

November 2, 1999

MEMORANDUM TO: Robert C. Pierson, Chief
Special Projects Branch
Division of Fuel Cycle Safety
and Safeguards, NMSS

THRU : Michael Tokar, Chief
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FROM: Richard K. Struckmeyer signed by R. Struckmeyer
TWRS Section
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SUBJECT: TRANSMITTAL OF INFORMATION PAPER COMPARING
RADIOLOGICAL PROTECTION STANDARDS IN 10 CFR PART 20
AND 10 CFR PART 835

Attached is an information paper that deals with the comparison of regulatory approach, dose limits, and monitoring thresholds stated in 10 CFR Part 20, Standards for Protection Against Radiation (Nuclear Regulatory Commission) and 10 CFR Part 835, Occupational Radiation Protection (Department of Energy). This information paper is intended to provide insights on possible impacts of the differences in these standards on the Tank Waste Remediation System-Privatization (TWRS-P) project. It is expected that this will be followed by additional information papers, looking to bring the information together into a Point Paper dealing with a wider range of radiological protection issues concerning TWRS-P.

Questions regarding this document may be directed to myself at (301) 415-7251 or to Mr. Richard Struckmeyer at (301) 415-5477.

Attachment: Regulatory Limits for Occupational Dose
Applicable to TWRS-P

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REGULATORY LIMITS FOR OCCUPATIONAL DOSE APPLICABLE TO TWRS-P

Comparison of Regulatory Approach, Dose Limits, and Monitoring Thresholds Stated in 10 CFR Part 20, Standards for Protection Against Radiation (NRC) and 10 CFR Part 835, Occupational Radiation Protection (DOE)

October 20, 1999

1.0 Introduction

The Hanford Tank Waste Remediation System-Privatization (TWRS-P) contract is currently the responsibility of the U.S. Department of Energy (DOE); however, there is a possibility of a transition to regulatory oversight by the U.S. Nuclear Regulatory Commission (NRC) at some future date. Should this transition take place, certain aspects of the contractor's Radiation Control Program could be affected. The purpose of this paper is to provide an introduction regarding the similarities and differences between 10 CFR Part 20, Standards for Protection Against Radiation (NRC), and 10 CFR Part 835, Occupational Radiation Protection (DOE), and provide a basis for a future document to discuss how these differences may affect the regulation of the proposed vitrification facility. It also seeks to explain some of the regulatory philosophy of the DOE Regulatory Unit (RU) that is responsible for oversight of the TWRS-P contractor, and how this philosophy may differ from that of the NRC.

It should be understood at the outset that the NRC and DOE numerical dose limits are identical for individuals who receive occupational dose, and another set of identical limits applies to members of the public. However, differences exist between Part 20 and Part 835 with respect to definitions of the conditions under which monitoring is required, and how persons and situations are classified in terms of the type of monitoring performed.

Misunderstandings may sometimes arise through the usage of terms that are not defined in the regulations, but which are similar to, or have the appearance of formal definitions. These include worker, radiation worker, radiological worker (defined in Part 835 but not in Part 20), and occupationally exposed, among others. Tables are provided that list and compare the definitions contained in the two Parts.

A discussion is undertaken of Occupational Dose Limits and Limits for Members of the Public as stated in Parts 20 and 835; it will be seen that the limits are nearly identical. A comparison of Monitoring Thresholds mandated by Parts 20 and 835 is also presented.

The Radiological Exposure Standards Above Normal Background for the TWRS-P Project are derived from Part 835 and the DOE RU Top Level Standards, and for this reason do not have a directly corresponding regulation in Part 20 with which to compare. These Standards are discussed in Section 3.0.

ATTACHMENT

For the TWRS-P facility, in addition to the categories of general employee and radiological worker (defined in Part 835) and member of the public (defined in both Parts), a third category known as the co-located worker (CLW), has been defined within the "Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for TWRS Privatization Contractors," DOE/RL-96-0006, Revision 1, July 1998. The co-located worker is defined in Section 6.0, Glossary, as the following:

An individual within the Hanford Site, beyond the Contractor-controlled area, performing work for or in conjunction with DOE or utilizing other Hanford Site facilities.

