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History

In March, 1964, ESRO - the European Space Research Organisation - was founded by Belgium, Denmark, France, the Netherlands, Italy, Switzerland, Spain, the United Kingdom, Sweden and Germany. The aim was to establish a co-ordinated programme for peaceful space research, combined with advanced research technological development, and to support European industry in the member countries. Esrange Space Center was built by ESRO and inaugurated in 1966. A great number of rocket projects were executed between November 1966 and June 1972, mainly by ESRO. However, the member states of ESRO also carried out rocket projects from Esrange on a national basis.

Since July 1, 1972, Esrange has been managed by the SSC. The rocket and balloon activities are co-ordinated and financed by the Esrange Andøya Special Project (EASP) within ESA (European Space Agency). The member states of ESA/EASP are today (1999) France, Germany, Switzerland, Norway and Sweden. In 1974 Esrange completed a launching facility for scientific balloons. This facility has been continuously upgraded to enable launchings of 1,000,000 m³ balloons. Esrange plays, since 1978, an important role in various satellite projects. A number of ground segments for the support of national and international spacecraft programmes are now in operation.

Mission

The assigned missions of Esrange, for sounding rockets and balloons are:
- Support of the sounding rocket and balloon programmes of the member states of ESA/EASP. Non-members can use the facilities on a second priority basis.
- Operation of ground based scientific instrumentation.

Range Layout and Boundaries

Esrange is located in northern Sweden above the Arctic Circle at lat. 67° 53'N, long 21° 04'E. The town closest to the range is Sweden’s principal mining town Kiruna (approximately 25,000 inhabitants), which is about half an hour away by car. Access to Kiruna is very good with several daily jet flight connections with Stockholm.

An extensive network of ground based scientific instrumentation has been established in northern Scandinavia. Some of the main facilities are located in the vicinity of Esrange. One is the Swedish Institute of Space Physics (IRF) where particularly phenomena in the atmosphere and magnetosphere are studied. Another important installation is European Incoherent Scatter Facility (EISCAT) comprising a system of stations at Tromsø (Norway), Kiruna (Sweden) and Sodankylä (Finland). In Abisko north of Kiruna is a climate research centre, which provides possibilities for scientific research in arctic regions and location of ground based instrumentation. Arena Arctica is a very large hangar at Kiruna Airport. The main purpose of the hangar is to support scientific measurements by aircraft.

Range Area

The Esrange premises are located in an area of 20 km² about 40 km east of Kiruna. The Main Building area is located in the Vittangi river valley and comprises the Main Building, the Telecom building, Hotel Aurora and garages. Close to the main building area is the area for balloon launchings including three buildings for operations control and payload preparation.

Further east is the launching area for rockets, which includes a blockhouse, rocket and payload preparation halls, chemical laboratories and launch pads. The satellite receiving station and a GPS reference station are situated on top of a hill 2 km southwest of the Main Building. A ground observation station, KEOPS (Kiruna Esrange Optical Platform System), is located on another hilltop about 1 km further west.

Impact Area

The rocket impact area is located north of Esrange in the Swedish tundra region. This area is divided into three zones, A, B, and C, with a total area of 5,600 km². Zone A, the impact area for boosters, can be extended when rockets with long-range boosters are launched. Zones B and C are impact areas for second and third stages as well as pay-
loads. Zone C is not allowed for use during the period May 1 - September 15. The nominal impact point normally chosen is situated 75 km north of the launch pads. The impact area for balloons covers the northern parts of Sweden, Norway, Finland, Russia, Canada and Alaska.

Central Complex
The Main Building was erected in 1964-65. It has four storeys with a total floor area of 3,930 m². The ground floor houses offices for Esrange administration and technical facilities, a front desk, a switchboard, a canteen, two conference rooms for 15 and 30 persons and a lounge.

The first floor has offices for operational staff, the operations centre for sounding rockets and rooms for timing, telemetry and scientific instruments (Scientific Centre). In an annex on the same floor there are offices. The top floor (second floor) has a large conference room for about 70 persons, and offices. The Main Building area also includes a warehouse with a total area of 490 m², warm and cold garages for cars and accommodation, a Hotel with 59 single rooms and 20 double rooms, sauna, training facilities and kitchens.

Staying at Esrange
The central complex includes all facilities that are necessary for a pleasant stay at Esrange.

Accommodation
Hotel rooms are located close to the Main Building where most people meet. Users and visitors are kindly requested to inform Esrange well in advance about their preferences regarding accommodation.

Restaurant
The restaurant has good quality and service. It is open during normal working hours and during the launching operations. In addition to breakfast, lunch and - during campaigns or upon special requests - dinner, our restaurant offers various kinds of beverages, including beer, wine and liquors. Special requirements regarding the opening hours, special dishes, etc., can normally be fulfilled.

Recreation
Within Esrange, there are many possibilities of mak-
**Work areas and equipment**

**Offices**
Three offices in the laboratory annex are available to the users. They are situated in close connection to the payload assembly hall. Three more offices are available in the main entrance corridor. Each office is equipped with standard furniture, telephone and Internet access. There is also a small common space and lavatories in both areas. Near the main entrance there is a well-equipped kitchen and a TV/Confencercroom for convenience.

**Payload assembly**
This hall has a floor area of 10.5 m by 20 m and a height of 3.9 m, except for the central portion, which has a higher ceiling to allow vertical assembly long payloads. A single rail electric gantry crane is installed for payload handling. If required, the area can be divided into sections by means of movable screen-walls. The area is equipped with work-benches some with electric power outlets. Single phase and three phase power and also two cold water supplies are available. The main access door to the hall is 4.08 m high and 3.81 m wide.

- Electric power: 230 V, 50 Hz single phase
- 110 V, 50 Hz single phase,
- 15 KVA 400 V and 200 V, 50 Hz three phase

Gantry crane:
Max. load: 1000 kg
Hoist speeds: 100 mm/sec and 10 mm/sec.
Max. height to the hook: 7 m.

**Rocket Assembly**
There are two motor assembly halls, referred to as “Centaure Assembly” and “Skylark Assembly” respectively, in accordance with the motors which were originally assembled therein. They can be, and are, of course, used for other motors.

**Centaure Assembly**
The hall is now mainly used as heated store for Esrange and customers equipment. This hall has a total floor area of 32.4 m by 10 m and a height of 4.4 m. An electrically operated gantry crane can be used over the entire floor area. The temperature is controlled and recording is possible, records are only kept when motors are in the halls. The access door is 3.98 m high and 3.00 m wide.

Gantry crane:
Max. load: 2000 kg
Hoist speeds: 100 mm/sec and 10 mm/sec.
Max. height to the hook: 2.9 m.

**Skylark Assembly**
This hall has a total floor area of 36.0 m by 10.5 m and a height of 4.5 m. Temperature control and recording are the same as those of the Centaure Assembly hall. An electrically operated gantry crane can be used over the entire floor area. Intercom and telephone are available. Two surface tables of the accuracy ± 30 microns, each 2 m by 1.5 m, level with respect to each other are installed. The distance between the tables is 3 m. The access door is 4.05 m high and 4.52 m wide.

