Four staff personnel will be present during the whole summer season. Some scientists will occupy the station for some weeks every summer for servicing and maintaining the monitoring equipment and for environmental sampling; others will use the station as a hub for scientific expeditions in the field.

Logistic functions and tasks of the station will grow depending on the needs of the research work.

2.3.2. Shipping and logistics

Once the station is operational, station personnel and scientists will use the DROMLAN link for access to the station and the Sør Rondane region in general. The yearly station provisioning by ship (Ice class) - via unloading at Breid Bay - will be as much as possible co-organized and shared with the other nations active in Dronning Maud Land.

An air and oversnow reconnaissance survey of Breid Bay and ice shelf area during Belare 2005 was carried out to assess the local situation. Breid Bay was used as a ship loading/unloading area during the Belgian (1958-1960) and Belgian-Dutch (1964-1966) expeditions to Base Roi Baudouin and during the Japanese Antarctic Research (JARE) expeditions to the now abandoned Asuka station (1986-1991).

Fig 2.5 : Fast ice in Leopold III Bay (Breid Bay) with ice cliff and ramp to ice shelf in the back.
(Picture taken in 1966)

The reconnaissance team mapped the approximately 200 km access route and identified a preferred and a back-up unloading site (see **Fig. 2.6**). The east route (1) is the preferred route and consists in an almost straight line from BEL-L0 (see **Table 2.1** for coordinates) to the station site. BEL-L0 was the preferred unloading site for helicopters, used by the Japanese expeditions. Although there are no crevasses or other obstacles in the last 80km of the route, due to the occurrence of large sastrugi some surface preparation will be required prior to the actual transports. For the east route a new (BEL-L0 NEW) reference point was established closer to the preferred unloading site. At point BEL-RAMP access to the fast ice is possible by means of a local recess in the terrain which forms a stable and gentle slope.

Alternative unloading sites and access routes were also identified. For the east route this is the Polarhav Bay (point BEL-LD) where unloading can be done directly on the ice shelf (the ice cliff being less than15m high). Satellite images show that typically the fast ice completely disappears in this area. Another unloading area can be found to the west (point BEL-LC) where a few ramps were detected. In this case, a more western route using the former Japanese L0 point (indicated as BEL L0) will be used. The west route (2) would provide the shortest way to the construction site. The terrain conditions are similar to the ones that can be found on the east route. Between both east and west options a large crevasse area was found near the edge of the ice shelf. This area was also surveyed. The closest point the routes come to the crevasses is at point BEL-CREV E, which is still at a distance of more than 2km.

