received dury 2/16/99

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LIMITED ACCESS AREA
INSTRUCTIONS TO VISITORS AND CONTRACTORS

INTRODUCTION

Neutron Products' Limited Access Area (LAA) is the portion of the facility where radioactive material is processed and stored. Entry to the LAA is restricted to prevent unauthorized access to Radiation Areas and to isolate radioactive contamination.

The major radioactive isotope found in the LAA is cobalt-60. Cobalt-60 is a metallic, manmade isotope that emits beta and gamma radiation. The beta radiation has low penetrating power and is completely absorbed by a thin layer of material, usually the stainless steel cladding which encapsulates the cobalt-60. However, the gamma radiation has very high penetrating power. Reducing the radiation emitted by high activity source to safe levels requires several inches to several feet of shielding material. Materials commonly used for shielding gamma radiation include lead, steel, concrete, and water.

The major facilities housed within the LAA include:

The Main Storage Pool and Transfer Canals - A 22,000 gallon, stainless steel lined pool, 24 ft at its deepest level where cobalt-60 inventory is stored. The pool is filled with high purity water, which shields the gamma radiation and cools the sources. Valved pass-throughs connect the pool to transfer canals used to move radioactive material into and out of the hot cell and irradiator storage pools. Items are handled underwater using long manipulator tools. The pool water circulates through a system that removes radioactive contamination, impurities, and heat.

The Hot Cell - A steel lined room with thick concrete walls where cobalt-60 is processed, calibrated, and transferred to and from shielded shipping containers. Operators use master-slave manipulator arms to handle radioactive material remotely. A five-foot thick window made of high density glass allows for observation of the cell. Personnel access is through a thick, heavily shielded door. An interlock system prevents entrance to the cell when high dose rates are present.

Hot Cell Exhaust System - Air from the hot cell exhausts through a series of high efficiency filters that remove over 99.99% of any airborne radioactive contamination before venting. The filters, fans, and other components of the system are located on the second floor in a normally locked room. As the filters collect contamination, the dose rate close to this equipment becomes significant.

Courtyard - The outside portion of the LAA which is surrounded by a security fence. Cobalt-60 shipping containers enter and leave the LAA through the courtyard gate which, except during shipping and receiving, is closed and locked. The courtyard also provides access to hot waste storage.

Hot Waste Storage - Two shielded rooms store radioactive waste. The doors of these vaults are normally locked.

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The LAA also includes workshops, laboratories, offices, storerooms, and a shielded room used for storage of contaminated tools and equipment.

RADIATION EXPOSURE AND HEALTH EFFECTS

Biological radiation doses are expressed in rem, a unit that relates to the radiation energy absorbed and to the potential for specific kinds of radiation to inflict biological damage. Typically, doses are measured in millirem (mrem); 1000 mrem equals 1 rem.

High energy radiation can cause chemical changes to occur in living tissue. Chemical bonds can be broken and cells may be damaged or killed. Most biological damage is reversed by our biochemical repair mechanisms which have evolved to counteract such effects as those from background radiation.

Radiation health effects may be acute or chronic. Acute health effects require exposure to doses of 25 rem or more in a short period usually hours or less. The seriousness of acute effects depends on the total dose received and the area of the body irradiated. Acute effects resulting from whole body irradiation are sometimes known as radiation poisoning. These can include nausea, hair loss, immune system damage, fever, weight loss, and an increasing likelihood of death as short-term exposures reach 300 or more rem. Somewhat larger doses confined to a potion of the body such as a hand would result in a nonlethal radiation damage to tissues. Acute effects require rapid exposure to high doses that exceed the body's natural ability to repair damage. Similar exposures occurring gradually over prolonged periods would not result in acute effects.

Chronic effects result from repeated exposure to smaller doses over long periods of time. The most important and only well established chronic effect from low level radiation exposure for humans is cancer.

The health risks from high acute doses are well known; however, any risk associated with low levels of exposure cannot be directly measured. The risk of developing cancer from low dose exposure is very small compared to the prevalence of cancer in the general population. Any effect caused by low-level radiation is too small to be directly determined from health statistics. Government agencies, such as the Nuclear Regulatory Commission, apply what is known as the Linear-No Threshold Hypothesis to predict the risk from low level exposure and set regulatory limits. The Linear-No Threshold Hypothesis is a model which assumes that health effects are proportional to dose and that no minimum dose, or threshold, is required for effects to occur. Using this model, known effects at high doses are extrapolated to zero dose to predict the unmeasurable effects of lower doses. The hypothesis has not been proven; in fact, many scientific data contradict it. However, it does provide a highly conservative estimate of risk, preferred by the International Commission on Radiation Protection as a prudent basis for controlling exposure to radiation. The risk estimates cited here are published by the NRC and are based on the Linear-No Threshold Hypothesis.