Gantry crane:
Max. load: 2000 kg
Hoist speeds: 100 mm/sec and 10 mm/sec.
Max. height to the hook: 3.95 m

**Laboratories**
Apart from standard tools and instruments, a variety of equipment for laboratory work, is available for use.
Four laboratories are available for advanced chemical work. They are all equipped with gas, warm and cold water, fume hoods, laminar airflow cupboards - horizontal or vertical -, refrigerators, deepfreezes, and lockable cupboards to store poisonous materials. One chemical laboratory is equipped with gas, warm and cold water, and a fume hood. One electronic laboratory is reserved for the launch crew.

**Equipment:**
- a high-temperature 3 litre oven. Thermostat controlled up to 1,200° ± 1°C
- a vacuum medium-temperature 130 litre oven 1 mbar thermostat controlled up to 250°C. (Leybold-Heraeus VT5050EK)
- an oil-diffusion pump, 10⁻⁶ mbar (Edwards diffstak CR100/300M)
- a turbomolecular pump, 10⁻⁸ mbar (Balzer TSU170)
- an ultrasonic cleaner, 5.5 litre (Branson 32)
- Containers for liquid nitrogen
- Containers for liquid helium
- a weighing-scale 0-1,200 g capacity, 0.1 mg readability. (Satorius 1206 MP)
- a stereo-zoom microscope. Magnification x30 to x210. Reflected light and camera adapter with 35 mm Contax camera (F:1.7), Bausch & Lomb Stereo Zoom 7)
- Microscope Nikon, Diophot + accessories
- Microscope Nikon, SMZ-2B, 2 pcs
- Microscope Nikon, SMZ-2T
- Schott coldlight source, KL 1500, 3 pcs
- Centrifuge Hettich Universal K2S + accessories
- Deepfreezes Colora, UF85-110T
- Autoclave Denley BA 852
- Magnetic Stirrer Nuova II, SP 18420-26
- Vortex mixer Eckli 600
- Distillation apparatus Schott 2481100
- Water demineralisation Seradest S750/520
- Transportbox Veba electronics, #378 37°C
- Transportbox Veba electronics, #379 37°C
- Transportbox Veba electronics, #833 4-22°C
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Workshops
One small mechanical and one electronic workshop are available.

Blockhouse Payload Control
To accommodate the large amount of ground check out equipment, mainly used for microgravity payloads, a dedicated blockhouse is available (124 B). Its roof and walls are reinforced to the same standards as the main blockhouse. The floor area is 8.0 m by 7.5 m. Payload cabling from the MAXUS building, the SKYLARK tower and the MRL launcher terminates in this room. The power supply includes 30 KVA, 230 V, 50 Hz uninterruptible power (UPS).

Rocket launchers

Skylark Launcher
The Skylark tower is a 30 m long 3-rail launcher, permanently heated. During 2005 the launcher was upgraded to fit rockets with a diameter of 22” (inch), like the Brazilian VSB 30 rocket.

The temperature in the launcher building is controlled and the launcher is constructed so that the rocket is elevated and positioned in azimuth ready for launch, with the building closed. Just before launch, the roof and blast doors are opened. In the event of a hold after the opening of the building it can be closed and the temperature rapidly brought back to that desired, to protect the motor and payload.

The launcher elevation and azimuth and the building roof and blast doors can be controlled locally or remotely from the blockhouse. Azimuth and elevation angles, roof and blast door positions and tower temperature are monitored on the launch console. Power outlets (some controlled remotely) are available at the payload platform.

Standard payload cabling consists of 10 screened cables, each containing 41 wires, each 0.75 mm². 16 twisted individually shielded pairs are available as well as coaxial cables, 16 cables 75 ohm and 4 cables 50 ohm. The cabling is terminated in the user’s blockhouse.

MRL Launcher
The MRL 7.5K launcher is a 11.3 m long single rail under slung beam launcher stored in a protective house with removable roof. For each countdown the roof is removed and the beam is elevated and turned to its launch position. During stand-by for launch, the vehicle is protected by means of a styrofoam tunnel and heated by oil burners. The launcher is remotely controlled and monitored from the launch console in the blockhouse.

Maximum vehicle elevation moment is 22,800 kpm.
Standard payload cabling is 8 cables each with 40
wires 0.75 mm² area, resistance 4 ohm, 3 cables each with 8 twisted pairs and 4 coaxial cables, 50 ohm. The cabling is terminated in the User's blockhouse.

The following types of rockets have been launched from this launcher: Orion, Nike-Orion, Taurus-Orion, Nike-Black Brant V, Terrier-Black Brant V.

**MAXUS Launcher**

This complex was originally built for the ARIES sounding rocket. In 1990 it was rebuilt to facilitate launches of the CASTOR 4B.

The launcher itself is a very simple launch stool support with retractable locking devices that secure the motor in windy conditions. The vehicle is protected by a movable house, 30 m high and with a floor area of 8 m by 10 m.

The building is heated, and the temperature is controlled to a temperature of ± 2°C. The temperature gradient between top and bottom of the vehicle is less than 1.5°C. An electrically operated gantry crane can be used over the entire floor area.

The maximum length of vehicle that can be handled is 17 m. Three work platforms at heights of 11.4 m, 14.0 m and 16.6 m above the floor are accessible by means of an elevator. Umbilical's are connected through a 15 m high tower with platforms for ground support equipment.

Remotely operated power outlets are available on these platforms. Shortly before launch the house is rolled 30 m away from the launch pad and the rocket locking devices are retracted by remote control from the blockhouse.

Gantry crane:
Max. load: 15 000 kg
Hoist speeds: 83 mm/sec and 5 mm/sec
Max. height to the hook: 19.4 m.
Elevator:
Max. load: 300 kg 4 persons.

Payload cables terminate at the platform levels and consist of 13 screened cables each with 40 wires, 0.5 mm² area, and also 21 coaxial cables, 50 ohm. The cabling is terminated in the User's blockhouse.

**MAN Launcher**

The MAN launcher is the property of DLR, but is available to users upon request. Maximum vehicle elevation moment is 30,000 kpm.

The launcher can be used both over- and under slung with rail lengths of 11700 mm and 10700 mm respectively. The launch pad is situated between the MAXUS and the MRL launchers.

**SULO/VIPER Launcher**

There are two smaller launchers between MRL and Skylark Tower for Super Loki and/or VIPER rockets. All operations as loading, unloading, elevation and azimuth are performed manually. The launch operation is done from Blockhouse Launcher Control both from same launch desk.

**FFAR launcher**

The FFAR launcher is close on the east side of MRL launcher and it is used for launching the Folding Fin Aircraft Rockets. The FFAR rockets are used for training of personnel operating the Radar Station.

**Storage**

**General**

A cold storage, 10 m by 16 m, is situated 50 m south of the payload assembly hall main entrance. It is used for long term storage of launch support equipment, and temporary storage of user's equipment. Also the Centaure Hall can be used as heated storage.

**Rocket motors**

Buildings for temporary storage of rocket motors, from time of arrival until preparations for launch begin, are available. Electrically operated gantry cranes can reach the entire floor area. Temperature control equipment is installed, temperature setting normally being +18°C ± 4°C.
Motors up to the size of Castor 4B can be accommodated.

