HOW DO I DEMONSTRATE THAT I CAN MEET RH 4.14 AND 4.15 of the COLORADO RULES AND REGULATIONS PERTAINING TO RADIATION CONTROL?

Revisions to Part 4 of the State of Colorado Rules and Regulations Pertaining to Radiation Control were implemented on January 1, 1994, changing the radiation dose limits for individual members of the public from licensed radioactive materials. Under the new requirements, a licensee or registrant shall conduct operations so that: (1) the dose in any unrestricted area from external sources does not exceed 2 millirems in any one hour, and (2) the dose to individual members of the public does not exceed 100 millirems in a year.

Before the Department can issue or amend a radioactive materials license, it must be determined that you can meet these general public dose limits. The dose limits apply to the actual doses received from licensed materials. However, the determination that you can meet the limits is based upon the types and quantities of materials which you have requested and the facilities in which they will be stored and used. When the Department issues a radioactive materials license, the license authorizes you to possess the maximum quantity identified on the license. Therefore, you must demonstrate that you can meet all applicable requirements for the maximum quantity requested.

The following guidance can be used to demonstrate that you can meet these requirements with the quantities of materials requested on the license.

1. A "restricted area" means an area, access to which is limited or controlled by the licensee or registrant for purposes of protecting individuals against exposure to sources of radiation. Anyone who can frequent a restricted area must be properly trained and must wear personnel monitoring, unless it has been determined that the individual will receive less than 10% of the occupational dose limit.

   Any area outside of the restricted area (i.e., outside of the storage cabinet, rooms adjacent to the storage area, or outside the locked building), must not exceed 2 millirems per hour, and 100 millirems per year if the general public can occupy these areas.

   General public includes any individual who is not an authorized user of the licensed devices. Therefore, if secretaries, the company president, visitors or customers, or a neighbor can be in any area near your sources, then those areas must meet the above dose limits.

2. Dose rates may be determined either by actual measurement or by calculation. Measurements require a calibrated survey meter and a survey completed by someone knowledgeable in interpreting the results. Qualified experts are available to help with these tasks. If no radioactive materials are currently possessed, then a calculation would be used to determine what dose rates could exist with licensed materials within an area of interest. (Please note that if actual measurements are to be used to demonstrate compliance, the quantity of materials present in the storage area while measurements are being taken should be clearly indicated along with the results of the measurement.)

3. Measurements with the maximum number of authorized sources may not be possible. However, if you have one or more sources, it is acceptable to estimate the increase in the dose rate from a measured rate to the rate that could occur from a larger number of sources. For example, if the dose rate is measured outside a wall with one source present, you may assume that two sources would cause 2X the measured dose rate. (This estimate assumes that all sources are at the same place within the room, and have the same activity. If the sources present do not have the maximum authorized activity, then a correction factor is needed.)

4. Calculation of dose rates at a location does require some information with which to begin and a simple mathematical calculation. For example, with portable gauges the Transport Index (TI) can be read from the transportation label on the gauge shipping container. Alternatively, the manufacturer's representative can provide the Transport Index (TI) for the gauges you have requested. The TI is the dose rate in millirems per hour at one meter from the outside of the gauge shipping container. A total TI can be assumed to be the TI for a single gauge, multiplied times the number of similar gauges. For example, if the TI is "1.5" and you have five identical gauges, you may estimate the total dose rate at one meter to be 1.5 x 5, or 7.5 millirems per hour. If a source has a measured dose rate at a given distance, and then you move away from the source, the dose rate will decrease with the inverse square of the distance. That is, if you double the distance from a source you decrease the dose rate by a factor of four. The formula for this calculation is given below.

$$\mathbf{R_2 = \frac{R_1(D_1)^2}{(D_2)^2}}$$

EXAMPLE: If the dose rate at one meter from a source is 12 millirems per hour, what would be the expected dose rate at 3 meters?