The hypothesis predicts that 1 rem of exposure will result in 4 fatal cancers among 10,000 adults. 2,000 out of every 10,000 people normally die of cancer, so a 1 rem exposure is assumed to increases the risk of cancer fatality by 0.2%. Since the hypothesis is linear, the risk is directly proportional to the dose; for example, an exposure of 0.1 rem (100 mrem) would result in a increased risk of fatal cancer of 4 out of 100,000. Remember, this risk estimate is based on data from high doses at high dose rates. There is still uncertainty associated with this estimate. However, the NRC believes it is the best available for workers to use to make informed decisions concerning acceptance of the risks associated with exposure to radiation.

It is helpful to place the risk of exposure to radiation in context with other risks routinely encountered other common activities. The risk of developing fatal cancer from a 100 mrem exposure is roughly equal to that of smoking a pack of cigarettes. Risks from low-level radiation exposure are smaller than those associated with motor vehicle accidents, industrial accidents, alcohol consumption, and being moderately overweight. Radiation work, on average, is safer than other occupations.

It is also useful to compare occupational exposure to background exposure. The average individual in the United States is exposed to a dose of about 360 mrem a year. Most of the background exposure is from radon, other naturally occurring radioisotopes and cosmic radiation. Some exposure results from medical uses, like x-rays, and from consumer products.

REGULATORY DOSE LIMITS

Exposure to radiation may be external or internal. Internal exposure arises from ingestion or inhalation of radioactive material. For regulatory purposes internal exposure is reported as the Committed Effective Dose Equivalent (CEDE). The CEDE is calculated by converting the annual intake of activity to the dose that would result over the next 50 years. Calculation of the CEDE takes into account the nuclear decay rate, the retention of the isotope by the body, and the body organs targeted.

The NRC has established an annual limit for workers at 5 rem total effective dose equivalent (TEDE). The TEDE combines the whole body external exposure and the CEDE. The NRC limits the dose to extremities and skin to 50 rem per year and the lens of the eye to 15 rem per year. In addition, no internal organ can receive a dose equivalent above 50 rem from intakes during one year.

Pregnant woman and minors under eighteen are limited to an annual occupational TEDE of 500 mrem. Members of the public are limited to an annual dose of 100 mrem. In Maryland, the regulations concerning radiation safety are enforced by the Radiological Health Program of the Maryland Department of the Enviroment.

LAA SPECIFIC FACTORS

This section contains information about specific radiation safety aspects of the LAA. General instructions for limiting exposure are provided for guidance only. Conditions within the LAA are subject to changes which are immediately made known to occupants.

Dose Rates

The dose rate within the LAA varies from less than 1 mrem/hr to greater than 1 rem per hour. Any area with a dose rate exceeding 5 mrem per hour is considered a Radiation Area. Any area with a dose rate exceeding 100 mrem per hour is a High Radiation Area.

Radiation Areas in the LAA are found in the areas immediately surrounding and above the main pool and canals, the hot cell access room, decon room, the courtyard outside the hot waste storage rooms and on the second level outside the hot cell fan room. High Radiation Areas are found within the hot cell, contaminated tool room, and hot waste storage rooms. Access to High Radiation Areas is restricted and controlled.

Time spent in Radiation Areas should be limited to that required by the specific task being conducted. Once the task is completed, minimize exposure by moving to an area with lower a dose rate. Visitors are not allowed in High Radiation Areas unless specifically authorized.

The self-reading pocket dosimeter keeps track of your accumulated dose. Reading the dosimeter will provide feedback on how much radiation exposure you have received at any point during the LAA entry.

Contamination Control

The LAA is divided into zones based on the likelihood and degree of removable radioactive contamination.

