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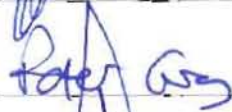
Europäische Organisation
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E-ELT PROGRAMME

E-ELT CONSTRUCTION - SAFETY MANUAL

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1 Related documents

1.1 Applicable documents

The following applicable documents form a part of the present document to the extent specified herein. In the event of conflict between applicable documents and the content of the present document, the content of the present document shall be taken as superseding.

AD1 Common definitions and acronyms;
ESO-193178 Issue 5 (E-SPE-ESO-313-0066 Issue 5)

1.2 Reference documents

The following Reference Documents provide background information as to the present document. Under no circumstance shall the content of Reference Documents be construed as applicable to the present one, in part or in full.

RD1 Safety Manual Garching/Santiago;
ESO-201102 Issue 1 (SAF-GAR-MAN-0002 Issue 1)

RD2 E-ELT Project Safety Plan;
ESO-192998 Issue 1 (in preparation.)
(E-PLA-ESO-100-1239 Issue 1)

2 Preface

This Safety Manual for the construction of the E-ELT has been drawn up in cooperation with ESO Safety and ESO Management. It reflects the various fields of safety mentioned in the ESO Safety Policy & Organisation (SAF-GEN-POL-0001): *Occupational Safety, Fire Safety, Product Safety, and Environmental Good Practices*. This document shall serve as a reference document and shall be made available and brought to the attention of every person working on the E-ELT construction. It is binding on all Members of Personnel, Visitors and Contractors.

This document implements the E-ELT construction Safety Policy & Organisation and provides instruction, guidance and information on safe working practices relating to the E-ELT activities. It summarises the safe working practice to be followed in day-to-day work, and is the prime information to be distributed to ESO Members of Personnel, Contractors and Visitors. This is for their guidance, knowledge, and to increase awareness of the most common risks related to E-ELT activities, and the respective control measures to be undertaken. The overall objective is to prevent work related accidents and promote safety awareness.

Chapter 6 provides a good overview over day-to-day safety working practices. The chapters thereafter provide more specific guidance.

3 Responsibilities – A reminder from the ESO policy

It is the Organisation's Policy to make sure that its facilities are operated in a safe and healthy manner. Therefore, each ESO Member of Personnel, and more generally everybody working on the E-ELT construction, must therefore comply with the applicable ESO Safety Manual(s) derived from the organisation's common safety policy & organisation and, as appropriate, with the national standards of the Host State, concerning health, safety, environmental protection and working conditions.

As a general principle, Management ultimately has the responsibility for health, safety and environmental protection for as far as its managerial responsibilities extend.

All Supervisors, therefore, must ensure a high level of healthy and safe working conditions by regularly assessing hazards, analysing and reducing identified risks, providing adequate training and the appropriate personal protective equipment to their staff.

In an environment, that is partly managed as a matrix organisation, this may mean to share this responsibility between Supervisors, who will consequently need to co-operate in this respect ("ownership" of premises and equipment, training requirements, day-to-day operational instructions).

Newly arrived ESO Members of Personnel, contractor personnel and anybody else working on the E-ELT construction must be familiarised with this E-ELT Construction Safety Manual during a safety briefing session at the beginning of their employment.

Everybody working on the E-ELT construction must exercise discipline, awareness and professionalism. They must perform their tasks with an adequate level of safety consciousness, and accept responsibility for doing the utmost to prevent injury to themselves and others.

If construction staff do recognise any risk or hazard, it is their right and duty to inform their Supervisor immediately, or any Site Safety Officer/Engineer. Site Safety Engineers are entitled to put a stop to any work, which they deem dangerous for life and limb.

Contractors working on ESO premises must adhere to the same standards of health and safety that apply to ESO Members of Personnel, and act in full compliance with applicable host-state legislation. All Contractors must however establish their own safety organisation.

4 Abbreviations and acronyms in this document

DG	Director General
DSO	Divisional Safety Officer
HoA	Head of Administration
HoD	Head of Division
DoO	Director of Operations
DoP	Director of Programmes
DoE	Director of Engineering
DoS	Director of Science
SSE	Site Safety Engineer

5 Normative references & documentation

The ESO Safety Policy is based on:

- ESO Staff Regulations, R III 2.01

ESO safety documentation comprises –

- ESO Safety Policy and Organisation (SAF-GEN-POL-0001).
- E-ELT Construction Safety Manual (ESO-206280) – The present document.
- Every and any ESO Safety regulations and/or procedure applicable to their work situation or location

All E-ELT Construction Personnel MUST refer to these where relevant for their work situation.

6 General safe working practices

The following is a quick reference to some general safe working practices, which apply to all activities developed or carried out for the E-ELT construction. The application of these safe working practices is mandatory, and must be communicated, trained and enforced.

6.1 Order and housekeeping

Good order and housekeeping is fundamental, necessary, and the responsibility of every person working on the E-ELT construction.

Work areas and walk surfaces, particularly those used as escape routes, must be kept clean and clear of unnecessary objects. There must be no materials, equipment or other obstructions, which might cause, facilitate or aggravate any accident, injury or fire.

- Store materials only in designated areas and in an orderly manner.
- Secure materials and equipment against adverse natural conditions (e.g. seismic, meteorological, etc.)
- Keep storage areas clean and materials neatly disposed or stacked.
- Use waste containers for disposal of scrap materials and other debris.
- Everyone must separate waste for appropriate recycling and disposal purposes. This is essential for economic and environmental reasons.
- Electrical, phone and network cables must not cross walkways or otherwise pose a trip hazard. Secure cables with proper cable covers and bridges.
- Close drawers and filing cabinet doors after each use.
- Never store boxes, papers and other materials on top of cabinets, as items may fall down or cause the entire cabinet to tip over.

6.2 Basic fire safety

Every person working on the E-ELT construction shall contribute to:

- Maintaining means of escape, stairwells and corridors free of obstacles;
- Limiting the fire loads, particularly in exits, stairwells and corridors, to the strict minimum;
- Not using any open flame or other ignition source without having obtained the respective fire-permit;
- Participating in the fire training program and fire drills;
- Following any specific requirements for evacuation established for their work areas;
- Knowing the location of the nearest fire alarm and/or telephone and the phone numbers needed for the alarm;
- Following any fire protection constraints established at the construction site.

6.3 Sparring resources

For financial and environmental reasons, every person working on the E-ELT construction are required to contribute in conserving energy and water where possible. This means inter alia to turn off unnecessary air-conditioning, lighting and heating.

6.3.1 Lighting

As far as possible, use natural lighting.

Lighting must be adequate to the needs. Preferentially, low consumption lighting should be used, and LED technology preferred over neon lighting.

Workplace luminaries must be periodically cleaned, as dust deteriorates the apparent brightness of the bulb or tube.

Outdoor lighting shall be designed with the role-model function of ESO as an astronomical organisation in mind, and avoid unduly contributing to light pollution.

Switch off lights, and other energy consuming equipment, when leaving the room.

6.3.2 Electric and electronic equipment

If electric/electronic equipment such as computers, screens, printers, etc., are not required, do not leave them in stand-by mode – switch them off properly. If there are any doubts, contact IT.

6.3.3 Heating, ventilation and air conditioning (HVAC) equipment

Heating/ Air Conditioning the premises is expensive. Therefore:

- Do not overheat or overcool the workplace atmosphere.
- Switch off HVAC equipment in the event of long absence.
- Keep windows closed when HVAC equipment or heating is on.
- Do not cover radiators; convection currents need to flow freely.
- Clean air filters, grids and vents on a regular basis; dust and dirt impede the airflow.
- Keep a record of maintenance activities.

6.4 Laboratories and workshops

Each Laboratory or Workshop must be clearly and visibly assigned to a responsible person. This person's duty is inter alia to oversee the work of Contractors and staff of collaboration projects.

Access control is needed whenever the work carried out may present a significant risk to the health or safety of a worker (as for example: working with a Laser or ionising radiation).

All E-ELT construction personnel or Visitors working in any ESO laboratory must adhere to the two-person-rule.

Every laboratory must clearly display safety and emergency information related to the substances handled there, based on the result of the workplace risk evaluation, and on the safety data sheets.

All E-ELT construction personnel must wear clothing suitable for the locations and conditions in which they are working. It is essential to keep laboratories and workshops clean and tidy at all times. Always remember that one person's activities potentially affect others working in the same area.

Immediately attend to leaks and spills of chemicals/gases/water and notify other personnel of potential hazards.

Consider substituting hazardous chemicals with inoffensive processes, and keep the amount of hazardous substances to a minimum, consistent with the work schedule. Always store hazardous substances in appropriate cabinets, according to their data sheets. Exhaust ventilation must be provided where necessary.

Do not store more than the necessary number of gas cylinders and replacements. Keep empty cylinders etc., in a designated store.

Keep corridors and spaces between benches clear and uncluttered for easy evacuation in the event of emergencies.

Only use flexible cable and plug assemblies to provide AC power to portable workbenches if ALL the following applies:

- The branch circuit voltage supplying the workbench is a nominal 240 V or less.
- The over current protection device rating on the branch circuit supplying the workbench must be 16 A or less. If higher current supply is required, industrial type plugs and sockets must be used.
- The flexible cable must be:
 - no longer than 4,5 m,
 - attached to the workbench with an approved tapered rubber-bushing cable-grip fitting,
 - no less in section than 2,5 mm²,
 - of industrial type,
 - protected from physical damage,
 - routed to prevent tripping hazards, and
 - terminated in a certified plug and socket assembly that has the proper voltage and current rating for the branch circuit feeding the workbench.
- Each workbench must have its own cable and plug & socket assembly. Workbenches must not be parallel-fed or daisy chained by plugging their power cables into a socket located on another workbench.
- Each workbench wiring system must have adequate equipment-grounding protection that consists of a correctly sized and identified grounding conductor, which must be an integral part of the flexible cable.
- All metal surfaces of the workbench assembly that are likely to become energised by an electrical fault must be properly bonded to the grounding conductor.
- Where seismic action has to be accounted for, furniture and storages have to be secured against falling over or releasing their contents in the event of a shake.

6.5 Work permits

Before starting work, all E-ELT construction personnel must sign a work register at the site entrance.

If there is doubt about the correct safety procedure applicable at the workplace, contact the Site Safety Engineer before starting any work.

All E-ELT construction personnel must have valid work permits if activities presenting a significant risk are involved. Such activities definitely include hot work (open flames, heat sources, welding, cutting and any other work that could provide any potential source of ignition), work in confined spaces or

laboratories with access restriction, working alone beyond official operating hours and with restricted communication possibilities.

Entry of E-ELT construction personnel into hazardous environments must be authorised by the Supervisor of this area. All E-ELT construction personnel must have an information briefing before entry, as for example: Laser laboratories, ionising radiation laboratories and workshops.

Generally, unless otherwise stated in writing, permits must be displayed in the location where the work is being performed.

6.6 Hand held tools, equipment and workshop machinery used for E-ELT Construction

All commercial tools, equipment and machinery must bear a recognised safety conformity label (e.g. CE, UL or GS Mark), unless purchased before the entry into force of the related directive. In case of doubts the Supervisor decides if certain tools are adequate. The decision needs to be documented in writing. The Supervisor should consult the Site Safety Engineer. Conformity labels shall however not solely be relied upon, in order to guarantee machinery is safe, given it is only a claim by the manufacturer that the equipment is manufactured according to the required safety regulations and processes. Therefore the Supervisor managerially responsible for a given area has to ensure all equipment is safety-checked at regular intervals, and earmarked accordingly. A visual check shall be performed by the user prior to any use of tools, equipment and machinery.

If the equipment was purpose-built, a "statement of conformity" must still be provided through the manager of the relevant E-ELT construction sub-project, to the effect to ensure the device can be mounted, operated, maintained and discarded safely by all E-ELT construction personnel.

Any damaged or defective tool, equipment or machinery must be reported immediately to the direct Supervisor, preferably in writing. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item must be taken out of use, tagged "**DO NOT OPERATE**" and stored in a controlled area until removed or appropriate repairs have been made.

There must be periodic inspections according to the manufacturer's manual, but at least every second year. Where required, technical experts on the specific subject matter shall perform these inspections.

The following information (in English and/or Host-State language) shall be kept where it can easily be consulted:

- The Manufacturer's Instruction and Maintenance Manual(s).
- The maintenance inspections records carried out on the equipment.
- Any operational procedure required to perform the work safely.

There must be adequate training, instruction and information for every person working with tools, equipment or machinery.

All personnel must wear personal protective equipment according to the work related risks.

Adequate eye protection must be worn whenever the work performed might create dangerous conditions by producing stone, metal or glass fragments, etc. and when there is the risk of exposure to cryogenic liquids and laser beams.

Next to the observance of the ESO policy on alcohol and drugs (Internal Memorandum dd. 06.04.2009), which prohibits work under the effect thereof, all E-ELT construction personnel shall duly take into account the side-effects of any medicine they may be taking, as well as the effect of the altitude at the E-ELT construction site.

Contractors must use their own tools and equipment, and make sure that they are legally compliant and properly identified (marked) and maintained; otherwise, they will be removed.

Where required, power tools, equipment and machinery must have guards in place, particularly during their operation. Following are general recommendations about machine guards:

- Use fixed guards wherever possible, properly fastened in place with screws or nuts and bolts that need tools to remove them.
- Check that guards are convenient to use and not easy to defeat, otherwise they may need modifying.
- Make sure the guards allow the machine to be cleaned and maintained safely.

6.6.1 Hand tools

Hand tools must not be altered or operated contrary to manufacturing specifications and instructions. Tools must only be used for their intended purpose.


Tools must be kept in good condition. Inspect them before each use for defects such as cracked handles, damaged cutting edges, splitting or cracked parts and broken adjusting components.

In certain areas a survey system for tools might be compulsory to make sure none is left behind once the works is completed. Also it might be needed to secure tools in certain areas to prevent them from falling down and damage any equipment underneath.

6.6.2 Portable power tools and machinery

Choose tools and equipment that are suitable for their intended use, and for the purpose and conditions in which it is used (working environment).

Portable power tools must be provided with healthy cables and plugs and they must be earthed, unless they are double-insulated equipment.

Double insulated equipment (clearly marked with the words "Double Insulated" or with the double square symbol ) provides additional protection against electrocution because of their construction.

Power tools must not be used in conditions where water or moisture can create the risk of an electric shock. Where flammable materials are present, even if only occasionally, do not use electric equipment capable of igniting them, unless measures are taken to prevent ignition or explosion. Such materials include, but are not limited to: flammable gases, vapours, or liquids, combustible dust, and ignitable fibres or fillings.

Electrical circuits feeding portable electrical tools must be protected by 30 mA rating RCD's (Residual Current Devices) or similar.

All powered hand tools used at the E-ELT construction site must once every year be thoroughly checked, particularly for soundness of the electrics. Records of all the items concerned shall be kept accurately by the Supervisor responsible for the area in question, including the date and nature of the tests, and the signature of the person performing the inspection.

6.6.3 Other technical equipment

6.6.3.1 Ladders

Ladders must only be used to provide access to places where people need to work.

- The ladder must be selected according to the type of work to be performed and the expected height and load to be carried.
- Only approved ladders may be used (e.g. GS sign; UL sign; ESO internal safety inspection mark).
- Ladders must be regularly inspected by the Supervisor. All defective ladders (weakened, broken, missing steps, broken side rails, etc.) must be tagged, removed from service and reported immediately to the direct Supervisor.
- Ladders must be strong enough for the intended use and charge.
- Do not use portable metal ladders near energised electrical circuits. You may only use approved non-metallic ladders when performing work on or near electrical systems.
- Stepladders must not be used for any other purpose than their designed characteristics.
- All portable ladders must be equipped with non-skid safety feet and must be placed on a stable base. Keep the access areas, at the top and bottom of ladders clear of obstructions.
- Do not place ladders in front of doors that open toward the ladder, unless the door is open, locked, or guarded.
- When placing a straight ladder, the inclination must be approximately 70°: As a rule of thumb, your lateral elbow extension will do.
- Ladders must extend at least 1 metre above the point at which a person may want to step onto a roof, platform or scaffold.
- When in use, portable ladders must be firmly placed, held, tied, or otherwise secured to prevent slipping or falling.
- Never use makeshift ladders, such as chairs, benches, boxes or crates.
- Do not place a ladder against an unsafe support. When using stepladders, be certain the legs are fully spread.
- When using a stepladder longer than 3 m high, another person must hold the ladder (except a platform ladder).
- Use both hands, and face the ladder when ascending and descending the ladder.
- Do not carry objects while climbing ladders.
- Do not climb on the top steps of a ladder.
- Never attempt to use a ladder in a strong wind without securing it properly and without using fall arrest equipment.

6.6.3.2 Fixed scaffolds and platforms

Scaffolds and platforms must be erected only by persons trained and certified for this purpose.

- Only use scaffolds and platforms that have a “SCAFFTAG” identifying approval for use.
- A SCAFFTAG must show the name of the company, the name of the person responsible for the erection of the scaffold or platform, the maximum load and the date of installation.
- Scaffolds must not be loaded more than the working load for which they are intended.
- Any scaffold damaged or weakened, whatever the cause, must immediately be repaired. It must not be used until repairs have been completed and approval for use (SCAFFTAG) re-issued.
- Remove scaffolds when work has been completed.

- Keep scaffolds or any other high reach equipment away from power lines. Contact with a power line can cause serious burns or electrocution. Keep a minimum safe distance of 3 m from power lines and 6 m from transmission tower lines.
- Whenever a work has to be performed at a height over 1.80 m, an appropriate fall arrest system must be used.
- Scaffolds and platforms must have proper railings (foot, knee and wrist-level).
- Every person having to work at heights must be properly trained, by a specialised person, on how to use fall protection systems.
- Scaffolds and platforms must be properly secured to prevent them from moving.

6.6.3.3 Mobile scaffolds

Mobile scaffolds must only be used on simple works, e.g. for inspection purposes, or operations not involving stacking of materials (except those immediately required), or where light equipment and tools are used but without material storage.

- Mobile scaffolds must be inspected and approval documented by a SCAFFTAG, before starting work.
- Mobile scaffolds with integrated wheels must have a locking system at all wheels to prevent movement of the scaffold.
- To increase safety and for ease of movement, the diameter of wheels must be at least 150 mm, for scaffolds up to 6 m height.
- A "steady bar" (bracing strut) must be mounted in the diagonal at the base, at the level of the wheels, to make sure the assembly is stable and non-deformable.
- Mobile scaffolds must have proper railings (foot, knee and wrist-level).
- Working platforms must have the greatest width allowed by the scaffold structure, with a minimum width of 60 cm.
- Never transport people and/or materials on the scaffold when it is in motion.
- Never throw materials from the working platforms. Any materials must be raised and lowered with appropriate help for example, with the help of pulleys suitably fixed to a rigid structure.
- Repairs and preventive maintenance must be done by qualified personnel.

6.6.3.4 Hoists and cranes

Only trained and certified personnel are allowed to operate hoists and cranes.

- Next to the observance of the ESO policy on alcohol and drugs, operators shall duly take into account the side-effects of any medicine they may be taking.
- The rated load of the crane must be plainly marked on each side of the crane. If the crane has more than one hoisting unit, the rated load must be marked on each hoist or on its load block, and this marking must be clearly readable from the ground or floor.
- Cranes must be electrically earthed through the superstructure whenever they might make contact with an electrical energy source.
- If there is a loss of electrical power, all controls shall be switched to the "OFF" position to prevent unexpected start-up when power returns.
- Slings shall be replaced immediately if excessive wear occurs. Inspect them visually before each use.

- To prevent persons and equipment from being struck, never let the crane load start to swing uncontrollably.
- If cranes use counterweights, the swing radius of all cranes must be fenced off to prevent persons and equipment from being struck by the counterweight.
- If site safety regulations require, a copy of the "Operating Regulations for Cranes" notice must be displayed near the main electrical isolator for the crane.
- Never store loads by hanging them on the crane.
- It is not allowed to stay under hanging loads.
- Repairs and preventive maintenance must be done by qualified mechanics.

6.6.3.5 Mobile work equipment (e.g. forklift trucks, hand trucks)

Make sure that mobile work equipment used for carrying people is suitable for this purpose.

- Never transport people on the forks of forklift trucks, or transport loose loads.
- Forklift truck drivers working at the E-ELT construction site must have a special forklift driving licence and specific equipment-related induction before they start work.
- Only competent and qualified workers who have received appropriate training are authorised to operate forklift trucks.
- Repairs and preventive maintenance must be done by qualified mechanics.
- Keep to low speeds (maximum 10 km/h) and within the load capacity.

6.7 Electrical installations

Electrical installations must constantly be kept in a safe state by the facilities department in general office locations and back-of-house, and by laboratory and workshop Supervisors within their attributed areas of responsibility.

- New electrical systems must be in accordance with applicable ESO and/or E-ELT (whichever is the strictest) standards and maintained in a safe condition.
- Existing installations must be properly maintained.
- Electrical extension cables must be of one continuous cable without a splice or intermediate connection.
- Flexible cables, attachment plugs and receptacles must be of the proper type, size, and voltage and current rating for the intended application.
- All cable and plug-connected equipment must be grounded with a correctly sized and identified equipment-grounding conductor that is an integral part of the ac power cable. Exception: equipment protected by a double insulation system or its equivalent.
- Cable and plug connection is only allowed at the E-ELT construction site for equipment that operates at a nominal 250 V or less, and has a maximum circuit rating of 16 A.
- Any equipment operating at higher voltages or currents must be permanently connected, and plug and socket connections avoided. If, however, a higher voltage or current cable-and-plug connection is desired, an Electrical Specialist must be consulted for requirements and guidelines.

- Temporary electrical systems must be grounded. All switches, distribution boxes and other systems must have all exposed electrical components protected against accidental contact by objects or persons.
- Electrical controls and switches must be labelled and identified.
- Electrical distribution systems must be labelled to show their voltage level and control area.
- All temporary facilities, electrical tools and equipment must be grounded to the same earth potential.
- Lightning Protection must be installed as an outdoor protection for all buildings, antennas, outdoor portal/ gantry cranes, etc. These structures are more likely to be struck because of their height or metal content.
- All outdoor, lightning-protected facilities must also have internal lightning protection, to protect electronic equipment against damage by a lightning strike. For example, this protection might be installed in the fuse cabinet for the main electrical supply to the building.
- For sensitive electronic equipment (test equipment, computers etc), it is recommended that there will be a third level, transient surge protection device installed next to or inside the equipment.
- Only qualified personnel may install, repair and maintain electrical tools, equipment and installations.

6.8 General requirements for handling and storage of material

Storage areas must be kept free from accumulated materials that might cause tripping, fires, explosions, or that may contribute to the harbouring of pests.

Materials must be properly secured and stored in an organised way. Avoid storing incompatible materials together. Heavy loads must be stored in lower shelves while lighter loads in higher shelves. Never store liquids above head height.

If applicable, a First In-First Out system of keeping stock must be used, so that old stock is used first.

Only use solid shelves and indicate maximum load.

6.9 Use of hazardous materials

Hazardous materials (HAZMAT) must be stored and handled in a safe manner.