**Scientific centres**

**Observation Centres**
Within the impact area there are two major observation sites. These are located close to the launching area, under the predicted apogee and at the nominal impact point. Both sites are designed to accommodate personnel and equipment for long observation periods. Communication is maintained by means of mobile telephones.

**Scientific Centre**
The Scientific Centre in the Main Building is the centre for the scientific observations. Data from the scientific instruments are displayed to enable the scientists to survey the scientific situation.

A heated observation dome permits comfortable observation of the sky. The room below the dome can be closed to eliminate all disturbing light during night observations. Users can install their own instruments on special platforms and data can be routed to the Scientific Centre by means of a permanent cable network. Telemetry data from the payload are also displayed in the Scientific Centre. Altogether, these facilities are vital to support critical launch decisions.

**Downrange Station**
The downrange station is located below the predicted apogee, approximately 25 km north of the launch area. There are no roads to the station, so equipment and personnel must be transported by air. The well-equipped building can accommodate six persons. In the building, there are areas for equipment and storage and there is also a small workshop. Electricity is generated on site by diesel-driven motor generators.

**Signal Display Facilities**
All measured data are concentrated to the Scientific Centre. The user is allocated a display console where experiment data and other data can be accessed. The display console consists of intercom, word selector/display, chart recorder, serial data distributor, and power outlets. Five units are available. Special equipment brought by the user can be installed.

**Scientific Instruments**
Ground based instruments of many types are used to support sounding rocket and balloon borne experiments. The results are displayed in the Scientific Centre for immediate access by the user.

Two other major scientific facilities are located near Esrange. The Swedish Institute of Space Physics is a centre for magnetospheric studies. EISCAT (European Incoherent Scatter Facility) is another international association with headquarters and a receiving station in Kiruna for ionospheric studies.

Together, these scientific institutions can offer unique opportunities for co-ordinated studies.

**Balloon Facilities**

**Overview**
Until now, about 500 scientific balloons have been launched from Esrange, the largest balloon with a volume of 1 120 000 m³, the heaviest payload being 2000 kg. The balloon launch area is situated about 300 m south of the Main Building. Three buildings for preparation, assembly, integration and test are located at the north edge of the field. There is one heated 300m² storage area. Balloons are launched by dynamic or auxiliary balloon technique. Normally, balloon payloads are commanded to land on Nordic or Russian territory. Balloons that are launched in the “turn around period” can stay afloat for several days in the vicinity of Esrange. Recovery of the balloon payloads by helicopter is standard procedure. Esrange Instrumentation can supply ATC radar transponders mandatory for balloon flights, homing beacons, and also a complete telemetry and telecommand system for balloon piloting and science data transfers.

The entire launch field is covered with fine gravel. 100 m south of the Chapel building a cavity is located, containing electrical power, ground cable, “Public address” loudspeakers, and a telephone line.

As an improvement a major extension of the entire launch field was done during the summer 2004. Today the total launch pad area is 250 000 m². The launch field is designed to launch balloons in different directions, divided into six runways. The directions are N, S, NW, NE, E and SE.

Since the start in spring 2005, long duration balloon flights in westerly stratospheric wind for landing in Northern Canada or Alaska territories has taken part almost every year.
Balloon preparation buildings

The “Chapel” building
This building holds 180 m² of floor area. The balloon payload assembly hall occupies 100 m². To support pre-flight operations, a crane of 1000 kg lifting capability is running along the top of the ceiling, also allowing loads to be carried 2 m outside the entrance door. One room is used as a preparation room for EBASS. One room for E-Link 10 m², One office 12 m², is available to the User, both with telephone and Internet access. A 30 m² area is used as storage for launch support equipment.

The “Cathedral” building
This building is basically designed for payload handling. The floor area is 375 m² out of which 296 m² is payload preparation area. The hall is equipped with an overhead travelling crane, which has a lifting capability of 3200 kg lifting to a maximum height of 7 m. The floor in the payload preparation area is heated and equipped with under pressure air vents to prevent dust accumulation. The port is 6.95 x 4.75 m.

The Basilica building
This building is basically designed for preparation of flight train. The floor area is 323 m² of which Assembly hall is 308 m². The hall is equipped with a crane, which has a lifting capability of 1000 kg lifting to a maximum height of 3.35 m.

The southern part of the building is a two floor area. The Operation office is situated on the top floor, including telephone and Internet access. On the ground floor area there are two User offices also equipped with Internet and telephones.

Instrumentation
The instrumentation section is responsible for operation and maintenance of the telemetry, timing, communication, tracking and scientific functions within Esrange. Electronic flight hardware for balloons is also provided by this section.

Most of the equipment and personnel are located in the Main Building, except for the tracking function, which is housed in a separate building. Activities during a campaign are concentrated to the Main Building where the user has easy access to operators and equipment.

Telemetry
The telemetry station is very flexible and can be configured for different missions. Several telemetry links can be maintained simultaneously. RF downlinks in P, S, or L-band can be received. Equipment for demodulation and recording of PCM, FM and TV signals are situated in the station. Signal decommutation and conditioning for quick look are also performed. Flight data is presented in real time or post-flight, using several different medias and formats.

P-band Tracking Equipment
There are one auto tracking and one program tracking system, with the antennas inside, radomes on the roof of the Main Building. A three-channel monopulse system is used for accurate target tracking. The received RF signals are routed to data receivers and/or distributed to the user.

L/S-band Tracking Equipment
A versatile tracking system for SHF frequencies is
located on the roof of the Main Building. An acquisition aid feed minimizes the risk of losing track of fast moving targets. Full coverage of the hemisphere ensures uninterrupted data acquisition from balloon-borne payloads. Polarization diversity combining improves the quality of tracking and data reception.

The received LeftHandCircular and RightHandCircular polarized RF signals are fed to the telemetry station for further distribution and demodulation.

Data Extraction
Composite signals, output from receivers, are further processed in FM or PCM equipment. Four separate PCM signal systems are available.

Video switching
All PCM video signals are distributed within the telemetry station over two 32×32 switching units, with full fan switching capability. The switches are configured for each mission by means of software. Each mission set-up is stored in the memory of the switch in order to enable fast change of the station video set-up.

PCM Decommutation
High performance bit synchronizers are used to regenerate and decommutate PCM data. Four independent systems are available. The user will have access to buffered outputs including data, clocks and all necessary control signals.

Magnetic Tape Recording
All vital signals from measurement are recorded on magnetic tape or HDD in real-time. Timing signals, local multiplex and voice communication are also included for reference purposes.

Two or more recorders are used simultaneously to ensure that no data are lost. A standard configuration with 10 DR and 4 FM tracks is used for maximum data capacity on the 1 inch reel recorder. Tape copies with other configurations can be produced.

Data can also be recorded on S-VHS media using a configurable Avalon cassette recorder, which can record 1 or 3 analogue signals simultaneously at data rates up to 8 or 2 MHz. IRIG-B time code is also recorded.

There is also a HEIM Hard Disc recorder which is capable of recording signals after bit synchronisation at data rates up to 30 Mbps.

Telescience
Besides manipulating onboard experiments during flights from Esrange it is also possible to do so from remote laboratories all over the world. Data, TV-video signals and Tele-commands can be transferred between Esrange and remote sites by terrestrial telecommunication links or broadband satellite links which enables the real-time telescience.

