensure that groups have the necessary equipment for the walk up (according to season may include crampons, ice axe). Ensure someone in group has GPS receiver with route co-ordinates. A light source and food is necessary in case of walk taking longer than planned. Avalanche risk must be evaluated. According to the safety form, NVE has the final decision on whether someone is allowed access to the tunnel, so can state that anyone who is not sufficiently fit or otherwise prepared to attempt the climb will not be allowed access. NVE personnel are not responsible for a group’s safety on the walk up, and groups without experience are encouraged to hire a guide.

To tunnel by helicopter:

- Ensure that groups using a helicopter understand that helicopter expenses can vary according to weather, and that they are responsible for these expenses if the helicopter attempts to come but has to turn back due to weather or other problems.

- Ensure that everyone understands the safety concerns regarding use of helicopters – no loose objects on the ground, prepare a landing place if possible (or use the plateau below the entrance, especially if many people), keep head and all objects low when near the helicopter. Approach the helicopter from the side and only after clear signal from pilot or loadmaster.

- Inform the pilots if there will be inexperienced people using the helicopter.

In the tunnel:

- A tunnel guide is present when external groups are working in the tunnel. A tunnel guide is usually an NVE or Statkraft person who is familiar with procedures in the tunnel.

- Upon arrival there is an initial safety briefing. Groups are informed about the light switches for the upper lights and importance of turning them off at night, location of escape masks, evacuation packs, fire extinguishers and first aid equipment. There is no smoking in the tunnel. Care should be taken when using hotplates, especially the ones in the lab area (sometimes used for melting ice samples), and when welding.

- Discuss use of personnel sheets at entrance and living quarters. Personnel sheet at entrance to be filled out on arrival and departure, and also when leaving tunnel for short periods.
Personnel sheet at living quarters to be filled out every time someone goes to the upper tunnel, with expected work area(s).

- Upper tunnel safety briefing – location of escape masks, fire extinguishers and first aid equipment. Rules regarding Spyletunnelen. This briefing may take place the day after arrival.

- Safety briefings also include procedure in case of fire alarm – fight fire if possible, rendezvous in safety rooms and controlled evacuation from tunnel and evacuation routes.

- A helmet and headlamp should be used at all times in the tunnel (headlamp is normally not turned on when walking along main tunnel). A second light source is taken when going beyond the main tunnel and research shaft.

- The chainsaw is to be used only by people who have had the appropriate training and have a safety certificate. Chainsaw trousers and boots must be worn when using the chainsaw.

- A protocol should be established upon arrival for use of the vehicle. The emphasis is on equipment transport rather than personnel transport. Groups wishing to use the vehicle must purchase petrol and transport it to the tunnel. There is no guarantee that the vehicle will work.

- NVE can veto opening of the horizontal and research shafts, or demand that they are closed if too much meltwater starts to come.

- Inflammable material should be stored in safe locations

- Groups should ensure that personnel do not work so many hours in a day or days in a row that it encroaches upon safety. All personnel need to take an overnight break from the tunnel at least every seven days.
Svartisen subglacial laboratory: Fire Drill Procedures (2012-04-26)

Participants: Four persons or more.

Before start:
1. Check both fire alarm panels. Both panels shall be in normal operation.
2. One or more persons shall be present in the research shaft (Forskningsjakten).
3. One or more persons shall be present in the laboratory (Laboratoriet).
4. One or more persons shall be present in the living quarters (Boligkvarteret)

Drill No 1: Fire outbreak in living quarters

Actions in living quarters:
1. Action No 1: Release fire alarm in living quarters from the manual call point in the cloak room.
2. Fire alarm breaks out by all detectors with buzzer, siren and the flashing light outside the building.
3. Action No 2: Discuss procedure for extinguishing the fire.
4. Action No 3: Call laboratory in order to give status.

Actions in laboratory:
5. Fire alarm breaks out by all detectors with buzzer, siren and two flashing lights outside the building.
6. Action No 1: Check in the laboratory and outside the building if there is a fire breaking out and discuss procedure for extinguishing fire
7. Action No 2: Look at the fire panel and confirm fire in living quarters.
8. Action No 3: If anybody in living quarters: contact them by telephone.
9. Action No 4: Collect an escape mask each (do not use in a drill)
10. Action No 5: Escape out of the building and proceed to Safe Room 1.
11. Action No 6: Proceed to Safe room 2 to replace mask if necessary or straight to the Exit.

Actions in research shaft:
1. Fire alarm breaks out by two flashing lights combined with a very strong persistent siren sound.
2. Action No 1: Collect an escape mask each (do not use in a drill)
3. Action No 2: Escape down the stairs and proceed to laboratory. Passing laboratory you will see if fire there or not.
5. Action No 4: Proceed to Safe Room 2 or straight to Exit

Drill No 2: Fire outbreak in laboratory in the kitchen.

Actions in laboratory:
1. Action No 1: Release fire alarm in laboratory from the manual call point.
2. Action No 2: Check in and around the laboratory and discuss procedure for extinguishing fire
3. Action No 4: If anybody in living quarters contact them by Telephone.
4. Action No 5: Collect an escape mask each (do not use in a drill)
5. Action No 6: Escape out of the building and proceed to Safe Room 1.
6. Action No 7: Proceed to Safe room 2 or straight to the Exit

Actions in living quarters:
1. Fire alarm breaks out by all detectors with buzzer, siren and the flashing light outside the building.
2. Action No 1: Check and try to find any fire outbreak.
3. Action No 2: Check the fire alarm panel to be informed about the fire in laboratory.
4. Action No 3: Contact laboratory, if anybody is there.

