



SECTION 38

RADIATION SAFETY PROGRAM



1. GENERAL REQUIREMENTS

1. Maul Electric, Inc radiation safety program along with 29CFR 1910.1096 and 10CFR 20.1101 include provisions for project sites to keep radiation doses to workers “as low as reasonably achievable” (ALARA)
2. To satisfy this requirement Maul Electric, Inc requires that all project sites participate in the ALARA program
3. All workers will be advised of ALARA program and it is the project sites responsibility to help keep dose equivalents ALARA
4. Once a year, the site will review the summaries of the types and amounts of by-product material used, occupation doses, changes in radiation safety procedures, safety measures and continuing education and training of all personnel who work with or near the by-product material.
5. The project proponent will conduct all of these tasks in order to ensure that Maul Electric, Inc personnel are assured with reasonable level of safety and collective occupational doses ALARA.
6. If the reviews of performance indicate that the goals of ALARA are not met, the project proponent will take steps to reach those goals.

2. DEFINITIONS

- A.** Radiation – includes alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but such term does not include sound or radio waves, or visible light, or infrared or ultraviolet light.
- B.** Radioactive material – any material that emits, by spontaneous nuclear disintegration, corpuscular or electromagnetic emanations.
- C.** Restricted area – any area access to which is controlled by the employer for purposes of protection of individuals from exposure to radiation or radioactive material.
- D.** Unrestricted area – any area access to which is not controlled by the employer for purposes of protection of individuals from exposure to radiation or radioactive materials.
- E.** Dose – quantity of ionizing radiation absorbed, per unit of mass, by the body or by any portion of the body. When the provisions in this section specify a dose during a period of time, the dose is the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time.
- F.** Rad – a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit of mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue (1 millirad (mrad) = 0.001 rad)
- G.** Rem – a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roentgen (r) of X-rays (1 millirem (mrem) = 0.001 rem). The relation of the rem to other dose units



depends upon the biological effect under consideration and upon the conditions for irradiation. Each of the following is considered to be equivalent to a dose of 1 rem:

1. A dose of 1 roentgen due to X- or gamma radiation;
2. A dose of 1 rad due to X-, gamma, or beta radiation;
3. A dose of 0.1 rad due to neutrons or high energy protons;
4. A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye;
5. If it is more convenient to measure the neutron flux or equivalent, than to determine the neutron dose in rads, as provided in above paragraph (3)(G)(3), 1 rem of neutron radiation may, for purposes of the provisions in this section be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there is sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to 1 rem may be estimated from the table below:

Neutron Flux Dose Equivalents

| Neutron energy (million electron volts (Mev)) | Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm²) | Average flux to deliver 100 millirem in 40 hours (neutrons/cm² per sec.) |
|--|---|--|
| Thermal | 970 x 10⁶ | 670 |
| 0.0001 | 720 x 10⁶ | 500 |
| 0.005 | 820 x 10⁶ | 570 |
| 0.02 | 400 x 10⁶ | 280 |
| 0.1 | 120 x 10⁶ | 80 |
| 0.5 | 43 x 10⁶ | 30 |
| 1.0 | 26 x 10⁶ | 18 |
| 2.5 | 29 x 10⁶ | 20 |
| 5.0 | 26 x 10⁶ | 18 |
| 7.5 | 24 x 10⁶ | 17 |
| 10 | 24 x 10⁶ | 17 |
| 10 – 30 | 14 x 10⁶ | 10 |

- H.** For determining exposures to X- or gamma rays up to 3 Mev., the dose limits specified in this section may be assumed to be equivalent to the “air dose”. For the purpose of this section air dose means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dosage rate.

3. SIGNS AND LABELS

- A. All areas where work is conducted using radioactive materials or radiation shall be properly labeled using appropriate signs and symbols.
- B. The symbol used shall be the conventional radiation caution colors (magenta or purple on yellow background and of the conventional three bladed design).



- C. All radiation signs shall be posted in a conspicuous location and be visible to all workers and visitors.
- D. The sign shall bear the standard radiation symbol with the word “Caution” and proper phrasing for the type or level of radiation in the area (i.e. Radiation Area, High Radiation Area, Airborne Radioactivity Area, Radioactive Materials, etc..)



E.

4. EXPOSURE

- A. Ionizing Radiation
 - 1. Restricted Areas
 - a) Maul Electric, Inc, shall not poses, use, or transfer sources of ionizing radiation in such a manner as to cause any employee or individual in a restricted area to receive in any period of one



calendar quarter (3 month period) a dose of radiation in excess of those listed below.

| | Rems per Calendar Quarter |
|--|---------------------------|
| Whole body: Head and Trunk; active blood-forming organs; lens of eyes; or gonads | 1 ¼ |
| Hands and forearms; feet and ankles | 18 ¾ |
| Skin of whole body | 7 ½ |