R_2 = ?
R_1 = 12 millirems per hour
D_1 = 1 meter
D_2 = 3 meters

R_2 = 12 x 1/9
R_2 = **1.33 millirems per hour**

5. Dose rates must be multiplied by the time period of the possible exposure. For an individual over which you have no control (i.e., a neighboring house or office) **you must assume an exposure time of 24 hours per day for 365 days per year, or 8760 hours**. For members of the general public within your facility, which you do control, the exposure time may be 8 hours per day, five days per week, for 50 weeks per year (2000 hours per year). For example, a full time secretary for the company would have the dose rate at her desk multiplied by 2000 hours per year to calculate the annual dose. Occupancy factors for other areas which may be used to adjust exposure times are:

1.0 for: offices, work areas, living quarters, and areas not controlled by licensee

0.5 for: rooms used for patient exams and treatments

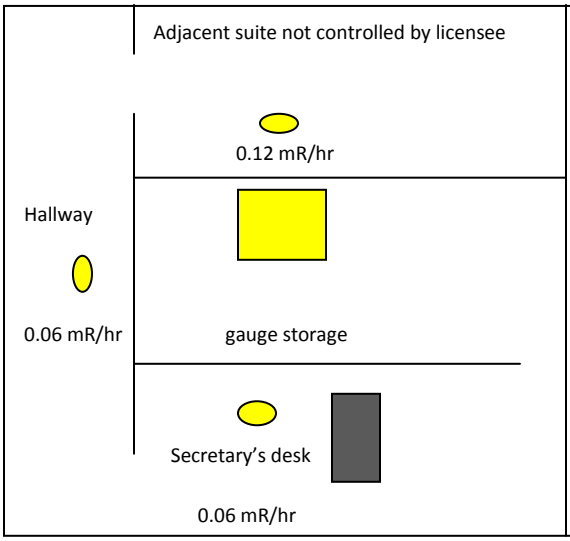
0.2 for: hallways, employee lounges and bathrooms

0.125 for: hallway doors

0.05 for: storage rooms, public bathrooms, outdoor seating areas, unattended waiting rooms, and vending areas

0.025 for: unattended sidewalks, parking lots, drop off areas, attics, and stairways

EXAMPLE: Assume your company is open to employees and visitors for 8 hours a day, 5 days per week for 50 weeks per year (2000 hrs per year). Assume your gauge storage area shares a wall with an adjacent suite owned by a different company and the back wall is adjacent to an unattended parking lot. Both the adjacent suite and the parking lot would use 8760 hours for exposure period as individuals in those areas are not under the control of the licensee. Using the exposure periods and occupancy factors provided, the dose estimates for annual exposure would be as follows:



Dose, hallway: 0.06 x 2000 x 0.2 = 24 millirems

Meets dose limits

Dose, Secretary's desk: 0.06 x 2000 x 1 = 120millirems

Parking Lot

0.04 mr/hr

Does NOT meet dose limits

Dose, parking lot: 0.04 x 8760 x 0.025 = 8.76 millirems

Meets dose limits

Dose, adjacent suite: 0.12 x 8760 x 1 = 1051 millirems

Does NOT meet dose limits

6. For the example above, action would have to be taken to reduce the dose to the secretary and to the adjacent suite. Choices include:
   - Decrease the number of sources in this area;
   - Add shielding to the storage cabinet or the walls between the storage cabinet and secretary and the storage cabinet and adjacent suite;
   - Increase the distance of the storage area to the secretary and adjacent suite;
   - A combination of the above.

7. The above calculations do not include calculations for shielding provided by brick or concrete walls. Books are available regarding shielding calculations and materials. However, a qualified expert or the manufacturer's representative should be able to perform calculations for the shielding provided by existing walls, or to design additional shielding, as necessary.

8. To demonstrate that you can meet 2 millirem per hour, and 100 millirem per year to a member of the public, submit a diagram together with the calculated or actual measurements of radiation dose rate for **each** area adjacent to the storage area. This should also include above and below the storage area if these are occupiable areas. Include with the measurements a "background" measurement, which is the radiation dose rate from the natural environment (excluding all licensed radioactive materials). Also include any assumptions you have made regarding occupancy. If you are authorized multiple storage locations, compliance with the dose rate and annual dose limit to the general public must be demonstrated for each location.

If you have specific questions, Ms. Cheri Hall, Licensing Lead, may be reached by phone at 303-692-3444, by fax at 303-691-7841, or by email at cheri.hall@state.co.us.

The Department's licensing staff are also available to answer questions and can meet with you prior to the submission of a license application to discuss any specific issues you may have regarding the licensing process, regulatory requirements, and the information to be provided with the application.