

# Boeing - SSFL EHS Manual

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## **SM-40.402, RADIOLOGICAL CONTROLS MANUAL: RADIOLOGICAL STANDARDS, JULY 13, 2012, JAMES BARNES**

**DOCUMENT CHANGE SUMMARY** – This document replaces issue dated November 27, 2007. Implements provisions of revised SOP C-401.

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### **APPLICABILITY**

This procedure applies to radiological activities conducted at the Boeing Santa Susana Field Laboratory (SSFL) campus (“Boeing - SSFL”).

The terms “shall,” “should,” “may,” etc. indicate procedural requirements or suggestions for good practices. These terms are intended to convey meanings typically used in quality assurance or standards documents (e.g., ANSI).

- “Shall” in this procedure denotes a mandatory requirement.

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- “Should” denotes a recommended practice, but which is not required. “Should” is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.
- “May” denotes an option. “May” indicates a course of action permissible within the limits of the procedure.

This procedure implements the requirements of SOP C-401, *Radiation Safety Program*. This procedure is intended to provide additional guidance to the requirements of the SOP. Stipulations of this procedure are to be interpreted in light of the SOP C-401 requirements.

Note that DOE dosimetry terminology has been changed. This procedure utilizes the former terminology. SOP C-401, Table 8 describes terminology equivalency.

## **PART 1 Administrative Control Levels and Dose Limits**

Boeing - SSFL's objective is to maintain personnel radiation exposure well below regulatory dose limits. To accomplish this objective, numerical Administrative Control Levels are established at levels below the regulatory limits to administratively control and help reduce individual and collective radiation dose. These control levels are multi-tiered with increasing levels of authority required to approve higher Administrative Control Levels.

Doses are measured in units of REM and mRem. The Committed Effective Dose Equivalent (CEDE) is used to assign internal dose received by personnel at Boeing - SSFL facilities. The CEDE is the resulting dose to the whole body over a 50-year period after intake from internally deposited radionuclides.

### **211 Administrative Control Level**

1. Administrative Control Levels (ACLs) are dose levels established that are less than regulatory exposure limits intended to serve as “hold points” to enhance control of radiation exposure.

ACLs for Boeing-SSFL are described in SOP C-401, Table 5; “Summary of Administrative Control Levels (ACLs) and Regulatory Dose Limits.”

2. In addition to the ACL, Radiation Safety may assign additional quarterly Investigation Levels<sup>1</sup> for administrative control purposes. These levels are assigned in the User Authorization. These levels can be adjusted by amending the User Authorization (See SOP C-401, Radioactive Materials and Ionizing Radiation).

No person **shall** be allowed to go above the Investigation Dose Level without the prior approval of the Radiation Safety Officer and the individual's cognizant senior manager.

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<sup>1</sup> Equivalent to the DOE's Facility Administrative Control Level.

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- An "Expected Dose Level" (EDL) indicates the routine maximum exposure expected for an individual in the activity. This EDL can be considered to be a planned maximum dose. This Level is determined by Radiation Safety from reviews of radiological conditions, past performance, proposed activities, etc. If the Level is exceeded, the inference is that the individual *may* have performed an action out of scope of the Authorization. Such a situation can be expected to trigger an *informal* inquiry by Radiation Safety.
- An "Investigation Dose Level" (IDL) assignment indicates that level of exposure which, if exceeded, would be considered strong evidence that the individual was engaged in activities outside the scope of the Authorization. Such an exposure would trigger a formal investigation by Radiation Safety personnel. The individual may be restricted from radiological work pending the outcome of the investigation.
- A "Suspension Dose Level" (SDL) assignment indicates that level considered to be strong evidence that the overall supervision and conduct of the activity was outside the scope of the Authorization. Such an exposure to an individual may suspend or restrict the scope of the Authorization pending the conclusion of a formal investigation by Radiation Safety personnel.

### 212 Lifetime Control Level

1. For workers involved in DOE-related work activities, in order to administratively control a worker's lifetime occupational radiation exposure, a Lifetime Control Level of **N REM shall** be established where N is the age of the person in years.

