FAQ Radiation Protection OD2019

The aim of this document is to give you some answers to questions that could arise from visitors attending the event "CERN Open Days 2019". This document have been prepared by the HSE Unit. As this list is not exhaustive, you can also inform the persons interested that members of the Radiation Protection Group are present in the building 500 (main entrance) during the event.

CERN and Radiation

1. What is ionizing radiation? What are the different types of ionizing radiation? What types of ionizing radiation are found at CERN?
   "Ionizing radiation (or radiation)" refers to particles (such as protons, neutrons, electrons, pions, etc...) or electromagnetic radiation (such as radio waves, visible light or UV radiation - but at higher energy) that may deposit enough energy in matter to ionize it (release electrons from atoms or molecules). The types of radiation commonly encountered in industrial or medical applications are alpha radiation (helium nuclei consisting of two protons and two neutrons), beta (electrons, positrons) and gamma (photons). All these types of radiation are used or produced at CERN.

2. Why does ionizing radiation pose a health risk?
   By ionizing tissue, ionizing radiation disrupts the various biological processes that occur in the cells or exposed organs. There may be a change in the biological properties of the cell so that they can then no longer play their role or there might be an alteration to the genetic material (DNA) causing mutations or death of the cells. Although the human body has mechanisms to repair cell damage, which occurs continuously, it is possible that these repairs can be faulty. If the damage is severe because the radiation dose received was too large, there may be adverse consequences on health.

3. What are the protective means against the risks associated with ionizing radiation?
   To minimize exposure to persons from radiation, shielding reducing or stopping radiation is used. Depending on the type and energy of the radiation, a sheet of paper may be sufficient (for low-penetrating particles) whilst in other cases several meters of concrete or iron may be necessary.
   The other two methods commonly used are to limit the exposure time (by optimizing interventions) and to increase the distance from the radioactive source (by using specific tools or remote intervention means).

4. What is radioactivity?
   The property of certain atomic nuclei to disintegrate spontaneously while emitting particles or electromagnetic radiation. As a consequence of the disintegration a new element or isotope is created. Radioactivity can be naturally occurring or artificially produced when the atoms' nuclei are bombarded.

5. What is the radiological impact of CERN's activities on the environment and its nearest neighbours?
   The radiological impact of CERN is very low. CERN's emissions remain well below the limits set by the regulations. To be sure, 800 online monitoring stations are spread over CERN's sites and in the vicinity, including detectors located at CERN's entrances, which measure the radioactivity of objects crossing the sites' gates. Teams from the Occupational Health and Safety and Environmental Protection Unit at CERN (HSE) also take samples of ambient air, soil, watercourses, groundwater, vegetation and agricultural products in the area and perform thousands of tests each year.

   This monitoring is supplemented by independent tests carried out by the Swiss Authorities (OFSP) and the French Authorities (IRSN). The results of these independent tests, which are published, confirm the insignificant impact of CERN on the environment.

   For the year 2016, the persons living very close to CERN's sites were exposed to a maximum annual dose limit of 12 microSv, which corresponds to less than 1% of the annual dose to which these people are exposed from other sources of ionizing radiation (cosmic rays, radon, medical examinations). For comparison, the dose received during a flight Paris-New York is about 35 microSv.

6. What is the radiological impact of CERN's activities on the people who work there?
People working at CERN in the accelerators may be exposed to higher doses but they are still very low. The exposure of these persons is continuously monitored by wearing a dosimeter. Today about 11,000 people are followed because they work in areas where radiation may be present but almost all of them receive such a negligible dose (less than 1 mSv / year) that they can be considered as persons non-exposed to radiation with respect to the regulations.

Only a few dozen workers exceed the annual limit for non-exposed persons, but even these people remain below 3 mSv in any consecutive 12-month period, whilst the legal limit is 20 mSv in any consecutive 12-month period.

People working at CERN do not suffer from diseases caused by ionizing radiation.

In general, CERN's population is in good health.

7. Is it dangerous to live over the LHC or SPS tunnel?
The SPS and LHC tunnels are located at a depth of 30 to 100 m below ground. At this depth there is more than enough earth to protect surface areas against the radiation emitted by the accelerators during their operation.