TV centre
The two TM stations receive the transmitted TV signals in two polarizations and distribute the video signals to the TV centre located in the Main Building. An operator chooses the best signals for recording and further distribution to the Blockhouse and the Scientific Centre. S-VHS video recorders

DLR L/S-band Tracking Equipment
Upon special agreements, there is a possibility to use the DLR telemetry station that is equipped with a tracking antenna for telemetry data acquisition. The station can receive, de-modulate, process, record and distribute the telemetry data.

S/X-band Tracking Equipment
Upon request there is a possibility to use the ETX satellite antenna for high altitude rocket flights. The antenna can be controlled from the telemetry station. RF/IF signals are routed to the telemetry station over optical links.

Receivers
The receivers are flexible and easy to set-up for specific tasks simply by altering configuration. Pre and post-detection polarization diversity combining is utilized whenever possible. Frequency demodulators are standard, but various demodulators can be used for different demodulation requirements. Wide bandwidth TV-signals can be received and demodulated.

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are used for recording. The TV centre is a property of MBB/ERNO in Germany and can upon special agreement, be used for TV selection and distribution during missions.

**Output Products**
Post flight products can be generated. The user can define several different types of media and contents.

**Digital Media**
Digital products from received data can be generated on media like CD-ROM, DAT or Internet FTP.

**Analogue Tapes**
Track allocation and recording parameters can be adapted to User specification. Special recordings may be produced in real time.

**Video Tapes**
Video tapes in PAL or NTSC format can be generated from TV-video data and also some ground instruments. Timing information can be mixed into the picture. Conversion from one format to another is also possible.

**Frequency Plan**
The frequency plan for Esrange is based on a permission issued by the Swedish authorities on a yearly basis. For all transmitters that are to be used, all technical data including frequency, output power and bandwidth must be submitted to Esrange at least two months before expected start of use.

**Trajectory Determination**
Different systems are used to determine trajectories and payload impact locations. An efficient recovery organization is readily available.

**DLR C-band Radar**
Located at Esrange is also the DLR RIR -774C. This system can, upon special agreement, be used for tracking of different payloads. The system is capable of tracking in skin and transponder mode.

**Ranging System**
Flight trajectory can also be provided by the automatic tracking telemetry antennas. The slant range to the rocket is determined with doppler measurements on the received PCM data. A highly stabilized oscillator is required for the payload PCM encoder. Pointing angles are given by the antenna control systems. These parameters together with timing information are then used for trajectory estimations. At elevations below 10°, the accuracy is degraded due to ground reflections and atmospheric conditions.

**Communications**

The nature of the activities and the geographical layout of Esrange require high performance communication systems for voice and data. A general public address system connected to loudspeakers both indoors and outdoors is the primary voice communication channel.

**Intercom System**
All stations involved in measurement activities are equipped with at least one intercom unit. Each unit has a loudspeaker and a microphone or a headset. There are eight separate communication “loops” dedicated for special purposes. Any of these loops can be accessed by means of front panel switches. If many loops must be monitored, special units are available which mix the sound from all selected loops into one loudspeaker.

**GO/NOGO System**
As reports on status of the systems involved are time critical, a light signal system is used. The Operations officer, who is responsible for the coordination of all activities, has an immediate survey of the current situation. Each station is equipped with a control panel where a red light corresponds to NOGO, i.e. system failure or the equivalent. Conversely a green light corresponds to GO, i.e. everything is under control.

**Video Message System**
General information to all stations is distributed via a local video system. A large number of video monitors are installed within Esrange. The basic information consists of Universal Time and Relative Time (count-down time). In addition, short messages can be displayed.

**External Communications**
Dedicated communication to/from Esrange can be arranged via the public telecommunication networks using ISDN, Internet or other suitable methods. Users can bring their own PC to Esrange and have access to Esrange Internet services provided that:
- the User’s PC is configured for DHCP (Dynamic Host Configuration Protocol).
- the User provides the PC cable with RJ 45 connector to connect to the Esrange network.

**Timing System**
Reference frequencies and time code signals are generated in a central facility. The system is synchronized to international standards, which are continuously monitored to ensure that synchronization is maintained at all times. A no-break power system is used to guarantee high system stability. The available signals are distributed to the user via the cable network.

**Time Code Signals**
All generated time codes are synchronized to Universal Time.
Reference Frequencies
All frequencies that are generated are synchronized to the station reference.

Telecommand System for Sounding Rockets
A ground to space transmitter system is available. This system is used mainly for the following purposes:
- Flight termination, in case a failure develops in the rocket-borne guidance system.
- Flight commanding and manoeuvring of payloads flown on rockets or balloons.
- Termination of balloon flights over land area, in case the payload must be recovered.

448.00 MHz carrier frequency is used for flight termination and payload commands are modulated on 449.95 MHz carrier. Both transmitters have separate power amplifiers and antennas. The transmitters can be operated as a redundant system using a priority scheme. For high altitude rockets, a 24 ft parabolic dish (ESC) can be connected, to achieve higher EIRP.

ESC-Antenna
A UHF antenna system for tele-command transmission is available. Antenna pointing is performed under computer control, to predicted angels or to actual angles delivered from tracking antennas.

Telecommand System For Balloons
The tele-command system is installed at the Radar hill. The modulators, amplifiers and antenna are remote controlled from the Esrange telemetry station.

Modulating Signals
The payload command transmitter can be modulated with signals from the user’s ground equipment, connected via the cable system to the modulator.

Flight Hardware for Balloons

E-Link data link
The E-Link system can offer fully transparent bidirectional Ethernet, asynchronous RS 232/422 or synchronous data link between the payload and ground equipment. The user can simply connect his/her equipment onboard using any of the interfaces types specified above and communicate with the equipment from ground.

The system is capable of transferring up to 2 Mbps of data on distances up to 500 km (TBC). The user can access his/her instrument over the Ethernet interface and the interface point can be extended to locations outside Esrange premises.

The stationary ground station is situated at the Keops hill and it is fully remote controlled from the telemetry station. There is a mobile ground station available if link needs to be established at other locations where the payload is not within line of sight for the stationary antenna.

Air Traffic Control Transponder
For safety reasons, all balloons with payloads heavier than 5 kg must carry Air Traffic Control (ATC) transponders. Special units that meet the ATC requirements are available that can be attached to the balloon flight train. The ATC unit can also be equipped with an Argos unit in order to obtain fast recovery position.

The Argos unit retrieves the present position using the onboard GPS receiver or using measurements on the Argos system satellite signals. The position can be obtained from the Argos web server in near
The transponder units can also be equipped with switch ON/OFF functionality during flight using either barometric pressure sensors or via remote command over a serial interface.

**Homing Beacon**

It is recommended that homing beacons are used to support successful recovery operations. Special units are available that can be attached to the balloon flight train. A unit consists of a styrofoam box containing a beacon transmitter, batteries and external antenna.

**Power Supply**

The power system at Esrange is a five-wire three-phase 50 Hz system. The phase to phase voltage is 400 VAC -6% +10%, 50Hz ±2Hz, phase to neutral voltage is 230 VAC -6% +10%, 50Hz ± 2Hz.

The system neutral is separated from safety ground in the local distribution systems. Neutral and safety ground will be connected only at one point, the main power inlet.

