ROYAL INSTITUTE
OF TECHNOLOGY

SAFETY REGULATIONS

for laboratories, workshops and power supply units at Space and Plasma Physics, Fusion Plasma Physics (Alfvén Laboratory), School of Electrical Engineering, KTH

September 2010

Lars Blomberg, Director, Space and Plasma Physics

Per Brunsell, Director, Fusion Plasma Physics

SAFETY

Work at the Alfvén Laboratory involves laboratory work employing high voltage, vacuum and laser equipment, as well as chemicals. Ionizing radiation is also created and used. There are mechanical workshops, where machine tools are used.

The object of these safety regulations is to minimise the risk of personal injury associated with all the various activities of the laboratory. Important prerequisites for minimizing the hazards are: Knowledge, consideration, caution and common sense. The individual employee or student needs to be personally convinced that he/she has sufficient knowledge of the performed activities, in order to be able to conduct them in the safest manner. References are made to handbooks and instructions, which should always be consulted unless already known.

It is everyone's responsibility to follow these regulations. Furthermore, anyone noticing any departures from these rules and/or incidents that could result in danger is obliged to notify the head of the department. Everyone is also urged to be vigilant of potential hazards, even if they are not covered in these instructions.

VALIDITY

Everyone who uses the facilities at the Alfvén Laboratory **must** obtain a copy of these safety codes and study the text in detail. For those performing work in the accelerator hall, there is a special set of radiation protection regulations, appended here. The safety regulations should be acknowledged and studied in detail. By signing the instructions the signer agrees to follow the regulations.

These regulations apply to all work performed when equipment in the laboratory is used, irrespective of it being permanently or temporarily installed. The person in charge of a laboratory or conducting an experiment is fully within their rights to order an immediate stop to hazardous experiments as well as ban those who violate these regulations from using the laboratories.

IN CASE OF ACCIDENTS
Call ambulance and fire brigade: 00-112
Then, call KTH's internal alert number 7700

IN CASE OF BUILDING DAMAGE OR MALFUNCTION
Call Akademiska Hus: 020 – 55 20 00

ASSEMBLE POINT
Assemble point after evacuation of the building, see the KTH Directory.
The area currently to be used is: the KTH Sports Hall, Brinellvägen 38

RULES

High Voltage

The hazards associated with non-insulated high voltage conductors are obvious. The following is applicable:

1. Conductors that are at high voltage (i.e. >600 V AC phase to ground, >900 V DC to ground) should be encapsulated or sealed off, e.g. through permanent barriers, and clearly labelled with warning signs.
2. Only permanent connections may be used in high voltage installations. I.e. crocodile clips, banana plugs or similar are not permitted.
3. All metal objects close to high voltage nodes must be connected to protective ground.
4. Capacitor banks must have an effective shorting provision for each unit, i.e. two independent systems of which one is, e.g., pneumatic.
5. Inductive loads must be equipped with over-voltage protection.
6. For parts fed by a high voltage circuit the leads should be shorted and grounded before being handled. This also applies to insulated connection leads.

Protective Grounding

Within the laboratories, protective grounding should be employed for all apparatus, unless it has double insulation.
For certain measurements , it is necessary to disconnect the protective ground of an instrument mains cable. In such cases, make sure that the instrument cases are interconnected via the measurement cables and that one of the instruments maintains a protective ground connection.

Vacuum

Glass vessels: The potential energy in a vacuum vessel of $1m^3$ is 100 kJ, i.e. almost as much as in a dynamite stick. Clearly an implosion could result in the complete destruction and devastation of the surroundings. Therefore, protection screens made of e.g. polyvinyl acetate should be used and placed so that persons normally are situated outside the screen.

Glass windows: Large glass windows on vacuum vessels, where implosions can result in injuries, should be provided with protection made of vinyl plastic, perspex or a metal wire net.

Protective goggles: Protective goggles must be used whenever in a hazardous zone.

Liquid Air

Liquid nitrogen should be used instead of liquid air, due to the fire hazard.

Laser

The instructions in the “Intern föreskrift” number 39/94, Laser utrustning, KTH-handbook 4, should be followed when using a laser.

The head of the department has designated a certain person to be responsible for the laser safety. Refer to the delegation order in effect.

Ionizing Radiation

Separate radiation protection regulations apply to work within the accelerator hall, see appendix "Safety regulations for the accelerator hall". The head of the department has designated a certain person to be responsible for the ionizing radiation safety. Refer to the delegation order in effect.

Chemicals

Main rule: The work with chemicals can be hazardous. The risk of fire, explosion, poisonous intake etc. must be taken care of. Work should be well planned. Many chemicals have toxic effects on the human body. Care should always be taken.

Knowledge: The best protection is to have knowledge of the chemical properties of the substances and their various reactions. Always follow the instructions carefully and read SAX: "Handbook of Dangerous Materials". Also, read the safety regulations for KTH's chemistry work. These can be found in the KTH Handbook No 4.

Work area: Keep the work area clean, tidy and free from unnecessary items and chemical containers. Find out where the emergency shower, fire extinguisher, and first aid kit are located and how to use them!