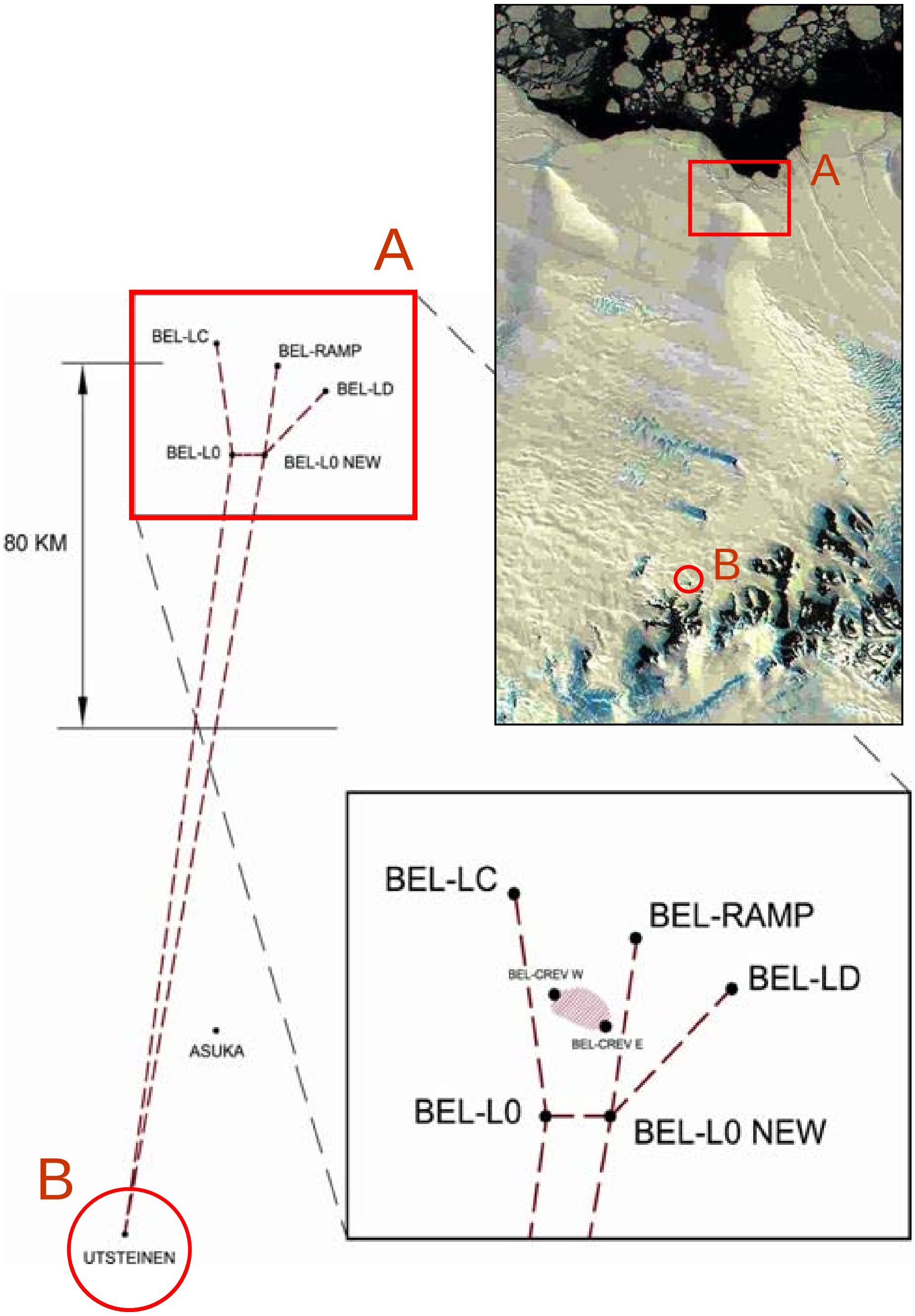

Fig 2.6: Overview of access routes (eastern and western) from Utsteinen to Breid bay and unloading site.

BEL-L0	S 70°29′50″	E 24°00′37″
BEL-L0 NEW	S 70°30′00″	E 24°12′00″
BEL-RAMP	S 70°20′26″	E 24°14′18″
BEL-LC	S 70°18′25″	E 23°52′32″
BEL-LD	S 70°23′06″	E 24°31′47″
BEL-CREV E	S 70°25′04″	E 24°10′43″
BEL-CREV W	S 70°23′08″	E 24°01′08″

Table 2.1 : Coordinates of major survey points

To limit the number of lay-days of the ship for unloading (for budget and safety reasons) an inland depot area has been located at a safe distance from the edge of the ice shelf. Transport containers will weigh maximum 8 ton for safe movement across the sea ice and easy handling. Fuel in bulk will be transferred in tank sledge-based containers.

After collecting the full cargo load on the inland depot site (which will have a base camp facility) the transport to the actual site will start. The estimated unloading time to the inland depot area is 5 days while the first load arriving at the construction site will be approximately 7 days after ship arrival (weather conditions permitting).

1	Logistics Support Equipment (LSE)	Large vehicles, sledges, snowmobiles … to be used for the building and operational phases. Some of this equipment will become redundant when the building is finished and will be removed from Antarctica.
2	Construction Support Equipment (CSE)	Equipment specifically for the building process (shelters, tools, generators, lifting equipment…) except for vehicles (see 1). Some of this equipment will become redundant when the building is finished and will be removed from Antarctica.
3	Construction Support Supplies (CSS)	Spare parts, food … Except for fuel (see 5) specifically foreseen for the building process itself.
4	Operational Support Equipment (OSE)	Work shop tools, spare parts, appliances … required to run the station.
5	Operational Support Supplies (OSS)	Spare parts, food … except for fuel (see 5) needed to support the first period of the operational phase of the station.
6	Fuel (FL)	Different kind of fuels (octane 95, JET A1 …) needed for the vehicles, emergency generator, powered tools and snowmobiles.
7	Building Construction Materials (BCM)	All construction materials that are part of the buildings and its auxiliaries.
8	Waste (W)	All kinds of waste resulting from the activities (human waste, food waste, packaging materials …).
9	Scientific Equipment (SE)	Instruments and other equipment for initial science projects
10	Excess Material (EM)	Equipment and material redundant when the building is finished. Will be removed from Antarctica.