- Hazardous substances must be clearly labelled and always stored in the correct containers.
- Safety data sheets must be maintained where they can be easily consulted.
- First aid equipment to be easy accessible and required explanatory notices displayed.
- Purchases of HAZMAT never used before at ESO must have the prior approval of the E-ELT Site Safety Engineer (SSE).
- All E-ELT construction personnel bringing hazardous substances into the E-ELT construction site must declare, via the ESO contact person, the type (identification) and quantity of those substances and means of storage.

- When not in use, containers for hazardous substances must be kept closed and in a safe manner, separated by classes, keeping incompatible materials separated. Secondary containment must be used with bulk chemicals.
- The amount of hazardous materials, either in workplace or in storage areas, must be kept to a minimum, consistent with the daily work schedule.
- The person responsible for the area where the hazardous substances are stored must carry out regular inspections as well as a yearly inventory. The inventory list must be forwarded to the E-ELT SSE on a yearly basis for site safety risk assessment. Chemicals with expired shelf lives and deteriorated or leaking containers must be disposed of safely.
- Adequate Personal Protective Equipment (PPE) must be used when handling chemicals. PPE must afford adequate protection against the risk from those hazardous chemicals to which the wearer is exposed, throughout the period during which such equipment is necessary, having regard to the type of work.

6.10 E-ELT construction site

The E-ELT construction site must be operated in a safe manner.

- When more than one Contractor work at the E-ELT construction site, a coordinator for health and safety matters in observance of the applicable host-state laws on the safety of construction sites shall be appointed. This shall by default be the main Contractor.
- Cooperation between Contractors is required. If there is no main contractor, clearly defined responsibilities is to be agreed in advance of the works.
- The E-ELT construction site must be clearly identified, properly secured and the boundaries clearly shown. For example, the construction site must be surrounded by a fence with warning signs stating that access on site is restricted to certain people. For smaller construction areas, it is sufficient to use for example, warning cones or barrier tape.
- Allow for adequate means of entry and exit, as well as the demarcation and laying-out of working areas, storage areas, passageways and traffic routes.
- Warning signs must indicate that there is a risk if people enter the construction area.
- The E-ELT construction site must be kept in good order and in a satisfactory state of cleanliness, locked at night or during breaks, appropriate safety checks to be done, e.g. for hot works.

7 Assessment of hazards and mitigation of risks

For all non-standard workplaces, processes and equipment, Supervisors shall investigate the associated hazards and risks, in order to provide adequate preventive solutions. All potential hazards identified will be assessed for probability of occurrence and severity as per the E-ELT Risk Management Plan by the Supervisor or by suitably experienced personnel (example: Work Package Manager with Contractor Safety Manager). The risk associated with a hazard is a product of the severity and probability of the hazard, and occupational health safety risks marked red, in particular those involving high severity levels and/or those likely to occur frequently are not acceptable to ESO.

Hazards, for the purpose of this document, are situations where a hazardous technical/ environmental context and human presence are concomitant, and where enabling factors potentially activate the hazard into an accidental event.

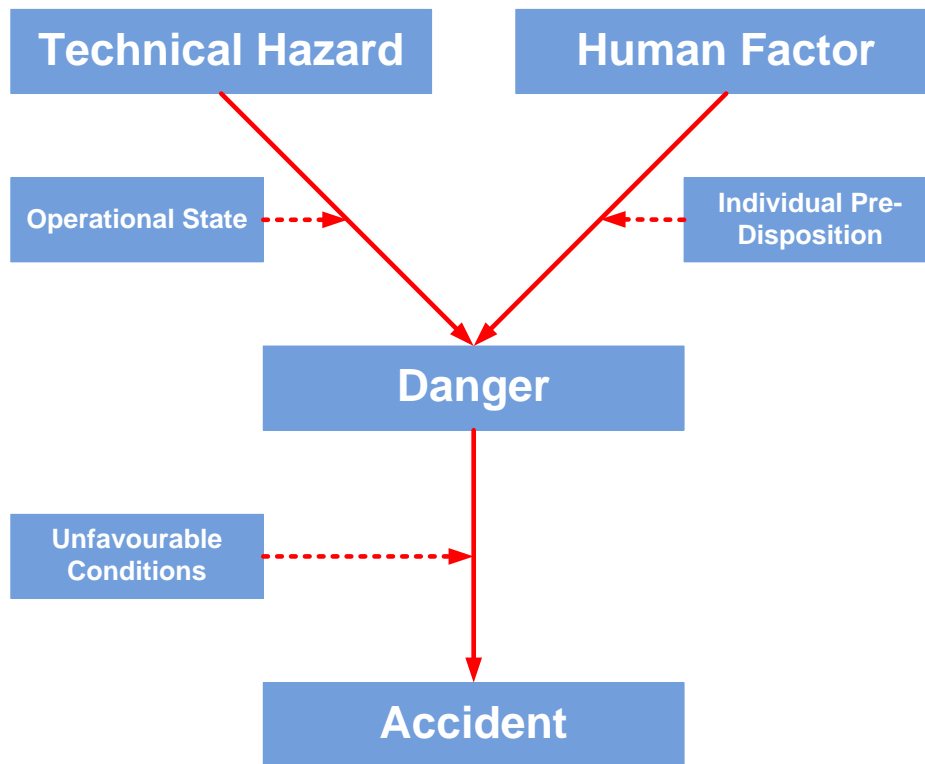


Figure 1. Hazard model

Hazard factors to be considered in this respect include (non-exhaustive list):

1. Mechanical hazards
 - 1.1 Unprotected moving machine parts
 - 1.2 Parts with dangerous surfaces
 - 1.3 Moving means of transport, moving work equipment
 - 1.4 Uncontrolled moving parts
 - 1.5 Falling, slipping, stumbling, spraining one's ankle
 - 1.6 Falling from a height
2. Electrical hazards
 - 2.1 Electric shock
 - 2.2 Electric arc
 - 2.3 Electrostatic charges
3. Hazardous substances
 - 3.1 Skin contact with hazardous substances (solids, liquids, wet work)
 - 3.2 Inhalation of hazardous substances (gases, vapours, mist, dusts incl. fumes)
 - 3.3 Swallowing of hazardous substances
 - 3.4 Physicochemical hazards (e.g. fire and explosion hazards, uncontrolled chemical reactions)
4. Biological agents

- 4.1 Infection hazards due to pathogenic microorganisms (e.g. bacteria, viruses, moulds)
- 4.2 Sensitising and toxic effects of microorganisms
5. Fire and explosion hazards
 - 5.1 Combustible solids, liquids, gases
 - 5.2 Explosive atmosphere
 - 5.3 Explosive substances
6. Thermal hazards
 - 6.1 Hot media/surfaces
 - 6.2 Cold media/surfaces
7. Hazard due to special physical effects
 - 7.1 Noise
 - 7.2 Ultrasonic, infrasonic
 - 7.3 Whole-body vibrations
 - 7.4 Hand-arm vibrations
 - 7.5 Non-ionising radiation (e.g. infrared radiation (IR), ultraviolet radiation (UV), laser radiation)
 - 7.6 Ionising radiation (e.g. X-rays, gamma rays, particle radiation (alpha, beta and neutron radiation))
 - 7.7 Electromagnetic fields
 - 7.8 Vacuum or gauge pressure
8. Hazards due to ambient working conditions
 - 8.1 Climate (e.g. heat, cold, inadequate ventilation)
 - 8.2 Lighting, light
 - 8.3 Suffocation (e.g. due to oxygen-reduced atmosphere), drowning
 - 8.4 Inadequate escape and transport routes, inadequate safety and health protection labelling
 - 8.5 Inadequate area of movement at the workplace, unfavourable arrangement of the workplace, inadequate break and sanitary rooms
9. Physical load / work intensity
 - 9.1 Heavy, dynamic work (e.g. manual handling of loads)
 - 9.2 One-sided, dynamic work, body movement (e.g. frequently repeated movements)
 - 9.3 Posture work (constraint posture), holding work
 - 9.4 Combination of static and dynamic work
10. Mental factors
 - 10.1 Inadequately designed tasks (e.g. predominantly routine tasks, over-qualification and under-qualification)
 - 10.2 Inadequately designed work organisation (e.g. work performed under great pressure of time, changing and/or long working hours, frequent night work, working sequence not thought through)
 - 10.3 Inadequately designed social conditions (e.g. lack of social contacts, unfavourable leadership style, conflicts)

- 10.4 Inadequately designed workplace and ambient working conditions (e.g. noise, climate, confined space, inadequate perception of signals and process features, inadequate software design)
- 11. Other hazards
 - 11.1 due to people (e.g. assault)
 - 11.2 due to animals (e.g. getting bitten)
 - 11.3 due to plants and vegetable products (e.g. sensitising and toxic effects)

Once a hazard has been defined and its risk potential rated, the appropriate action(s) to be taken to eliminate or reduce the hazard should be identified. A remediation goal or target should be formulated and documented.

The priority shall be to remove the hazard, or to implement prevention measures allowing to rate it in a lower risk category if it cannot be removed. Once mitigating action has been taken, the hazard can be re-assessed to establish whether further action is needed, or whether the hazard has reached an allowable and acceptable risk status.

Once the hazard has been judged to be allowable and acceptable, no further action is required, but the hazard should be periodically reviewed throughout normal operation, or as part of the life-cycle of the Project (or individual Contract) to ensure that it so remains. If a hazard has been removed, for example by changing the design, it may be closed and need not be reviewed further, but a record of the hazard and the action taken must be kept.

Assessment and mitigation of hazards should only be carried out in conjunction with the Members of Personnel affected, be documented in writing, and communicated to the E-ELT Site Safety Engineer.

7.1 Mitigation: T-O-P

Mitigation of hazards shall be prioritised along the T-O-P principle, which – by preference – ensures the reduction of hazards at their source, i.e. suppresses the coincidental concurrence of the hazard factor with human presence.

This is to deliberately avoid the less reliable remedies being preferred, which either depend solely on the worker's co-operation (e.g. instructions), or even lead to new strains (e.g. excessive wearing of PPE).

7.1.1 Technical

Risks for which the evaluation reveals a need for mitigation shall where possible be removed, substituted or otherwise avoided. If this is not possible, technical measures for reducing the risk shall be implemented.

7.1.2 Organisational

These cures may be complemented by organisational measures, such as variable assignments to reduce exposure, specified break-times, access restrictions, etc.

7.1.3 Personal

Residual risks can then be addressed by Personal Protective Equipment (PPE), and by providing instructions, information and training (in that order of preference and effectiveness).

8 Fire safety

For basic provisions see also Chapter 6.

A fire can cause enormous damage, with potential loss of life and severe injuries. Therefore:

- Smoking and open flames are prohibited in all ESO buildings. Smoking is only allowed in the designated smoking areas.
- Combustible material must not be placed in corridors – particularly escape routes – even temporarily, without fire prevention measures.
- Presentations and posters in corridors must generally meet trade-fair fire standards (EUROCLASS C or DIN 4102 B1), unless otherwise stated by the E-ELT SSE. This also applies to cables and furniture.
- Posters in escape routes and corridors must be hung in non-combustible frames and displays, open pin boards shall not be used.
- Notice-boards and displays must be provided with metal frames and a glass cover.
- If waste paper bins must be kept in a corridor, they shall be of a self-extinguishing design and make.
- Work, catering and decoration involving open flames or other kinds of heat or spark sources must have a specific fire permit before installation (refer to section 6.5).
- As far as possible, furniture must be of fire-resistant material.
- Storage of hazardous substances must take into account incompatibilities between substances.
- Electrical appliances shall be switched off or disconnected outside the working schedule, or when left unattended.
- Electrical plugs and distributions must not be overloaded.
- Equipment with faulty insulation or cables must be taken out of use.
- In potentially combustible areas, installed electrical systems must be explosion-proof, and only certified equipment and tools may be used (e.g. non-sparking tools).

8.1 Escape routes and exits

In an emergency, everybody must be able to escape quickly, easily and safely. Therefore:

- Escape routes and exits must be indicated by appropriate signs, and must lead as directly as possible to the open air or to a safe area.

- Escape routes must be kept unobstructed, and free from any combustible materials. They must be appropriately illuminated independently of the availability of mains current.
- Hydrants, extinguishers, escape routes, stairs and exits, and the traffic routes and doors giving access to them, must be free from obstruction so that they can be used at any time without hindrance.
- Doors in escape routes must never be locked. They must be easily and immediately opened by any person who may need to use them in an emergency. Final exit doors are to be provided with panic hardware (bars). If for security reasons entrance needs to be restricted, doors shall be under alarm.
- Lifts (elevators) shall not be used in the event of an emergency. Display appropriate signage on each floor.
- In the event of a danger that requires evacuation, everybody must leave their workplace immediately and as calmly and safely as possible, and proceed to the designated safety zone/emergency meeting point.

8.2 Fire detection and fire fighting

Buildings must be equipped with appropriate and sufficient fire-fighting equipment and, as appropriate, with fire detectors (smoke-, flame-, or heat detection) and an alarm system.

Manual fire-fighting equipment, such as hand-held extinguishers and hoses, must be easily accessible and simple to use. They must be indicated by signs, displayed at appropriate points.

Monthly visual inspections must be performed by the facilities department in general office locations and back-of-house, and by laboratory and workshop Supervisors within their attributed areas of responsibility. Maintenance checks must be performed by a qualified person at least every two years.

All E-ELT construction personnel must be trained on building evacuation and on the correct use of fire extinguishers.

Persons with disabilities and Visitors must be given help in an evacuation. E-ELT construction personnel directly responsible for the person with disabilities and Visitors must establish adequate measures to support their evacuation in an emergency (see safety work permits, two-person-rule and lockout/tag-out). The E-ELT SSO must be informed in due time about the presence of persons with disabilities.

8.3 Fire risk assessment and fire safety inspections

All Supervisors are responsible for implementing adequate fire protection measures within their area of responsibility. Therefore, a Fire Risk Assessment must be carried out by the Supervisor in coordination with the E-ELT SSE. Regular updates of the fire risk assessment must be carried out to identify any potential new risks and to provide any necessary corrections. These corrections may imply the update of the fire prevention plans.

The Fire Risk Assessment must consider the potential fire hazards within their area of responsibility (e.g. hazardous substances and preparations, potential explosive atmospheres, combustible materials and ignition sources, unsatisfactory structural features, etc).

Fire safety inspections shall be regularly carried out by the E-ELT SSE in coordination with the Fire Brigade.

8.4 Fire prevention plans

In cases, where the Supervisors Risk Assessment show specific risks of fire in their area of responsibility, they must prepare a written fire prevention plan, for this particular activity.

This Fire Prevention Plan must include, at a minimum:

- a list of the major workplace fire hazards and their proper handling and storage procedures;
- the potential ignition sources (such as hot work and others) and their control procedures;
- the type of fire protection equipment or systems to control the potential ignition source;
- the name(s)/regular job title of personnel responsible for maintenance of equipment and systems installed to prevent or control ignitions or fires;
- the name(s)/regular job title of personnel responsible for control of ignition source hazards;
- the housekeeping procedures, in particular those concerning the control of accumulations of flammable and combustible waste materials and residues, which may contribute to a fast developing fire, rapid spread of smoke or a potential explosion;
- the actions, that must be taken to ensure personnel-safety from fire.

8.5 Emergency action plans

The Fire Prevention Plans may be integrated in a global site specific Emergency Action Plan, under coordination of the E-ELT SSE, and must address emergencies that are reasonably expected in the workplace/ Site.

Examples are:

- Technological risks – fire, chemical releases or spills, radiological release
- Natural risks – earthquake, lightning, floods
- Social risks – arson, vandalism, bomb threat

The global Emergency Action Plan must include, at least:

- the organisational structure for emergencies;
- responsibilities within the context of emergency;
- procedures to be followed by those belonging to the organisational structure for emergencies;
- specific training to be followed;
- alarm systems;
- emergency escape procedures;
- evacuation plans;
- safe areas for evacuation;
- post-emergency procedures.

The objective of an Emergency Action Plan is to minimise potential consequences from an emergency, to assure a rapid and safe evacuation of all occupants and to permit an effective intervention of the Fire Brigade and those with responsibilities in case of emergency.

To verify the effectiveness of the Emergency Action Plan, it must be tested by means of drills as set up by the E-ELT SSE, but at least every two years and in case of major changes at the E-ELT construction site.

Before implementing the Emergency Action Plan, the E-ELT SSE must inform the Members of Personnel of the existing alarm types (if more than one), the necessary emergency action, and what their role is in carrying out the plan.

8.6 Evacuation plans

Evacuation plans support the emergency action plans and clearly show the emergency escape routes, means of escape, and the location of fire alarms, fire extinguishers, hydrants, hose reels, emergency safety signs, and the emergency meeting point.

Each area must display the respective Evacuation Plan. These plans (or maps) must indicate the actual position of the person on the plan when reading it (i.e. "You are here") and a résumé of the relevant safety instructions, e.g. "Behaviour in case of emergency"; and "Reporting a Fire".

8.7 Technical fire safety

To minimise potential consequences of fire, it is important to establish root preventive measures, which mainly fall upon:

- Building features, such as construction products and materials;
- Providing technical means for fire safety (for example: portable and fixed fire extinguishing systems, hydrants and hose reels, fire detection and alarm systems); and
- Observance of fire safety good practices.

8.7.1 Building features

8.7.1.1 Means of escape

Height: Means of escape, such as access ways, exits, entrances and stairways, must be high enough and wide enough to guarantee a safe evacuation of all occupants in case of emergency.

Width: The minimum passage width is 0.90 m (refer to the table below). In exceptional cases, such as connecting paths, a width of 0.60 metres is permitted. An adequate exit route for disabled persons with disabilities must however be ensured, and/or specific "safe areas" provided.

The standard gauge must be as described in Table 1:

<i>Number of people in the work area</i>	<i>Minimum Width [m]</i>
Up to 5	0.9
Up to 20	1.0
Up to 100	1.25
Up to 250	1.75
Up to 400	2.25

Table 1. Width of escape routes

- Paths for control and operation of equipment and experiments may vary with the respective environment. If the standard gauge listed in Table 1 cannot be met (for example, due to technical reasons within a given laboratory) the Supervisor for the area and the E-ELT SSE must perform a risk assessment. The minimum dimensions for access should never fall below 0.50 m width and 1.80 m height, unless jointly authorised by the area Supervisor and the E-ELT SSE. Emergency exit doors must open easily and swing in the direction of evacuation. Preferably, they must be equipped with anti-panic bars.
- Sliding and revolving doors must not be used as primary emergency exit doors.
- All emergency exit doors must have clear emergency exit signs. Where direct sight of an emergency exit is not possible, an illuminated directional sign (or series of signs) must be provided to help people find the emergency exit. Where applicable luminescence signs may also be used.

8.7.1.2 Construction products and materials

Generally, building materials, fittings and linings must have a very low inherent contribution to fire. The higher the local risk of fire, the more stringent the classification for building materials.

The following information is intended to be an example, as real as possible, to E-ELT reality. If required, a Fire Safety Specialist must be consulted for E-ELT implementation purposes.

The required EUROCLASS classification for building features (new constructions or refurbishments) is as follows:

<i>Fire Risk</i>	<i>Building Feature (example)</i>	<i>EUROCLASS (ESO Member States)</i>	<i>Classification acc. to DIN 4102 (ESO Host State: Germany)</i>
Low-Medium Risk (e.g. administrative work areas)	Ceilings	B	B1
	Walls	C	B1
	Floors	Cfl	B1
	Test hangings, cables, furniture	C	B1
High Risk (E.g. Laboratories; Workshops)	Ceilings	A1	A1
	Walls	A2	A2
	Floors	A2fl	A1
	Test hangings, cables, furniture	B	B1

Table 2. Reaction to fire classification

Presentation displays and Posters in corridors must generally meet EUROCLASS C or DIN 4102 B1, unless otherwise stated by the E-ELT SSE.

The use of products containing halogens or sulphur must be avoided to minimise toxic smoke production in case of fire. Where work is carried out within high fire risk areas, or areas where high value electronic components require a high reliability, LSZH cables must be used. If the requirement cannot be met a justification must be prepared by the requestor, which in addition must be approved by the respective Site Manager and E-ELT SSE.

Other types of activities and occupancy imply a different fire risk level and therefore a different classification.

8.7.2 Technical means for fire safety

8.7.2.1 Emergency lighting

By default, all E-ELT construction site facilities shall be equipped with emergency lighting, ensuring sufficient illumination of corridors, meeting spaces and evacuation routes in case of emergency. These devices shall be individually powered by accumulators, or connected to a centralised emergency power generator.

8.7.2.2 Fire detection and alarm systems

By default, all E-ELT construction site facilities shall be equipped with fire (smoke) detection and alarm systems that give evacuation alert to all occupants in case of emergency. This shall be particularly enforced in accommodations and dormitories, and can be waived by the E-ELT SSE in individual offices, sanitary areas and other areas.

The need for further fire detection and alarm systems is determined by the Fire Risk Assessment.

Areas considered as high fire risk must have evacuation sirens automatically triggered by a fire detection system. Example areas:

- Premises containing flammable gases, liquids or hazard materials;
- Service rooms with high combustible contents;
- Stores opening directly towards a stairwell;
- Workshops, laboratories, meeting rooms, premises not continuously occupied and with some combustible items;
- Corridors shared by these premises.

Manual call points (push button controls) must be installed on escape routes and, where possible, close to the exits and close to special fire risk areas (for example flammable materials handling and storage areas). Manual call points must be located around 1.50 m from the floor, and must not be hidden by decorative elements (for example: flower pots, curtains, blinds) or, e.g., by doors when opened.

All alarm devices must be clearly marked.

- The choice of the evacuation sirens must allow for the likely noise level of the environment, especially where hearing protection is being worn. It must be at least 10 dB(A) above background sound level, with a minimum of 65dB(A) intensity. If lower than 15 dB(A) above the ambient noise level, there must be an additional visual signal (e.g. flashing light). In exceptional cases organisational measures may also be used after approval of the E-ELT SSE.
- The siren must be audible by everyone in any place of the building. Where hearing impaired people are expected, the siren must integrate strobe lights (and/or vibration alarms in accommodations and dormitories).

8.7.2.3 Fire extinguishers

The choice of the fire extinguishing system, the fire extinguishing agent and the amount needed must be based on the Fire Risk Assessment, and shall be compatible with host-state requirements.

Fire extinguishers must be positioned at clearly visible, protected places easily accessible in the case of fire. They must be mounted on brackets or in wall cabinets with the carrying handle placed preferable at 1 to 1,20 m above the floor. Fire extinguishers must be conspicuously indicated.

Fire extinguishers must be approved by a recognised testing laboratory and bear a recognised approval mark. They must be kept in good working order, and their maintenance must be kept up to date and according to applicable standards by the responsible facilities management. Maintenance records must be kept for one year after the recorded date or the life of the shell of the extinguisher.