The system is designed to eliminate 50 Hz hum on signal lines. It is important that all user equipment which shall be connected to the system is designed such that neutral is separated from safety ground (chassis) and signal ground. Power transformers must have separate primary and secondary windings. It is possible to supply 110 VAC 50 Hz power at certain locations.

Back-up power is installed in the main building (800 kVA), the launching area (300 kVA) and the radar hill (300 kVA). No-break-power (UPS) is installed in the main building 70 kVA; 20 minutes, launching area 30 kVA; 20 minutes, and radar hill 5.0 kVA; 20 minutes.

**Specifications**

### P-band Tracking Equipment

**Antenna 1**

Frequency range: 215-260 MHz
Tracking: Three channel monopulse system
Antenna type: Crossed dipole array with a common ground plane
Gain: 18 dB over isotropic
Polarization: RHCP
Beamwidth: 18°
First sidelobe: 20 dB
Type of pointing: Autotrack, manual
Tracking speed: 5°/sec, nominal
Acceleration: 5°/sec², nominal

**Antenna 2**

Frequency range: 395 - 405 MHz
Tracking: No tracking
Antenna type: Four stacked helical antennas.
Gain: 14 dB over isotropic
Polarization: RHCP
Beamwidth: 28°

### L/S-band Tracking Equipment

Frequency range: L-band 1440 - 1790 MHz, S-band 2200 - 2400 MHz
Antenna type: 2.4 m parabolic reflector
Tracking feed: prime focus, conical scanning horn
Acq. aid feed: sequentially scanned dipole array
Beamwidth: 3 dB: 4° and 30° respectively
Polarization: simultaneous RHCP and LHCP
G/T:
L-band: 5.0 dB/°K
S-band: 8.0 dB/°K
Tracking speed: 20°/sec min
Acceleration: 20°/sec² max

### DLR L/S-band Tracking Equipment

Frequency range: S-band 2200-2400 MHz, L-band 1650-1750 MHz
Antenna type: 5 m parabolic reflector
Tracking feed: Prime focus, Monopulse system
Beamwidth: S-band 1.8°, L-band 2.4°
Polarization: RHCP or LHCP
G/T: S-band 14 dB/°K min
Tracking speed: 30°/sec
Acceleration: 30°/sec² max

### S/X-band Tracking Equipment

Frequency range: S-Band 2200-2400 MHz, X-Band 8025-8400 MHz
Antenna type: 13 m parabolic reflector
Tracking feed: prime focus monopulse, five crossed dipoles
Beamwidth, 3 dB: S-Band 0,7°, X-Band 0,18°
Polarization: S-Band simultaneous RHC and LHC, X-Band switchable RHC and LHC
G/T: S-Band: 23 dB/°K, X-Band: 33 dB/°K
Tracking speed: 4°/sec
Acceleration: 10°/sec² max

### Receivers

Microdyne Mod. 1100 AR
Demodulation: FM Intermediate/wide band
Second IF bandwidth: 300, 500, 750 kHz, switch selectable, or 0.75, 1.5, 2.4 MHz, switch selectable

**Video Characteristics**

Output impedance: 75 Ohm
Frequency response: 10 Hz- 2 MHz
Output voltage: 1-10 V p-p, 2.8 V p-p nominal
Connectors: BNC

### Diversity Combiner, Microdyne 3200-PC

Type of combining: Simultaneous Pre-Detection and Post-Detection, Dual channel, AGC controlled including an absolute value AM detector
Output frequency range: 10 Hz to 5 MHz
Output level: 0-8 V p-p, 2.8 V nominal
Connector: BNC

Microdyne Mod. 700 MR
Demodulation: FM, PM, BPSK, QPSK
Second IF bandwidth: 0.3, 0.5, 0.75, 1.5, 6.0 MHz, switch selectable

**Video Characteristics**
- Output impedance: 75 Ohm
- Frequency response: 10 Hz – 5 MHz
- Output voltage: 2.8 V p-p nominal
- Connectors: BNC

**Diversity Combiner, Microdyne 1620-PC**
- Type of combining: Post-Detection, Dual channel, AGC controlled
- Output frequency range: 10 Hz to 5 MHz
- Output level: 2.8 V nominal
- Connector: BNC

**Microdyne Mod. 700 MRB**
- Demodulation: FM
- Second IF bandwidth: 0.75, 4, 8, 20 MHz, switch selectable

**Video Characteristics**
- Output impedance: 75 Ohm
- Frequency response: 10 Hz – 8 MHz
- Output voltage: 2.8 V p-p nominal
- Connectors: BNC

**Diversity Combiner, Microdyne 1620-PCB**
- Type of combining: Simultaneous Pre-Detection and Post-Detection, Dual channel, AGC controlled including an absolute value AM detector
- Demodulation: FM, PM, BPSK, QPSK
- Output frequency range: 10 Hz to 15 MHz
- Output level: 2.8 V nominal
- Connector: BNC

**Cortex RTR receiver and combiner**
- Two Cortex RTR units, where each houses RHCP/LCHP receivers, PRE/POST-D combiners and bit-synchronizers.
- Demodulation: FM, PM, BPSK, QPSK and SQQPSK
- Second IF bandwidth: 30 MHz to 50 kHz selectable in steps

**Video Characteristics Combiner and Receiver**
- Single ended bi-polar
- Video filters: 12.5 kHz to 18 MHz selectable in steps
- Output impedance: Low, 75 or 50 Ohm selectable
- Output voltage: 2.8 V p-p nominal
- Connectors: BNC
- De-Emphasis: CCIR 405-1 625/525 lines

**Video Characteristics Bit synchronizer**
- Maximum bit rate: 20 Mbps in NRZ codes and 10 Mbps in other
- Single ended TTL or differential RS422
- Output impedance: 50 ohm
- Output voltage: TTL or RS422

**SSC-C1000**
- Type: TV receiver

---

Demodulation: FM
- IF bandwidth: 10 or 20 MHz switch selectable.
- De-emphasis: CCIR 405.1 switch selectable.

**Video characteristics**
- Output impedance: 75 Ohm
- Output voltage: 1.0 V p-p nominal
- Frequency response: 5 MHz
- Connector: BNC

**PCM Video Switching**
- Two Universal Switching model 11966 units 32 inputs×32 outputs, Non-blocking (full fan out)
- Input type: Single ended
- Input impedance: 50 ohm
- Input level: Maximum ±5V
- Output impedance: 50 ohm
- Frequency range: DC to 75 MHz
- System gain: Unity
- Crosstalk isolation: > 40 dB

**PCM Decommutation**
- Bit Synchronizer, Aydin-Monitor 318
  - Bit rates: 1 bps to 1.2 Mbps
- Input waveform codes: NRZ-L, NRZ-M, NRZ-S, BiO-L, BiO-M, BiO-S,
- Outputs (TTL): NRZ-L plus four clock phases (0°, 90°, 180°, 270°)

- Bit Synchronizer, Aydin-Monitor 3335
  - Bit rates: 10 bps to 32 Mbps for NRZ codes, 10 bps to 16 Mbps for all other codes
- Acceptable PCM: NRZ-L/M/S, BIO-L/M/S RZ, DMM-M/S, DBIO-M/S, MDM-M/S
- Outputs: NRZ-L data, true and complement. Four phases of clock.