For workers whose lifetime exposure exceeds this control level, a Special Control Level (Article 216) for annual occupational exposure **shall** be established. The Special Control Level **shall not** exceed 1 REM. It *should* be established at such a level as to allow the person's lifetime occupational dose to re-approach N REM as additional occupational exposure is received.

2. The internal contribution to lifetime dose *should* continue to be reassessed as further bioassay results and improved methods for assessing internal dose become available.

### 213 Radiological Worker Dose Limits

1. Dose limits are provided in Table 2-1 (1) and **shall not** be exceeded. These regulatory limits are consistent with the "Radiation Protection Guidance to Federal Agencies for Occupational Exposure" signed by the President; with California Administrative Code Title 17; with 10 CFR 20, "Standards for Protection Against Radiation;" and with 10 CFR 835, "Occupation Radiation Protection."
2. Workers must meet the following requirements in order to be considered Radiological Workers for the purposes of these dose limits:

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- a. Complete Radiological Training as stipulated in Boeing - SSFL procedures or Use Authorization.
  - b. Complete any specialized training stipulated by facility procedure or Use Authorization.
  - c. Complete a Badge Issue Sheet (which details current and lifetime exposure information).
  - d. Submit a baseline bioassay sample, if anticipated duties warrant such sampling.
  - e. Obtain personal dosimetry, if required.
3. Planned Special Exposures (as defined in 10 CFR 835 and 10 CFR 20) will **not** be permitted for Boeing - SSFL personnel.
  4. Emergency exposure limits are not Planned Special Exposure limits. Guidelines for emergency exposures are provided in 1A.

### **214 Visitor Dose Limit**

Visitors to Boeing - SSFL sites **shall** be limited to an annual radiation dose as stipulated in SOP C-401, Table 5. Higher dose limits may be permitted only when the individual meets the requirements of Article 213 (i.e., qualifies as a radiological worker), or meets the special considerations of Article 657 (i.e. member of a tour group, a visiting dignitary, scientist or specialist; see SM-40.406).

### **215 Embryo/Fetus Dose Limits**

For the protection of the unborn fetus or embryo, the dose to a female radiological worker may be controlled to the limit stipulated in this section. This limit may be applied only after a female radiological worker voluntarily notifies Boeing - SSFL medical **in writing** that she is pregnant. When this letter is provided to medical, she is considered a “declared pregnant worker.”

1. Boeing - SSFL **shall** provide the option of a mutually agreeable assignment of work tasks, without loss of pay or promotional opportunity, such that further occupational radiation exposure is unlikely.
2. As described in SOP C-401, Table 5, for a declared pregnant worker who chooses to continue working as a radiological worker:
  - a. The dose limit for the embryo/fetus from conception to birth (entire gestation period) is 500 mRem.
  - b. Efforts *should* be made to avoid exceeding 50 mRem per month to the pregnant worker.

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3. If the dose to the embryo/fetus is determined to have already exceeded 500 mRem when a worker notifies her employer of her pregnancy, the worker **shall** not be assigned to tasks where additional occupational radiation exposure is likely during the remainder of the gestation period.
4. A declared pregnant worker status ends when:
  - ◆ The child is born
  - ◆ The pregnancy is terminated prior to birth of the child
  - ◆ The worker notifies Boeing - SSFL Medical **in writing** that she no longer wishes to be considered pregnant (i. e., revokes the declaration of pregnancy)

### 216 Special Control Levels

Certain situations may require lower individualized exposure control levels. The Radiation Safety Officer (RSO) is responsible for establishing these special controls. The RSO may wish to establish these Special Control Levels using advice from Radiation Safety professional staff and from appropriate Boeing - SSFL management.

Boeing - SSFL needs to be attentive to special circumstances of employees, such as those undergoing radiation therapy, and establish Special Control Levels as appropriate.

## PART 2 Contamination Control and Control Levels

Control of radioactive contamination is achieved by using engineering controls and worker performance to contain contamination at the source, reducing existing areas of contamination and promptly decontaminating areas that become contaminated.