Table 3 shows the Fire Classes and the correspondent fire extinguishing agent(s) that can be used:

Fire Extinguisher Types	Fire Classes and Substances to be Extinguished			
	A	B	C	D
	Solid substances that result in glow heat	Liquid or liquefiable substances	Gaseous substances also under pressure	Combustible metals
Powder extinguisher with ABC powder	✓	✓	✓	✗
Powder extinguisher with BC powder	✗	✓	✓	✗
Powder extinguisher with metal-fire powder	✗	✗	✗	✓
Carbon dioxide extinguisher	✗	✓	✗	✗
Water extinguisher (also with admixture)	✓	✗	✗	✗
Foam extinguisher	✓	✓	✗	✗
Legend: ✓ Suitable ✗ Not suitable				
Please note (US / CL Fire classes): A – solid B – liquid/gas C – electrical D – metal				

Table 3. Classes of fire & extinguisher types

8.7.2.4 Fire blankets

Fire blankets are used to suffocate small fires as well as to wrap round a person that may be burning.

8.7.2.5 Fire hydrants and hose reels

Where required, a pressurised fire hydrant connected to a fire fighting system must be installed. Fire hydrants must be located within 100 m of each entrance to the building and must have road access for the Fire Brigade.

Hose reels in buildings must be distributed in such a way, that all parts of the area to protect are within reach of at least one hose.

8.7.3 Emergency exits

To guarantee that emergency exits allow quick escape in case of fire or other emergencies, observe the following safety measures:

- Always keep escape routes free of combustible materials and obstacles;
- Make sure there are no locks, chains or fastenings to prevent free escape from the inside;
- Emergency exits shall open in the direction of egress, and be provided with panic hardware (bars). Revolving or sliding doors are not considered suitable, unless specifically approved by the E-ELT SSE or providing emergency opening in direction of means of escape in case of evacuation.
- Exit doors and escape routes must not be decorated, hidden or obstructed in any way that would obscure or confuse their purpose.

8.8 First aid equipment/material

First Aid equipment/material (first aid boxes, eye-wash, stretchers etc.) must be provided, allowing for the type of risk and the number of people potentially affected. This equipment/ material must be easily accessible and checked periodically (at least every two years) to make sure that material is adequate for the purpose, sufficient in quantity, and within the validity period(s) stated.

9 Laboratories

For basic provision see also Chapter 6.

9.1 General

All Laboratories have to bear a sign giving the name of the responsible Supervisor(s). They must make sure, that Members of Personnel working in their laboratories has the necessary and appropriate training, competence, equipment and conditions to perform their tasks safely.

Furthermore, all E-ELT construction personnel with supervising functions must make sure that:

- Visitors and external collaborators¹ have an assigned Supervisor for their work;
- Contractors, in particular cleaning staff, have been informed by the laboratory Supervisor about the risks present in their working area; about how to behave during regular work in the laboratory; and in the case of an alarm sounding.

¹ Person(s) from partner organisation(s)

The development of experiments/tests may involve unforeseen risks due to the constant modifications during their lifespan. Hence, the Supervisor in charge of the experiment/test must carry out a risk assessment, and must instruct all participants about related risks found.

The laboratory Supervisor must carry out another risk assessment concerning the interaction between simultaneous activities within the laboratory. The laboratory Supervisor must inform the experiment/test Supervisors about safety, health and environmental issues beyond their own control.

9.2 Risk assessment

A written risk assessment is mandatory and must be carried out during the preparation for an experiment/test. It shall consider the potential risks and/or technologies employed and the necessary means to cover safety related matters (financial, human and material means) for the duration period of the experiment.

The Supervisor in charge of the experiment/test must also carry out regular updates of the risk assessment during the construction, installation, commissioning and operation phases. The assessment must:

- verify the effectiveness of the preventive and control measures;
- identify any potential new risks;
- provide any necessary corrections.

The Supervisor may consult Internal or External Safety Experts for advice.

The Appendix to this Safety manual consists of a safety survey checklist which is a supporting tool for the risk assessment. The Supervisor must at least complete this checklist according to the specific risks in the laboratory or additional hazards generated by the experiment/test. The checklist must be completed before the actual conduct of an experiment/test and if required, must be adopted/extended, depending on the specific safety risk. The result of the risk assessment must be provided to the E-ELT SSE.

Safety Risk Assessment Records:

All risk assessments must be recorded and retained, together with the experiment documentation.

9.3 Safety measures for laboratory areas

The safety measures to be implemented are determined by the result of the risk assessment. However, the following general safety measures are to be considered in all circumstances.

9.3.1 Engineering measures

Laboratory Test and Experiment areas must consider the hazards present in the area, and the specific needs of the fields concerned; for example, electricity, laser, radiation, cryogenics, etc. Intrinsically safe measures for the safety of people, property and the environment must be implemented, including (if applicable):

- *Test benches.* Test benches must be properly powered and grounded, preferably with a separate fuse cabinet and an emergency stop (positioned according to the needs of the experiment/test);
- *Isolation transformers.* If isolation transformers are used to supply power to fixed socket outlets as part of a distribution system for test supplies, the sockets must be of a different type from standard sockets, in order to prevent using the wrong plugs. For example, colour coding could be used – white for standard sockets and another colour for experiments/tests. This must make sure they are only used for the purpose intended.
- *Portable power tools.* All electrical equipment must bear a recognised safety mark and must be double insulated. Electrical circuits feeding portable power tools must be protected by adequate Residual Current Devices or similar devices;
- *Construction measures.* Emergency ventilation of the building; automatic fire fighting equipment; and class 4 laser proof walls where appropriate. Where required provide technical measures to confine leaks, to automatically shut off certain areas, etc. to be able to confine an incident to a specific location.
- *Safety sensors.* Safety sensors must be installed if necessary; e.g. smoke / CO2 / (low) O2 detectors; fire alarms.

9.3.2 Organisational measures

- *Access restriction.* Access to laboratories must be restricted to the responsible personnel, unless otherwise stated in writing by the supervising person of the area. These areas must be clearly identified and display warning signs about the risks that may be present, such as radiation, laser, electricity, unprotected moving parts, etc.
- *Operational procedures.* Site operational procedures must be provided to inform E-ELT construction personnel about specific risks, for example, radiation safety manual; laser safety manual; and specific operational manuals, (e.g. working alone; lock-out / tag-out; etc.). Those must be prepared by the Supervisor in co-ordination with the E-ELT SSE.
- *Testing or electrical work.* Where electrical work or testing is done by a Contractor or non-ESO staff invited to the E-ELT construction site, safe work arrangements must be discussed with the ESO Member of Personnel responsible for the experiment/test, and agreed before the work starts, preferably in writing at the contracting stage.
- *Training.* Regular specific training must be provided, as required.
- *Two-person-rule.* If necessary, implement the two-person-rule.
- *Safety resources.* Sufficient budgetary resources have to be planned for and set aside, so to implement the appropriate safety measures, and to make sure that the experiment is carried out as safely as possible.
- *Safety task competence.* Members of Personnel appointed to work in laboratories or on an experiment/test must have the capability, education, knowledge, skills and competence to perform the task safely.

9.3.3 Protective measures

The Supervisor responsible for the experiment or test must provide:

- Personal protective equipment, according to the risk assessment. Examples are: Laser safety goggles, hearing protection, protective gloves, etc.

- Collective protective equipment, as determined by the project specifications and complemented by the risk assessment. Examples are: manual or automatic fire fighting equipment; emergency spill clean-up kit, etc.

10 Workplaces, ergonomics and manual handling

All Supervisors must periodically assess their Member of Personnel's workplace conditions and implement the necessary actions to eliminate and/or reduce potential risks.

This assessment can be made using the following checklists for guidance:

Checklist Office Workplace:



Microsoft Office Word
Document

Checklist Laboratory Workplace:



Microsoft Office Word
Document

Due to the host state specific environmental constrains (temperature, humidity, and building design) alternative preventive measures might be required at the E-ELT construction site. This might require to define adequate measures on a case-by-case basis.

10.1 Workplace ergonomics

10.1.1 Workplace space

Permanent workplaces should have a gross floor space of at least 8 m² per occupying person. The amount of floor space also needs to be adapted to the amount of additional equipment placed in the room.

Each workroom must have at least a minimum headspace of 12 m³ for seated work, 15 m³ for standing work, and 18 m³ for physically heavy work.

10.1.2 Workplace design

With regard to workplace design, there are dimensional key values, which are intended to help minimise the strains for the employees.

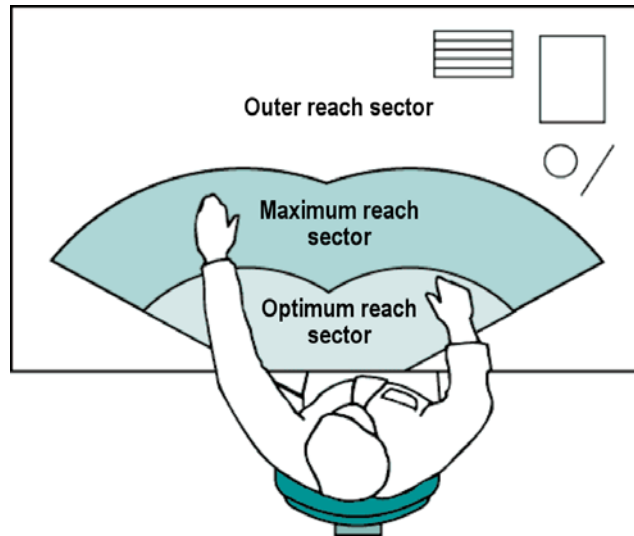


Figure 2. Field of reach on a desk

Ideally, each employee must have at least 1,50 m² free working area at his/her workplace. The movement area must never be less than 1,00 m wide. If the free working area is less than 1,50 m² then the employer must provide a 1,50 m² free working area near to the workplace.

10.1.3 Working environment

The following paragraphs provide conditions and limits for thermal comfort (temperature, humidity, air flow), lighting and noise at the E-ELT construction site.

10.1.3.1 Thermal Comfort

The following values apply to interior conditions intended for everyday use.

General Activity	Temperature (°C)			Air Speed (m/s)
	Min.	Rec.	Max.	Max.
Administrative work	20	22	24	0,1
Light manual work, seated	18	20	24	0,1
Light manual work, standing	17	18	22	0,2

Table 4. Thermal comfort by activity

The relative humidity depends very much on the site climate. Therefore, local national site safety recommendations should be considered at the E-ELT construction site.

The temperature should not exceed 26 °C for a longer period of several days. Should this however happen, Supervisors must take adequate organisational measures to support the employees concerned, e.g. modified work schedule, access to drinking water, alleviated dress-code, etc.

10.1.3.2 Lighting levels

The following values apply to interior lighting intended for everyday use.

<i>General Activity</i>	<i>Typical Locations / Types of Work</i>	<i>Nominal Luminance (lx)</i>
Movement of people	Corridors, Circulation routes	50
Work requiring limited perception of detail	Storage hall, buildings maintenance rooms (for electrical supplies / heating / air conditioning equipment, etc) as well as stairs	100
	Shipment, Cafeteria, Canteen	200
Work requiring perception of detail	Offices, Assembly/ Integration hall	500
Work requiring perception of fine detail	Drawing offices, factories assembling electronic components, electronics lab, mechanical workshop, etc.	750

Table 5. Luminance by activity

Generally, illumination decreases over time due to accumulation of dust and dirt on lamps, and the decline in output of fluorescent lamps etc. In any case, illumination must not fall below 0.6 of the nominal value listed in Table 5.

It is recommended to make full use of natural daylight.

10.1.3.3 Noise levels

The following values in Table 6 refer to the maximum noise levels for different types of work and apply to exposure during 8 working hours per day, 5 days per week.

<i>Types of Work</i>	<i>Maximum Noise Level [dB(A)]</i>
Work essentially requiring mental concentration (e.g. general office work)	<55
Work requiring verbal communication or great accuracy and attention	<65
Work involving noisy equipment	<80

Table 6. Noise levels by activity

Anything causing noise levels above these limits must be removed or controlled. Above 80 dB hearing protectors must be made available, above 85 dB they must be worn.

By way of example, place acoustic hoods over noisy printers and fax machines, or locate them away from the immediate working area. Noise from technical equipment should be as low as possible. If equipment noise increases, contact Maintenance/IT helpdesk immediately.

10.2 Manual handling of materials

Wrong manual handling of loads can cause musculoskeletal disorders (MSDs).

No person working on the E-ELT construction shall be asked or allowed to lift or carry any load whose weight is likely to put at risk his or her health or safety. Where manual handling of loads cannot be avoided, the direct Supervisor must take the appropriate organisational measures (for example, two persons lifting instead of one), use or provide appropriate means in order to reduce the risks involved.

Any person working on the E-ELT construction and assigned to regular manual transport of loads, must receive prior adequate training in working techniques, in order to safeguard health and prevent accidents. Such training must include how to lift, carry, put down, unload and stack different types of loads.

Also, workers must have precise information on the weight of the load and the centre of gravity of the heaviest side when a package is unevenly loaded.

Table 7 shows the weight limits for manual handling. They must be considered individually to avoid harm, particularly to the back.

The maximum load for manual handling shall be estimated before lifting anything.

<i>Manual Handling of Materials</i>	<i>Recommended</i>	
	<i>Occasional</i>	<i>Frequent</i>
Men	30 kg	20 kg
Women	27 kg	15 kg
Pregnant or Nursing	10 kg	

Table 7. Recommended limits for manual handling of loads

When lifting loads, try to use the legs rather than the back. The correct posture is shoulders pushed backwards, the back straight and the knees bent. Hold the load as close as possible to the body.

11 Work equipment and machinery

For basic provision see also Chapter 6

Supervisors must ensure that:

- Work equipment made available to workers is suitable for the work to be carried out, and can be used by workers without risk to health and safety. In selecting the work equipment, the responsible person must consider health and safety in the specific work conditions and the kind of hazards that exist in the workplace.
- Work equipment complies with ESO Regulations.
- Commercial work equipment bears the safety/conformity marking legally required for being marketed in the corresponding ESO host-state. (In Chile, where there is no compulsory marking scheme, preferably procure products with recognised/well reputed voluntary safety marking.)
- Work equipment is kept safe throughout its working life, by means of adequate maintenance and regular inspections.
- Use of work equipment that is likely to involve a specific risk to the health and safety of workers, is restricted to those persons given the task of using it.
- Appropriate information, instruction and training is periodically provided to their Members of Personnel, taking account of the functions and abilities of different categories of workers.

Users must systematically check before its use that the work equipment is:

- Suitable for the intended use.
- Safe for use, maintained in a safe condition and periodically inspected.
- Accompanied by suitable safety measures, e.g. protective devices, markings and warnings as specified in the operating instructions.

11.1 Purchase of new work equipment

When purchasing new commercial work equipment, the requester must specify and control that it shall:

- Bear a safety/conformity marking legally required for being marketed in the corresponding ESO host-state (in Chile, where there is no compulsory marking scheme, preferably procure products with recognised/well reputed voluntary safety marking);
- Be provided with a Declaration of Conformity/ Declaration of Incorporation;
- Be provided with instructions in English and, if required, additionally in the language of the respective ESO host-states;

New work equipment must comply with all specific ESO Regulations in matters of health and safety. It must also comply with the host-state's regulations applicable to the location where it will be put in service.

The E-ELT SSE can provide advice, on request, regarding the purchase of new commercial work equipment, not previously purchased.

11.1.1 Check new work equipment on receipt

The requester must, at least, check the following:

- Existence of a safety conformity label (preferably CE marking or other recognised labels) and the corresponding declaration of conformity / declaration of incorporation.
- Explanation from the internal or external supplier about what the work equipment is designed for, and what it cannot be used for, unless this is commercial work equipment.
- Relevant documentation supplied for operation, including instructions for safe use, assembly, installation, commissioning, safe handling, adjustment, maintenance, decommissioning, etc.
- Provision of an instruction manual. All documents must be written in English, and – if required – in the language of the ESO host-state where it will be used.
- Availability of information regarding any remaining risks from the work equipment, and the precautions the user needs to take to deal with them. These may include electrical, hydraulic, pneumatic, stored energy, thermal, radiation or health hazards.
- Provision of data about noise and vibration levels.
- Easy understanding and visibility of warning signs.
- Required periodical safety inspections.

If the requester considers the work equipment not to be safe, it must not be used. Arrangements must be made to correct the non-conformities.

If required, the requester may ask for the support of the E-ELT SSE or other Safety Experts (for example, a Laser Safety Specialist) in performing a hazard analysis.

11.1.2 Contents of a declaration of conformity/declaration of incorporation

A declaration of conformity must have, at least, the following information:

- The name and address of the manufacturer or other responsible person.
- The make, type and serial number of the work equipment.
- The signature of an authorised person and information on:
 - which standards have been used in the design and manufacture (if any); and

- what Regulation (Directive) the work equipment complies with.

11.1.3 Work equipment incorporated into an assembly

For work equipment that is to be included in an assembly, and which cannot function independently once assembled, the manufacturer must draw up a '*Declaration of Incorporation*'. Such work equipment must meet all relevant safety regulations, as far as possible, and the manufacturer must provide instructions for all safety measures to be followed during assembly. In this case, the work equipment must not have a marking.

When the work equipment is incorporated into another work equipment or assembly, particular attention must be given to any individual hazards, but also to those hazards that may have been caused by the incorporation and the interaction of different sub-systems. The person responsible for the incorporation of work equipment must perform an adequate interface safety check before putting it into service. Additional safety guards or other controls (for example, emergency stop controls) may be required.

Once the work equipment has been fitted, all related safety documentation must be added to the safety documentation of the whole system.

11.2 Work Equipment manufactured or put into service before 1995

All work equipment in use before 1995, must be assessed and retrofitted to current safety standards, without – however – requiring conformity marking.

All work equipment manufactured before 1995, whether bearing a safety label (mark) or not, must be subject to a hazards analysis. Corrective measures, to meet safety requirements, must be implemented accordingly. Hazard analysis and implementation of corrective measures must be documented. In particular the following issues must be checked:

- unprotected moving machine parts
- parts with dangerous surfaces (e.g. sharp edges and corners)
- moving means of transport and operation (e.g. cutting, crushing or pinching injuries, etc.)
- machine parts that move in an uncontrolled manner
- contact with electrical live parts (e.g. electrical injuries – shock, electrocution, burns, etc.)
- contact with hot media (e.g. burns)
- contact with cold media (e.g. frostbite, etc.)
- projection from particles (e.g. eye injuries, etc.)
- fumes (e.g. respiratory injuries, etc.)
- fire

If required, the E-ELT SSE can provide advice, in order to meet the ESO work equipment safety regulations.

11.3 Implementation of safety measures

According to ISO 12100-1, implementing safety measures to improve safety on work equipment must be performed in the following order of priority:

1. Eliminate or reduce risks by design and construction.
2. Move work tasks outside the risk area.
3. Use guards/ safety devices.
4. Develop safe working instructions, information, training, etc.
5. Use warning signs, as pictograms, lights, sounds (alarms), etc.

11.4 Periodic safety inspections of work equipment in use

Periodic inspections, as per ESO inspection rules and as stated in the manufacturer's maintenance manual, must be carried out to make sure the work equipment is safe to operate. Inspection records must be kept in a file.

Any defective work equipment must be made unusable for operation by using a relevant lockout/tagout procedure. If possible, it must be removed and securely locked away. The respective Supervisor must be immediately informed so that appropriate, site-specific measures can be undertaken.

12 Electrical installations

For basic provision see also Chapter 6.

No person is permitted to undertake any work activity where technical knowledge or experience is needed to prevent electrical danger or injury, unless that person has the appropriate technical knowledge or experience, or is under such supervision as is necessary for the work undertaken. Depending on risks involved (e.g. high voltage) the two-person-rule applies.

Any person working on the E-ELT construction and working on electricity, must attend complementary periodic training in safe work practices at least once a year and coordinated by the respective person with supervising functions. The degree of training required must be determined by the complexity of the work and the risk to which the person may be exposed.

12.1 Members of Personnel with specific functions

Supervisors must make sure that every person assigned to work on or with electricity has the necessary and appropriate qualification, training, competence, equipment and conditions to perform their assigned task safely, as defined below.

It must be ensured that ESO Members of Personnel working on electrical equipment have basic, site-specific training before starting work with electricity, and that they participate in regular complementary training.

12.1.1 Ordinary person (degree 0)

An ordinary person is someone who is neither a skilled person nor an instructed person.

He/she may perform tasks that do not require specific electrical skills, such as plug and unplug electrical equipment.

12.1.2 Instructed person (degree 1, e.g. electrician helper)

An instructed person may perform, under the supervision of a skilled person, basic electrical work like modifications and/or new installations of low voltage wiring, such as lighting and power socket circuits.

12.1.3 Skilled person (degree 2, e.g. electrician)

A skilled person is someone with relevant education, knowledge and experience to perform work on electrical installations and carry out testing and commissioning of new and/ or modified electrical installations, based on Inspection and Testing Plans. Examples: switchboards, power cables, motor circuits, lighting, etc.

The skilled person may supervise work carried out by an instructed person and electrical Contractors working on the E-ELT construction.

12.1.4 Electrical expert (degree 3, e.g. electrical engineer)

An Electrical Expert is someone with the proper knowledge, skills, ability, training, education and experience relevant to the type of work to be carried out. He/ she may:

- have an engineering degree and a minimum of three years of experience working on operation / maintenance / construction of electrical installations; or
- have no engineering degree, but several years of experience (ten years or otherwise defined by the respective person with supervising functions) working on operation / maintenance / construction of electrical installations.

An Electrical Expert, depending on education, knowledge and experience, may be appointed to:

- Direct management of the global work activity concerning electrical projects.
- Direct management of an electrical installation.
- Prepare / analyse / approve Operational Procedures and Technical Specifications and Work Instructions for each activity type. These documents must be in accordance with:
 - Regulations established by ESO;
 - Host-state legislation for the E-ELT site;
 - International Standards and EU Directives (e.g. IEC, ISO, CEN, CENELEC);

- Recognised Regulations and Standards of ESO Member States;
- Prepare / analyse / approve electrical drawings for new electrical installations or its modifications.
- Prepare / analyse / approve / implement training plans for Skilled and Instructed Persons.
- Supervise and/ or execute work activities on or near electrical installations (transformers, power cables, switchboards, motor control cabinets, lighting circuits, etc.) involving activities on:
 - operating;
 - construction;
 - measurement and testing;
 - inspection;
 - maintenance.

12.2 Electrical risks

The risks of electricity are directly related to its physical parameters: voltage, current, impedance and frequency.

12.2.1 General safety requirements

A safe working environment is created by controlling contact with electrical voltages and the currents they may cause, either by direct and indirect contact, or due to the proximity of high voltages in the surrounding area. A safe working environment may be attained by implementing engineering, organisational and/or protective measures, as defined below.

Any doubts must be clarified by the respective Supervisor or E-ELT SSE.

12.2.2 Risk assessment

A risk assessment is mandatory for electrical work.

Work must be planned before starting, and must consider both safety and environmental protection. It must include hazards identification, risk analysis and the necessary control measures that must be implemented to ensure a high safety level.

12.2.3 Engineering safety measures

Only approved and undamaged tools, accessories and materials for electrical work (double insulated) may be used when working on or with electricity.

Electrical plugs and receptacles must be suitable for the current and voltage requirements.