5. AIR AND PERSONNEL MONITORING

A. Personnel Monitoring

1. Occupational exposure to radiation must be monitored by external devices and or bioassay when an adult is likely to receive, in one year from sources external to the body, a dose in excess of 10 percent of the limits given in the permissible exposure to radiation.
2. Minors and declared pregnant women likely to receive, in one year from sources external to the body, an dose in excess of 10% of any of the applicable limits. These limits must be a summation of external and internal doses.
3. Maul Electric, Inc, will follow the occupational dose limits requiring personnel monitoring as outlined in the federal guidelines. When volatile materials are used for research purposes the RSO will also ask that personal monitoring be conducted.
4. The use of individual monitoring devices for external dose is required for:
 - a) Adults who are likely to receive an annual dose in excess of any of the following (each evaluated separately):
 - a. 0.5 rem (0.005Sv) deep-dose equivalent.
 - b. 1.5 rems (0.015 Sv) eye dose equivalent.
 - c. 5 rems (0.05 Sv) shallow-dose equivalent to the skin.
 - d. 5 rems (0.05 Sv) shallow-dose equivalent to any extremity.
 - b) Minors who are likely to receive an annual dose in excess of any of the following (each evaluated separately):
 - a. 0.05 rem (0.5mSv) deep-dose equivalent.
 - b. 0.15 rem (1.5 mSv) eye-dose equivalent.
 - c. 0.5 rem (0.005 Sv) shallow-dose equivalent to the skin, or
 - d. 0.5 rem (0.005 Sv) shallow-dose equivalent to any extremity
 - c) Declared pregnant women who are likely to receive an annual dose from occupational exposure in excess of 0.05 rem (0.5 mSv) deep-dose equivalent, although the dose limit applies to the entire gestation period.



- d) Individuals entering a high or a very high radiation area. Internal exposure monitoring (not necessarily individual monitoring devices) is required. There are no such designated areas at Maul Electric, Inc.
- e) Adults likely to receive in one year an intake in excess of 10% of the applicable ALI's for ingestion and inhalation.
- f) For minors and declared pregnant women likely to receive in one year a committed effective dose equivalent in excess of 0.05 rem (0.5 mSv).

B. Monitoring of External Exposures

- 1. The personnel monitoring devices level depending on the area working and exposure level this will be determined by the RSO and Project Proponent.
- 2. All Necessary monitoring devices and medical surveillance will be provided by the project site and/or project proponent. MDH forms and NRC Forms 4 and 5 will be kept and filed, if this monitoring demonstrates that personnel were exposed to detectable levels of radiation. These forms are required only if recommended doses be exceeded by calculation or by demonstration through monitoring.

C. Placement of Personnel Monitoring Devices

- 1. If individual dosimeters are used, the monitoring device should be placed near the location expected to receive the highest dose during the year. For example, the badge should usually be worn on the lapel of the shirt. The finger-badge dosimeters should be worn on the index finger of the hand most likely to contact the radioactive material (Example: right hand index finger of right handed person) under the disposable glove which **must** be worn whenever working with radioactive materials.
- 2. Individual personal dosimeters should be removed and stored in a dark area away from extremes of sunlight, temperature or humidity at the end of the workday. Personal dosimeters should not be worn home or worn at any time outside of the work area. If inadvertent wearing of dosimeters outside of the work area occurs, notify the RSO summarizing any activities conducted during that time which might cause erroneous dosimeter results for that month. If work no longer requires a personnel-monitoring device, notify the RSO immediately so that ordering of dosimeters can be discontinued.

D. Occupational Exposure Limits

| <u>Part of Body</u> | <u>Adult Yearly (mrem)</u> | <u>Minors Yearly (< 18 yrs. age) (mrem)</u> | <u>Adult ALARA Yearly (mrem)</u> |
|--|----------------------------|--|----------------------------------|
| Whole Body, Head and Trunk, Active Blood Forming Organs (TEDE) | 5,000 | 500 | 500 |
| Lens of Eye (LDE) | 15,000 | 1,500 | 1,500 |
| Extremities (SDE) (Elbows, Forearms, Hands, Knees, Lower Legs, Feet) | 50,000 | 5,000 | 5,000 |



| | | | |
|--------------------------|--------|-------|-------|
| Single Organ Dose (TODE) | 50,000 | 5,000 | 5,000 |
| Skin of Whole Body (SDE) | 50,000 | 5,000 | 5,000 |

6. PREVENTING PERSONNEL AND FACILITY CONTAMINATION

- A. Maul Electric, Inc. management, the RSO, the RSC and all contractors must participate in the ALARA program. The initial training, refresher courses, individual training **will be provided by the proponent and/or project site**, which will also give the guidelines and the workers' responsibilities for maintaining ALARA. In addition to the attention to permissible levels and personnel monitoring requirements, the following guidelines are some of which will be used at Maul Electric, Inc. to keep exposure levels ALARA.
- B. Work areas must be labeled with the "Caution Radioactive Materials" sign, or marked off with the radioactive warning label tape. If the area is seldom used for radioactive materials, the area may be labeled only for the duration of the use, providing that it is surveyed for contamination and is free of contamination before the labels are removed. If the work area is frequently used, it is best to label the area permanently.

7. EMERGENCY SIGNALS

- A. All personnel working in areas where radioactive materials are used or stored shall be familiar with the emergency signals in use by the facility to order and evacuation.
- B. All personnel shall also be trained on proper emergency procedures for evacuation and isolation of the incident to assist in the prevention of contamination to personnel and the environment.

8. TRAINING

- A. Maul Electric, Inc., will ensure that all employees and personnel working in or visiting an area with a radioactive hazard have received proper training as prescribed by the Nuclear Regulatory Commission (NRC) as well as any applicable OSHA requirements or requirements set for by other governing agencies.
- B. Postings will be maintained and copies of documentation shall be made available to the employees for review.

9. RECORDKEEPING

- A. Maul Electric, Inc. will maintain records of the radiation exposure of all employees for whom personnel monitoring is required by the OSHA standard and advise each of his or her employees of their individual exposure at least annually.