Table 2.2: Categories of transport needs

Category		**Transport Volume (m^3)**	**Net weight (kg)**	**N° ISO containers (20′)**	**Weight containers (2300kg)**	**Total Weight (kg)**
CSE	Used for all constructions	76	10000	2	4600	14600
CSS	Belare 2006-2007 period	115.5	20000	3	6900	26900
OSE	Garage building	154	21000	4	9200	30200
	Main building	383	60000	10	23000	83000
	Stand-alone facility 1/2	38.5	2000	1	2300	4300
	Emergency shelter	38.5	1500	1	2300	3800
	Wind turbines	115.5	20000	3	6900	26900
OSS	Minimum 2 years period	152	15000	4	9200	24900
FUEL	JETA1/gazoline oct. 95	76	20000	3 units (tank version)	15000	35000
	Gasoline oct. 95	38,5	4400	1 (drums inside)	2300	6700
BCM	Garage	270	42200	7	16100	58300
	Main building	536	96200	14	32200	128400
	Stand-alone facility 1/2	38.5	5000	1	2300	7300
	Emergency shelter	38.5	5000	1	2300	7300
TOTALS		**2070.5**	**322300**	**55**	**134600**	**457600**

Category		**N°**
LSE	Heavy snow Tractors	3
	20′ Sledge 01	12
	Lifting crane	2
	Bulldozer/tractor	1
	Snowmobiles	2

Table 2.3: Ship cargo transport needs for construction (incoming goods 2006/2007/2008)

Belare 2006 Expedition
Objective: Preparation of building site camp

- Ship => January 2007: in: 5 ISO-norm containers 20″ + 2 Vehicles (2 tractors) + 4 big sledges ($250m^3$) + 2 people
- Air => January: Team of 8 people + 2 extra snowmobiles (already at Novo) flies in from Novo
- Air => February: Team of 8 people flies out via Novo

Belare 2007 Expedition
Objective: Building the station

- Air => November: A team of 12 people flies in
- Ship => December/January: in: 45 ISO-norm containers 20″ + 4 Vehicles (1 tractor, 1 bulldozer and 2 cranes)+ 8 big sledges ($2000\ m^3$) + 2 people
- Air => January : A team of 20 people flies in+ 8 people out
- Air => February: 26 people out

Belare 2008 Expedition
Objective: Remove redundant equipment, waste and containers + first scientific activities

- Air => November: a team of 8 staff people + scientists (number unknown) flies in
- Ship => December/January: 2 people + 5 ISO containers 20″ => 200m³ IN + containers + 3 vehicles (1 tractor and 2 cranes) OUT (1600m³)
- Air => January: 6 staff people out
- Air => February: 4 staff people out
- Air =>period unknown: scientists out