### 221 Personnel Contamination Control

1. Personnel exiting posted areas (e.g., Contamination Areas, High Contamination Areas, Radiological Buffer Areas, or Airborne Radioactivity Areas) established for contamination control **shall** frisk for contamination as required by Article 338. These requirements may be suspended by Radiation Safety for personnel exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment.
2. Frisking equipment **shall** be provided in suitable locations for monitoring for contamination. Frisking equipment, under laboratory conditions, **shall** be able to detect total contamination of at least the values specified in SOP C-401, Table 2.2
3. Personnel found with detectable contamination on their skin or personal clothing, other than noble gases or natural background radioactivity, **shall** notify Radiation Safety for assistance. Individuals *should* be promptly decontaminated as described in Article 541 unless an emergency situation or medical condition would make such an attempt hazardous.

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## 222 Contamination Control Levels

1. Contamination may be present in a fixed condition or in readily removable condition. The limits for contamination are provided in SOP C-401, Table 2.2. Where levels meet or exceed the appropriate limits, the materials *should* be controlled appropriately. Where the levels are less than the applicable limits, the materials may be released from radiological controls.
2. Where radioactive contamination is volumetrically distributed within a material, the material is considered to be contaminated if any statistically significant activity above natural background can be identified by normal laboratory assessment techniques, e.g. "identifiable peaks" are noted during gamma spectroscopy (see Boeing - SSFL N001SRR140119, "Analysis of Hazardous Waste for Radioactivity").
3. If an area is found to have removable contamination in excess of SOP C-401, Table 2.2 limits, and cannot be decontaminated promptly, then it **shall** be posted as specified in Article 235.
4. Contamination may adhere tightly to a substrate ("fixed contamination"), or it may be removable ("removable" or "loose" contamination). If a substrate has fixed contamination, but the levels of removable contamination are below the applicable limits, then:
  - a. The following controls apply to the contaminated surfaces:
    - Routine radiological surveys **shall** be performed to detect contamination that may become removable over time.
    - A discrete area of fixed contamination (as opposed to an entire room surface) **shall** be delineated and marked to readily identify the location of the contamination. Markings *should* conform to the criteria of Articles 231 and 236, be clearly visible from all directions and contrast with the colors of the surface coatings. Area markings **shall** be kept legible.
  - b. Surfaces containing fixed contamination may be located outside Controlled Areas where unrestricted access is not likely to result in a dose to any person greater than 100 mRem in a year. Such exemptions **shall** be approved in writing by the RSO or listed in the User Authorization for the activity.

If additionally authorized by the RSO, such areas may be exempted from the general posting requirements of Article 231 and entry and exit requirements of Chapter 3.
5. Surfaces or materials less than the referenced limits may be released from radiological controls ("free-released"). [Note: At this writing, a moratorium is in place on removing clean materials from DOE sites or activities. Material may not be removed from these areas without the permission of the ETEC Restoration Project Manager.]

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6. Surfaces exceeding the values of SOP C-401, Table 2.2, "Surface Contamination Values in dpm/100 cm<sup>2</sup>," for total contamination may be covered with a fixative coating to prevent the spread of contamination.

Removable contamination *should* be reduced to below detectable levels before a fixative coating is applied.

A fixative coating **shall** not be applied<sup>2</sup> without the prior approval of the Radiation Safety Officer.

7. Areas where soil contains levels of radioactivity exceeding the limits for soil contamination listed in SOP C-401, Table 2.2, **shall** be appropriately posted to alert personnel to the presence of the contaminated soils.

### **223 Airborne Radioactivity Control Levels**

1. Personnel exposure to airborne radioactivity **shall** be maintained within regulatory exposure limits (see SOP C-401, Table 5 and Table 6; "Derived Airborne Concentration (DAC) values for Common Boeing—SSFL Isotopes"). Personnel *should* not be exposed unnecessarily to airborne radioactivity. Use of engineering and administrative controls to reduce the potential for internal exposure *should* be evaluated before allowing personnel, with or without respiratory protection, to enter areas with airborne radioactivity.
2. Occupied areas with airborne concentrations of radioactivity that are greater than or potentially greater than 10 percent of a Derived Air Concentration (DAC) (SOP C-401, Table 6) **shall** be posted as specified in Article 235. For most radionuclides, air containing 10 percent of a Derived Air Concentration results in a committed effective dose equivalent of approximately 10 mRem if inhaled continuously for one work week.
3. Estimates of intakes, using appropriate air sampling techniques and incorporating respiratory protection factors, for personnel working in Airborne Radioactivity Areas **shall** be determined and documented for each entry by Radiation Safety. Intake estimates *should* be expressed in DAC-hours.
4. [DELETED]
5. For purposes of compliance to the limitation of dose to workers, Total Effective Dose Equivalent (TEDE) may be calculated using the following formula:

$$\text{TEDE} = (\text{external whole body dose}) + (2.5 \text{ mRem} * \text{DAC-hours})$$