8. Is it dangerous to stay near an accelerator during its operation? Do people work in the tunnels during the operation of the accelerators?
According to the energy, intensity and type of accelerated particles, radiation levels can be very high near the beam line when the accelerator is running. Therefore, a person present in these areas during the operation of the accelerator could be exposed to a very high radiation dose with significant consequences for their health. This is why CERN has put in place a very high performance system for access control and the protection of persons as well as strict procedures to ensure that no one is present in the accelerator during operation.
These systems also ensure that the beams cannot be injected by mistake when these areas are occupied.

9. Why is the LHC underground?
The LHC was installed in an existing tunnel that previously hosted the electron-positron collider LEP. The average depth of the earth above the tunnel is 100 meters (between 50 to 175 meters depending on the location), considering the geological layers giving maximum stability to the infrastructure. This construction has the advantage of protecting the detectors against unwanted interactions with high energy cosmic radiation. The fact that the accelerator is underground also ensures that radiation from accelerator operation is absorbed in the layer of earth, therefore protecting surface areas.

10. Why does CERN produce radioactivity?
The energy of the particles studied at CERN is sufficient to cause changes in the nuclear structure of the atoms bombarded with particles from the beam. As a consequence, these nuclei become radioactive and decay by emitting ionizing radiation. The production of radioactivity is an unwanted but unavoidable result of the operation of high-energy accelerators. Significant efforts are made (particularly in the choice of the materials used for the construction of beam lines and infrastructure as well as in the techniques for the "manipulation" of the beams) to minimize the activation of materials.

11. Where can you find radioactivity at CERN?
Wherever the beam interacts with matter there is a possible risk of activating matter. In particular the beam absorber blocks, the collimators and the target areas are known to be radioactive. The equipment present during beam operation in these radiation areas is potentially radioactive and subject to strict controls and monitoring.

12. Are radioactive areas accessible during the event "Open Days 2019" ?
Some radiologically classified areas are accessible within the framework of the event or with guided tours organised throughout the year. The itineraries have been studied carefully by the Radiation Protection Group to ensure that the dose received by visitors is inferior to 1 microSievert (µSv). To make a comparison, the dose received during a dental X-ray is in the order of tens of µSv. The radiological impact on visitors

participating in the event is therefore negligible. For comparison, the dose received during a flight Paris-New York is about 35 microSv.

13. Is there a risk of contamination in the accessible areas during the event?
There are two means of exposure to ionizing radiation: from external exposure (the radioactive source is external and at a distance from the body) and from internal exposure (due to incorporation in the body of radioactive material). The risk of external exposure has been minimized so that the health risk to visitors participating in the event (see above) is negligible. Few areas at CERN are concerned by a risk of internal exposure and these areas are not accessible to visitors as part of this event.

14. Does CERN use radioactive sources?
Yes, CERN's physicists use radiation from radioactive sources to test and calibrate the detectors used for physics experiments. Standards and very strict rules govern the use of radioactive sources at CERN.

15. Why do we sometimes see white smoke clouds over CERN?
The white clouds that can sometimes be seen over CERN have two sources. They can come from the traditional cooling towers for the electrical power installations for example. In this case, it's just fog. They can also come from the cooling of the LHC accelerator. In order to operate in a superconducting state, the LHC needs to be cooled to -271 ° C. The first step taken in this cooling process is to use liquid nitrogen to cool the helium which will ultimately circulate in the accelerator underground. During this process, the helium transfers its heat to the nitrogen, which then changes from a liquid to a gaseous state before being released into the atmosphere, which can create aqueous mist. This phenomenon is absolutely harmless because nitrogen is the highest constituent of the air that we breathe, composed of 78% nitrogen and 21% oxygen.

16. Does CERN generate radioactive waste? How is it managed?
Material that has become radioactive after being used in the accelerators becomes radioactive waste when it no longer has an identified use. Significant efforts are made (particularly in the choice of materials used for the construction of beam lines and infrastructure as well as the techniques for "manipulation" of the beams) to minimize the activation of material as well as the production of radioactive waste.