Fume hoods: All experiments where toxic,, corrosive substances or aggressive solvents are present must be performed inside a fume hood. Always make sure that its suction fan works properly.

Storage of chemicals: Chemicals must be stored in specially designated areas. The chemical containers must always be labelled clearly stating the content and with applicable warnings.

Poisons: Toxic substances must be stored in the appropriate locked closet. Remaining quantities must be placed in the closet immediately after use. Use rubber gloves.

Diluting acids: When diluting concentrated acids, e.g. sulphuric acid, always pour the acid carefully into the water. Never the other way around!

Pipette use: Using a pipette to draw toxic or highly corroding substances is preferably done with a suction bulb or a water suction installation. **Never by mouth!**

Chemicals and organic volatile liquids, which cannot be disposed of without risk, must not be poured out into the sink, but must be stored in vessels with the contents being clearly stated, in order to be sent for disposal in a knowledgeable and professional manner.

The head of the department has designated a certain person to be responsible for hazardous substances**, as well as one** for flammable substances. Refer to the delegation order in effect.

Mechanical Injury Protection

Whenever there is a risk for mechanical injury, for example due to shaft couplings, shaft pivots and belt pulleys, the appropriate protection should be arranged.

Existing protective devices on machinery and other equipment may not be removed.

Protective Switch

Permanently installed experiments must have protective switches, which much be clearly indicated and have sufficient circuit breaking capacity. Protective switches must be easily accessible.

Handling of Live Parts

All possible arrangements must be made to maintain the highest possible safety standards to avoid any touching of live parts. However, parts that carry low voltage (in dry environments $\leq$ 25 V AC or $\leq$ 60 V DC), e.g., leads in electric welding machines may be touchable.

Variacs and autotransformers: Note that the transformer's terminals may be on full voltage depending on how the plug contact is turned. **In case the transformer is furnished with a panel switch, make sure that this disconnects all poles!**

Ground fault breakers: Note that a ground fault breaker does not work properly in all situations. It reacts to the sum of currents in the phase and neutral conductors and shuts off in case this exceeds 10 to 30 mA. This means that in a full transformer, the secondary winding can supply current along any path without the breaker shutting off.

Capacitors: High voltage capacitors must be discharged and short-circuited before they are handled. The hazard associated with voltage recovery after the capacitors being discharged should be observed very closely. Large capacitors must be stored short-circuited.

The Responsibility of the Managers

Before the person responsible for the laboratory, his/her substitute or the one in charge of the experiment leaves the laboratory at the end of the day, he/she must make sure that all voltage sources are disconnected. Exceptions may be applied to work that is judged to be non-hazardous or tests that have been judged to be of no risk to people or property, even without attendance. In such cases labels and a safety barrier should be set up around the experimental area.

Responsibility of Notification

Anyone who notices that the equipment, set-ups and connections or the manner in which an experiment is being conducted may result in human injury, fire or other material damage, is responsible to notify the findings to the head of department or the safety representative.

Permanent Installations

The main principle is that all permanent installations must be performed in accordance with electrical safety codes. From 1 July 2004 the old regulations ELSÄK-FS-1994:7 are in effect parallel with the new regulations ELSÄK-FS 2004:1, which can be found on www.elsakerhetsverket.se. Make sure to note that there are two electricity supply systems at the Alfvén Laboratory: One 3-phase 400/230 V system with neutral wire and another 3-phase 230/130 V system without neutral wire. All installations must be conducted and overlooked by fully knowledgeable professional personnel, who are also responsible for adhering to the safety codes during the time of work. (For example work on or in a dangerous proximity to live parts.)

Experimental Installations

Certain experiments may require (to produce scientifically useful results) that permanent installations contain items non-compliant with the letter of the electrical safety codes or not covered by these codes. These items should be made and used in such a precautious manner, so that they can be considered equivalent to the spirit of the safety codes in order to prohibit personal and material injury. This practice is only acceptable when dictated by the scientific quality of the experiment, it may never be used as a "short-cut" in order to save time or reduce work.

Do not start the experimental devices without first inspecting them as well as consulting the person who used it the last time.

Semi-provisional Systems

When more or less long-term systems of provisional character are used, e.g., in case of large research work in development, the installations should be done to prevent personal and material injury in such a way as stated in the safety regulations.

Systems Designed within the Laboratory

Devices of permanent nature, made within the department, should be built to correspond to the intentions of the applicable safety regulations.

Power Hand Tools

Precaution must be taken when working with power hand tools. **Use protective goggles.**

Work Precautions

Work may be done in the laboratory only with another person in attendance, able to provide aid with little delay, unless the work is obviously of low risk.

Workshops

The tools, machines, welding sets, etc may only be used by competent personnel.

Machines and tools: The workshop machines may only be used if the hazards are regarded as very small, and if another person is in attendance, able to provide aid with little delay. The existing protective devices on the machines must never be removed.

Lifting devices: Lifting devices like telphers, traverses, trucks etc, may only be manoeuvred by persons having received instructions in their use by experienced personnel. Heavy lifts may not be done by anyone alone.