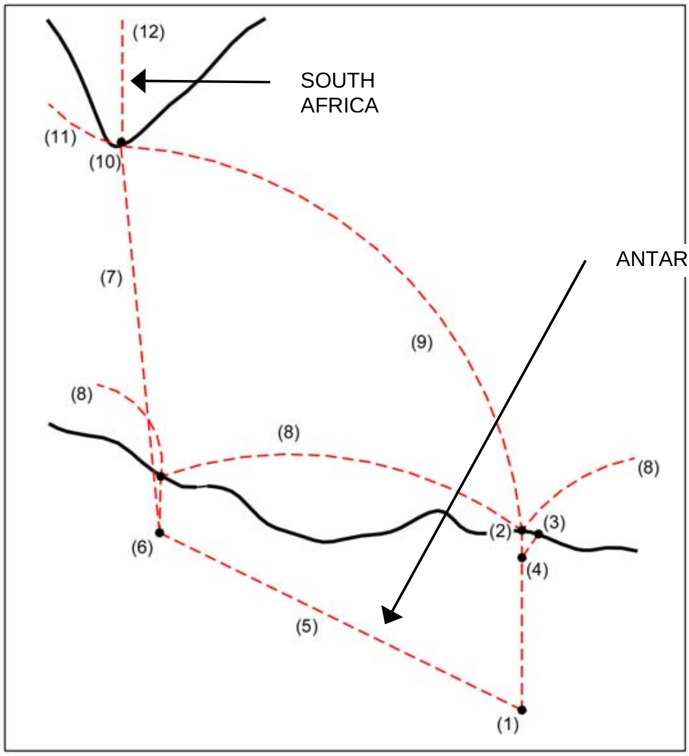

Fig 2.7: Scheme of different transport routes for the proposed activity
(cargo discharge at coast, construction, operation and science):
(1) Utsteinen construction site; (2) Preferred unloading site (Breid Bay); (3) Alternative unloading site in Breid Bay (Polarhav Bay); (4) L0 point (Ice rise); (5) Flight-route from Novolazarevskaya station;
(6) Novolazarevskaya; (7) Flight-route from Cape Town; (8) Supply shipping combined with other stations;
(9) Direct sea route from Cape Town; (10) Cape Town; (11) Cape Town sea route to Europe;
(12) Cape Town air route to Europe.

2.4. Station description

The station concept presented in this section is the baseline design selected for further development. This will be carried out during the last part of the concept validation phase of the project (due end of February 2006). This means that some modification will be possible depending on the final outcome of tests and calculations.

As already said the new Belgian station is a compact and efficient facility to support the scientific field work. Key features are its low-emission character and the low demand on resources to operate it. The station has been designed to anticipate the evolution towards automated scientific experiments and logistic support to field work in the wide area.

2.4.1. Station programme

User scenarios

Prior to the actual design process of the station a comprehensive study covering the wide spectrum of characteristics typical to the Antarctic building tradition was done. This study, with the valuable support and feedback of different polar institutes and individuals experienced in the field, led to an exhaustive specification and requirement list including guidelines and lessons learned. The approach, as for the whole of this project, was fourfold: environment, human factors, technology and cost. A key-element to define the programme (and energy needs) were the user scenarios. These gave a detailed insight on how people will live and work in and out of the station.

Building surface and basic layout

The extensive study of the user scenario's resulted in a building programme that foresees in a total building surface of ± 800 m². Taking into account the requirements of the building programme and the terrain conditions it was decided to construct two major building units separate from stand-alone facilities for specific scientific activities.

The air-conditioned main building is the living area of the station and has a usable floor space of approximately 300 m². The "garage/storage" building accommodates secondary functions such as work shops and storage of supplies and spare parts. The station will provide an efficient and pleasant living/working environment for the crew but the programme is also developed according to energy efficiency needs and the specific technical demands imposed by the winter close-down of the station.

Main building

The main building has a concentric architecture laid out around a "technical core" (see **Fig. 2.8**). All temperature-sensitive installations and equipment, such as the waste water treatment system, are concentrated in this area of the building. A second concentric layer around the technical core consists of space for active systems such as the kitchen, sanitary, laundry and the station's energy management system. It also has storage for fragile office equipment during winter. A third concentric layer consists of "passive" areas, for example, the living and sleeping rooms. Temperature buffer spaces are included below the floor and above the ceiling. The fourth and last of the containment levels is the outer shell. This structure consists of a number of passive and active elements such as insulation materials, air-gaps for buffering and energy-related systems.

The core-based architecture allows a "feed-through-the-wall" concept for water supply, drainage and other services resulting in compactness and a high level of system integration. This has positive repercussions on key-features such as energy preservation, reliability, maintenance and cost. From an energy point of view all "internal gains" of the building are centralized in the building layout thereby reducing the additional heating load required (note that for most of the summer the building simulations performed so far indicate that no additional heating is required).