**Format Synchronizer, Aydin-Monitor 1023A**
The synchronizer performs the following operations:
- Word synchronization
- Frame synchronization
- Format synchronization
- Serial-to-parallel conversion
- Single-channel binary and decimal display
- D/A conversion
- Input bit rate: Up to 1 Mbps
- Word length: Up to 31 bits
- Frame length: 2-999 words
- Format length: 2-512 frames
- Frame sync. length: Up to 33 bits
- Format sync. types: ID counter or pattern

**Format sync.**
- Pattern length: Up to 33 bits
- Output serial data: NRZ-L, positive true
- Timing pulses: Bit rate clocks, 1/4 bit wide, Word clock, 1 bit wide, Frame clock, 1 bit wide, Format clock, 1 bit wide

**Format Synchronizer, Aydin-Monitor 3440**
The synchronizer performs the following operations:
- Word synchronization
- Frame synchronization
- Format synchronization
- Serial-to-parallel conversion
- Data capture
- Single-channel binary/octet/hex/decimal display
- Digital to analog conversion

Input bit rate: 1 bps to 20 Mbps
Word length: Up to 32 bits
Frame length: 1 to 8192 words
Format length: 2 to 4096 frames
Frame sync length: Up to 32 bits
Format sync types: ID counter or pattern

Format sync.
Pattern length: Up to 32 bits
Output serial data: NRZ-L, positive true
Timing pulses: Bit rate clocks, 1/4 bit wide, Word clock, 1 bit wide, Frame clock, 1 bit wide, Format clock, 1 bit wide.

**FM Discrimination**

**Subcarrier Discriminator, Astrodata 404**
Demodulates FM subcarrier signals. The center frequency and deviation are determined by a plug-in channel selector. The intelligent frequency response is determined by a plug-in low-pass filter for MI = 5, switchable CA or CO response.

Subcarrier center frequencies: 400 Hz-165 kHz, IRIG proportional bandwidth standard
Frequency deviation: ± 7.5 % and ± 15 %
Special low pass filters for the following frequencies: 6.5 kHz, 8.5 kHz, 25 kHz and 50 kHz
Output voltage: Adjustable up to 10 V for full deviation

**Tunable Discriminator, EMR Model 229**
Subcarrier frequencies: 300 Hz to 300 kHz tuned by front panel switch and dial
Frequency deviation: ± 7.5 % or ± 15 %
Deviation ratio: 1, 5, 10, 25, 50 or 100
Data frequencies: 3 Hz to 30 kHz
Output voltage: Adjustable up to 10 V for full deviation. Frequency increase gives negative going voltage.

**Magnetic Tape Recording**
The FM system operates in low band, intermediate band or wideband I, selectable by internal strapping. Nominal configuration is intermediate band.

**Penny & Giles MDR2014**
Tape width: 1 inch
Tape length: 9200 feet max
Tape speed: 15/16 - 240 inch/s
Direct record/reproduce characteristics (4 tracks):
Input level: 0.1 - 2.5 Vrms, 1 Vrms nominal
Frequency response: IRIG WB 2
Output level: 0.5 Vrms - 1.5 Vrms into 75 Ohm for normal record level

**Avalon AE 3840 HW**
Tape: S-VHS cassette
Recording time: 60 minutes
Frequency response: 1 channel 8 MHz or 3 channels 3 MHz
Output level: 1 Vpp

**Heim GSR120 HD recorder**
120 Mbit/s maximum recording capacity
Two DCM12 modules up to 20 Mbit/s each
Input type: RS422, TTL, 1V bi-phase, Data+Clock, Data only, Bi-Phase
One MRG 12 module 4 channels with maximum 5 Mbit/s/channel or total maximum 12 Mbit/s
Input type: Data + Clock, Data only, Bi-phase

**Video Recorder, Panasonic AG-7330**
Tape: S-VHS 1/2 inch cassette
Record/reproduce time: Max 180 min
Video signal system: CCIR/PAL/M-NTSC
S/N ratio (B/W): 45 dB
Video input/output: 1.0 V p-p nominal
Impedance: 75 Ohm
Connector: BNC (composite video) or 4P (S-VHS)

**Video Recorder, Panasonic NV-SD22**
Tape: VHS 1/2 inch cassette
Record/reproduce time: Max 180 min
Video signal system: PAL
S/N ratio (B/W): 45 dB
Video input/output: 1.0 V p-p nominal
Impedance: 75 Ohm
Connector: SCART

**DVD recorder, SONY RDR-4X720**
Video signal system: PAL
Video input/output: 1.0 V p-p nominal
Impedance: 75 Ohm
Connector: BNC/SCART

**Frequency Plan**
Telemetry and data-video transmissions:

<table>
<thead>
<tr>
<th>Frequency band (MHz)</th>
<th>Maximum output power (W)</th>
<th>Bandwidth (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>137.0 - 141.0</td>
<td>10</td>
<td>0.025</td>
</tr>
<tr>
<td>227.0 - 256.0</td>
<td>10</td>
<td>0.500</td>
</tr>
</tbody>
</table>

**Connector:** BNC
Frequency band (MHz) | Maximum output power (W) | Bandwidth (MHz)
---|---|---
400.0 - 405.0 | 2 | 0.500
1425 - 1525 | 10 | 5
2200 - 2400 (Recommended > 2300) | 10 | 10

Telecommand transmissions: 448.00 MHz and 449.95 MHz
Frequency pairs for radar transponders: 5612/5662 MHz and 5712/5762 MHz

**DLR C-band Radar**
Antenna
Reflector: 2.4 m front - fed parabolic
Beam width: 1.4°
Gain: 39 dB isotropic
Polarization: Vertical

Transmitter
Frequency: 5400-5900 MHz
Power Output: 650 kW
Pulse length: 0.25, 0.5, or 1.0 µs
PRF: 160, 320, or 640 pps

**Ranging System**
Range measurement resolution: 1 m
Angular measurement:
L/S-band auto tracking system
Readout resolution: 0.1°
Angular accuracy: 0.3° RMS

S/X-band auto tracking system
Readout resolution: 0.01°
Angular accuracy: 0.05° RMS

**Timing System**
Amplitud Modulated Time Codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Carrier frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRIG A</td>
<td>10 kHz</td>
</tr>
<tr>
<td>IRIG B</td>
<td>1 kHz</td>
</tr>
<tr>
<td>NASA 36</td>
<td>1 kHz</td>
</tr>
</tbody>
</table>

Modulation ratio: 3:1
Positive edge synchronous: UTC ± 50 µs
Phase jitter: ±100 nsec
Transformer coupled outputs:
Output impedance 600 ohm, Output amplitude 5 V p-p
DC-time codes
IRIG A: 1,000 pps
IRIG B: 100 pps
IRIG H: 2 pps
NASA 36: 100 pps
Positive edge synchronous: UTC ± 50 µs
Opto coupled outputs, capable of driving TTL level into a 50 W load.

**Station reference frequency**
Frequency: 5 MHz
Long term stability: 5 x 10^{-11} per month
Output level: 1 V RMS into 50 ohm load
Transformer coupled output

**Secondary reference frequencies**
Available frequencies: 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz
Opto coupled outputs, capable of driving TTL level into a 50 ohm load.