Actions in research shaft:
1. Fire alarm breaks out by two flashing lights combined with a very strong persistent siren sound.
2. Action No 1: Collect an escape mask each (do not use in a drill)
3. Action No 2: Escape down stairs and proceed to laboratory. Passing laboratory you will see the fire.
5. Action No 4: Proceed to Safe Room 2 or straight to Exit
### SVARTISEN SUBGLASIAL LABORATORIUM
#### BRANNVARSLINGSANLEGG TESTPROTOKOLL

#### 1. TESTPROTOKOLL FOR BRANNVARSLINGSANLEGGET

**Test utført av:**

<table>
<thead>
<tr>
<th>1. Handlinger</th>
<th>OK</th>
<th>Nei</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ved ankomst til sentralene:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Sentralen i boligkvarteret i normal drift. Dersom den ikke er i normal drift skal årsaken kartlegges og status nedskrives før sentralen nullstilles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Sentralen i Laboratoriet i normal drift. Dersom den ikke er i normal drift skal årsaken kartlegges og status nedskrives før sentralen nullstilles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Test utgått fra sentralen i laboratoriet:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Begge flashnlysene i forskningsområdet, ved bjelkestengslet og ved sikkerhetsrom 1 aktivert uten forsinkel. Lyd og lys tilfredsstillende.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Én person befinner seg ved sentralen i boligkvarteret og har telefonkontakt med laboratoriet.</td>
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<td></td>
</tr>
<tr>
<td>6. Sokkelsirene i laboratoriet aktiveres uten forsinkel.</td>
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<td></td>
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<tr>
<td>7. Rosningsiren ved laboratoriet aktiveres uten forsinkel.</td>
<td></td>
<td></td>
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<tr>
<td>8. Sokkelsirene i boligkvarteret aktiveres uten forsinkel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Rosningsiren i boligkvarteret aktiveres uten forsinkel ved alarm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Når alle angitte observasjonen er foretatt, tilbakestilles alarmen fra sentralen i Laboratoriet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Nullstilles samtidig sentralen i boligkvarteret automatisk?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Test utgått fra sentralen i boligkvarteret:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Én person befinner seg i forskningssjakten.</td>
<td></td>
<td></td>
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<tr>
<td>13. Én person befinner seg i laboratoriet ved sentralen.</td>
<td></td>
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<tr>
<td>20. Én person befinner seg i boligkvarteret og har telefonkontakt med laboratoriet.</td>
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<tr>
<td>15. Alle sokkelsirener i boligkvarteret gir alarm</td>
<td></td>
<td></td>
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<tr>
<td>16. Strobelyset utenfor boligkvarteret gir alarm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Når alle angitte observasjonen er foretatt, tilbakestilles alarmen fra sentralen i boligkvarteret.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Nullstilles samtidig sentralen i laboratoriet automatisk?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. **BESKRIVELSE AV ANLEGGET**

**BRANNVARSLSINGSANLEGG**

<table>
<thead>
<tr>
<th>Antall</th>
<th>Utstyr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Brannvarslingssentral AutroSafe 4 116-P-AUTROSAFE4/OAN BS-420, Betjeningspanel BS-430. Ferdig utviklet i 2008</td>
</tr>
<tr>
<td>17</td>
<td>Optisk røyketekstorer – BH-200</td>
</tr>
<tr>
<td>8</td>
<td>Sokkelsirener BBR-110</td>
</tr>
<tr>
<td>5</td>
<td>Flashnlys, kombinert varsellys og sirene</td>
</tr>
<tr>
<td>2</td>
<td>Sirener Roshni LP</td>
</tr>
<tr>
<td>2</td>
<td>Varmedetektorer – BD-200</td>
</tr>
<tr>
<td>4</td>
<td>Manuelle meldere BF-300V2</td>
</tr>
<tr>
<td>1</td>
<td>Reservedel: Optisk detektor</td>
</tr>
<tr>
<td>1</td>
<td>Reservedel: Sikringsett for brannvarslingssentralen</td>
</tr>
<tr>
<td>5</td>
<td>Reservedel: Glass for manuelle Brannmeldere</td>
</tr>
<tr>
<td>1</td>
<td>Verktøy: Boks med testgass</td>
</tr>
</tbody>
</table>

Begge sentralen gir brannalarm når én eller flere av detektorene aktiveres. Sentralenes tekstdisplay gir melding i klar tekst om brannalarmen. Brannalarmen kan avstilles fra begge sentraler.

På grunn av skadelig batteribelastning ved langvarig strømavbrudd er det lagt inn en bryter ved hver sentral for inn/ut kobling av batteriene. Denne bryteren skal betjenes ved ankomst og avreise fra hhv. Laboratoriet og boligkvarteret. Det er laget separat dokumentasjon for denne prosedyren som er vedlagt dette dokumentet og som vil bli lagt ved de respektive sentralene.

**FIBERKABELANLEGG**

Kabel med åtte fibre er installert mellom vinterinngangen og boligkvarteret/telecontainer og mellom boligkvarteret/telecontainer og laboratoriet. Fibrene er terminert i patcheskap montert på vegg. Fire av fibrene mellom boligkvarteret og laboratoriet er benyttet for brannvarslingsanlegget. De resterende fibre er ledige. Ref.: FDV-Dokumentasjon

**TERMEOLEMENTER PÅ KJELEN**

Tre nye termoelementer er montert på kjelen. Ref.: FDV-Dokumentasjon

**DOKUMENTASJON**

Entreprenøren har etablert en ringperm med FDV-Dokumentasjon med følgende innhold:

2. Samsvarserklæringer og sjekkliste.
5. Fiberkabel.
7. Prosedyre for betjening av brannsentralene.

Ringpermen er i to eksemplarer: Én for oppbevaring på SSL og én for oppbevaring hos NVE.