The building will be optimised for typical summer season conditions but also for winter close-down. Close-down preparation work will be practical and easy. For example drainage of the water tubes will be very straightforward. For winter each individual layer is "sealed" thereby creating a number of temperature-controlled buffer zones against the cold exterior environment. This makes it possible to maintain all layers at a guaranteed minimum temperature with minimal energy supply, protecting installations and whole year active systems located in the technical core as well as the appliances located in the second layer. The "passive" area (third layer) acts as an additional buffer zone. All building zones will be monitored for temperature routinely.

The building layout will guarantee good acoustic comfort. The distribution of noise sources and the layout of the functionalities and storages (acting as buffer-zones) in the building have been reviewed for compatibility with the user scenarios to assure there is minimal disturbance caused by the activities. Wind-induced noise (turbulence areas on the building) has also been studied and a number of noise limiting measures will be used in the detailed design phase of the project.

The entrance has a lock with self-closing doors that can only be used consecutively. The aim is to reduce heat loss through the entrance. Once through the lock, people enter an area where exterior clothing equipment or supplies can be left. This zone gives access to different parts of the building, including:

- the storage area (after having recovered the equipment left in the transition zone),
- the sanitary facilities,
- the laundry (integrated in the wardrobe area),
- the lab/office area,
- the sick bay and
- the living area.

A demountable wall section and over-head rail system will allow heavy equipment or spare parts to be carried directly from the entrance lock to the technical core.

The sanitary facilities include toilets, bathroom with showers and, eventually, a sauna. The sleeping area has a flexible layout but there are also a number of dedicated rooms for the station crew. Care has been taken to group the communication room, the station control room and the station manager's office. The technical core is a crew-only area and during normal conditions no access is required.

Very important to the building concept is the common living space with annexed kitchen. Here people meet and eat together. This room, as most of the third layer, has a multifunctional and flexible character. It can be used as a "quite corner" for reading but can be transformed into a meeting space. In general flexibility is a key-element in the design. While some areas of the building have dedicated functions there still is a lot of flexibility in sub-dividing the building space for alternative layouts to cope with changing needs.

A dedicated area near the building entrance, with easy access for a stretcher, can rapidly be transformed into a sick bay in case of illness or injury. If required this area can easily be upgraded into a small and well equipped hospital room. The room will be designed following best practice guidelines for sterility and efficiency.