The radioactive waste produced by CERN is eliminated through the existing channels in the Host States, France and Switzerland, according to the procedures in force in these countries. Part of the radioactive waste can be temporarily stored and pre-treated on CERN's sites under the close supervision of CERN's Occupational Health and Safety and Environmental Protection Unit (HSE). By its nature the radioactive waste produced at CERN is very different to that originating from the nuclear fuel cycle. The specific activity levels involved are much lower, the life-time of the radionuclides concerned are short or medium and, with rare exceptions, the waste does not pose a contamination risk (the radioactivity is "fixed" in the mass of the material) and therefore storage does not pose a risk to the environment.

17. How does CERN measure radioactivity or radiation levels?
CERN applies European and international radiation protection standards and continually strives to limit radiation exposure as much as possible. CERN's emissions remain well below the limits set by the regulations. To be sure, 200 online monitoring stations are spread over CERN's sites and in the vicinity, including detectors located at CERN's entrances which measure the radioactivity of each object crossing the sites' gates. Teams from the Occupational Health and safety and Environmental Protection Unit at CERN (HSE) also take samples of ambient air, soil, watercourses, groundwater, vegetation and agricultural products in the area and perform thousands of tests each year.

With regards to exposure of persons, this is controlled by dosimeters which must be worn in areas with a radiation risk. The limits set by CERN regarding the exposure of staff and visitors are based on the regulations of the European Union.

18. Is there a website where it is possible to view the radiation measurements at CERN?
The measurements made at CERN's facilities are not published online. However, CERN produces an annual report intended for the public which is published by the Swiss Authorities. In addition, the results of the OFSP's

measuring station (Federal Office of Public Health) situated on CERN's Meyrin site are available online at the website: http://www.radair.ch/

19. Why does the name CERN include the word "nuclear"?
CERN was founded in 1954, at a time when the main objective of fundamental physics research was to understand the interior of the atom, that is to say the nucleus, hence the use of the term "nuclear". For all that, the research carried out at CERN is not at all focused on nuclear energy, neither on the resulting applications. Today, as our understanding of matter goes beyond the atom's nucleus, CERN should be called the "European Laboratory for Particle Physics," the name we give it sometimes.

20. Is there the possibility of a nuclear explosion at CERN?
No, to cause a nuclear explosion, it is necessary to have significant amounts of fissile material to initiate a chain reaction. CERN uses very small amounts of fissile material and only on limited occasions for physics experiments, the quantity is insufficient to initiate such a reaction.

21. What is the difference between CERN's accelerators and a nuclear power plant?
The purpose of a nuclear power plant is to produce electricity from the heat released in a nuclear chain reaction. There is no reactor at CERN neither a sufficient amount of fissile material to initiate and sustain a chain reaction. The reactions studied at CERN are initiated by particle beams and cannot lead to a chain reaction. The electrical energy required for the operation of the accelerators is also much higher than the one deposited in matter following the interaction with particle beams.

22. Why isn't iodine distributed to people living near to CERN?
The distribution of stable iodine pills to people living near nuclear power plants is a preventive measure in case of an accident against the incorporation of radioactive iodine, which is produced following fission of the uranium or plutonium used in nuclear fuel. Radioactive iodine inhaled or ingested can increase the risk of thyroid cancer. The iodine pills serve to saturate the thyroid with stable iodine to prevent the radioactive iodine from attaching.

Because a nuclear accident releasing radioactive iodine cannot happen at CERN, it is pointless to distribute iodine to people living near CERN.

23. Does CERN conduct research to develop nuclear weapons?
According to the constituent convention (the treaty that founded CERN), CERN's mission is fundamental particle physics research. The convention explicitly prohibits CERN from conducting research for military purposes.

24. What rules vis-à-vis nuclear safety are applied at CERN?

In matters of safety and security, CERN meets the European and international standards.

CERN has always collaborated with its two Host States, France and Switzerland, to make the laboratory's radiation protection and radiological safety practices transparent. CERN regularly communicates the results of radiological measurements for example to the Nuclear Safety Authority (ASN) in France and to the Federal Office of Public Health (OFSP) in Switzerland. Both Authorities also conduct visits at CERN. Finally, CERN presents its rules, practices, procedures and projects to the ASN and OSFP during regular Tripartite meetings.

Acronyms:

OFSP : Office Fédéral de la Santé Publique (CH)
ASN : Autorité de Sûreté Nucléaire (FR)
IRSN : Institut de Radioprotection et de Sûreté Nucléaire (FR)

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