If an extension cable is necessary, it must be chosen with sufficient current rating for the load being used, and with adequate characteristics to suit the environment (local conditions) where it will be used.

To reduce the risk of damage to the cables that are often moved or subject to stress, S-type (hard service) insulation cables must be used.

12.2.4 Organisational safety measures

12.2.4.1 Operational work

Clearance space is needed when working around power and lighting circuit breaker panels, motor controllers and other electrical equipment. This clearance space ensures safe access for personnel who inspect, adjust, maintain, or modify energised equipment. If the clearance cannot be provided, the Supervisor of the area concerned must request a risk assessment to be performed by the E-ELT SSE in collaboration with an Electrical Expert. Special protective procedures must be taken into account such as, for example, providing protective isolating barriers on conductive parts.

When working on electrical installations, the workplace must be secure in order that no third person can be harmed.

The lockout/tag-out procedure must be followed.

A Residual Current protective Device (RCD), Ground Fault Circuit Interrupter (GFCI) or Earth leakage circuit breaker (ELCB) must be used when using electrical portable tools and extension cables. For tools, check that the switches work, and inspect the insulating parts for damage, before using them to work on a job. If it is defective, the tool or equipment must be tagged with a "do not use" tag and the Supervisor must be immediately informed to take the appropriate measures.

The manufacturer's instructions for use, cleaning and maintenance must be followed, both for electrical equipment and personal protective equipment.

Wet working conditions must be avoided. If it cannot be avoided, special safety measures are required and must be defined by an Electrical Expert.

12.2.4.2 Work on buildings – electrical installations

The person carrying out major electrical work on building installations, which might have an effect on people working in this area or operation must sign the E-ELT construction site "*Permit for Work on Electrical Installation*" and implement the appropriate lockout/tagout procedure.

The Permit for Work on Electrical Installations must be forwarded to the ESO contact person (in the case of Contractors) or to the respective Supervisor of the person who performs the work, with copy to the E-ELT Site Safety Engineer.

On completion of work, a de-isolation certificate must be issued and signed by both the person who carried out the work and by the person who requested the work. Once the de-isolation is signed off, no further work can be carried out on that particular installation.

12.2.5 Personal protective equipment

Personal protective equipment must be worn in accordance with the risk assessment. The appropriate personal protective equipment must be approved for work on or with electricity.

13 Inspections

Performing regular maintenance and inspections helps to keep facilities and equipment in compliance with health, safety and environmental requirements. It helps to extend their useful life by identifying problems before they become critical, and also to prevent injuries and illnesses to workers in those facilities.

Supervisors are responsible for the continued safe functioning of facilities and work equipment, and for the safety of personnel involved in or near inspection and/ or maintenance activities, within their sphere of responsibility. They are responsible for contracting suitable and qualified inspection and/or maintenance Contractors, and must make sure that the persons that will undertake the work are qualified in the field concerned.

It must thereby be ensured that maintenance personnel have adequate professional qualification and ability for the purpose, and receive regular training as necessary.

13.1 Inspection coordination

For the E-ELT there are at least three types of inspections:

1. Acceptance inspections.
2. Regular preventive inspections.
3. Performance checks before use (user inspections).

13.1.1 Acceptance inspections

An Acceptance Inspection is a final stage that verifies the conformity of a facility or work equipment with the respective project specifications, and is mandatory for the following situations:

- New facilities.
- New work or scientific equipment.
- Installation of new work equipment.
- Significant modifications or maintenance measures.

An Acceptance Inspection must be carried out in co-ordination with the E-ELT SSE at the site, while or before the facility or equipment/ instrument is commissioned or the installation is taken in use, unless otherwise stated in the E-ELT Commissioning Plan.

If the commissioning plan does not require the involvement of the E-ELT SSE, then a copy of the Commissioning Plan must always be sent in due time to the E-ELT SSE before commissioning starts.

The person responsible must inform the E-ELT SSE in due time, and provide the E-ELT SSE with all relevant documents concerning the item to be inspected for acceptance. The E-ELT SSE may request support from internal and/or external Safety Experts, as required.

13.1.2 Regular preventive inspections

Regular preventive inspection of installations and work equipment must be performed according to the Manufacturer's Operation Manual unless otherwise stated in writing.

These inspections must verify (as applicable):

- Conformity of the facility in health, safety and environmental matters;
- Correct performance with relevant regulations and working instructions.

Inspections are scheduled and organised by the person with supervising functions, having ultimate responsibility for the work activity.

13.1.3 Performance checks before use (user inspections)

The person assigned to operate the work equipment or system is responsible for doing performance checks / user inspections before using the equipment. These inspections must include at least visual inspections, functional checks before use and, for example, simple lubrication, minor adjustments of the equipment or system etc., as recommended by the manufacturer.

The user must follow the manufacturer's operation instructions and must report breakdowns and deficiencies beyond his/her capacity or authority immediately to the respective person with supervising functions, or to the E-ELT SSE.

13.2 Frequency of inspections

The frequency of regular inspections depends on

- the facility concerned;
- the conditions of use;
- the relevant host-state regulations, and
- the manufacturer's recommendations.

The most stringent constraints must apply.

If any facility has had major modifications, or has not been serviced for a long time, or if there has been any other event that may compromise its suitability and safety, then it must be given an extraordinary inspection by either a Specialist or an Expert as defined by the E-ELT SSE, to ensure its adequacy for use.

13.3 Inspections documentation

For efficient planning of inspections, a "*Facilities Inspection Table*" should be developed for each Division/Department. For coordination reasons, the persons having the ultimate responsibility for the work activity shall provide the Table to the E-ELT SSE. Strong cooperation between all parties is essential to establish an efficient, homogenised and economic inspection plan for the E-ELT construction site.

The table should include, at least:

- the type of facility to be inspected (installations or work equipment);
- the inspection interval;
- the inspector (technical expert, skilled electrician, external company, etc.) and
- the inspection evidence required (Inspection Report, Inspection Certificate, Test Book, etc).

Inspection results must be documented in writing, as an inspection report, checklist or other document as appropriate. They must be stored for at least five years. A copy of each inspection report must be provided to the E-ELT SSE.

If any corrective actions are found necessary during an inspection, these must be undertaken at the earliest possible opportunity and new inspection evidence issued.

13.4 Safety measures required before inspection activities

If more than one person is required to carry out inspection activities, one of them must be designated as coordinator and will be responsible for:

1. Setting up a team, which must comprise:
 - Team coordinator;
 - a safety expert (e.g. Divisional Safety Officer / Site Safety Officer / Laser Safety Specialist or other);
 - a technical expert (competent person), as required;
 - other personnel, if required.
2. Establishing a programme, which must consider:
 - The type of activity to carry out (commissioning, regular inspection, modifications, etc.);
 - The items to be inspected (i.e., installation or work equipment);
 - The location/site/division;
 - The entity responsible for performing the inspection activity (e.g., internal personnel/ external company);
 - The scheduled date for the activity and subsequent intervals;
 - The required evidence (test report, certificate, etc.).
3. Taking appropriate safety measures in accordance to the work activity to be carried out, i.e.:
 - Identification of the potential work related hazards and the respective safety measures (e.g. isolation of the working area, work permits, etc);
 - Following the manufacturer's manual, when appropriate.

All relevant safety measures must be followed during inspection activities. In particular cases, where safety measures may need to be overridden, the E-ELT SSE must be involved and approve such activities.

After the inspection activities are complete and the facility is ready for normal operation, the inspector must check the area around to make sure that no one is exposed to any residual hazard, that no property damage may occur, and that safe conditions are restored.

13.5 List of facilities that need regular inspection

An example list of facilities for which inspections are compulsory can be found in the following document (*Facilities Inspection List*):



Microsoft Office Word
Document

This example shows a typical Facilities Inspections Table with the most common ESO facilities subjected to inspection. Such an inventory has to be drawn up and maintained on every site.

14 Hazardous substances

For basic provision see also Chapter 6

Purchases of Hazardous Substances never used before at ESO must have the prior approval of the E-ELT Site Safety Engineer (SSE) on the basis of the related materials safety data sheet.

In the case of new substances, the requestor must inform the E-ELT SSE, in order to analyse its characteristics and approve its use, to evaluate health and safety requirements before purchase and adoption in E-ELT operations. The requester must always check if there is a substitute product available.

Non-ESO personnel bringing Hazardous Substances into the E-ELT sites must on beforehand declare and document, via the ESO contact person, the type (identification) and quantity of the products.

14.1 Labelling and marking

All Hazardous Substances must be clearly labelled and marked with their identification.

The purpose of the label is to give essential information on:

- the classification of the chemical;
- its hazards;
- the precautions to be observed.

The information must refer to both acute and chronic exposure hazards.

Labelling of hazardous substances may be impracticable because of the size of the container or nature of the package. It must, however, include the information required for labelling, by such means as tagging or accompanying documents. In these circumstances, all containers of Hazardous Material must at least indicate the hazards of the contents by appropriate wording (English and/or Host-State language) or symbols.

The mark chosen must enable users to distinguish between chemicals during receipt, handling and use.

14.2 Safety data sheets (SDS)

The supplier of hazardous material must provide the essential information about Hazardous Material in the form of a safety data sheet. The information must be given in English, but may additionally be provided in the official language of the host-state.

SDS must include the following information:

- Chemical product and Company identification.
- Composition/information on ingredients.
- Hazard identification.
- First-aid measures.
- Fire-fighting measures.
- Accidental release measures.
- Handling and storage.
- Exposure controls and personal protection.
- Physical and chemical properties.
- Stability and reactivity.
- Toxicological information.
- Ecological information.
- Disposal considerations.
- Transport information.
- Regulatory information.
- Other information.

The safety data sheets must be available at the workplaces and on the ESO Intranet so that employees can consult them at all times.

14.3 Preventive and control measures

14.3.1 General principles

Supervisors, in collaboration with the E-ELT SSE and other safety experts (e.g. Divisional Safety Officer or Safety Specialist) if required, must

- Check hazardous materials being used at work for their possible substitution with non- or less hazardous products or processes.
- Maintain an accurate inventory of chemicals/materials used, together with their safety data sheets on site and on the ESO Intranet, and review this at least on a yearly basis.
- Obtain information about their hazards.
- Make an assessment of the potential risks involved.

- Take steps to limit exposure of workers to hazardous material in order to protect workers against hazards from the use of chemicals at work.

The measures taken must eliminate or minimise the risks, preferably by substitution using non-hazardous or less hazardous chemicals, or by the choice of technology; but where this cannot be achieved, the risks must be eliminated or minimised using engineering controls (e.g. exhaust ventilation systems).

Other measures such as safe work practices, personal protective equipment and the provision of information and training will further minimise risks and may have to be relied upon for some activities entailing the use of chemicals. Depending on the risks involved the two-person-rule may apply.

For new work activities involving the use of chemicals, the hazards must be identified and the risks assessed at an early stage when the new work activity is being considered. The hazards and risks must be reviewed at each subsequent stage in the development of a new process.

14.3.2 Assessment of risks related to the use of chemicals

The assessment of risks must consider the chemicals used, and the nature of their hazards; i.e., whether they present a risk of one or more of the following:

- Acute or chronic ill health by entry into the body through inhalation, skin absorption or ingestion;
- Injury or ill health from skin or eye contact;
- Injury from fire, explosion or other events resulting from physical properties or chemical reactivity.

The host-state classification system, in particular the REACH (Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals) and CLP (Classification, Labelling, Packaging, based on UN GHS) legislation forms the basis of this assessment (see <http://www.echa.europa.eu>)

The assessment of risks must take into account:

- The quantity of the chemical present at the workplace, and the amount used in the work process;
- The operating conditions and processes applied at the workplace;
- The qualification of users of chemicals for which the Supervisor functions is responsible. This might include handling, storage, transport and disposal;
- The variety of tasks that contribute to a work activity, particularly those where the engineering controls provided are not available, e.g. during certain maintenance, breakdown or cleaning tasks;
- The nature of the chemical and whether the hazards and associated risks are increased by the way it is used, e.g. low temperatures and pressures;
- The consequences and likelihood of a possible failure or sequence of failures of the control measures provided.

Atmospheric sampling should be used where appropriate. It might be used as a control parameter for the effectiveness of measures provided and, in particular, for assessing exposure where operations or tasks are complex and the chemicals involved have established exposure limits.

14.3.3 Ventilation

The ventilation system must be designed and installed to contain or minimise the risks from chemicals used at work, e.g.:

- By reducing the release of harmful or flammable chemicals including the vapour and dust from such chemicals;
- By preventing the spread of fire and explosion in the workplace.

14.3.3.1 General ventilation

Work areas must be supplied with clean air to balance the volume of extracted air that is exhausted through the various extraction systems. This ensures efficient extraction and helps to reduce concentrations of chemicals.

The flow rates of general ventilation must be sufficient to change the air of the work area according to health and safety requirements, taking into account its size, the working conditions and numbers of workers.

Recirculation of extracted air into workrooms must be avoided. Where recirculation is allowed:

- Effective methods must be used to decontaminate the air (the method must be regularly checked and maintained);
- Some air must be vented during recirculation and replaced by fresh air, to avoid accumulation of possible contaminants;
- The design must prevent any inadvertent release of hazardous chemicals from causing a hazard and spreading it to other working areas.

14.3.3.2 Local exhaust ventilation

Where total enclosure of a process involving hazardous chemicals is not reasonably practicable, local exhaust ventilation equipment must be provided and maintained, to ensure that exposure limits are not exceeded and that hazards such as flammable concentrations are eliminated or kept to a minimum.

For efficient prevention of exposure to the worker, the exhaust ventilation must be located as close as possible to points of emission of hazardous chemicals. The length of ducting and the number of bends must be kept to a minimum to enable efficient operation.

14.3.4 Monitoring in the workplace

Supervisors must monitor (or must require monitoring by a recognised specialised company) and record the exposure of workers to hazardous chemicals, to ensure their health and safety. They must make sure that workers are not exposed to chemicals to an extent that exceeds exposure limits, or other exposure criteria for the evaluation and control of the working environment. Based on the monitoring data, Supervisors functions must assess the exposure of workers to hazardous chemicals.

Airborne concentrations of hazardous chemicals must be measured in all places of work where necessary to ensure the health and safety of workers against inhalation risks.

Measurements of airborne contaminants are necessary if other techniques do not suffice to provide a valid estimate of the risk of exposure and to assess the existing control measures.

Techniques for this risk assessment may include the following:

- Information on the intrinsic health and physical hazards, obtained from the chemical safety data sheets;
- Estimation of exposure based on the method of work and work pattern;
- Advice from the supplier;

- Experience of exposure in the workplace or of other users; and
- Simple qualitative tests.

14.3.5 Medical and health surveillance

In the case of exposure of workers to specific hazards, medical and health surveillance must include, where appropriate, any examination and investigations necessary to detect exposure levels and early biological effects and responses.

Medical surveillance is to be organised by the Supervisor where:

- It is required by national law of the E-ELT construction host state whenever workers are liable to be exposed to chemicals hazardous to health; or
- ESO is advised by an occupational health service that it is necessary as part of the protection of workers exposed to chemicals hazardous to health, given special attention to pregnant and breastfeeding women and other susceptible workers.

Exposure to the following types of chemicals may require medical surveillance:

- Chemicals that have a recognised systemic toxicity, i.e. an insidious poisonous effect;
- Chemicals known to cause chronic effects, e.g. occupational asthma;
- Chemicals known to cause severe dermatitis;
- Chemicals that are known or suspected carcinogens;
- Chemicals that are known or suspected teratogens or mutagens, as science develops;
- Other chemicals where there is a likelihood that the disease or effect may occur under particular conditions of the work activity.

14.3.6 Use of hazardous material

Hazardous substances must be handled, kept and stored in such a way that people's health and the environment are not endangered:

- Always follow the instructions in the safety data sheets. Misuse and incorrect use must be prevented.
- Rooms in which hazardous substances are stored must only be accessible to trained personnel who work there.
- Containers whose shape or labels might be confused with food containers must not be used for hazardous substances.
- Private or rental cars must never be used for transportation of hazardous materials. In exceptional cases, rental cars may be used in line with national legislation, and after written approval of the Supervisor in coordination with the E-ELT SSE, under the consideration that adequate insurance is in place for this purpose.

14.4 Control measures for the disposal and treatment of hazardous material

Risk assessment must consider both the disposal of hazardous material, that is no longer required, and also the risks to workers. Chemicals must be handled, treated or disposed of in a manner that eliminates or minimises the risk to health and safety, and to the environment.

Containers that have been emptied, but which may contain residues of hazardous material, must be treated as hazardous.

Hazardous material deemed to be waste must be disposed of according to procedures compatible with then criteria established by the competent host-state authority or laid down in specific legislation, and must cover, where applicable:

- *Identifying waste products:*
Waste products must be identified as waste by their origins and also by their main components, where known (refer to the European Waste Catalogue). The main components are determined from the history of the products. In cases of doubt about the degree of hazard, the waste must be classified as the highest hazard;
- *Handling contaminated containers:*
Empty containers that have not been cleansed of hazardous chemicals must be closed and stored to await disposal or reuse, and treated as if they contained those hazardous chemicals. Empty containers must retain the identification, marking and labelling of their previous contents;
- *The identification, construction, nature, integrity and protection of waste containers:*
The waste containers must be designed or chosen to provide protection to workers against the hazards identified above, taking into account the methods of work and disposal to be followed;
- *Demarcation of disposal areas:*
Disposal and storage areas for waste products must be set aside. Sufficient disposal space must be provided on site to prevent keeping waste containers in the normal process and storage areas;
- *Provision, maintenance and use of personal protective equipment and clothing:*
Personal protection must be provided against the hazards identified and in accordance with the method of work to be followed;
- *Method of disposal or treatment:*
All waste disposal services at ESO sites are centrally organised. If a hazardous waste container for disposal is full, almost full or in bad condition, the responsible person at the site needs being contacted.

Each Site must fill in the Waste Disposal Table for all waste produced at the respective Site. A copy of this table must be provided to the respective E-ELT SSE.

The values recorded will allow an overview of all hazardous waste produced on ESO premises. Also, it must be possible to trace which company has been responsible for removing the hazardous waste.

If you are not sure whether a specific material for disposal is hazardous waste or not, look, for example, in the European Waste Catalogue, or ask your superior or the designated person at the Site.

15 Cryogenics

The cryogen fluids most commonly used at ESO are Liquid Nitrogen (LN₂) and less commonly use Liquid Helium (LHe).

ESO uses LN₂ by preference. If other substances than LN₂ or LHe are to be used, the E-ELT SSE must be informed before purchase.

A Cryogenics Safety Specialist shall be appointed to oversee the operation of cryogenics, and to ensure adequate security to prevent unauthorised access.

Small containers (usually Dewars of 120/ 50 litres) are used to bring LN₂ to the experiments and instrument test benches. They may be used in four different ways:

- A Dewar supplies LN₂ directly via a vacuum-insulated pipe to the instrument. These are called continuous flow cryostats.
- Another type of instrument, that uses a bath cryostat, is normally refilled with LN₂ from a storage tank once or twice a day using removable hoses.
- Instruments that are permanently connected to a storage tank that is exchanged every few days. Refilling takes place automatically, once or twice a day.
- Instruments that are only pre-cooled with LN₂ from a pressurised storage tank for approximately 24 to 36 hours, and then use a closed-cycle cooler to keep it cold, while the LN₂ line is disconnected, emptied and sealed to prevent cryo-pumping inside the pre-cooling lines inside the vessel.

15.1 Hazards associated with cryogenics

The hazards arising from the use of cryogenic liquids are:

- Asphyxiation in oxygen-deficient atmospheres. If vented into a closed space, a cryogenic liquid will vaporise, displacing oxygen and possibly causing asphyxia. In sudden and acute asphyxiation, such as that from inhalation of pure nitrogen or helium gas, unconsciousness is immediate. The person falls as if struck down and may die within minutes.
- Cold burns, frostbite and hypothermia. The extremely low temperatures of cryogenic liquids mean that liquid, cold vapour or gas can produce serious skin burns. Objects and non-insulated items of equipment can stick to skin and flesh may be torn on removal. Cold vapours or gases can cause frostbite after prolonged or severe exposure of unprotected body parts. Transient exposure to very cold gas produces discomfort in breathing and can provoke an attack of asthma in susceptible individuals.
- Over pressurisation from the large volume expansion of the liquid. Boiling of liquefied gases within a closed system increases the pressure. For example, if liquid nitrogen enters sample vials during storage, the vials, when removed from the liquid nitrogen can become rapidly over pressurised with the risk of explosion of the vial (the expansion ratio is 710).
- Embrittlement – cryogenic liquids can cause many common materials such as carbon steel, plastics and rubber to become brittle, or even fracture under stress. Cryogenic liquids must not be disposed of down a drain, as piping in laboratory sinks may not be able to withstand the low temperature.
- Flammability hazards associated with Liquid Nitrogen. Nitrogen is an inert gas and will not support combustion; however, there are some subtle means by which flammable or explosive hazards may develop. Cold traps or open-mouth Dewars containing liquid nitrogen can condense air and cause – due to its natural composition – oxygen enrichment into the liquid nitrogen at about 77 K (-196 °C). As the liquid nitrogen evaporates, the liquid oxygen content steadily increases so that the last portion of liquid to evaporate may be significantly oxygen-enriched. The nitrogen container must then be handled as if it contained liquid oxygen. The oxygen-rich air condensate can saturate clothing, wood, asphalt, pavement, etc and can cause

the same problem as those associated with the handling of spillage of liquid oxygen. Again, good housekeeping is essential.

15.2 Preventive measures for the operation of cryogenics

15.2.1 General requirements

It is required that only personnel with adequate training may operate cryogenics and closed-cycled cooling systems.

Manufacturer's instructions on operation, inspection and maintenance must be followed.

All materials used with cryogenics, closed-cycled coolers or vacuum vessels must comply with the respective applicable standards.

The respective Supervisor must perform an initial risk assessment, together with the Cryogenics Safety Specialist, and consider the nature and hazards of the cryogenics used.

Here are the physical properties of the most common cryogenics used at ESO:

Cryogenic Substance	Boiling Point at 1 atm. (°K)		Liquid-to-gas Expansion Ratio	Critical Temperature		Critical Pressure		Explosion/ Fire Danger
	(°C)	(°K)		(°C)	(°K)	(MPa)	(bar)	
LHe	-269	4.2	780	-268	5	0.23	2.3	No
LN ₂	-196	77	710	-147	126	3.39	33.9	No

Table 8. Physical properties of the most common cryogenics used at ESO

The risk assessment must consider:

- the quantity of the cryogenics present at the workplace;
- the operating conditions and processes applied at the workplace;
- the range of uses, which might include handling, storage and transport;
- the variety of tasks that contribute to a work activity, particularly those where the engineering controls provided are not available; e.g. during certain maintenance, breakdown or cleaning tasks;
- the consequences and likelihood of a possible failure or sequence of failures of the control measures provided.

15.2.2 Preventing oxygen deficiency

A small liquid spill produces a large volume of gas and displaces the air in a confined space, thus creating a potentially serious oxygen deficiency that can suffocate occupants of the area.