**Telecommand System**
*Flight Termination Transmitter For Sounding Rockets*
Frequency: 448.00 MHz
Modulation: FM
Max deviation: 125 kHz
Max modulating freq.: 50 kHz
Input impedance: 50 ohm
Antenna gain: 9 dBi
EIRP: + 30 dBW
Antenna polarization: LHCP

*Payload Telecommand Transmitter For Sounding Rockets*
Frequency: 449.95 MHz
Modulation: FM
Max deviation: 125 kHz
Max modulating frequency: 50 kHz
Input impedance: 50 ohm
Antenna gain: 9 dBi
EIRP: + 30 dBW s
Antenna polarization: LHCP

**ESC-Antenna**
*System characteristics and performance*
Antenna reflector: 7.3 m parabolic
Frequency range: 400 MHz - 470 MHz
Polarization: RHC and LHC
G/T (receive mode): 4 dB/° K min
System gain (transmit mode): 26 dB
Power handling capability (transmit mode):
RCP channel: 1000 W
LCP channel: 250 W
Pedestal type: Az/El
Drive range:
Az: ± 380°
El: -4° to +95°

**Telecommand System**
*Flight Termination Transmitter*
Frequency: 449.95 MHz (ALT. 448.00)
Modulation: FM
Max deviation: 125 kHz
Max modulating freq.: 50 kHz
Input impedance: 50 ohm
Antenna gain: 12 dBi
EIRP: + 34 dBW nominal + 37 dBW MAX
Antenna polarization: RHCP

**Modulating Signals**
*Standard Interface:*
Bandwidth: 100 Hz - 50 kHz (3 dB points)
System modulation sensitivity: An input voltage of ± 1 V produces, ± 10 kHz deviation of the transmitted RF frequency
Max input voltage: ± 12 V
Input connector: BNC female
Input impedance: 10 k Ohm

**GMSK Interface:**
Bandwidth: 2 Hz - 200 kHz (3 dB points)
System modulation sensitivity: The input has adjustable deviation of the transmitted RF frequency
Max input voltage: 5 V
Input connector: BNC female
Input impedance: 10 K Ohm

**Opto Interface For Balloon Telecommand:**
Bandwidth: DC - 15 MHz
System modulation sensitivity: Adjustable
Max input voltage: 1 V Peak to Peak
Input connector: BNC female
Input impedance: 75 Ohm

**Homing Beacon**
*Recommended recovery beacon specifications:*
Frequency range: 240-260 MHz
Modulation type: CW or pulsed
Output power: min. 0.4 W
Battery lifetime at ambient temperature: min. 48 h
Note! 121.5 MHz and 243.0 MHz are international emergency frequencies and can NOT be used as beacon frequency.

The recovery beacon frequencies most frequently used are: 240.8 MHz, 242.0 MHz, 244.05 MHz
Safety

General
As a general rule, Swedish safety regulations and laws apply for work at Esrange. The Work Environment Act contains the basic provisions concerning occupational safety and health questions in Sweden. This act is a general act of law which is backed up by special rules and regulations in different fields, for example Explosives, Inflammable materials, Toxic materials, Electrical facilities. The specific safety rules and regulations that apply for work at Esrange are defined in the document Esrange Safety Manual, ESM, which is available on site at Esrange. In the following, general safety information is lined out.

Scheduling
Esrange provides launching opportunities any time of the year, any time of day, within the measure of Swedish Laws. The long-term scheduling of the Esrange launching programme is carried out by the secretariat of the Programme Advisory Committee (PAC) situated at ESA Headquarters in Paris. A revised schedule is issued every second month.

Operational Support
Assembly and preparation of rockets and balloons is normally done by Esrange personnel. In the event that the user teams do these operations, all work must be performed in accordance with the ESM regulations. Assembly, preparation and checkout of payloads, which is normally executed by the range user, must likewise adhere to the ESM regulations.

Recovery of Rockets and Payloads
Recovery of rockets and balloon payloads is standard procedure at the range. The land impact area makes Esrange very suitable for all kinds of flights where recovery is necessary. The open landscape allows smooth payload landing contributing to a minimum of impact damage. After impact, the payloads seldom drag in the recovery parachute thanks to the prevailing low winds. Balloon payloads are recovered all over northern Scandinavia and northern Russia. Provided that payloads are equipped with proper homing devices, recovery operations are very likely to be successful. All other parts, without beacons, such as motor cases, nosecones, etc., are recovered as soon as they have been located. The excellent helicopter support from pilots well acquainted with this uninhabited region of Scandinavia, makes it possible to maintain a very high probability for successful recovery. The necessary equipment to support recovery, ATC transponders and homing beacons, can be supplied by Esrange Instrumentation.

Safety Organization
The President and CEO of SSC is overall responsible for safety in the company. He/she is responsible for approving overall safety and security policies in the company including the Esrange Safety Manual (ESM).

The President of Science Services Division is responsible for implementing the range safety policies and criteria. He/she is responsible for approving Flight Safety Plans and Ground Safety Plans.

The Head of Sounding Rocket and Balloon Department is responsible for conducting operations in accordance with the ESM and other complementary safety policies and regulations. He/she is also responsible for preparing Safety Plans and for appointing a Flight Control Officer in a mission with a Flight Termination System.

The Esrange Project Manager is responsible for all contacts with customers and contractors when planning, building up and conducting rocket and balloon missions at Esrange. He/she is responsible for coordination and delegation of responsibilities of campaign activities including all safety matters. He/she shall superintend all safety and security regulations and arrangements related to the mission.

The Chief Security Officer is responsible for the overall planning of security matters at Esrange, including supervision of the fulfilment of security regulations in the ESM and in the Esrange Föreskrifter för Säkerhet och Skydd (EFSS) and other complementary safety and security policies and regulations.

The Range Safety Officer is responsible for the overall planning of safety matters of launch operations at Esrange, including supervision of the fulfilment of safety regulations in the ESM and in the Esrange Föreskrifter för Säkerhet och Skydd (EFSS) and other complementary safety policies and regulations.

The Head of Operations and Flight Safety Section is responsible for performing safety analysis and developing safety plans or data packages for all balloon and sounding rocket missions. He/she is also responsible for preparing Campaign Documents and Rocket Introduction Documents to Swedish authorities.

The Head of Launch Team is responsible for the ground safety in the launching areas.

The Superintendent for Explosives is responsible for all handling of explosives at Esrange.

Restricted Areas
During operations, there are certain areas that must be closed for safety reasons. Only authorized personnel will have access to such areas.

Rocket Launching Area
The road to the rocket launching area is closed near the Main Building by means of a remotely control-
led road-block. Authorized personnel gain access by using a special badge. Inside the launching area there are further restricted areas that require further authorization.

Balloon Launching Area
The road to the balloon launching area is closed near the Main Building by means of a remotely controlled road-block. Authorized personnel gain access by using a special badge. The buildings at the north edge of the balloon launching area are not restricted.

Radar Stations
Due to the health risk arising from RF radiation, no persons are allowed to enter the radar station without permission from the radar team leader. There is also a non-permitted area around the radar. When the radar is transmitting, a blue flashing warning-light is activated.