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<sup>2</sup> This coating is applied to hold the contamination in place. Strippable coatings that are applied and then subsequently removed in order to decontaminate surfaces are not subject to this control.

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Dose estimations based upon bioassay measurements and assessment *should* be used in lieu of this estimated dose where Committed Effective Dose Equivalent (CEDE) is:

- ◆ Greater than 10 mrem CEDE in a specific event (4 DAC-hours); or,
- ◆ Greater than 25 mrem CEDE in a calendar quarter (10 DAC-hours); or,
- ◆ Greater than 50 mrem CEDE in a calendar year (20 DAC-hours).

For some isotopes, Committed Dose Equivalent (CDE; direct organ dose) is more conservative than CEDE. In these cases, the following alternate controlling values are:

- ◆ Greater than 100 mrem CDE in a specific event (4 DAC-hours); or,
- ◆ Greater than 250 mrem CDE in a calendar quarter (10 DAC-hours); or,
- ◆ Greater than 500 mrem CDE in a calendar year (20 DAC-hours).

## **PART 3 Posting**

### **231 Posting Requirements**

1. Radiological posting **shall** be used to alert personnel to the presence of radiation and radioactive materials and to aid them in minimizing exposures and preventing the spread of contamination.

Facility-specific posting criteria may be provided in facility procedures or in User Authorizations. Such guidance **shall** supersede the requirements of this Program.

Posting signs **shall** be positioned where they are readily visible from any normal angle of approach. Sign lettering *should* be legible at a distance of 20 feet.

2. Signs **shall** contain the standard radiation symbol (ANSI trefoil) colored magenta or black on a yellow background. Lettering **shall** be either magenta or black, magenta being the preferred color over black. Standardized signs, as described in the standardized core training, *should* be used where practicable.
3. Radiological postings *should* be displayed only to signify actual or potential radiological conditions. Signs used for training *should* be clearly marked, such as "For Training Purposes Only."

Informational posting may be utilized to provide additional radiological instructions to the worker. The wording of these instructions *should* be succinct, i.e., long explanations or instructions may not be appropriate to a posting.

4. Posted areas *should* be as small as practicable for efficiency.

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5. Postings *should* be maintained in a legible condition and updated based upon the results of the most recent surveys.
6. If more than one radiological condition (such as contamination and high radiation) exists in the same area, each condition *should* be identified.
7. In areas of ongoing work activities, the dose rate and contamination level or range of each *should* be included on or in conjunction with each posting as applicable.
8. Entrance points to areas of ongoing work activities controlled for radiological purposes *should* state basic entry requirements, such as dosimetry, Controlled Work Permit (RWP) and respirator required.
9. Rope, tape, chain and similar barriers used to designate the boundaries of posted areas *should* be yellow and magenta in color.
10. Physical barriers *should* be placed so that they are clearly visible from all directions and at various elevations.

When the posting sign is applicable to general conditions within an enclosed area within a building structure, the sign **shall** be positioned near each normal access into the area.

When the posting is applicable to a sub-area within a larger physical area, the area affected by the posting sign **shall** be barricaded behind barrier ropes. The appropriate posting signs **shall** be spaced along the barrier rope to designate the area conditions. Adequate stantions *should* be used to hold the rope near waist level.

In lieu of barrier ropes, floor or wall markings may be used when barrier ropes would unnecessarily restrict normal traffic flow in an area. Combinations of floor markings and barrier ropes may be utilized to facilitate access into an area (e.g., at the entry into an area). Posting signs **shall** be provided to explain the purpose of the floor or wall markings.