The requirements of the ESO Work Permits Safety Rule must be followed before entering a cryogenic fluid vessel (cryostat, cold box) or premises where there could have been a cryogenic leak, where mist clouds are present, or pockets of cryogenic vapour may have accumulated due to poor ventilation.

15.2.3 Preventing oxygen enrichment

The surface temperatures of containers of helium and nitrogen may be at a sufficiently low temperature to condense air, which can become oxygen rich. Dripping air must be collected in a properly designed vessel of non-combustible material, and any combustible material kept away from that point.

15.2.4 Preventing overfilling

Overfilling can cause condensation of humidity from the atmosphere and ice formation at undesired locations, and this may block vital relief valves. To prevent overfilling, the pressure must be continuously monitored.

The pressure gauge must be checked at regular intervals according to the basic safety requirements for facilities inspections.

If required, a level switch or other elements, such as liquid level, flow or temperature sensors, may be installed, to activate an alarm or shut down the cryogenic facility in case of a fault.

15.3 Design of cryogenics and closed-cycle cooler systems

15.3.1 Vent lines

Vent lines are the classical solution for controlled release of large quantities of cryogenic fluids from buildings. A vent line avoids any gas release to the atmosphere at undesired places. Vent lines can be applied only if the Dewar or plant discharges at predetermined places (valves, safety relief devices).

In general, all discharge elements for controlled release of gases must connect to a vent line, conveying the gas to the atmosphere outside the building, or into a specific storage device.

Make sure there is no back-flow of air from the discharge opening to the line, normally by installing a flap valve at the discharge aperture of the line. The line must be tested for leak-tightness.

Make sure the flap valves work correctly in adverse conditions (rain, snow, ice formation; or birds entering or nesting). Test all flap valves at regular intervals not exceeding one year.

15.3.2 Pressure relief devices

Pressure relief devices (only in case of closed-cycled cooler systems) must be sized for the maximum possible back pressure under all operating conditions. They must be inspected at regular intervals for leakage, frosting, dirt accumulation, and as required by the manufacturer.

15.3.3 Seals and O-rings

Only use material approved by an ESO Cryogenics Safety Specialist.

Materials used in cryogenic service must be of proven compatibility and ductility at design temperature to preclude brittle failure.

To prevent leakage, seals and O-rings must be constructed from a Viton material with sufficient elasticity at low temperature, and UV-resistant. Other materials need prior approval by the Cryogenics Safety Specialist.

15.4 Ventilation in cryogenics facilities

Proper ventilation must be provided for all portable Dewar filling stations.

In case of potential leaks too large for adequate handling by natural ventilation, forced ventilation is necessary (minimum of six air changes per hour) and low-oxygen alarms must be installed.

The forced ventilation system must closely match the individual features of the installation. Simple reliance upon existing building ventilation is insufficient and may be unsafe.

Cryogenics facilities and storages should furthermore be fitted with pressure relief devices, that deliver excessive pressure from accidental discharge (vessel-burst) to the outside of the building.

15.5 Marking and labelling of cryogenic vessels (containers)

Cryogenic vessels bigger than 120 litres must bear the following markings in clearly legible and durable characters:

- name and address, or other means of identification of the manufacturer of the cryogenic vessel;
- serial number of the cryogenic vessel;
- maximum allowable working pressure (PS in bar);
- test pressure (PT in bar);
- volume of the inner vessel (in litres);
- year of manufacture;
- danger label(s) associated with the fluid;
- name of the fluid supplier.

Marks must be permanently affixed, e.g. stamped, either on a reinforced part of the cryogenic vessel, or on a data plate. The material used must be UV-resistant.

Other markings are permitted, provided that they do not obscure, or create confusion.

The cryogenics supplier must provide the respective Safety Data Sheet with information given in English. Another copy may be provided in the official language of the respective host-state.

15.6 Warning signs and access restriction

The warning sign for cryogenic fluids hazards (shown below) must be clearly visible at the Dewar and premises that house cryogenic facilities; e.g. in rooms, entrance or working areas. Posters with first-aid instructions must be clearly displayed.

Access to these areas is restricted to the appropriate personnel.



Figure 3. Warning from low temperatures

An operation procedure must be displayed on a Dewar bigger than 120 litres. Operation procedures for a Dewar smaller than 120 litres must be made easily accessible.

15.7 Personal protective equipment (PPE)

The use of PPE must not be regarded as an alternative to engineering or other suitable control measures, but must be provided and maintained where such control measures cannot ensure adequate protection.

PPE must be used if the probability of spillage of cryogenics is high. Following are recommendations on the appropriate PPE to be used.

15.7.1 Skin protection

Cryogenic liquids flow very freely and can penetrate woven or other porous clothing much faster than water. Therefore:

- Wear non-porous clothes, without pockets or cuffs that could catch the liquid. If using larger quantities of cryogenic liquids, wear an apron of a non-woven material such as leather.
- Wear boots with tops high enough to be covered by trousers (pants) without turn-ups (cuffs).
- Wear loose-fitting, insulated gloves when handling anything that may have been in contact with a cryogenic liquid. The gloves must be loose so that they can be thrown off quickly if liquid spills into them. Insulated welding gloves are one type of glove that has been found useful.

15.7.2 Eyes and face protection

Always wear safety glasses whenever you are refilling cryogenic liquids. Protect the eyes with a full-face shield if a cryogenic liquid is poured, or if an open container of the cryogenic may bubble.

15.7.3 Breathing protection

If ventilation is not adequate, a respirator must be worn. Check the respective Safety Data Sheet for general guidance, and note that air-purifying respirators do not protect against oxygen-deficient environments. In situations where low oxygen levels occur, use supplied air or self-contained breathing apparatus.

For other than rescue missions, work in potentially dangerous atmospheres (O₂ depleted, toxic, explosive) and/or with breathing apparatus is prohibited for E-ELT construction personnel; Exceptions to be decided by the respective head of department and the E-ELT SSE.

15.8 Transport of cryogenics movable containers

15.8.1 Transport within the laboratory/building

Implement the following in order to minimise exposure:

- PPE must be worn if necessary.
- The container of cryogenic liquids must be transported with the loose safety cap on, or sealed within the transfer system.
- Plan the transport route in advance.
- Lift-travel (elevator) together with cold (not completely emptied) Dewars is prohibited.

15.8.2 Transport by vehicle

Cryogenic fluids may only be transported in a car or a van where the driver's compartment is entirely separate and sealed from the load, and where the load compartment is ventilated (e.g. Pick-Up).

The following must be addressed before transporting cryogenics:

- Do a risk assessment.
- Make sure the labelling on the cryogenic container identifies the contents, and displays the correct hazard warning sign.
- The driver(s) must be made fully aware of the nature of the load, the associated hazards and emergency procedures.
- Provide the appropriate PPE to the driver.
- An information sheet (with the contents, the quantity and emergency and first aid procedures) must be carried within the vehicle to inform emergency services in the event of a crash.
- The vehicle must bear the appropriate ADR signs, even on ESO premises.

Private cars must never be used for transportation of cryogenics.

16 Laser

16.1 Laser Safety Specialist

A Laser Safety Specialist (LSS) is to be appointed in writing, to oversee safety for all operational, maintenance and servicing of lasers of Class 3R emitting energy outside of the 400 nm to 700 nm wavelength range or Class 3B or Class 4.

16.1.1 Specific duties of the Laser Safety Specialist

The Laser Safety Specialist (LSS) has the authority and responsibility to monitor and enforce the control of laser hazards.

He/she is responsible for

- evaluation of laser hazards;
- establishment of appropriate control measures, such as establishment of hazard zones;
- approval of:
 - site Operational Safety Procedures/Instructions,
 - maintenance/service procedures,
 - equipment and installations,
 - safety training for laser personnel,
 - and recommendation of personal protective equipment and other administrative responsibilities.

He/she shall also:

- Make sure that an effective safety programme is developed and implemented whenever there is a special hazard due to Class 3B and Class 4 laser radiation;
- Know the exposure levels in the vicinity of the equipment under normal conditions of use;
- Investigate and report laser exposures that may be higher than recommended limits;
- Instruct Members of Personnel;
- Establish emergency procedures for medical examination and treatment of over-exposed workers in the case of accidental exposure.

16.1.2 Specific duties of workers

Laser users in charge of the day-to-day operation and maintenance of laser-radiation-emitting devices, are required to:

- Be aware of the hazards associated with operating the specific laser devices assigned to you. In particular, note the importance of any interlock systems and dangers associated with defeating such systems, and adherence to all occupational restrictions.
- Be able to recognise malfunctions of the specific devices assigned to them that might result in high laser exposures.
- Be aware of and trained in normal safe operating practices and the procedures to be followed in the event of malfunction of the devices, or in an emergency situation arising from excessive laser radiation emissions.

- Use protective equipment provided, as necessary.
- Be willing to undergo reasonable prescribed medical surveillance.

16.2 Laser Classification

Lasers are Classified into one of several Classes in order to provide a basis for laser safety requirements. Associated hazards are further described in the following document:

Laser classification:



Microsoft Office Word
Document

The Classification scheme relates specifically to the accessible emission from the laser system and the potential hazard based on its physical characteristics. The Classification considered here is congruent with IEC 60825 (definitions simplified).

Classes of Laser are:

<i>Class of Laser</i>	<i>Wavelengths defined for this Class</i>	<i>Level of Safety</i>	<i>Comments</i>
1	400 – 700 nm < 25 µW	Safe	Previously: Class 1.
1M	302,5 – 4000 nm < 25 µW	Safe provided optical instruments are not used.	Previously: non-visible part of Class 3R and devices which have been part of Class 3B due to maximal capacity (five times of Class 2).
2	400 – 700 nm ≤ 1 mW	Visible lasers. Safe for accidental exposure (< 0.25 s).	Previously: Class 2.
2M	400 – 700 nm ≤ 1 mW	Visible lasers. Safe for accidental exposure (< 0.25 s) providing optical instruments are not used.	Previously: visible part of Class 3R and devices which have been part of Class 3B due to maximal capacity (5 mW)
3R (previously called 3A)	302,5– 106 nm 1-5 mW	Not safe. Low risk.	Previously: Class 3B, extended in the visible range in the wavelengths 302,5 nm – 106 nm.
3B	302,5– 106 nm 5-500 mW	Hazardous. Viewing of diffuse reflection is safe.	Previously: Class 3B without 3R.
4	302,5– 106 nm > 500 mW	Hazardous. Viewing of diffuse reflection is also hazardous. Fire risk.	Previously: Class 4.

Table 9. Laser Classes according to IEC 60825-1

16.2.1 Class 1/1M lasers

A Class 1 laser is considered safe based upon current medical knowledge. This Class includes all lasers or laser systems which cannot emit levels of optical radiation above the exposure limits for the eye under any exposure conditions inherent in the design of the laser product.

Class 1 lasers are safe under every conceivable condition of use, including the use of optical instruments for intrabeam viewing. Therefore, Class 1 lasers are generally exempt from most control measures or other forms of surveillance.

Class 1M lasers are safe for the unaided eye with no added optical elements, but may be hazardous if the user employs optics within the beam.

Some special-purpose lasers may receive a Class 1 rating because their intended use limits exposure to a non-hazardous level. Lasers that are not used for their intended purpose may require reclassification.

16.2.1.1 Engineering controls for Class 1 lasers

Class 1 lasers must be placed in protective housings whenever practical.

16.2.1.2 Administrative controls for Class 1 lasers

The following administrative controls apply to all Class 1 lasers:

- Signs or labels are not required for Class 1 lasers.
- Beam controls are not required.
- A Class 1 laser beam may be viewed directly if the Laser Safety Specialist determines that:
 - The laser's output still complies with the Classification given on the laser hazard label or in the manufacturer's operating manual, and
 - The laser is being used as the manufacturer intended.

16.2.2 Class 2/2M lasers

A Class 2 laser emits visible but low-power radiation in either continuous-wave laser or pulsed visible wavelengths of 400 to 700 nm. Continuous wave Class 2 lasers are limited to powers of less than or equal to 1 milliwatt.

Because of its brightness, Class 2 laser light will be too dazzling to stare into for extended periods. Momentary viewing is not considered hazardous since the upper radiant power limit on this type of device is less than the Maximum Permissible Exposure (MPE) for momentary exposure of 0.25 second or less. Intentional extended viewing, however, is considered hazardous (if a person stares directly into a laser beam on purpose, the eye's blink reflex will not work! Permanent eye damage can result, even from Class 2 lasers).

Training to operate the above devices consists of following the Manufacturer's Instruction Manual.

16.2.2.1 Engineering controls for Class 2 lasers

The following engineering controls apply to all Class 2 lasers:

- Protective Housings. Class 2 lasers must be placed in protective housings whenever practical.
- Interlocks on Protective Housings. Class 3B and Class 4 lasers that are enclosed to prevent accessible radiation from exceeding Class 2 levels must have an interlocked housing to prevent inadvertent exposure to hazardous levels of laser radiation, or the housing must be fastened closed requiring a tool for opening or removal.

- Service Access Panels. Parts of the protective housing that can be removed from any laser or laser system only by the due personnel, and that permit direct access to Class 3B or 4 laser radiation, must be interlocked or designed to require a tool for removal.
- Housing and Cover Labelling. A label, indicating the laser radiation hazard contained within the housing, must be placed on all removable protective housings that have no safety interlock and that can be removed or displaced during maintenance or service, which would allow access to laser radiation higher than the MPE.
- Collecting Optics. Optical systems used to view the laser beam or its interaction on a material must be evaluated by the LSS, and must have permanently attached attenuators or shutters to prevent hazardous levels of radiation from entering the eye when the beam equals or exceeds the MPE.

16.2.2.2 Administrative controls for Class 2 lasers

The following administrative controls apply to all Class 2 lasers:

16.2.2.2.1 Beam control – Class 2

To minimise possible direct eye exposure, consider the following precautions to control the beam:

- Enclose laser beams as much as possible.
- Position lasers in such a manner that no beam or hazard exists at the room's entrance.
- Confine all laser beams to a well-defined area of use.
- Mark or block access to areas where beams cross pedestrian or vehicular thoroughfares.
- Terminate the beam at the end of its useful path.
- Position the beam path at a height other than eye level whenever practical.
- Block unnecessary beam reflections and remove shiny objects (e.g., jewellery and tools) that may cause unexpected reflections.

16.2.2.2.2 Signs and labels – Class 2

Display a hazard warning sign indicating that the work area includes Class 2 lasers.

- Each entry to a Laser room must be labelled with a warning sign.
- Each device between Class 2 and Class 4 must have a warning label according IEC 60825-1 chapter 5. The label must show the Laser Class, wavelength and output power/energy of the laser system.

16.2.2.2.3 Beam alignment and direct viewing – Class 2

Nobody must ever intentionally look directly into the beam of a Class 2 or higher laser. In cases where direct viewing cannot be avoided, the LSS must conduct a safety review before approval of the planned work or alignment procedure.

As an alternative, special provisions must be developed (e.g., filters, beam expansion, or controls on the exposure time) to make sure that the beam's intensity is below the MPE for the viewing conditions.

16.2.3 Class 3R lasers

Class 3R lasers emit light of a different wavelength than Class 2/2M lasers and are marginally hazardous in case of intrabeam viewing by the unprotected eye. The risk is lower than for Class 3B lasers, and fewer manufacturing requirements and control measures for the user apply than for Class 3B lasers.

16.2.3.1 Engineering controls for Class 3R lasers

In addition to the Engineering Controls for Class 2 lasers, the following apply to all Class 3R lasers.

- When a Class 3R or higher laser is to be operated outdoors or in open areas within buildings, the LSS must establish a nominal hazard zone in the space around a laser in which exposure to laser light possibly exceeds the MPE.
- The boundary of the nominal hazard zone must be clearly identified by signs and access restriction, and no laser radiation exceeding the MPE may exist outside the nominal hazard zone.

16.2.3.2 Administrative controls for Class 3R lasers

In addition to the administrative controls for Class 2 lasers, the controls below apply to Class 3R lasers.

- Post a hazard warning sign indicating that the work area includes Class 3R lasers.
- Lasers generating beams with irradiances or radiant exposures below the MPE must be labelled with CAUTION labels. Lasers generating beams with equal or higher power must have DANGER labels.
- Labels must be firmly affixed to the laser or the carrying case in which the laser is stored.

16.2.3.3 Beam alignment and direct viewing – Class 3R

Nobody must ever intentionally look directly into the beam of a Class 2 or higher laser. In cases where direct viewing cannot be avoided, the LSS must conduct a safety review before approval of the planned work or alignment procedure.

As an alternative, special provisions must be developed (e.g., filters, beam expansion, or controls on the exposure time) to make sure that the beam's intensity is below the MPE for the viewing conditions.

16.2.4 Class 3B and 4 Lasers

Class 3B and Class 4 lasers are considered hazardous. These lasers can cause eye injury so quickly that the natural aversion response will not prevent eye injury. They can also injure the skin.

16.2.4.1 Class 3B lasers

Moderate-risk, medium-power laser device.

Class 3B lasers are hazardous to unprotected eyes and may be hazardous to the skin. Diffuse reflections from Class 3B lasers may also be hazardous, such as when an individual stares at the diffusing surface from within the nominal hazard zone.

16.2.4.2 Class 4 lasers

High-risk, high-power laser devices.

Beams may be visible or invisible. Class 4 lasers are powerful enough to produce diffuse reflections that could rapidly injure the eyes or skin. Consequently, Class 4 lasers are hazardous to the eyes and skin, whether exposure is to the direct beam of the laser, its specular reflection, or diffuse reflections.

Some Class 4 lasers are capable of igniting combustible materials. Lasers emitting more than 2 W/cm² are considered ignition hazards.

Important: Very stringent control measures are required for a Class 4 laser or laser system.

16.2.4.3 Engineering controls for Class 3B and Class 4 lasers

Engineering controls specified for Class 2 and 3R lasers also apply to Class 3B and 4 lasers, unless the following requirements specifically supersede the requirements for lower Class lasers.

16.2.4.4 Controlled laser area – Class 3B / 4

When Class 3B and Class 4 lasers are being used, a Laser Control Area (e.g. a Laser Laboratory – an enclosed room or laboratory with walls or barriers that block laser radiation) must be defined. This area must be approved by the LSS and access must be controlled.

Only personnel who have been authorised may enter the laser control area. An authorised, suitably trained person must accompany Visitors at all times.

16.2.4.5 Safety interlocks – Class 3B / 4

Class 3B and Class 4 laser areas require a safety interlock system (or alternate controls defined and approved by the LSS) on access panels and doors, to prevent entry of unprotected personnel while laser radiation is present in the control area. Personnel who have to enter the control area must be properly informed about the interlock system.

16.2.4.6 Multiple occupancy – Class 3B / 4

If more than one laser or laser system operation is necessary, install appropriate shielding, and define the conditions of coexistence and methods for maintaining a safe work environment.

16.2.4.7 Warning systems – Class 3B / 4

The activation of a laser must be preceded by a verbal warning and/ or lighted status panels.

The laser operator must always make an announcement before laser emission commences to allow workers the opportunity to take appropriate protective action.

16.2.4.8 Reflection control – Class 3B / 4

Wherever possible, materials that are diffusely reflective or have a low reflection coefficient must be used.

Non-reflective tools must be used, whenever possible.

Remove or cover jewellery and other reflective personal items during laser alignment or other work near laser beams. Keep laser areas as free as possible of unnecessary clutter. Laser users must remove unnecessary tools and equipment from laser tables.

16.2.4.9 Optical viewing aids that concentrate Light – Class 3B / 4

Use of optical systems to view laser beams may be hazardous to the eye. Therefore, all optical instruments intended for viewing a laser or laser system must be equipped with suitable means (e.g., filters, attenuators, or interlocks) to preclude transmission of laser light exceeding the MPE to the eye.

16.2.4.10 Administrative controls for Class 3B and Class 4 lasers

Administrative controls specified for Class 2 and 3R lasers also apply to Class 3B and 4 lasers unless the following requirements specifically supersede the requirements for lower-Class lasers.

16.2.4.11 Signs and labels – Class 3B / 4

The outside of the laser enclosure must be posted with hazard warning signs specifying the highest laser Class in use. Also,

- if there is no manufacturer label, attach a laser Classification label in a conspicuous place on or near the laser housing.
- display a "DANGER" sign at each entrance to the operating area. The hazard warning sign must indicate that the work area includes Class 3B or Class 4 lasers, stating the Class and wavelength of the laser used.
- there must be an illuminated sign at each entrance showing "LASER ON", to warn personnel of the presence of laser radiation.

16.2.4.12 Safety evaluation of direct viewing – Class 3B / 4

Nobody must ever intentionally look directly into the beam of a Class 2 or higher laser. When direct viewing cannot be avoided, the LSS must conduct a safety evaluation and specifically approve the work or alignment procedure for direct viewing.

16.2.4.13 Beam alignment – Class 3B / 4

Alignment is the most hazardous laser activity, because Members of Personnel have to override engineering and administrative safeguards. Therefore, laser optical systems (e.g., mirrors, lenses, and beam deflectors) must be aligned in a way that minimises the possibility of exposing the eye or skin to the laser beam (or to the beam's specular or diffuse reflections) higher than the MPE.

Everyone within a controlled laser area or a nominal hazard zone must use eyewear that meets the laser eyewear requirements. Such eyewear must be provided by the LSS.

16.2.4.14 Unattended laser operation – Class 3B / 4

Except for visible continuous wave 3B lasers ≤ 15 mW, an operating laser is considered unattended if none of the authorised operators is in the controlled laser area or at the remote operating station. If an unattended laser is not in use, the power supply must be de-energised and the keys removed from the power switches or master interlocks, or the laser area must be locked to prevent access.

16.2.4.15 System safety check – Class 3B / 4

Safety systems that may have been bypassed, tampered with, or de-energised to allow maintenance or adjustments (especially by outside vendors or service representatives) must be tested or inspected to make sure these safety systems are working properly, before the laser is returned to service.

16.3 Personal protection

16.3.1 Protection for the eyes

It is strongly recommended to use protective goggles for the use of Class 3B and Class 4 laser devices. If you intend to use Class 4 lasers, eye protection is definitely required if there is any possibility of viewing either the direct or specularly reflected beam, or of viewing a diffuse reflection through magnifying optics.

Before starting an experiment/test, consider whether and which kind of goggles you will need. The exact wavelength(s) of the laser must be noted on the laser type label. If not, ask the LSS.

16.3.2 Protection for the skin

This is primarily of importance with Class 4 lasers. Working with Class 4 laser devices means a greater risk of accidental exposure of the skin to dangerous levels of laser radiation.

Skin protection is mandatory for personnel working with radiation levels of > 2000 W/m² within a wavelength of 400 – 1400 nm.

If you plan to work with wavelengths outside of the range of 400 - 1400 nm, you must first make specific safety arrangements in consultation with the LSS.

Class 4 lasers are a potential fire hazard, and protective clothing must be made of suitable flame- and heat-resisting material if exposure is expected, although engineering controls must be relied upon rather than resorting to protective clothing.

If protective gloves or any other protective measures are required, contact the LSS.

16.4 Optical fibre laser systems

Optical fibre cables, which are widely used at ESO, can pose a safety hazard. If somebody looks into the unprotected end of the cable while it is being powered, he/ she may suffer from sight disturbances according to the power applied.