INSURANCE PROTECTION

Personnel employed by KTH are covered by the national occupational insurance system. Please note that this is only applicable during working hours, including travelling to and from the work area!

Other people, who conduct work in the Alfvén Laboratory without being employed by KTH, are urged to check that their own personal insurance coverage is appropriate for the work/activities that they are planning.

GUEST SCIENTISTS

The host for the guest scientist or another non-temporary visitor at the Alfvén Laboratory has the responsibility to inform the guest of the safety codes at the laboratory, as is deemed applicable.

Appendix: Safety Regulations for the Accelerator Hall

I. All the personnel of the accelerator group and persons taking part in experiments in the accelerator hall must know these instructions. It is the duty of the head of each research group to see to it that the group members read and understand the regulations and that the personnel know the location and function of safety circuit breakers and alarm signals.

II. All work shall be planned in such a way that minimum possible individual doses are received. Each unintentional quarterly dose detectable by the personal thermo luminescent dosimeters – sensitivity limit about 0.05 mSv (5 mrem) – should be regarded as a failure and corrective measures taken. The body dose shall fall below 3 mSv/quarter (300 mrem/quarter). Doses higher than that shall be reported to the head of the group, who shall investigate the cause, if necessary, together with the radiation protection superintendent.

III. Mishap or incident which has implied or could have implied major human exposure shall be reported to the local safety representative .

IV. Whenever an accelerator is running, a responsible operator shall be present. Only persons approved in writing by the radiation protection superintendent may be responsible operators. For each accelerator, a register of such persons shall exist in the accelerator hall. The register shall be revised at least once a year.

All accelerator operation involving the activation of powder, fluid, or gas, not belonging to the permanent installation, shall have a responsible experimentalist.

A journal including type of operation, possible essential deviations from the normal exposure situation, responsible operator, and, if applicable, responsible experimentalist shall be kept, so that it clearly can be understood who has the responsibility of radiation protection while each accelerator is running. Observations of interest for radiation protection shall be noted in the journal.

V. New experiments or modifications involving an essentially changed situation for radiation protection, shall be approved in advance by the safety representative.

VI. The responsible operator is obliged to:

1. When required, assure that a responsible experimentalist exists and is available within five minutes.

2. Each day, before starting an accelerator, make sure that the radiation monitors are functioning.

3. Before each start or restart, make sure that no person is loitering behind the concrete shields and that the interlock circuit for doors is working.

4. Convince him- or herself that the actual radiation situation is not giving rise to too high radiation levels outside the shields (See VII) or have the parts of the accelerator hall evacuated, where the integrated neutron and photon dose rate is (will be) too high.

Note: To allow for a rapid and simple measurement, it can be assumed that the race-track microtron gives the same neutron as photon radiation level in this area.

5. After each run at electron energies higher than 8 MeV, judge – with the aid of fixed or portable monitors – to what extent access to accelerator room or experimental space can be permitted and, when needed, supervise that doors and gates are closed before the area is left after finished work. (See VII)

6. See to that required journals are kept.

VII. Dose rate limits for access to different areas:
(Observe that the radiation level can vary greatly even between adjacent areas!).

a) Up to 2,5 μSv/h (0,25 mrem/h): Free entrance.
b) Up to 10 μSv/h (1 mrem/h): Continuous work can be permitted, but the person staying in the area shall carry a personal dosimeter.
c) Up to 100 μSv/h (10 mrem/h): Only a short stay (up to an hour per week) can be permitted. A portable monitor shall be carried.
d) Up to 1 mSv/h (100 mrem/h): Stay shorter than one minute can be permitted for the accelerator group personnel or a specially instructed member of a research group.
e) Over 1 mSv/h (100 mrem/h): Entrance forbidden.

VIII. The responsible experimentalist shall, before and after each exposure run, make sure that the experimental apparatus used is in such a condition and kept in such a way that activity of importance from the radiation protection point of view cannot leak out.

IX. Induced activity and contaminated objects.

a) Before work with active objects is begun, all parts shall be controlled with a radiation monitor. The question whether the work can be initiated is determined from case to case with regard to point II, but a upper limit of 1 mSv/h (100 mrem/h) at the surface is applicable unless it is the case of intentionally produced radionuclides.

Note: The radiation often consists of positrons or electrons. Thus, protective hoods around the monitor should be removed during the measurement.

b) Objects which are moved to the workshop for machining shall be ”inactive”.

c) Protective coat and protective gloves shall be used while working with active objects. The work shall, as far as possible, be done in the fume hood, which is situated inside the concrete screens of the circular microtron and the linear accelerator. Disposable plastic gloves and a special toolbox are found nearby the fume hood. The fume hood is mainly intended for work with and storage of active objects.

d) Contaminated consumable articles shall be disposed of in the active waste bin.

e) Hands shall be washed immediately after finished work.

f) Active objects shall be kept in the fume hood or – in case of mildly active dustless solids – in the special decay tray for decay situated in the experimental space of the racetrack microtron.