11. Posting of doors *should* be arranged such that the postings remain visible when doors are open or closed.
12. Posting of "temporary" radiological areas may be waived if both of the following criteria are met:
  - The area will exist for 8 hours or less; and,
  - An individual remains in constant attendance at the area, and ensures that no individual exceeds the exposure limits established by Boeing - SSFL procedures or government regulations.

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Temporary conditions may be signified by the use of lights or audible alarms. In this situation, postings may be modified to apply when the condition is present; e.g., "High Radiation Area when Red Light is On."

## **232 Posting Controlled Areas**

1. Areas within the site boundary **shall** be clearly posted to alert personnel to the presence of radiation and radioactive materials above natural background levels. These areas **shall** be designated Controlled Areas. Perimeters of these areas **shall** be positioned such that persons who enter only a Controlled Area (without entering Radiation, Contamination, Airborne Radioactivity or Radiological Buffer Areas within the Controlled Area) will be unlikely to receive more than 100 mRem in a calendar year.
2. The type of sign used may be varied to avoid conflict with local security requirements. This selection **shall** be approved by the Radiation Safety Officer and the Manager, Security and Fire Services.
3. Dose rates outside of a Controlled Area boundary (i.e., uncontrolled areas), shall be limited to less than 2 mrem in any one hour and less than 100 mrem in a calendar year to an individual in the area.

## **233 Posting Radiological Buffer Areas**

1. A Radiological Buffer Area may be established within the Controlled Area to provide a secondary boundary to minimize the spread of contamination. The Radiological Buffer Area is intended for use where ongoing work activities may create airborne radioactivity or the spread of contamination. It is not expected that Radiological Buffer Areas would be established around inactive or secured Contamination Areas. In some cases, the establishment of a Radiological Buffer Area surrounding a Radioactive Materials Area may be appropriate.

Radiological Buffer Areas are a control measure for the containment of contamination. It is not a *requirement* that a Buffer Area exist around every Contamination Area. Entry into Buffer Areas *should* be controlled; they *should not* be considered routinely accessible.

2. The size of the Radiological Buffer Area *should* be commensurate with the potential for the spread of contamination outside Contamination, High Contamination and Airborne Radioactivity Areas. In general, the Radiological Buffer Area *should* include the area adjacent to any exit from and entrance to Contamination, High Contamination and Airborne Radioactivity Areas.

A separate Radiological Buffer Area is not required for High Contamination Areas that are completely within Contamination Areas.

3. [DELETED]

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4. Posting of Radiological Buffer Areas *should* be in accordance with Article 231. Postings *should* clearly identify a Buffer Area. Boundaries of Radiological Buffer Areas that are coincident with those of Radiation Areas may be posted as Radiation Areas in lieu of Buffer Areas.

### **234 Posting Radiation Areas (Radiation, High Radiation, Very High Radiation)**

1. Areas **shall** be posted to alert personnel to the presence of external radiation in accordance with SOP C-401, Table 2.1; "Criteria for Posting Radiation Areas," and Article 231.
2. Dose rate measurements used to determine criteria for Radiation Areas *should* be made at a distance of 30 centimeters (12 inches) from the radiation source or from any surface through which the radiation penetrates.

For **Very** High Radiation Areas, the measurement *should* be made at 100 cm.

3. Hot Spots *should* be posted where they contribute to a significant, non-uniform dose rate in the surrounding, accessible area. Contact readings (<1 cm) and associated readings at 30 cm *should* be used to determine the presence of and to characterize Hot Spots.
4. The type of personnel dosimeter used by the facility *should* be included on the sign if the personnel dosimeter is not an Optically Stimulated Luminescent Dosimeter (OSLD), Thermoluminescent Dosimeter (TLD) or Film Badge.
5. The requirement for an RWP may be included either on or in conjunction with the posting. Such postings *should* be used if such a requirement is not a normal operating procedure for the posted area and workers need to be alerted to the special requirement.
6. Doses should be posted based upon survey meter readings. The "averaging" of total doses over a period of one hour (where dose rates may exceed the posting guideline for short periods of time), may be used as the criterion for posting (Column 2 of Table 2-3) **only** with the specific approval of the Radiation Safety Officer. In this table, the unit "RAD" is associated with dose rates that pose an immediate danger, i.e., extremely high levels of radiation dose.
7. Areas where radiation levels are produced only by X-ray generating devices **shall** be posted as follows:

**General.** Except as provided below, radiographic operations **shall** be posted as described above.

**Facility Access.** Rooms or areas in which radiographic operations occur **shall** be posted with signs stating:

"AUTHORIZED PERSONNEL ONLY"

or

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"KEEP OUT"

as appropriate.