In order to minimise safety risks, Members of Personnel must contact the LSS before working with high-power lasers, or if there are laser-specific concerns.

Lasers or laser systems that use optical cables to transmit light from one laser area to another are considered an enclosed system, with the optical cable forming part of the enclosure. If disconnecting a connector results in accessible radiation above the MPE level, then appropriate engineering and administrative controls consistent with the hazard Classification must be applied.

The following engineering and administrative controls apply to all fibre-optic applications.

16.4.1 Engineering controls – Fibre optics

Optical fibres that deliver high-power laser light can burn through standard fibre sheathing, if the fibre breaks.

Special design controls must be used to protect the fibres from damage, and to prevent exposure to laser radiation.

Flammable and combustible materials must be kept away from fibres carrying high-power laser radiation. When practical, fibre-optic cables should have an armoured or fireproof cladding. Fireproof conduit must be considered when high power levels need to be transmitted over fibre-optic cables. Trays, cabling, or enclosures must be appropriately identified, with a laser hazard label affixed at an interval of 3 m or less.

16.4.2 Administrative controls – Fibre optics

If hazardous radiation levels may be present at the end of optical fibres, a CAUTION or a DANGER label (as determined by the LSS) must be attached near the end of the fibre or fibre holder. The optical fibre must be capped off, if possible, when not in use.

Work areas where fibre-optic cables are cut, cleaved, or spliced must be covered with black cloth so that cleaved fibres can be easily seen.

16.5 Inspection, maintenance and purchase of lasers

Every person working with lasers is responsible for keeping laser devices in a safe condition.

Take the normal safety precautions for any electrical equipment. Before using a laser, perform a visual inspection; inspect the laser device, its electric cable and plug for visible damage (e.g. faulty insulation so that bare wire can be seen).

It is forbidden to use a laser device when any part of the device is visibly damaged. In this case Members of Personnel must remove it if possible, warn colleagues not to use it and contact the LSS.

A Certified Expert/ Competent Person (degree 3) must carry out an annual inspection of the laser devices. Persons working in with lasers are asked to cooperate with these experts and to provide required information.

If a laser device is purchased, the laser must be properly labelled.

The Classification scheme relates specifically to the accessible emission from the laser system and the potential hazard based on its physical characteristics. Laser products must be Classified by the manufacturer and labelled with that Class in accordance with the appropriate national regulation and IEC 60825.

The laser must be labelled with a sensible ESO Laser Lab-specific number. The LSS must add information about the newly acquired laser device to the laser register.

If purchasing a laser of Class 3B or 4, notify both the E-ELT SSE and the LSS.

To maintain a high standard of safety, regular safety checks must be conducted, and these must cover, at least

- Status of control area and restricted area: differentiation between controlled area and restricted area; signage; warning lights; access control.
- Interlock system.
- Emergency stop system.
- Protection against over voltage.
- Engineering measures for all laser devices in use.
- Potentially hazardous items in the Laser Lab: reflective, combustible, etc.
- Escape routes and doors.
- Places with a high risk of stumbling, head injuries, squeezing, crushing, etc.
- Safety devices for gas bottles/ exhaustion system.

17 Ionising radiation protection

Supervisors intending to allow E-ELT construction personnel the use of ionising radiation must, in co-operation with the E-ELT SSE

- nominate, in writing, a suitably qualified and trained person as a Radiation Safety Specialist (RSS) when all sources combined at the Site exceed 1,000,000 Bq in activity.
- provide suitable training for all users of ionising radiation.
- implement specific Site Rules, in collaboration with the E-ELT SSE and with the RSS. These must cover the acquisition, safe use and disposal of all sources of ionising radiation, and the monitoring of radiation doses received by all persons associated with the work.

The RSS must ensure compliance with the E-ELT construction safety requirements and host-state legislation for the use of ionising radiation, and is responsible for the safety and secured storage, use and disposal of radioactive materials.

17.1 General provisions

No E-ELT construction personnel or E-ELT construction site visitors may carry out work with ionising radiation, unless

- a suitable and sufficient prior risk assessment has been undertaken.
- the programme of work has been approved and the necessary control measures introduced. They must make sure that radiation doses received by a worker are as low as reasonably achievable, and do not exceed 20 mSv per annum (1 mSv if under 18 years or pregnant).
- the person has received sufficient and appropriate training.
- an adequate system for monitoring the radiation dose received has been implemented.

Also:

- No source of ionising radiation may be brought onto the E-ELT construction site without the appropriate authorisation of the E-ELT SSE. The E-ELT SSE must be informed if the combined radiation activity of all sources stored and used at the site exceeds combined 1,000,000 Bq.
- No radioactive material may be disposed of without authorisation of the E-ELT SSE.

17.2 Purchase, acquisition and disposal of radioactive material

No closed source or instrument containing a radioactive source may be brought onto the E-ELT construction site without the authorisation of the E-ELT SSE. The RSS supports the E-ELT SSE in this matter.

The requester must complete the Prior Authorisation Form and seek the prior approval of the RSS. The reason for this is to control the amount of radioactive sources within the E-ELT construction site and make sure that ongoing safety measures and practices are put into place.

Shipments of radioactive materials must be authorised in advance by the destination SSE.

A Radiation Materials Record Book (RMRB) must be developed by the E-ELT SSE in cooperation with the RSS. It must be maintained by the RSS, recording at least the following data:

- The kind of Emitter;
- The level of radioactivity in [Bq];
- The required storage and shielding;
- Date of Purchase;
- Date of Disposal.

All acquisitions and disposals of radioactive substances must be recorded.

17.3 Closed sources – Operation safety requirements

17.3.1 Prior risk assessment

The user must carry out a risk assessment before starting any new activity with ionising radiation that was not covered by a previous assessment, or where significant changes have been made to the work being done.

The results of this assessment must be recorded.

The risk assessment must give information on the work to be performed and consider, at least:

- the nature of the sources of ionising radiation to be used;
- estimated radiation doses to which anybody could be exposed (with particular reference to female employees of childbearing age);
- the possibility of contamination arising and being spread;
- the consequences of the possible failure of control mechanisms;
- procedures to be taken for foreseeable accidents;
- whether the area being used for work with ionising radiation should be designated a restricted area.

Procedures (which must be approved by the ESO Safety Engineer) for carrying out this risk assessment must be established at the E-ELT construction site.

The respective RSS and E-ELT SSE must approve the risk assessment when complete.

17.3.2 Safe handling of radioactive materials

The Radiation Safety Specialist must register all handling processes, which must have the signatures of both the RSS and the Recipient, and show the date of issue/return. Radioactive materials, stored or used in areas common to both authorised and unauthorised personnel, must be secured at all times from unauthorised personnel.

Exposure of everybody at the E-ELT construction site, and the general public, to radiation must be kept as low as reasonably achievable; ALARA approach – see enclosed document:

Radiation Guidance:



Microsoft Office Word
Document

The radiation exposure of personnel must not exceed the maximum permissible dose.

Women working with radiation, who become or suspect they are pregnant, must notify their Supervisor and the Radiation Safety Specialist in writing, as soon as possible. Additional safety measures are necessary for pregnant women.

Radioactive wastes are considered as radioactive materials. Radioactive wastes must be placed in lockable containers and secured at all times.

17.3.3 Safe storage of radioactive materials

When not in use, store all radiation sources in a secure, lockable, shielded cabinet, in a location that is free of flammable material. The store must display clear indication that it contains radioactive sources, and show the name and contact number of the person responsible for the sources in the store.

Radioactive materials must not be left unsecured at any time.

All laboratories containing radioactive materials must be locked when unoccupied during daytime hours and at night.

17.3.4 Hazards associated with ionising radiation from closed sources

The risk from an occupational radiation dose depends on the amount of radiation dose received, the time over which the dose is received, and the parts of the body that have been exposed.

If not handled properly, radiological operations could result in internal or external dose to workers; contamination of workers, work areas, equipment, or facility systems; or release of radioactive material to the environment. Absorption of radioactive particles may occur if the cover of an emitter is damaged.

Before any emitters are used, there must first be a visual inspection of the cover(s); i.e. look for cracks, deformations and heavily-worn edges.

If the cover of a closed source is damaged, the emitter must be taken out of use. Use tongs to put it back into a secure, locked cabinet. Inform the respective SSO immediately and then block the entrance to the laboratory, or inform E-ELT construction members of personnel/colleagues who have to enter the laboratory.

If any closed source has been damaged such that radiation is released (that is, it is no longer a closed source), then as a safety measure, any E-ELT construction member of personnel that may be contaminated must immediately consult the E-ELT construction site doctor or paramedic at the site. If there is any possibility that your clothes have been contaminated, remove these clothes before leaving the laboratory. In any case, always thoroughly wash your hands after using radioactive material.

The place where the incident occurred must be immediately secured and preferably locked. The incident must be immediately reported to the person responsible for the area where the defective radiation source is located.

To make sure that there is no leakage of activity from closed sources, including those in instruments, a qualified expert must test all closed sources every two years. These tests will be organised by the RSS, and the results must be forwarded to the ESO Safety Engineer.

17.4 X-Ray generating devices – Operation safety requirements

Here are general recommendations for the safe use of X-ray generating devices.

- All X-ray generating devices must meet relevant provisions of the applicable ESO Safety manual, in particular "Safety & Use of Work Equipment";
- Only trained personnel may work with X-ray generating devices;
- Inspections must be kept up to date according to the manufacturer's maintenance manual;

- If any equipment shows any deficiency, or needs maintenance, report it immediately to the respective SSO;

Responsibilities of ALL users of X-ray generating devices:

- Read the manufacturer's manual.
- Keep emergency shut-off switches clear of obstruction, for easy access in emergencies.
- Be familiar with locations where radiation is most likely to leak;
- Be familiar with inappropriate conditions; for example, there must be no gaps between entry and exit tunnels and the gantry.
- Report immediately any missing flaps or blown bulbs, to the respective SSO, for maintenance.
- Do not displace curtains or reach into the machine while X-ray lights are on;
- Do not bypass safety interlocks or use foreign objects to engage safety interlocks.

The person responsible for the X-ray device must store a copy of the manufacturer's operation manual next to the device.

18 Work permits

For basic provision see also Chapter 6.

18.1 Responsibility and Authorisation

18.1.1 Appointed responsible for safety issues

Supervisors must appoint in writing a Responsible for safety issues if hot work or work in hazardous environments has to be carried out.

This person may be the Contractor's contact person from ESO in case a Contractor is doing the work.

The task of the Responsible for Safety Issues is to make sure that necessary precautions are taken, and to check safety at each stage:

- Know the specific hazards of the workplace/environment;
- Make sure that atmospheric testing and/or other relevant appropriate preparations have been done before carrying out hot work or work in hazardous environments;
- Verify that safe conditions have been attained;
- Make sure that acceptable entry conditions are maintained, where applicable;
- Make sure that proper equipment is on site and operational;
- Make sure that workplace is clear of unauthorised personnel;
- Verify emergency plan and confirm rescue team availability, where applicable;
- Sign the Work Permit;

- Close the Work Permit once the operation is completed.

The Responsible for safety issues may need to remain present while work is under way.

18.1.2 Authorised workers

Personnel appointed to work in hazardous environments must have sufficient experience of the type of work to be carried out and proper training, i.e. generally:

- Know the specific hazards, exposure routes, signs, symptoms and adverse health effects that could result from exposure;
- Use adequate PPE;
- Follow the applicable procedures;
- Perform the assigned job;
- Is alert to any prohibited condition;
- Communicate with attendant (applicability of 'two-person-rule');
- Evacuate immediately, if necessary.

18.2 General requirements for work permits

Work Permits are intended to achieve safe working conditions. They define the duties and responsibilities of all persons involved, and provide a method of documenting that each person has carried out his/her responsibilities.

The Supervisor or ESO contact person prepares the Work Permit to allow the development of specific work that is either critical, or has to be carried-out under critical conditions or in hazardous environments.

Use the Work Permit as a checklist to document the completion of all steps necessary to prepare for safe work.

A Work Permit is required in the following cases:

- Hot Work (welding, cutting, soldering, thawing, defrosting, abrasive cutting operations);
- Hazardous Workplaces:
 - Work on major electrical installations (servicing and maintenance operations) and affecting third parties;
 - Work in confined spaces (storage tanks, sewers, underground vaults, manholes, degreasers, vats, boilers, vessels, tunnels, pits, crawl spaces under buildings, etc.);
 - Work alone in workshops;
 - Work at heights (over 1,80 metres);
 - Work with hazardous material.

The essential features of a Work Permit:

- Must provide a clear identification of who may authorise particular jobs (and any limits to their authority);
- Who is responsible for specifying the necessary precautions (e.g. isolation, air testing, emergency arrangements, etc);

- Ensure that Contractors engaged to carry out work are included;
- Allow the provision of training and instruction while being issued;
- Provide for appropriate monitoring and auditing to make sure that the authorisation system works as intended.

The applicable permit forms are included below:

Permit Forms and Guidance:



Microsoft Office Word
Document

Work Permits are issued for a specific job being done, and for a specific time period. If more time is needed to perform the job, the Work Permit must be amended.

Each Supervisor must establish extra Work Permit restrictions as needed, in consultation with the E-ELT SSE.

Contractors and personnel engaged in the work activities detailed on the Work Permit must strictly adhere to all conditions, precautions and activities detailed on the permit.

18.3 Hot work permits

A Hot Work Permit is issued for use in process/operational areas where a source of ignition is involved. Some examples are welding, burning, brazing, propane soldering, oxyacetylene cutting, grinding ferrous metals and metal drilling.

Failing to follow the information provided by the Hot Work Permit can create hazardous conditions that may cause a fire, explosion, damage and/ or injury.

Hot Work Permits are issued for a specific job being done, and for a specific time not exceeding 24 hours. If more time is needed to perform the job, a new Hot Work Permit must be established.

18.3.1 Hazards associated with hot work

The most common hazards associated with hot work are:

- Fires/Explosions (hot surfaces can start a fire).
- Burns (both from welding equipment itself and hot surfaces).
- Toxic fumes, particles and smoke.
- Eye injuries (burn and particles projection).
- Electric shock.
- Noise.

18.3.2 Hot work safety precautions

The person performing the hot work must make sure that all necessary precautions have been taken at the work site.

Sprinkler systems in the hot work area must remain in working order, unless specifically approved by the E-ELT Site Safety Engineer. If a sprinkler system needs to be taken out of service, specific procedures must be followed to ensure safety in that work area.

- Smoke/ Fire detectors in the immediate hot work area must be temporarily disabled until work is completed.
- Gas hoses, backflow preventers, fire resistant tarpaulins, curtains and other cutting and welding equipment must be maintained in good working order.
- Ensure adequate ventilation during the hot work process.
- Anything that can burn must be removed or protected from the immediate work area:
 - The floor must be swept clean of any combustible debris.
 - Flammable and ignitable materials and debris must be moved at least 10 m from the hot work area, or covered and protected with fire resistant materials.
 - Any explosive atmosphere in the area must be eliminated.
 - Cracks, holes and ductwork in floors, walls and ceilings must be covered or plugged.
 - Combustible floors must be wetted and covered with fire resistant material.
 - Explosives, compressed gas cylinders or stored fuel must be moved at least 15 metres from the hot work area, or protected from it.
 - Construction materials must be non-combustible and must have no combustible covering or insulation.
 - Check areas adjacent to walls being worked on, for combustibles. Any combustibles must be either removed or protected.

Personal protective equipment

Adequate Personal Protective Equipment must be used:

- Workers and assistants performing these operations must wear goggles and face shields that give maximum eye protection for each welding, flame cutting and soldering process.
- They must wear flame-resistant gloves and aprons during welding, flame cutting and soldering processes.
- They must wear safety shoes with protected tops, to protect the operator from spark hazard.
- If protective hard hats are worn, they must be flame resistant.

Fire watch

A Fire Watch must be provided during and for at least 30 minutes after work, and during any coffee or lunch breaks that occur during hot work activities.

The respective Supervisor or ESO contact person for the work appoints a Fire Watch, who must be a person with knowledge of the work being done and of fire safety. His/ her main responsibility is to monitor the area for the possible development of fire from the hot work. Other work can be performed provided the Fire Watch can still adequately monitor the area for potential fire.

Fire watches must be supplied with suitable extinguishers or charged hose reels. They must be trained in the use of fire extinguishing equipment and in sounding an alarm.

Hot work completion

Before leaving the area, the persons involved in the hot work must verify that no smouldering fires have developed within walls, cracks in floors, or in ceiling areas where they have been working.

The Hot Work Permit must be returned to the person who issued it, within 30 minutes of job and fire-watch completion, so that he/she may complete any necessary further steps.

Record keeping

The person who issued the Hot Work Permit must sign it after return, and keep the record for at least 3 years.

18.4 Lockout/Tag-out (control of hazardous energy)

The lockout/tag-out procedure (control of hazardous energy) covers any work, servicing or maintenance on machines or equipment in which the unexpected start-up or energising of the machine or equipment, or the release of stored energy (e.g. in electrical systems, pressure and vacuum systems, water systems, gas systems, etc) could cause injury or death. It shall be used to ensure that the machines or equipment are isolated from all potentially hazardous energy, and are locked out or tagged out before employees perform any servicing or maintenance activities where unexpectedly applying energy, start-up or release of stored energy could cause injury.

Only authorised employees may determine which equipment will need to be locked out or tagged out.

Only authorised workers may proceed with the lockout/ tag-out procedure.

Hard-wired equipment must have the circuit breakers turned off, and then locks or tags attached to the breaker or equipment to prevent personnel from re-energising the equipment. Equipment connected by cable and plug must be unplugged.

Note: Minor tool changes and adjustments, and other minor servicing activities that take place during normal production operations, are not covered by this standard, provided that

- they are routine, repetitive, and integral to the use of the equipment for production, and
- the work is performed using alternative measures that provide effective protection.

18.4.1 Types of hazards (energy) requiring lockout/tag-out

Lockout/tag-out procedures must be used in, but are not limited to the following situations:

- Exposure to powered equipment – repairs, adjustments, and maintenance on conveyors, agitators, vehicles, presses, mills, lathes, exhaust fan blowers, and similar manufacturing or office equipment.
- Electrical exposures (applies to equipment operating at >50 V) – work on power lines, machinery and equipment connections. Disconnect switches, and electrical panel boxes.
- Exposure to hazardous materials – repairs and maintenance on pumps, boilers, pipelines or tanks containing flammable liquids, acids, caustics, steam and other harmful liquids and gases.

These situations may involve the following risks, which need to be evaluated in a hazard analysis:

- Electrical (to remove voltage on electric circuit).
- Hydraulic (to shut off hydraulic transmission).
- Pneumatic (to shut off pneumatic transmission).
- Mechanical (to clamp mechanical, hydraulic and pneumatic transmission).
- Chemical (to suppress the supply of all fluids).
- Thermal (to insulate from cold or heat).

- Others (for example, interactions of the above).

18.4.2 Examples of types and means of tags

18.4.2.1 Danger Tag

A Danger tag is used to assure the owner that he/she can work safely in a machine or equipment. It is PERSONAL and protects only the owner of the Tag.

Fill in the tag completely, with the following information:

- Owner's name.
- Lockout position.
- Date and Time.

Never re-use a tag. If necessary, fill in a new tag every time.

18.4.2.2 Out of Service Tag

An out of Service tag is used to protect a machine or equipment, that can't be moved, from damage. This may be due to the equipment being incomplete or damaged. It is NON PERSONAL and belongs to the equipment.

Fill in the tag completely, with the following information:

- Equipment locked out.
- Reason for isolation.
- Date and Time.

Never re-use a tag. If necessary, fill in a new tag every time.

18.4.3 Procedures involving more than one person

If more than one individual needs to lockout or tag-out equipment, each must place his/her own personal lockout device or tag-out device on the energy isolating device(s).

When an energy-isolating device cannot accept multiple locks or tags, a multiple lockout or tag-out device (hasp) must be used.

Examples of tag-out/ lockout hasps:



Figure 4. Examples of lockout hasps

18.4.4 Training

Training is the responsibility of the maintenance Supervisor.

Affected employees must receive annual lockout/tag-out training and testing on basic procedures. Initial training must be provided so that employees understand the procedures, purpose, skills and knowledge to perform work safely. Refresher training must be provided annually by the maintenance Supervisor.

Training records must be stored for at least three years after the end of the current financial year. They must record an outline of topics covered, a sign-in sheet of those employees attending, and copies of basic test documents.

18.4.5 Contractors and lockout/tag-out

If outside service personnel or Contractors are engaged in activities covered by the lockout/tag-out procedure, they also must strictly adhere to it. The maintenance Supervisor must review annually the lockout/tag-out procedure with the Site Safety Officer and make changes as required.

18.5 SCAFFTAG/Ladder-tag

The SCAFFTAG/Ladder-tag system is a permit for the safe use of a scaffold and a ladder, respectively.

All ladders that go higher than 1,80 m, and scaffolding exceed 12 m³, are subject to the SCAFFTAG/Ladder-tag system, before work starts.

All scaffolding must only be erected, moved, dismantled or altered, by or under the direct supervision of a competent person. A competent person is one who has documented training on building scaffolding, and must be certified by a competent and recognised entity.

Using unsafe or improper ladders or scaffolding, or using them improperly, can cause a fall and subsequent injury. Therefore, ALL scaffolding and ladders must have tags and/ or signage to indicate its safety condition, for example, by using a SCAFFTAG. The following colours indicate scaffolding/ladder conditions:

- RED = DANGER – DO NOT USE SCAFFOLDING. Must be used on incomplete or erection-in-progress scaffolds.
- GREEN = SCAFFOLD IS SAFE TO USE. Personal fall arrest equipment is not required if the scaffolding working surface is fully guarded.
- YELLOW = CAUTION. Scaffolding is safe to use but personal fall arrest equipment is required. Scaffold deficiency must be identified on tag or sign.

Here are examples of SCAFFTAG and Ladder-tag systems.



Figure 5. SCAFFTAG and Ladder-tag examples

Two-person-rule: The two-person-rule also applies.

Contractors needing to use scaffolding for their own purposes on the E-ELT construction site must follow a similar process.

18.6 Entry Permits

18.6.1 Entry permits for confined spaces

Whenever entry into confined spaces cannot be avoided, the Supervisor must prepare a Safety Plan before work starts in that area. The objective of this Safety Plan is to establish the necessary safety requirements in order to minimise the risk of accidental injury or death associated with entry or work in confined spaces. Failure to follow the guidelines established in the Safety Plan may result in serious injury or death.

At minimum two persons are required for work in any confined space. The second person shall stay on guard at the confined space entrance. His/her duty is to provide help in case something happens to the first person carrying out the work in the confined space, and must not leave his/her position for any reason other than to help the first person.

For other than rescue missions, work in confined spaces in potentially dangerous atmospheres (O₂ depleted, toxic, explosive) and/or with breathing apparatus is prohibited for E-ELT construction personnel; Exceptions to be decided by the respective Head of Department and the E-ELT SSE. In all such cases two helpers at minimum are required to secure the first person.