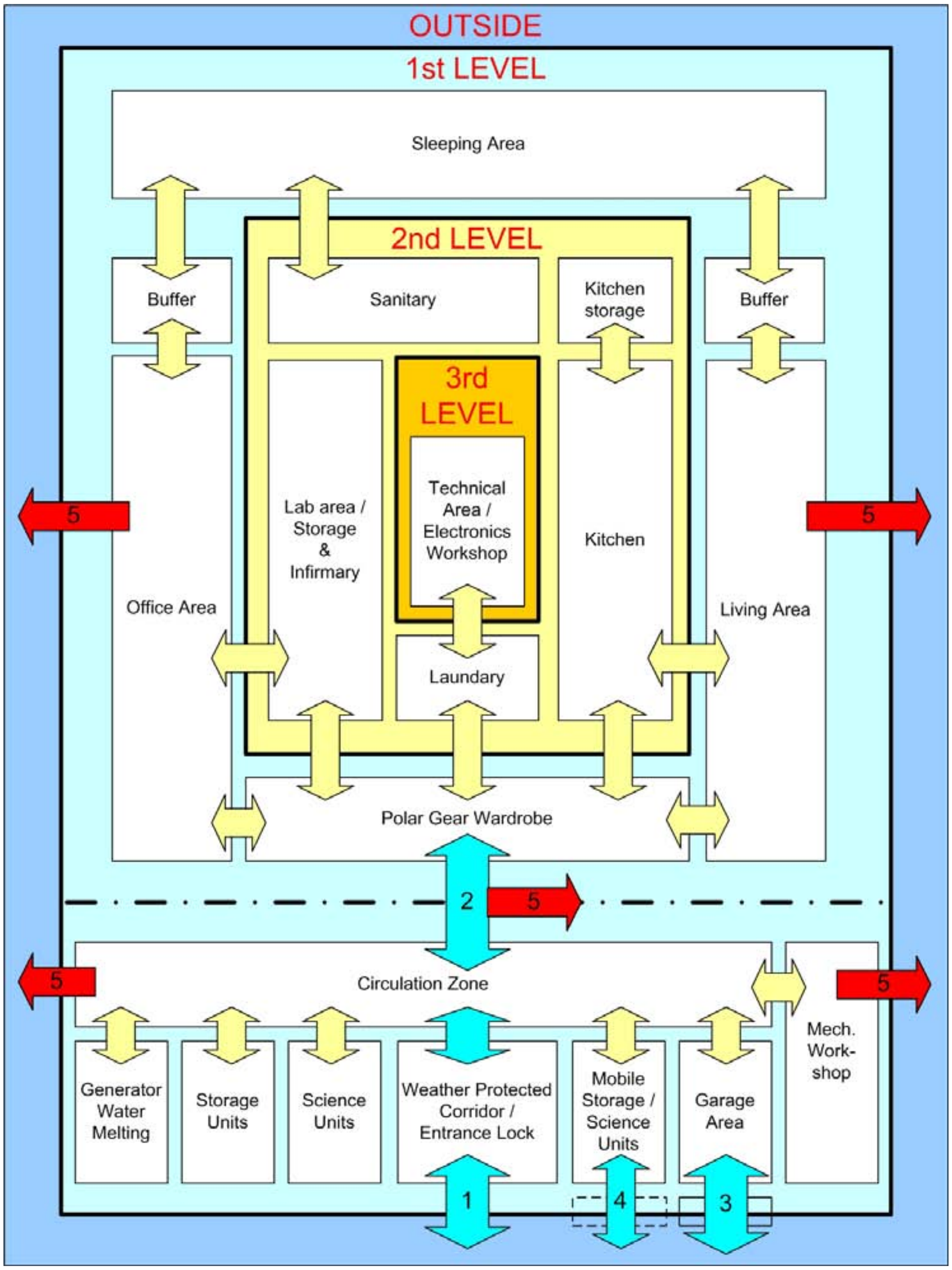

Fig 2.8: Building programme - functional relations and thermal layers (abstract)
(1) Entrance (no vehicles); (2) weather protected connection corridor between building volumes;
(3) Entrance vehicles; (4) access removable units; (5) Emergency exits

The garage/storage building

This building is an under-snow surface construction connected by an aerodynamically shaped and weather-protected staircase to the main building, and follows the design philosophies of minimal environmental and visual disturbance, best comfort and energy efficiency. This construction protects the crew against bad weather conditions (note that there is increased wind speed in this part of the site) and minimises walk distances. All tubing and cabling between both building units will be integrated, minimising the heat load required for water tubing and facilitates maintenance. A simple lift system will help to carry heavy loads from garage/storage to the main building.

The garage/storage building has a minimum height of 4 m. Most of the building is below the snow surface and the roof is used as an airflow diffuser (see **Section 2.4.5** Aerodynamics). The garage/storage building will contain stores, workshops and field support facilities. It will house the two emergency back-up generators and the water melting system. The building has a very simple construction. The main open area which is basically only a roof will house a number of 20′ ISO-norm containers on sledges for most of the functions including transportable science lab. Part of this open area will be used to repair vehicles and for vehicle storage during winter. Under the roof construction there are three building units that are supported independently from the roof supports. The middle one interfaces to the staircase and has some sanitary and workshop facilities requiring temperature control. One unit at the north side of the building has the generators and snow melting system. The unit to the south contains the mechanical workshop. These units are well insulated from the environment for energy efficiency but also to deal with potential stability problems that could occur by melting of the ground surface.