**X-Ray Controls.** All devices and equipment capable of producing radiation when operated **shall** be appropriately trefoil labeled so as to caution an individual that such devices or equipment produce radiation when operated.

The label(s) *should* be positioned near the operating controls. It *should* state:

"CAUTION"  
"PRODUCES X-RAYS WHEN ENERGIZED"

or words conveying the same intent.

**"Nested" Radiation/High Radiation Areas.** In field radiography operations, High Radiation Areas occur around the tube head. In lieu of posting both High Radiation Area and Radiation Area boundaries, a posting ("High Radiation Area") may be erected at the boundary of the Radiation Area, provided that High Radiation Area controls (i.e., "locked or guarded") are implemented at the boundary to the Radiation Area.

Note that these boundaries are to be erected at 2 mR/hr by survey meter reading.

### **235 Posting Contamination, High Contamination and Airborne Radioactivity Areas**

1. Areas **shall** be posted to alert personnel to contamination in accordance with SOP C-401, Table 2.3, "Posting Criteria for Contamination, High Contamination, Soil Contamination, and Airborne Areas," and Article 231.
2. The requirement for an RWP may be included either on or in conjunction with the posting. Such postings *should* be used if such a requirement is not a normal operating procedure for the posted area and workers need to be alerted to the special requirement.
3. Derived Air Concentrations ("DACs") for the common isotopes encountered at Boeing - SSFL facilities are listed in SOP C-401, Table 6; "Derived Airborne Concentration (DAC) values for Common Boeing – SSFL Isotopes."

### **236 Posting Radioactive Material Areas**

1. The definition of radioactive material and the requirements for labeling radioactive material are contained in SM-40.404.
2. Areas where radioactive materials are used, handled or stored *should* be posted "CAUTION, RADIOACTIVE MATERIAL." When used, the posting **shall** meet the requirements in Article 231.

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3. Where feasible, Radioactive Materials Areas *should* be located within Controlled Areas. Exceptions to this may be authorized by specific exemption in a User Authorization, when quantities of materials used do not warrant the additional restrictions associated with Controlled Areas (e.g., small laboratory quantities of materials, check sources, etc.).
4. Posting for Radioactive Material Areas is not required when the radioactive material is inside a posted Contamination or Airborne Radioactivity Area.
5. Areas may be excepted from the radioactive material area posting requirements of this Article when:
  - The area is posted as a Contamination Area, High Contamination Area, or Airborne Radioactivity Area; or,
  - Each item or container of radioactive material is labeled in accordance with SM-40.404, such that individuals entering the area are made aware of the hazard; or,
  - The radioactive material of concern consists solely of structures or installed components which have been activated (i.e. such as by being exposed to neutron radiation or particles produced in an accelerator).
  - The radioactive material consists of packages received from radioactive material transportation labeled and in non-degraded condition pending completion of a receipt survey (see SOP C-405, Instructions For Receipt of Shipments Containing Radioactive Materials).

### **237 Posting Underground Radioactive Material Areas**

1. Where radioactive material may be located underground, Radioactive Material Areas **shall** be established to indicate the presence of underground items that contain radioactive materials such as pipelines, radioactive cribs, covered ponds, covered ditches, catch tanks, inactive burial grounds, and sites of known, covered, unplanned releases (spills).
2. Underground Radioactive Material Area **shall** be posted as Radioactive Material Areas. Additional informational postings may be included to indicate the general location of the materials. The posting **shall** meet the applicable requirements of Article 231.
3. Where an underground Radioactive Material Area is not likely to result in a dose to a member of the general public in excess of the limits of Table 2-1 (i.e., 100 mRem/year), the areas may be located outside of Controlled Areas. The areas meeting these criteria are exempt from the entry and exit requirements of Chapter 3.