Contamination Control Zones (CCZ) are areas which are treated as if they were contaminated at significant levels. Entry to a CCZ requires an extra pair of shoe covers and sometimes other additional protective clothing as appropriate. A CCZ may be established anywhere within the LAA based on sampling data or operations taking place. The CCZ will be cordoned-off or otherwise posted. Standing CCZs include: the roped off area in front of the main pool, the area behind the pool and south canal, the hot cell, hot cell access room, decon room, contaminated tool storage room, and the hot waste storage rooms. Visitors may not enter contamination control zones unless authorized to do so.

The General LAA is an area where significant removable contamination is not likely to be found. Contamination in the General LAA is, however, possible, and shoe covers are required. The area is routinely surveyed.

Clean Rooms serve as a buffer between the LAA and the rest of the facility and surrounding property. The contamination levels in the Clean Rooms are expected to be very low. The area is used for changing clothes, showering, surveying, and other activities associated with entry to and exit from the LAA.

To prevent migration of radioactive contamination from the LAA, protective shoe covers are worn. When moving from the General LAA to a CCZ, an additional layer of shoe covers is worn. When exiting a CCZ for the General LAA the outer most layer of shoe covers are removed at the step-off pad and deposited in the receptacle provided. When exiting the LAA to the Clean Room a step-off pad is provided for removing shoes and donning a new pair of shoe covers. Some operations in a CCZ may require gloves or disposable clothing. These are, also, removed before exiting the CCZ.

To reduce the chances of contamination, avoid casual contact with surfaces inside the LAA.

Airborne Contamination

Airborne contamination levels in the LAA are usually very low. Full time LAA personnel receive an insignificant fraction of their annual TEDE from airborne activity. During normal LAA conditions the likelihood of inhaling or ingesting a measurable quantity of cobalt-60 is very small, but remains finite.

Certain infrequent operations, such as hot cell decontamination or waste transfer, create the potential for airborne dispersion of fine radioactive particles. This raises the chances for inhalation or ingestion of a particle. Therefore, protective equipment like supplied air hoods or purifying respirators is used to prevent internal exposure. These activities are limited to trained Neutron employees.

ENTRY AND EXIT PROCEDURES

Unless otherwise specifically authorized, a knowledgeable escort is provided for all LAA visitors and contractors. Follow his instructions and those of LAA personnel when directed.

Prior to entry you will be given a self reading pocket dosimeter. This is in addition to the visitor's badge you received when entering the plant. Both of these are to be worn at all times while in the LAA. The pocket dosimeter measures accumulated dose, not dose rate.

Complete and sign a LAA Visitor's Form and the LAA Entry Log following the directions of your escort.

If you plan to bring any items with you into the LAA, bear in mind that they may become contaminated. All items will be surveyed for contamination before being released from the LAA. If found to be contaminated, every effort will be made to decontaminate the item. However, if decontamination efforts are ineffective, the item cannot be removed from the LAA. The taking of photographs or video tapes in the LAA is not allowed without prior permission.

To prevent the migration of radioactive contamination from the LAA and to minimize the potential for exposure, street clothes are not worn in the LAA. Coveralls will be furnished for your visit. Change into the clothes provided, and place a pair of shoe covers over your socks. Affix both dosimeters to the coveralls and proceed into LAA. Select a pair of shoes from the rack. These will have shoe covers on them already.

To exit the LAA, remove one shoe at a time at the step-off pad and replace on the rack. Remove one shoe cover and place in the receptacle and put on a new shoe cover. Repeat with the other foot.

Reenter the Clean Rooms and proceed to the frisking station. Under direction of your escort, slowly move the pancake probe over your body paying particular attention to hands, wrists, feet, face, neck, chest, and abdomen. If contamination is found, follow the instruction of health physics personnel.

Remove your protective clothing and go on to the shower room. Shower, scrubbing vigorously with a wash cloth and soap; shampoo your hair. After drying off, put on your underwear and a new pair of shoe covers on your feet.

You will be instructed in the operation of the HECM portal monitor. Highly sensitive beta counts will be taken from all four sides. Each count takes about thirty seconds. If contamination is found, health physics personnel will locate the activity and assist in decontamination.

If HECM results are negative, you may return to your street clothes. Submit all items carried out of the LAA for survey. Sign out on the LAA Entry Log recording pocket dosimeter reading and time out. Return pocket dosimeter to the rack.

CONCLUSION

This document is intended to provide information required for visitors and contractors to make informed choices regarding the potential risks of LAA entries and to impart essential radiation safety instructions. It is impossible to treat either topic exhaustively in a brief text. We encourage you to ask questions.