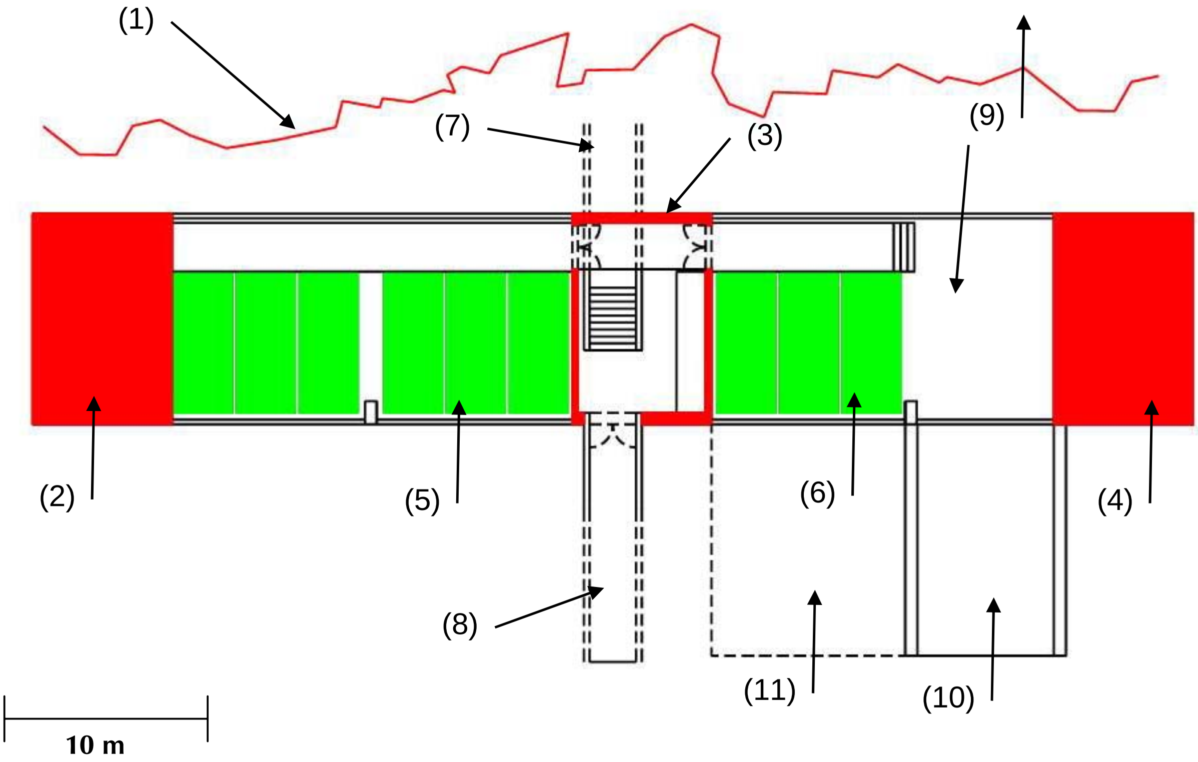

Fig 2.9: Garage/storage building (under-snow)
(1) Utsteinen ridge – granite bedrock; (2) Snow melting/emergency power unit (north-side); (3) Entrance lock unit; (4) Mechanical workshop unit; (5) Storage/lab units (ISO-norm containers); (6) Removable storage units (ISO-norm containers); (7) Staircase to main building; (8) Entrance to west (people only); (9) Garage area (repairs/maintenance); (10) Entrance ramp garage (regular use); (11) Access ramp to removable units (sporadic use)

Accessibility

Emergency exits on the north and south side of the main building assure good evacuation possibilities. The normal entrance of the station is located at the west side of the garage building and consists of a small people entrance (8) used on a daily basis and a large vehicle entrance (10). Removable panels will allow access for sledge units (11) that will be removed every few years, for example full waste containers. During the summer season vehicles will remain outside except for maintenance or other practical reasons. The use of the large entrance therefore is limited. Both entrances are located to make best use of the aerodynamic characteristics of the site in order to keep them snow-free. The garage/storage building also has two emergency exits.