2.0 Definitions

2.1 Members of the Public

Definitions related to members of the public are listed in alphabetical sequence in Table 1.

From the NRC (Part 20) perspective, an individual who is outside a licensed facility's restricted area would normally be considered a member of the public.¹ In contrast, an individual outside a controlled area as defined in Part 835 may be either a member of the public or a co-located worker, although the concept of co-located worker is not defined for all DOE facilities, and as stated above, is not contained in Part 835. If such an individual is employed in a neighboring facility where he or she is subject to receiving an occupational dose, that individual may be considered to be a co-located worker relative to the BNFL Inc. facility. Otherwise, that individual may fall into one of three other categories discussed below under "Individuals Subject to Occupational Dose."

Although both Part 20 and Part 835 contain regulations governing dose limits to members of the public, and although the definitions of *member of the public* are similar in both, the regulatory language differs in several respects. Part 20 provides limits for members of the public in general, while Part 835 provides limits only for those members of the public entering a controlled area. Note that *controlled area* is defined in Part 835 differently from Part 20, and that the definition of a *restricted area* in Part 20 is very close to that of a *controlled area* in Part 835. The Part 20 definition of a *restricted area* has no parallel in Part 835. The dose limits associated with these definitions are provided in Section 3.0.

¹ An exception would be if an individual normally permitted to receive an occupational dose utilizes radioactive materials from the licensed facility outside its restricted area, but under the control of the licensee.

| TERM | Part 20 Definitions | Part 835 Definitions |
|----------------------|---|--|
| Controlled Area | Controlled area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason. | Controlled area means any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material. |
| Member of the Public | Member of the public means any individual except when that individual is receiving an occupational dose. | Member of the public means an individual who is not a general employee. An individual is not a "member of the public" during any period in which the individual receives an occupational dose. |
| Public Dose | Public dose means the dose received by a member of the public from exposure to radiation or radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with §35.75, or from voluntary participation in medical research programs. | <i>(no corresponding definition)</i> |
| Restricted Area | Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area. | <i>(no corresponding definition)</i> |
| Site Boundary | Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee. | <i>(no corresponding definition)</i> |
| Unrestricted Area | Unrestricted area means an area, access to which is neither limited nor controlled by the licensee. | <i>(no corresponding definition)</i> |

Table 1. Definitions Related to "Member of the Public"

2.2 Individuals Subject to Occupational Dose Limits

While *Member of the Public* is defined by both Part 20 and Part 835, a comparison of the regulations pertaining to occupational dose is not as clear. The definitions in each Part differ with respect to individuals employed as workers in a facility that utilizes radioactive material. This section discusses the contrasting definitions and regulatory approaches of Parts 20 and 835 with respect to occupational dose. Table 2 lists the definitions in alphabetical order, and clearly shows where a definition in Part 20 has no equivalent in Part 835, and vice-versa.

Because terms related to "radiation area" are contained in the definitions of Table 2, Section 2.3 provides definitions of such terms in Table 3.

To summarize, the Part 20 regulations distinguish only between a "member of the public" (discussed above) and an individual who receives an "occupational dose." An individual may receive an occupational dose from radioactive materials present in the facility where the work is performed without being directly employed by that facility.

In contrast, under the regulations in Part 835, an individual may be a "member of the public," an individual receiving an "occupational dose," a "general employee," or a "radiological worker." An individual need not be a general employee or a radiological worker in order to receive an occupational dose. As with the Part 20 regulations, an individual may receive an occupational dose from radioactive materials present in the facility where the work is performed without being directly employed by that facility. A person may receive an occupational dose even though he or she is not a radiological worker.