18.6.1.1 Confined spaces safety plan

A specific safety plan for work in confined spaces needs to be established by the Supervisor or ESO contact person, which shall include, at least, the following elements:

- Appointment, in writing, of a Supervisor for safety issues, which may be the E-ELT SSE;
- The training and suitability of the authorised entrant;
- Isolation: For example, mechanical and electrical isolation of equipment is essential if it could inadvertently start working. Isolation includes the following:
 - Identify potential mechanical hazards.

- Complete the de-energising of all electrical, mechanical, pneumatic and hydraulic systems and all other energy sources.
- Lock out and tag out all electrical circuits and fluid valves.
- Block or otherwise secure equipment that could have stored energy.
- Guard or remove equipment from the area.
- Make sure isolation procedures are fully implemented.
- Cleaning/ventilating before entering.
- Checking the size of the entrance.
- Providing adequate oxygen to the air in the space.
- Controlling atmospheric contaminants.
- Preventing fire and explosion hazards.
- Controlling heat and humidity.
- Testing the air, if required, to check that it is free from both toxic and flammable vapours, and that it is fit to breathe. A competent person must use a suitable, calibrated, gas detector to carry out testing. Where the risk assessment indicates that conditions may change, or as a further precaution, continuous monitoring of the air may be necessary.
- Provision of special tools and lighting. Non-sparking tools and specially protected lighting are essential where flammable or potentially explosive atmospheres are likely.
- Provision of rescue harnesses. All authorised entrants and rescuers entering confined spaces must use full body harnesses and retrieval lines, unless it is determined that the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue operation.
- Communications. An adequate communication system is needed to enable communication between people inside and outside the confined space and to summon help in an emergency.
- Alarm system in case of emergency.
- Permit-to-work. Where hot work operations are carried-out, a hot work permit is needed. One of the dangers of hot work operations is the increased risk of fire and explosion because of the introduction of an ignition source into a space with an already hazardous atmosphere.

18.6.2 Entry permits for other hazardous environments

An entry permit is necessary whenever a person has to enter an enclosed space where specific environmental conditions exist that may be hazardous to the health of people, either

- due to the work carried out within that area (e.g. Workshop, Assembly Hall), or
- due to the kind of fire protection system (CO₂, etc.) existing,

18.7 Two-person-rule

The two-person-rule applies whenever work in hazardous environments is carried out, in order to minimise the risk of injury to E-ELT construction personnel, and to ensure adequate rescue if required. The following are identified as specific tasks that require two persons to be present in order to perform them:

- Any significant risk or hazard attended to outside normal working hours.
- Lifting operations using an overhead crane.
- Entering confined spaces.
- Electrical work.
- Working with hazardous substances.
- Working in the workshop.
- Erecting or working on ladders and scaffolds.
- Initial set-up of new/unknown equipment

The second person must be someone who can provide appropriate assistance in the event of an emergency (e.g. call for help), and be within audible or visual range.

To satisfy the requirements of a two-person-rule, both individuals must be:

- in visual and/or audible contact with each other, and
- aware that they are working together, and
- in a position to provide timely assistance if a mishap occurs to either party.

When multiple maintenance teams are working in a hazardous environment, a member from one team may act as the second person for another maintenance effort. However, all parties must be aware of their additional responsibilities.

Organisational measures in cooperation with the security service may be used: Upon prior announcement, the two-person-rule may be fulfilled by radio contact, or preferably by contact using devices working with a distress-signal function for automatically triggered alarm (dead-man function).

18.7.1 Overhead crane lifting operations

An experienced overhead crane operator may perform lifts which are less than or equal to 1.5 metres and less than 130 kilograms only if overall view is guaranteed and no other person is working in the area. Overhead crane operations that require lifts exceeding this height and weight, must be attended by persons.

Two persons are required to perform high-risk lifts, defined as lifts that create or present a risk to personnel and/or risk of collateral damage.

18.7.2 Lifting platforms operations

All usage of lifting platforms ("cherry-pickers"), other than moving the unit from one point to another, requires two persons.

18.7.3 Scaffolds and ladders

Two persons are required when working from stepladders more than 1.80 metres high, or from unguarded extension ladders, scaffolds, or elevated areas above 1.20 metres.

If work has to be performed higher than 1.80 metres, an appropriate fall arrest system must be used. An appropriate fall arrest system includes a properly fitted full body harness, a fall arrest device and a suitable anchorage.

All fall protection equipment must be inspected before each use.

A person specialising in using fall protection systems must train workers having to work at heights.

Make your presence overhead known to people below, by posting warning signs and/or roping off the area below.

18.7.4 Electrical work

At least two persons must be present when performing work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energised at more than 600 V, and/or when performing any other work that exposes an employee to electrical hazards of 600 V or more.

18.7.5 Working with hazardous substances

In some cases (e.g. work with products releasing dazing fumes) the use of Hazardous Substances may require the application of the two-person-rule. When working with Hazardous Material the person with supervising functions must perform a workplace hazard analysis together with the E-ELT Site Safety Officer to verify if the "two-person-rule" is applicable.

18.7.6 Working in the workshop

Only qualified persons are allowed to work alone in a workshop and use tools and equipment if people are working nearby. Qualification is determined by the respective Division / Department Head in writing based upon experience and/or training.

18.7.7 Emergency procedures

Emergency arrangements will depend on the risks. They must consider:

Communications

There must be an effective means to communicate from inside the hazardous workplace area to people outside, so that rescue procedures may be possible. Night, shift work and weekends are special cases that must be considered also. Effective methods of communication include:

- Verbal
- Hand signals
- Two-way radios
- Signalling through safety lines when oral communication is not possible
- Intercom system
- Light signals.

Check whether the two-person-rule applies.

Electronic equipment

All electronic equipment must:

- Be intrinsically safe; there must be no chance of it becoming an ignition source.
- Not interfere with atmospheric monitors.
- Always be backed up by a non-electronic communication system.

Rescue and Resuscitation Equipment

Provision of suitable rescue and resuscitation equipment will depend on the likely emergencies identified. Where such equipment is provided for use by rescuers, training in correct operation is essential.

Rescue equipment may, amongst others, include:

- Full body harness with retrieval line attached.
- Hand-cranked mechanical winch and tripod.
- Ladder.
- Explosion-proof lighting.
- Atmospheric monitors for O₂ and toxic gases
- Self controlled breath apparatus (SCBA).
- First aid equipment and supplies
- Stretcher.
- Approved head protection.
- Hyperbaric chamber

Capabilities of Rescuers

Rescuers must be

- Properly trained;
- Fit enough to carry out their task;
- Available;
- Capable of using any equipment provided for the rescue, e.g. Breathing apparatus, lifelines and fire fighting equipment.
- Protected against the cause of the emergency.

19 Building and construction safety

When ESO, as overall Project Owner, appoints Contractors (outside companies) to do construction work, ESO must appoint in writing a coordinator for Health, Safety and Environmental Protection matters for any construction site on which more than one Contractor is present, in order to fulfil host-state construction-site safety legislation. This then also applies for construction of the E-ELT.

By default, the main Contractor shall be appointed as the coordinator for Health, Safety and Environmental Protection matters.

The Project Supervisor must make sure that a Health and Safety Plan is drawn up before setting up the E-ELT construction site.

For basic provision see also Chapter 6.

19.1 Roles and responsibilities

19.1.1 General duties of Coordinators

19.1.1.1 During the project design and preparation stage

The coordinator for health and safety matters – if already appointed – shall collect all safety-relevant information and process it into a safety plan during the project preparation stage; these tasks and responsibilities shall be borne by the planning & design Contractor, if a coordinator in the sense of a construction company is not yet appointed:

- Prepare a file of Health and Safety Information that is relevant to the characteristics of the project, and that will apply to subsequent works.
- Coordinate implementation of the provisions. Draw up a Health and Safety Plan that sets out the rules that apply to the construction site concerned.

19.1.1.2 During the project execution stage

These are the responsibilities of the coordinator(s) for health and safety matters during the project execution stage:

- Ensure compliance/compatibility with home-state legislation on safety of construction sites
- Coordinate implementation of the general principles of prevention and safety when –
 - technical and/or organisational aspects are being decided, in order to plan the various items or stages of work that will take place simultaneously or in succession;
 - estimating the period required for completing such work or work stages;
- Coordinate implementation of the relevant provisions in order to make sure that Contractors and, if necessary for the protection of workers, self-employed persons –
 - apply the principles of prevention and safety in a consistent manner,
 - if required, follow the Health and Safety Plan;
- If required, adjust the Health and Safety Plan to take account of the progress of the work and any changes that have occurred.
- Organise cooperation between Contractors, including successive Contractors on the same site. Coordinate their activities in order to protect workers and prevent accidents and occupational health hazards. Make sure that self-employed persons are involved in the process if necessary.
- Check that working procedures are being implemented correctly.
- Make sure that only authorised persons are allowed onto the construction site.

19.1.2 General obligations on Contractors

It is the Contractor's responsibility to protect the health and safety of his workers; to prevent occupational risks; to provide information and training; and to provide the necessary organisation and means.

The Contractor must adjust these measures to take account of changing circumstances and aim to improve existing situations.

The Contractor must implement these measures based on the following general principles of prevention:

- Avoid risks.
- Evaluate unavoidable risks by:
 - mitigating the risks at source;
 - adapting the work to the individual, especially regarding the design of work places, the choice of work equipment and the choice of working and production methods. Aim to alleviate monotonous work and work at a predetermined work-rate, in order to reduce their effect on health.
- Adapt to technical progress.
- Keep the building site clean and tidy at all times.
- Replace the dangerous by the non-dangerous or the less dangerous.
- Develop a coherent overall Prevention Policy that covers technology, organisation of work, working conditions, social relationships and the influence of factors related to the working environment.
- Give collective protective measures priority over individual protective measures.
- Give appropriate instructions and training to workers.

The Contractor must, by taking into account the nature of the activities, –

- Evaluate the risks to the health and safety of workers in, among other things, the choice of work equipment, the chemical substances or preparations used, and the fitting-out of work places. After this evaluation, if necessary, the preventive measures and the working and production methods implemented by the Contractor must:
 - assure an improvement in the level of protection afforded to workers with regard to Health, Safety and Environmental Protection;
 - be integrated into all the activities of the undertaking and/or establishment and at all hierarchical levels.
- Where he entrusts tasks to a worker, he must take into consideration the worker's capabilities regarding Health, Safety and Environmental Protection.
- Take appropriate steps to make sure that only workers who have received adequate instructions may access areas where there is serious and specific danger.

Where several undertakings share a work place, the Contractors must cooperate in implementing the Health, Safety and Environmental Protection and occupational hygiene provisions. Depending on the nature of the activities, they must coordinate their actions to protect the environment and reduce occupational risks. They must inform one another and their respective workers and/or workers' representatives about these risks.

Measures for safety, hygiene and health at work must never involve workers in financial cost.

Equipment labelling: Contractors must identify all their equipment with a label stating the company's name, contact person and phone number.

19.1.3 General obligations of workers

It is the responsibility of each worker to take care, as far as possible, of his own health and safety, and that of other persons affected by his acts or commissions at work, in accordance with his training and instructions given by his employer (Contractor).

Therefore, workers must, in particular and in accordance with their training and the instructions given by their Contractor:

- make correct use of machinery, apparatus, tools, dangerous substances, transport equipment and other means of production;
- make correct use of personal protective equipment supplied to them; and, after use, return it to its proper place; In particular abide by general the hard-hat, safety shoe, high-visibility clothing and eye-protection rule on the E-ELT construction site!
- refrain from disconnecting, changing or removing arbitrarily safety devices fitted, e.g. to machinery, apparatus, tools, plant and buildings, and use such safety devices correctly;
- immediately tell the employer (Contractor), and/or workers with specific responsibility for the health and safety of workers, of any work situation that represents a serious and immediate danger to health and safety, and of any shortcomings in the protection arrangements;
- cooperate with the employer (Contractor) and/or workers with specific responsibility for the health and safety of workers, according to national practice, for as long as may be necessary to allow the employer to make sure that the working environment and working conditions are safe and pose no risk to health and safety within their field of activity.

19.2 Health and safety plan

The Health and Safety Plan sets out the rules that apply to the construction site concerned, taking into account the industrial activities taking place on the site. The Plan must include at least the following information:

1. Identify the construction site.
2. Define the general organisational structure.
3. State the responsibilities of persons and organisations involved in the construction.
4. Define the works to be carried out. Include information on signalling; routes; circulation; use and control of equipment; handling and storage of materials; utilities; waste disposal; control and access to construction site.
5. Identify equipment and materials to be used.
6. Provide a schedule of the works to be carried out.
7. Risk assessment (identify hazards and related control measures).
8. Minimum requirements for health and safety.
9. Set out the management of information and communications between all relevant Contractors, in matters of health and safety.
10. State the emergency procedures, including evacuation.
11. Set out a communication system for reporting accidents.
12. Include accommodation areas; sanitary installations, etc.

This plan must also include specific measures for work that falls within one or more of the following categories, which involve particular risks.

1. Work that puts workers at risk of –
 - 1.1 burial under earth falls; or
 - 1.2 engulfment in swamp land;
 - 1.3 working at high altitude; or
 - 1.4 falling from a height,
– where the risk is particularly aggravated by the nature of the work or processes used, or by the environment at the place of work or site.
2. Work that puts workers at risk from chemical or biological substances that constitute a particular danger to the safety and health of workers, or that involve a legal requirement for health monitoring.
3. Work with ionising radiation that requires controlled or supervised areas as defined in Article 20 of Directive 80/836/EURATOM.
4. Work near high voltage power lines.
5. Work exposing workers to the risk of drowning.
6. Work on wells, underground earthworks and tunnels.
7. Work carried out by divers having a system of air supply.
8. Work carried out by workers in a caisson (a watertight structure within which construction work is carried out under water) with compressed air.
9. Work involving the use of explosives.
10. Work involving the assembly or dismantling of heavy prefabricated parts.

19.3 Building permit / prior notice

Given ESO's legal status, the office of the DG shall initiate in time all steps required with respect to the host-states authorities, such as building permits etc.

19.4 Technical requirements

19.4.1 Stability and solidity

Materials, equipment and, more generally, any component which, when moving in any way, may affect the safety and health of workers, must be physically stabilised in an appropriate and safe manner.

Access to any surface that is not strong enough to support the weight is not authorised, unless appropriate equipment or means are provided to enable the work to be carried out safely.

19.4.2 Energy distribution installations

Installations must be designed, constructed and used so as not to cause a fire or explosion hazard. Persons must be adequately protected against risk of electrocution caused by direct or indirect contact.

The design, construction and choice of equipment and protection devices must allow for the type and power of the energy distributed, external conditions and the competence of persons with access to parts of the installation.

19.4.3 Escape routes and exits

- Escape routes and exits and the traffic routes and doors giving access to them shall remain clear and unobstructed at all times, so that they can be used at any time without hindrance and lead as directly as possible to a safe area.
- In the event of danger, it must be possible for workers to evacuate all workstations quickly and as safely as possible.
- The number, distribution and dimensions of escape routes and exits depend on the use, equipment and dimensions of the site, the rooms, and the maximum number of persons that may be present.
- Specific escape routes and exits must be indicated by prominent signs that are sufficiently resistant to the environment (UV etc), and placed at appropriate points.
- Escape routes and exits requiring illumination must be provided with emergency lighting of adequate intensity in case the lighting fails.

19.4.4 Fire detection and fire fighting

- Depending on the characteristics of the site, the dimensions and use of rooms, the on-site equipment, the physical and chemical properties of the substances present and the maximum potential number of people present, an adequate number of appropriate fire-fighting devices must be provided, and -where required- fire detectors and alarm systems be installed.
- Check and maintain these fire-fighting devices, fire detectors and alarm systems regularly.
- Appropriate alarm tests and fire drills must take place at regular intervals.
- Non-automatic fire-fighting equipment must be easily accessible and simple to use.
- The equipment must be indicated by prominent signs.
- Such signs must be sufficiently resistant to the environment (UV etc) and placed at appropriate locations.

19.4.5 Ventilation

- Take steps to make sure there is sufficient fresh air, allowing for working methods used and the physical demands placed on workers.

- If a forced ventilation system is used, keep the system in good working order. Do not expose workers to draughts, which may be harmful to health.
- Any breakdown of ventilation must be indicated by a control system, if this is necessary for workers' health.
- For certain areas involving specific risks it might be required to interrupt any ventilation to confine the effects of an incident to a limited area (stop dissemination of smoke, gas, radiation, etc.), especially in areas with hazardous substances, cryogenics facilities, etc.

19.4.6 Exposure to particular risks

Workers must not be exposed to harmful levels of noise, or to harmful external influences such as gases, vapours or dust.

If workers have to enter an area where the atmosphere may contain toxic or harmful substances, or may have insufficient oxygen, or be inflammable, the confined atmosphere must be monitored and appropriate steps taken to prevent any hazards.

A worker must never be exposed to a high-risk confined atmosphere. He must at least be watched at all times from outside and all appropriate precautions must be taken to ensure that he can be assisted or rescued effectively and immediately.

19.4.7 Environmental temperatures

During working hours, the temperature must be appropriate for human beings, allowing for working methods used and physical demands placed on the workers.

19.4.8 Natural/artificial lighting of workstations, rooms and traffic routes on site

- Workstations, rooms and traffic routes must have, as far as possible, sufficient natural lighting. It must be provided with appropriate and sufficient artificial lighting at night or when natural daylight is inadequate. If necessary, use portable light sources that are protected against impact.
- The colour of artificial light used must not alter or affect the perception of signals or signposts.
- Lighting installations for rooms, workstations and traffic routes must be placed so that there is no risk of accident to workers because of the type of lighting fitted.
- Rooms, workstations and traffic routes where workers are especially exposed to risks in the event of failure of artificial lighting must have emergency lighting of adequate intensity.

19.4.9 Doors and gates

- Sliding doors must be fitted with a safety device to prevent them from being derailed and falling over.

- Doors and gates opening upwards must be fitted with a mechanism to secure them against falling down.
- Doors and gates along escape routes must be appropriately marked.
- Near gates intended primarily for vehicle traffic, there must be doors for pedestrians, unless it is safe for pedestrians to cross. These doors must be clearly marked and kept clear at all times.
- Power operated doors and gates must operate with minimum risk of accident to workers, and must be fitted with emergency stop devices that are easy to identify and access. Unless they open automatically in the event of a power cut, it must be possible to open them manually.

19.4.10 Traffic routes – danger areas

- Traffic routes, including stairs, fixed ladders, loading bays and ramps, must be designed, located, laid out and made negotiable to ensure easy, safe and appropriate access to prevent risk to workers employed near these traffic routes.
- Routes used for pedestrian traffic and/or goods traffic, including those used for loading and unloading, must be dimensioned in accordance with the number of potential users and the type of activity concerned.
- If vehicles are used on traffic routes, there must be sufficient safety clearance or adequate protective devices for other site users.
- Routes must be clearly marked, regularly checked and properly maintained.
- Sufficient clearance must be allowed between vehicle traffic routes and doors, gates, passages for pedestrians, corridors and staircases.
- If the site includes limited-access areas, these must have devices to prevent unauthorised workers from entering.
- Appropriate measures must be taken to protect workers who are authorised to enter the danger areas. Danger areas must be clearly signposted.

19.4.11 Loading bays and ramps

- Loading bays and ramps must be suitable for the dimensions of the loads to be transported.
- Loading bays must have at least one emergency exit point.
- Loading ramps must have sufficient safeguards to prevent workers from falling off.

19.4.12 Freedom of movement at a workstation

The floor area at a workstation must allow workers sufficient freedom of movement to perform their work, allowing for any necessary equipment or appliances present.

19.4.13 First aid

- The Contractor must make sure that First Aid can be provided, and that the staff trained to provide it are available at any time.
- Make sure that workers who have had an accident, or have suddenly been taken ill, can be removed for medical treatment.
- There must be one or more first-aid rooms if the scale of the works, or the types of activity carried out, so require.
- First Aid rooms must be fitted with essential first-aid installations and equipment, and be easily accessible to stretchers.
- First Aid equipment must be available at all places where working conditions so require. This equipment must be suitably marked and easily accessible. Display clearly the address and telephone number of the local emergency service.

19.4.14 Sanitary equipment

Changing rooms and lockers

- There must be appropriate changing rooms for workers if they have to wear special work clothes and if, for reasons of health or propriety, they cannot be expected to change in another area.
- Changing rooms must be easily accessible, big enough and provided with seating.
- Changing rooms must have facilities to enable each worker, where necessary, to dry his working clothes as well as his own clothing and personal effects, and to lock them away.
- If necessary (e.g. dangerous substances, humidity, dirt), e facilities to allow working clothes to be kept separate from workers' own clothes and personal effects shall be provided.
- There must be separate changing rooms, or separate use of changing rooms, for men and women.
- If changing rooms are not required as above, each worker shall be provided with a place in which he can lock away his own clothes and personal effects.

Showers and washbasins

- There must be suitable showers in sufficient numbers for workers, if required by the nature of the work, or for health reasons.
- There must be separate shower rooms, or separate use of shower rooms, for men and women.
- Shower rooms must be big enough to permit each worker to wash without hindrance in conditions of an appropriate standard of hygiene. The showers must have hot and cold running water.
- Where showers are not required, there must be a sufficient number of suitable washbasins with running water (hot water if necessary) near workstations and changing rooms.
- There must be separate washbasins, or separate use of washbasins, for men and women when so required for reasons of propriety.
- Where the rooms housing showers or washbasins are separate from changing rooms, there must be easy communication between the two.

Lavatories and washbasins

- Special facilities with an adequate number of lavatories and washbasins must be provided for workers near workstations, rest rooms, changing rooms and rooms housing showers.
- If required, there must be separate lavatories, or separate use of lavatories, for men and women.

19.4.15 Break rooms

- Where health or safety so requires, in particular because of the type of activity carried out, or the presence of more than a certain number of employees, and the remote nature of the site, there must be easily accessible rest rooms and/or accommodation areas for workers.
- Rest rooms and/or accommodation areas must be large enough, and equipped with enough tables and seats with backs, for the number of workers concerned.
- If there are no facilities of this kind, there must be other facilities provided in which workers can stay during interruptions in work.
- Fixed accommodation areas, unless used only in exceptional cases, must have sufficient sanitary equipment, a rest room and a leisure room. They must have beds, cupboards, tables and seats with backs. They must take into account the number of workers, and be suitably allocated if workers of both sexes are present.

19.4.16 Pregnant women and nursing mothers

Pregnant women and nursing mothers must be able to lie down to rest in appropriate conditions.

19.4.17 Workers with Disabilities

The workplace must be organised to allow for workers with disabilities, if necessary. This applies in particular to doors, passageways, staircases, showers, washbasins, lavatories and workstations used or occupied directly by disabled persons.

Appropriate measures shall be taken to ensure adequate assistance to workers with disabilities in case of an emergency.

19.4.18 Miscellaneous provisions

The surroundings and the perimeter of the site must be signposted and laid out to be clearly visible and identifiable.

There must be sufficient drinking water and possibly another suitable non-alcoholic beverage provided for workers at the site, both in occupied rooms and near workstations.