Operations Centre and Scientific Centre
Signs with the text “No Access” are placed above the doors to the Operations Centre and Scientific Centre. When these signs are illuminated, only authorized personnel have access.

Rocket Flight Safety
The main objectives of flight safety are to minimize injuries to personnel, damage to property and the probability of impact outside the range boundaries. Each vehicle flight must be planned to optimize the probability of the success of the flight objectives and to minimize the element of risk. It is the policy of the Swedish Space Corporation that the risk associated with each launch at Esrange is controlled so that the hurt risk (i.e. personal injury) never exceeds one in a million. In order to implement this policy it is required that every vehicle launched from Esrange is categorized into one of the following two categories:

Category A
Vehicles that meet the following three requirements:

- Do not have control or guidance system
- Have demonstrated vehicle reliability
- Have impact dispersion such that the hurt risk criteria are fulfilled

Category B
Vehicles that cannot be classified category A. All category B vehicles are required to have a destruct system. When launching a category B vehicle, a Safety Operations System (SOS) will be established to control the mission risk. A Flight Safety Plan will be prepared for each Category B vehicle to document:

- The Safety Operations System data requirements and/or qualification test.

- The flight limits. These flight limits define the areas in which the vehicle under certain conditions should be destroyed.

Acceptance of New Rocket Types
Rocket types new to Esrange will be accepted if they can fulfil the requirements under Category A. All Category B vehicles will be judged from case to case whether the main objectives of flight safety can be fulfilled by means of guidance system, destruct system etc. If a User wants to introduce a new rocket type, an application has to be made at least six months before planned launch date.

Nominal Impact Point
The nominal impact point will be chosen as Az: 350°, dist: 75 km during the period September 16 - April 30, when zones B and C are permitted impact areas. During summer the nominal impact point will normally be chosen in Az: 350°, dist: 60 km, when only zone B is a permitted impact area. The reason is to minimize the hurt risk and the probability of impacts outside the range boundaries. Exceptions can be made for rockets with low dispersion and demonstrated reliability. A nominal trajectory for all rockets to be launched from Esrange has to be presented at least two months before planned launch date.

Balloon Flight Safety
Application for launching of stratospheric balloons must be forwarded at least six months before planned launch date as Esrange has to apply for permission from Swedish Air Traffic Control authorities. Launchings of large stratospheric balloons can take place from Esrange or some other place in northern Sweden under the supervision of Esrange safety personnel. All balloons are filled with helium gas and released by range personnel. Stratospheric balloons must carry all equipment necessary to fulfil Air Traffic Control and Esrange safety requirements. Impact and recovery in Scandinavia is normal routine, but permission for impact and recovery in northern Russia can normally also be arranged.

Explosives
All explosives to be brought to Sweden requires an import licence issued by Swedish authorities. It is the responsibility of Esrange to prepare an application for such a licence.

Dangerous Equipment
Dangerous equipment is defined as all equipment containing micro-organic, explosive, pyrotechnic, poisonous, corrosive, or radioactive materials. When an experiment with dangerous material is proposed, any material listed in the book “Handbuch der gefährlichen Güter” (Himmel Springer-Verlag, Berlin, Heidelberg, New York) must be notified to Esrange.
Operational support for Sounding rocket and balloon
Esrange appoints a Project Manager for every project that is planned to be carried out from Esrange. The Project Manager is the Esrange contact for the range User. He/She is responsible for the campaign planning, co-ordination, countdown procedure, and operations at the range. All requirements and correspondence should be addressed to the Project Manager. All operations, whatsoever, occur under the Laws of Sweden. Esrange officials are responsible for flight control and flight safety of all vehicles that are flown from Esrange.

Approval to Use the Range
All projects, which will be carried out at the range, require approval by the President of Science Services Division. All plans for the use of Esrange should be discussed with Head of Sounding Rocket and Balloon Department, such that all priority questions can be settled and the long-term planning requirements be satisfied.

Range User’s Requirements
A range user must prepare a Flight Requirement Plan which defines the mission requirements and also the services to be provided by Esrange.

It is recommended that the document is prepared in co-operation with the Head of Launch Services at Esrange such that the rules and regulations in the Esrange Safety Manual are not violated, and that eventual difficulties can be eliminated at an early stage.

The range user should submit at least two copies of the Flight Requirements Plan, arriving at Esrange no later than three months prior to the scheduled start of the campaign.

Based on this plan, permission from government agencies can be applied, in the case it would be necessary.

Should a balloon be supposed to fly over foreign countries, an application must be made no later than six months prior to the planned campaign.

Similarly, should a new rocket type be introduced to Esrange, an application has also to be made at least six months in advance.
Range User's Requirements

**FLIGHT REQUIREMENT PLAN FORMAT**

This section describes the format of the contents required in the Flight Requirements Plan.

**General Information**

**Mission**
A short description of the scientific objectives of the project.

**Organization**
A description of the organization with responsible persons and addresses, telephone and telex numbers of participating organizations.

**Personnel**
A list of participating personnel including name, responsibility and position.

**Operations**

**Launch Conditions**
A brief description of scientific and meteorological conditions required for launch.

**Time Schedule**
This item should include Transport to Esrange, Arrival of personnel, Unpacking, Payload assembly, Payload tests, Payload/Vehicle integration, Pre-flight meeting, Test countdown, Launch window and Launch period.

**Countdown**
A list of main countdown events.

**Payload**

**General**
A general description of the payload including dimensions, weight, centre of gravity and a drawing.

**Experiments**
A short description of the experiments in the payloads.

**Hazardous Items**
All hazardous items in the payloads must be defined under this headline (radioactive sources, explosives...).

**Launch Vehicle**

**Rocket**
Give as complete a description of the rocket as is reasonably possible. The range user should describe in adequate detail or provide references for rocket handling, motor performance, wind weighting and physical dimensions. Drawings are required for rockets/payloads which have not previously been launched from Esrange. Input parameters required for each rocket configuration include tower tilt effect, unit wind effect, wind weighting curve. If the rocket consists of more than one stage these parameters must be given for all stages.

**Flight Sequence**
A time table of all important events during flight.

**Trajectory**
A preflight trajectory based on nominal launch angles.

**Esrange Support**

**Telemetry**
An adequate description of the payload-borne telemetry instrumentation including the following items:
- Telemetry system including frequencies and power output
- Antenna configuration
- Polarization
- Bandwidth, format, sync words and data rates
- Recording requirements

**Tracking**
A specification of tracking requirements and tracking systems in the payload.

**Timing, Communications and Cabling**
Besides regular services all specific requirements on timing, communication and cabling should be specified under this item.

**Scientific Ground Instrumentation**
A specification of operational models of requested scientific ground instrumentation on the range. Use of down range stations should also be requested under this headline.

**Data Handling, Processing, and Distribution**
Requests for play-backs, scientific recordings, general data processing, etc. are to be addressed to the project manager, before the start of the campaign. Requests should include a distribution list of all persons/organizations that are to receive post-flight data.

**Launch Support**
A specification of launch support. Gas supplies for payload, umbilical cabling etc.

**Recovery**
Requests for recovery. Specification of beacon, parachute colour, etc.

**Supplies and Transportation**
Requests for working areas, offices, accommodation, transportation, unloading of material, car rental, etc.

Give any special user requirements.
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