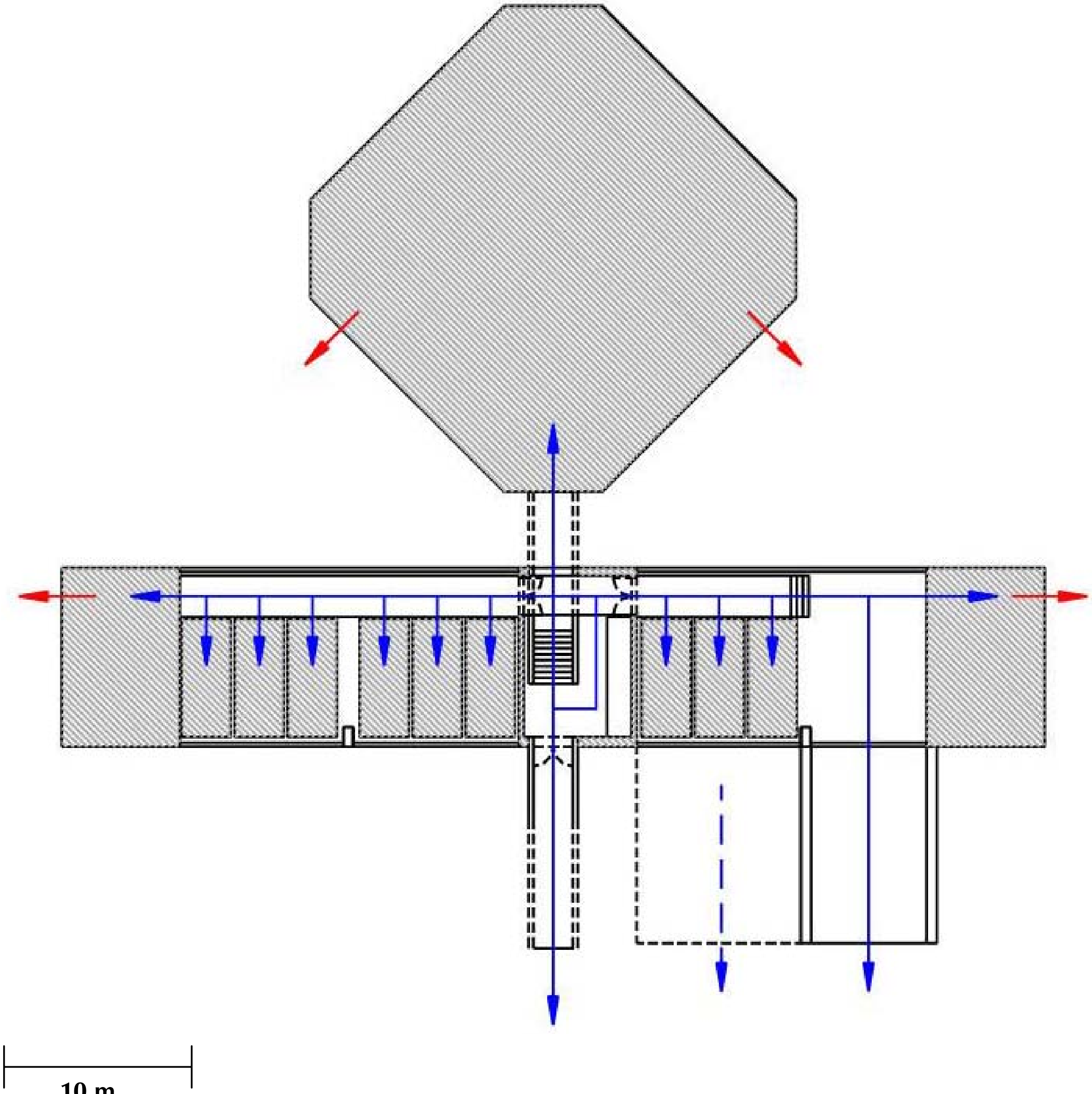

Fig 2.10: Accessibility of garage and main building
(Emergency exits shown in red)

Psychological aspects

The building will have excellent natural light conditions but also the contact with the environment from inside the building is considered very important to create a good living atmosphere. It is no coincidence that the site survey teams (Belare 2004, 2005) were struck by the sheer beauty of the area and recommended good visual contact with the surrounding landscape and, especially, with Utsteinen Nunatak and the Sør Rondane mountains beyond. Preliminary energy calculations predict a maximum of 30% glassed surface on each side of the building, giving passive solar gains. Design of the window layout will take the panoramic view into consideration. A triple glazed window system is under evaluation. In addition to the main glazed surfaces an additional array of small "portholes" located at eye-height for a seated person will allow visual contact with the environment from separate rooms regardless the building's internal organisation. This concept will not compromise the integration of energy related systems in the outer building surface.