Workers must have facilities to allow them to prepare and eat their meals in satisfactory conditions.

Smoking shall be restricted to designated outside zones.

19.5 Work equipment and specific risks

The Contractor must obtain and/or use work equipment that complies with the provisions of any relevant international standard, EC directive, ESO member state regulations, Host State regulation or equivalent.

Maintenance: The Contractor must take measures necessary to ensure that work equipment is adequately maintained throughout its working life.

When the use of work equipment is likely to involve a specific risk to the safety or health of workers, the Contractor must take measures necessary to ensure that:

- the use of work equipment is restricted to those persons given the task of using it;
- in the case of repairs, modifications, maintenance or servicing, the workers concerned are specifically designated to carry out such work.

20 Work at high altitudes

Work at high altitudes is far more tiring and demanding than at sea level, and presents a certain medical risk, which can range up to fatality. Chilean workers law has specific provisions on work above 3000m above sea level (ASL).

The main risks related to work at high altitudes are:

- Mountain sickness
 - Acute Mountain Sickness – AMS is a term applied to a group of symptoms likely to occur in un-acclimatised people who make direct ascents at high altitude. It also occurs in people who partially acclimatise then make an abrupt ascent to a higher altitude.
 - High Altitude Pulmonary Edema – HAPE is abnormal fluid accumulation in the lungs resulting from mal-adaptation to altitude. HAPE rarely occurs below 2,500 m.
 - High Altitude Cerebral Edema – HACE is swelling of the brain thought to be caused by hypoxia-damage to brain tissue. HACE generally occurs above 3,500 m but has been recorded at 3,100 m.
- Impairment of concentration, reaction, judgement and physical aptitude, notably affecting the ability to conduct hazardous operations or machinery.
- Natural UV radiation, where indices at Cerro Armazones show extremely high levels.
- De-hydration.

Therefore, Supervisors shall:

- Refuse personnel working on the E-ELT construction to work at high altitudes, who do present signs of not being fit for this work environment;
- Only allow personnel working on the E-ELT construction to work above 3000m, who carry the necessary certifications.
- Ensure adequate on-site supervision (including information, instruction and verification/oversight); Failing personal supervision, establish a two-person scheme.
- Ensure adequate PPE and means of rescue, notably UV protection and oxygen, is available and – where required – actually used.

- Establish work processes and procedures to take adequate account of the limited physical and intellectual performance at high altitudes.

20.1 Specific responsibilities of personnel working on the E-ELT construction

All personnel working on the E-ELT construction must:

- be aware of the specific risks and hazards related to high-altitude work;
- wear the appropriate altitude-related PPE provided by his/her Supervisor;
- Take particular precaution and pay particular attention when executing potentially hazardous work or driving machinery;
- communicate altitude-related impairments, before they cause further harm.

20.2 Preventive measures

20.2.1 Prevention of altitude sicknesses

The best way to prevent altitude sickness is to acclimatise slowly and progressively, and to adapt behaviour to the environmental constraints. Before starting to work at high altitude or before visiting the high altitude site above 3000m, people have to stay one night at around 2000m to 3000 m altitude. The altitude at which a person sleeps is more important than the maximum height reached during the day. People with mild or moderate symptoms must immediately descend, and rest until recovered. However, if symptoms persist or become worse, immediate further descent is essential – even 500m can help. If available, give oxygen (via face mask). If available, use a hyperbaric bag or Portable Altitude Chamber. This is only a temporary measure to improve an AMS Victim, if descent is impossible.

General guidelines for proper acclimatisation include:

- Drink extra water or juices. Mountain air is dry and cold, and moisture is lost with breathing. Evaporation of sweat may occur unnoticed and result in dehydration.
- Alcohol is forbidden at all ESO high altitude sites, not only because of its inebriating properties, but it can increase the risk of dehydration.
- Eat light, high-carbohydrate meals.
- Avoid sedatives and similar medication.

Never use medicinal treatment instead of descending, without consulting an ESO physician or paramedic at the site. Medicines can reduce symptoms, but they can also mask warning signs.

Evacuate immediately anyone suffering from HACE or HAPE, to a medical facility for proper follow-up treatment.

Visitors must never stay for more than 4 hours per day at the high altitude site.

20.2.2 Prevention of UV/sunlight related hazards

The main personal preventive measures for environment/weather conditions are:

- Skin protection: for example, wear clothing that covers arms and legs, and a hat; apply a broad-spectrum sunscreen of sun protection factor 15+ liberally on areas of the body not protected by clothing, and reapply it frequently.
- Eye protection: for example, wear UV-protection sunglasses of a wrap-around design, and a wide-brimmed sun hat.
- Drink extra water or juices, in case of low humidity and dehydration.

20.3 Prior high-altitude examinations as condition for access and work

Work at altitudes above 3000m ASL at the Cerro Armazones requires the following clearance:

20.3.1 ESO members of personnel

ESO members of personnel have to have successfully completed a high-altitude examination within the past year, according to the HR/Safety Internal Memorandum of 7 March 2008. It is strongly advised to carry a paper-copy.

20.3.2 Contractors

Contractors ascending to the Armazones peak are required to either present a (max. one year old) medical certificate from their occupational physician certifying on the basis of a high altitude exam, and that there is no known medical condition that makes it inadvisable for them to perform work beyond 3000m,

or provide a certificate signed by their HR department (max. one year old) stating that their employee meets the legal requirements and those of their workplace accident insurance (social security) to perform work at beyond 3000m.

20.3.3 Free-lancers and Visitors

Access for visitors to the E-ELT construction site must be authorised through the ESO headquarters office in Santiago, Chile.

Free-lancers (no compulsory work safety insurance) and authorised visitors to the E-ELT are required to read the informative pamphlet below, and sign the acknowledgement and release waiver before being escorted to the site.

20.3.3.1 ESO/E-ELT Release of Liability, Waiver of Claims and Assumption of Risks form for Free-lancers and Visitors

Date of visit: _____ (valid one week)
Time: _____
Location: _____ (continues on next page)

Please Read This Carefully

Visiting the E-ELT construction site or working there as self-employed free-lancer without compulsory work accident insurance, including transportation between the Base Facility and Summit Facility (hereinafter the “visit/free-lance work”) involves significant risks to the visitor/free-lancer.

You may encounter potentially hazardous conditions and situations which may result in serious bodily injury and/or death. The ESO E-ELT project facilities are being constructed for operation as a working laboratory and are operated as such. Some of the risks include, but are not limited to, unpaved and steep roads, loose rocks, slips, falls, exposure to sun, wind, and snow, dehydration, altitude sickness, motion sickness, extreme cold and adverse weather conditions, fire, and the presence and proximity of heavy equipment, machinery, and/or other equipment, within and around the E-ELT construction site.

The E-ELT project is located at the summit of Cerro Armazones, almost 3050m above sea level. Because of the elevation, ascent to the summit exposes you to a reduction in atmospheric pressure and oxygen capacity. You may suffer headaches, tiredness, irritability, lack of appetite, insomnia, reduced intellectual capacity, impaired exercise/exertion tolerance, nausea and/or vomiting. High altitude can be dangerous to those with heart and respiratory problems, SCUBA divers, children under the age of 16 and ill, pregnant or obese persons.

The altitude may also aggravate pre-existing conditions such as cardiovascular disease and respiratory disease. It is therefore strongly advised that all visitors/free-lancers seek the advice of their health care providers before visiting the summit.

_____ (Initial) I am aware that my visit/free-lance work involves risks which may result in serious bodily injury and/or death. I understand that the description of risks in this *Release of Liability, Waiver of Claims & Assumption of Risk* (hereafter referred to as “Document”) is not complete and that other risks or events that are known or unknown, anticipated or unanticipated, may result in serious bodily injury and/or death. In consideration of being authorised to this visit/free-lance work, I agree on my own behalf and on behalf of my children and all minors in my care, custody or control (hereafter included in “I” or “my”) to assume full responsibility for the risks identified herein and those risks not specifically identified, and hereby release from liability and waive any and all claims that I have or may have in the future against the European Organisation for Astronomical Research in the Southern Hemisphere, their affiliates, subsidiaries, officers, employees, contractors, subcontractor, agents, representatives and assigns, and any and all parties or persons acting on their behalf in connection with the visit/free-lance work (hereafter collectively referred to as “Releasees”). My participation in the visit/free-lance work is voluntary and at my own will. No one is forcing me to participate and I elect to participate having full knowledge of the risks associated with my participation.

_____ (Initial) I certify that:

- (1) I am in good physical health;
- (2) I am physically able to participate in the visit/free-lance work safely;
- (3) I have read and fully understand and agree to abide by and follow the Safety Advice provided; and
- (4) I will follow all instructions given by ESO Personnel; and
- (5) I have received the necessary instruction to participate in the visit/free-lance work safely. I agree to fully and forever release and discharge, and not to sue, Releasees for any injuries or damages, including property damage, that may result from, arise out of or be related in any way to participation in the Tour. If any portion of this Document shall be declared unenforceable for any reason, the

unenforceable portion shall be considered severed from the Document and the remainder of the Document shall not be affected thereby and shall be valid and enforceable to the fullest extent permitted by law.

I ACKNOWLEDGE THAT I HAVE READ THIS ENTIRE DOCUMENT AND THAT I UNDERSTAND ITS TERMS AND AGREE TO BE BOUND BY THEM. I UNDERSTAND THAT THE EFFECT OF THIS DOCUMENT IS THAT I AM RELEASING LIABILITY AND WAIVING MY RIGHT TO SUE RELEASEES AND I AM ASSUMING RISK FOR MATTERS RESULTING FROM, ARISING OUT OF OR RELATING IN ANY WAY TO MY PARTICIPATION, INCLUDING THE PARTICIPATION OF MY CHILDREN OR OTHER MINORS IN MY CARE, CUSTODY OR CONTROL, IN THE VISIT/FREE-LANCE WORK, INCLUDING BUT NOT LIMITED TO PERSONAL INJURY, DEATH AND PROPERTY DAMAGE. I ACKNOWLEDGE THAT THIS DOCUMENT APPLIES EVEN IF RELEASEES MAY BE NEGLIGENT IN WHOLE OR IN PART. I UNDERSTAND THAT THIS DOCUMENT APPLIES TO AND SHALL BE EFFECTIVE AND BINDING UPON ME, MY HEIRS, ASSIGNS, PERSONAL REPRESENTATIVE, ESTATE, ALL MEMBERS OF MY FAMILY, MINORS AND OTHERS IN MY CARE, CUSTODY OR CONTROL.

INDEMNIFICATION

I expressly agree to indemnify, defend and forever hold harmless Releasees against any loss or liability resulting from any and all claims, demands, or actions that have been made or may hereinafter at any time be made or brought against Releasees by the participant or any person or any entity holding by or through the participant or any insurance carrier or organization or person for payment or reimbursement of any debts, obligations, liens, joint tortfeasor claims or claims for contribution or indemnity, relating in any way to the injuries and/OR damages sustained or claimed by participant in the visit/free-lance work. This indemnification provision shall apply even if the claim, demand or action is based in whole or in part on actual or alleged negligence or other fault or responsibility on the part of Releasees.

DATED:

Name of participant (please PRINT): _____

Signature of participant: _____

(If participant is under 18 years of age, co-sign by parent or guardian.)

Address: _____

21 Meteorological hazards

Inclement weather can occur in the Cerro Armazones area. Volatile weather can exist any time of the year, and as such, contingencies must be made to deal with such events. Inclement weather and natural events that may exist in this area include:

- Thunderstorms and Lightning
- High winds
- Heavy snow or hail storms
- Fog and mist
- Flash floods and landslides

Therefore, Supervisors shall:

- Use the weather station information, as provided by Paranal Observatory.

- Visually monitor the actual weather situation
- Inform and instruct their supervisees accordingly
- Ensure adequate measures are taken in due advance time against adverse weather effects
- Ensure work processes and equipment are brought to a safe state, when the actual weather tends to exceed their environmental specifications.
- Promptly follow the authoritative instructions issued by ESO safety personnel in reaction to the meteorological situation

21.1 Specific responsibilities of E-ELT construction personnel

All E-ELT construction personnel must:

- be aware of, and never exceed the environmental specifications of the processes and equipment they operate (e.g. max. wind speeds for craning equipment);
- prepare for retreat, when meteorological conditions near alert levels;
- promptly follow the authoritative instructions issued by their supervisors or any ESO safety personnel in reaction to the meteorological situation

22 Personal protective equipment

E-ELT construction personnel are required to wear and use PPE required by the circumstance of their work. To this end, Supervisors shall coordinate with the E-ELT SSE to determine the requirements for use of PPE, in particular the period for which it is worn, on the basis of:

- the magnitude of the risk;
- the frequency of exposure to the risk;
- the characteristics of the workstation of each worker, and
- the performance of the PPE.

Supervisors must make sure that all PPE comply with general requirements on PPE detailed in section 22.2 below. PPE must be supplied free of charge to workers.

If multiple risks make it necessary for a worker to wear different items of PPE at the same time, Supervisors must make sure that all PPE are compatible and continue to be effective against the risks in question.

22.1 Specific responsibilities of E-ELT construction personnel

All E-ELT construction personnel must:

- be aware of which PPE is needed, why it is needed, when it must be used, repaired or replaced, and its limitations;
- wear the appropriate PPE provided by his/her Supervisor, depending on the risks he/she may be exposed to.
- make sure PPE is kept clean and in good repair, and stored properly when not in use; for example, in a dry, clean place. Follow the manufacturer's maintenance schedule (including recommended replacement periods and shelf lives);
- ask for replacement equipment when it is worn out.

22.2 General requirements for PPE

The use of PPE must not be regarded as an alternative to engineering or other suitable control measures. PPE must be provided and maintained where such control measures cannot ensure adequate protection.

PPE must:

- be suitable for the risks involved, without itself causing increased risk;
- be suitable for existing conditions at the workplace;
- take account of ergonomic requirements and the worker's state of health;
- fit the wearer correctly after adjustment;
- bear a safety conformity label, preferably CE marking, or other recognised labels, to provide evidence of conformity to the Host State's legal requirements;
- be provided with instructions in English. Another copy may be provided in the official language of the respective Host State.

CE marking, or other recognised labels, means that the PPE satisfies certain basic safety requirements and in some cases will have been tested and certified by an independent body.

Always give priority to engineering controls and safe systems of work to remove risk. PPE is the final personal protection against risks to health and safety, if other measures fail.



Figure 6. Examples of PPE

23 Safety signage

Safety signs are required where hazards, dangers and risks need to be highlighted and brought to the attention of E-ELT construction personnel and coincidental Visitors. All Supervisors shall provide appropriate health and/or safety signage, within their sphere of responsibilities and according to their knowledge about existing risks. Signs should however only used, if hazards cannot be avoided or adequately reduced by techniques for collective protection, or measures methods or procedures used in the organisation of work.

Supervisors must in particular take care to:

- use safety signage:
 - to draw attention rapidly to objects or situations affecting health and safety, and to achieve rapid understanding of a specific message;
 - for instructions that are related to health and safety.
- post safety signs where deemed necessary, ensuring their meaning is clear and unambiguous (i.e. people cannot misinterpret them to mean something else);
- inform all personnel appropriately about the meaning of safety signs.

23.1 General requirements

Where signs may not be self-explanatory, use supplementary text or signs.

Text on health and safety signboards must appear in English and may display as well in the language of the Host State.

Internationally standardised (by ISO/IEC/ITU) signage, colour-coding, symbols etc. shall be preferred over other systems (e.g., fire- or hazardous materials classification, electrical colour-coding.).

The scope of a risk assessment must include where to locate signs.

23.2 Signboards

Signboards are signs that provide specific information by a combination of a geometric shape, colours, a symbol or pictogram, and must be made visible by lighting of sufficient intensity.

Table 10 shows the meaning of colours and shapes that apply to health and safety signs.

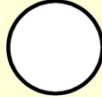



Colour	Meaning	Shape and Meaning			
					
Red	Sign prohibiting behaviour likely to incur or cause danger.	Prohibition	–	Fire-fighting equipment	
Yellow	Sign giving warning of a hazard or danger.	–	Warning	–	
Green	Sign giving information on emergency exits or first-aid or rescue facilities.	–	–	Absence of hazard First-aid Emergency escape	
Blue	Sign prescribing specific behaviour.	Mandatory	–	Information or instruction	

Table 10. Meanings of Colours and Shapes used for Safety signage

Outdoor signboards must be made from UV resistant material so that they resist adverse weather conditions, at least until the next inspection occurs.

The respective SSO must check signboards, to make sure that their characteristics and location remain adequate. Replace any deteriorated signboard immediately.

23.3 Illuminated signs

Illuminated signs are signs made of transparent or translucent materials, which are illuminated from the inside or rear in such a way as to give the appearance of a luminous surface.

Illuminated signs are mostly used for emergency and evacuation purposes.

Where direct sight of an emergency exit is not possible, there must be an illuminated directional sign (or series of signs) to help people find the emergency exit.

If normal lighting is interrupted, an emergency lighting system must provide illumination automatically for at least one hour, for premises evacuating immediately. The system must operate either

continuously (permanent lighting), or be capable of repeated automatic operation without manual intervention.

23.3.1 Estimating the viewing distance of signs

Signs can either be internally illuminated, such as exit boxes or edge-lit emergency luminaries (with a screened sign) that have a controlled luminance, or painted signs with an external emergency light illuminating them.

Maximum viewing distances are:

- Internally illuminated signs – 200 x panel height
- Externally illuminated signs – 100 x panel height

23.3.2 Luminance requirements

Illuminated signboards

The minimum luminance of any part of an illuminated signboard must be 2 cd/m².

Escape routes

For escape routes up to 2 m in width, the horizontal luminance on the floor along the centre line of an escape route must not be less than 1 lux.

Open areas (also called anti panic)

Areas larger than 60m², open areas with an escape route passing through them require emergency lighting.

The minimum luminance required for open areas (e.g. reception hall) is 0,5 lux, anywhere in the central core of the floor area. This core area excludes 0,5 m to the perimeter of the area.

The shadowing effects of movable objects in the core area are excluded.

Hazardous environments (high risk tasks)

There must be Emergency Lighting in any room where people at work would be especially exposed to danger if artificial lighting failed.

Areas of high physical risk (hazardous environments) must have emergency lighting to allow safe shut-down of systems. Emergency lighting must provide 10% of the normal lighting level at the hazard, with a minimum of 15 Lux.

Full emergency illumination must activate within 0.5 seconds and last for the duration of the hazard.

23.4 Acoustic alarm signals

An acoustic alarm signal is a coded sound signal, which is released and transmitted by a device designed for that purpose, without the use of a human or artificial voice.

Acoustic alarm signals must:

- have a sound level of at least 10 dB(A) above background sound level, with a minimum of 65dB(A) intensity. If lower than 15 dB(A) above the ambient noise level, there must be an additional visual signal (e.g. flashing light). In exceptional cases organisational measures may

also be used after approval of the SSE. The choice of the evacuation sirens must allow for the likely noise level of the environment, especially where hearing protection is being worn.

- be easily recognisable, particularly in terms of pulse length and the interval between pulses or groups of pulses, and be clearly distinct from any other acoustic signal and ambient noises.

If a device can emit an acoustic signal at variable and constant frequencies, use the variable frequency to indicate a higher level of danger or a more urgent need for the requested/imposed intervention or action compared with the steady frequency.

There must be a continuous signal for evacuation. Sirens must only operate during emergencies or emergency simulations. Place sirens in such a manner as to cause the least possible adverse noise effects on persons.

23.5 Verbal communication

Verbal communication is a pre-determined spoken message communicated by a human or artificial voice. It uses short texts, phrases, group of words and/or individual words, so that spoken messages are short, simple and clear as possible.

Examples are:

- 'Start' – to indicate the start of a command;
- 'Stop' – to interrupt or end a movement;
- 'End' – to stop the operation;
- 'Raise' – to have a load raised;
- 'Lower' – to have a load lowered;
- 'Forwards' – to be coordinated with the corresponding hand signals;
- 'Backwards' – to be coordinated with the corresponding hand signals;
- 'Right' – to be coordinated with the corresponding hand signals;
- 'Left' – to be coordinated with the corresponding hand signals;
- 'Danger' – for an emergency stop;
- 'Quick' – to speed up a movement for safety reasons.

23.6 Hand signals









A hand signal is a movement and/or position of the arms and/or hands, in coded form, for guiding persons who are carrying out manoeuvres that might be a hazard or danger for workers.

Hand signals must be precise, simple, expansive, easy to make and to understand, and clearly distinct from other such signals.

Where both arms are used at the same time, move them symmetrically, and to give only one signal.

Hand signals apply in particular to construction sites, and are used by a signaller (person with specific training) to give manoeuvring instructions to the equipment operators.

Table 11 shows the meaning of hand signals.

<i>Meaning</i>	<i>Description</i>	<i>Picture</i>
General Hand Signals		
Attention/Start (attention; start of command)	Point the right arm upwards with the palm facing forwards.	
Stop (interruption; end of movement)	Extend both arms horizontally with the palms facing forward.	
Vertical Movements		
Raise	Point the right arm upwards with the palm facing forward, and slowly makes a circle.	
Lower	Point the right arm downwards with the palm facing inwards, and slowly make a circle.	
Slow	Small waiving movements with the horizontally extended right arm.	
Horizontal Movements		
Move forwards	Bend both arms with the palms facing upwards. Make slow movements of the forearms towards the body.	
Move backwards	Bend both arms with the palms facing downwards. Make slow movements with the forearms away from the body.	
Move Right (to the signalman's)	Extend the right arm more or less horizontally with the palm facing downwards. Slowly make small movements to the right.	




Meaning	Description	Picture
Move Left (to the signalman's)	Extend the left arm more or less horizontally with the palm facing downwards. Slowly make small movements to the left.	
Horizontal distance	Space your hands to indicate the relevant distance.	
DANGER hand signals		
DANGER (emergency stop)	Both arms point upwards with the palms facing forwards.	

Table 11. Meanings of Colours and Shapes used for Safety signage

23.7 Barricades or tapes

Barricades are an effective means of communicating information concerning safety hazards to observers so that risk of injuries resulting from these hazards can be avoided. Below are described some types of barricades that may be in use at the E-ELT construction site.

23.7.1 Red/white barricade = danger

This type of barricade tape indicates DANGER and that a potential serious hazard may be present.

Keep out!

No personnel, other than those assigned to work inside a red/white barricade, may enter without first obtaining permission from the erector of the barricade. This barricade is used for, but is not limited to, the following:

- Overhead work;
- Live electrical components;
- Scaffold under construction;
- Around swing radius of equipment with a rotating superstructure.

23.7.2 Black/yellow barricade = caution

This type of barricade serves as a caution to indicate to employees of a potential hazard. Personnel must not go beyond the barricade without permission from the erector of the barricade. This barricade tape is primarily used for the following:

- Excavation less than 1,2 meters in depth;
- Identification of tripping hazards and low hanging objects;
- Material storage on the site.

23.7.3 Black/white barricade = housekeeping

Black/White barricades indicate housekeeping, aisle and lane marking.

Note: Remove or cover safety signs and barriers promptly when a hazard no longer exists.