The occupational dose limits are the same in both Parts. However, for the TWRS-P facility, a set of dose limits has been established for a series of "event probability ranges," as described in RL/REG-98-18, Revision 0, "Regulatory Unit Position on Radiological Safety for Hanford Co-Located Workers," September 16, 1998, Exhibit 1: Table 2-1, "Radiological Exposure Standards Above Normal Background." Numerical limits are discussed in Section 3.0,

In accordance with DOE/RL-96-0006, individuals designated as co-located workers are permitted to accrue occupational dose that is greater than that permitted for members of the public. Under NRC regulations, the concept of "co-located worker" is undefined. At NRC regulated facilities, absent other considerations, workers at adjacent facilities would be considered members of the public with respect to any exposures received from the operation of the regulated facility, or with respect to abnormal conditions or accidents that might occur.

| TERM | Part 20 Definitions | Part 835 Definitions |
|---------------------|--|---|
| Controlled Area | Controlled area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason. | Controlled area means any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material. |
| General Employee | <i>(no corresponding definition)</i> | General employee means an individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or an individual who performs work for or in conjunction with DOE or utilizes DOE facilities. |
| Occupational Dose | Occupational dose means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with §35.75, from voluntary participation in medical research programs, or as a member of the public. | Occupational dose means an individual's ionizing radiation dose (external and internal) as a result of that individual's work assignment. Occupational dose does not include doses received as a medical patient or doses resulting from background radiation or participation as a subject in medical research programs. |
| Radiological Area | <i>(no corresponding definition)</i> | Radiological area means any area within a controlled area defined in this section as a "radiation area," "high radiation area," "very high radiation area," "contamination area," "high contamination area," or "airborne radioactivity area." |
| Radiological Worker | <i>(no corresponding definition)</i> | Radiological worker means a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose equivalent. |
| Restricted Area | Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area. | <i>(no corresponding definition)</i> |
| Site Boundary | Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee. | <i>(no corresponding definition)</i> |
| Unrestricted Area | Unrestricted area means an area, access to which is neither limited nor controlled by the licensee. | <i>(no corresponding definition)</i> |

Table 2. Definitions Related to "Occupational Dose"

2.3 Radiation Area, High Radiation Area, Very High Radiation Area

The previous section provided definitions of terms related to "Occupational Dose." Some of the terms contained in the definitions in Table 2 require explanation. Table 3 in this section provides definitions of terms related to "radiation area" as defined in Table 2.

| TERM | Part 20 Definitions | Part 835 Definitions |
|--------------------------|--|---|
| Radiation Area | Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. | Radiation area means any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates. |
| High Radiation Area | High radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates. | High radiation area means any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. |
| Very High Radiation Area | Very high radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or 1 meter from any surface that the radiation penetrates. (Note: At very high doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts)). | Very high radiation area means any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates. |

Table 3. Definitions Related to "Radiation Area"

2.4 Contamination and Radioactive Material

Table 4 in this section captures additional definitions relevant to radiological protection contained in the Part 20 and Part 835 regulations. These terms are listed because they are related to the means by which occupational radiation doses might be encountered in facilities utilizing radioactive materials. It also serves to point out some of the other differences in the two sets of regulations. Both Parts provide definitions of "Airborne Radioactivity Area," but the remaining terms are defined only in Part 835.

| TERM | Part 20 Definitions | Part 835 Definitions |
|-----------------------------|--|--|
| Airborne Radioactivity Area | <p>Airborne radioactivity area means a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations --</p> <p>(1) In excess of the derived air concentrations (DACs) specified in appendix B, to §§20.1001 - 20.2401, or</p> <p>(2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.</p> | <p>Airborne radioactivity area means any area, accessible to individuals, where:</p> <p>(1) The concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the derived air concentration (DAC) values listed in appendix A or appendix C of this part; or</p> <p>(2) An individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week.</p> |
| Contamination Area | <i>(no corresponding definition)</i> | <p>Contamination area means any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in appendix D of this part, but do not exceed 100 times those values.</p> |
| High Contamination Area | <i>(no corresponding definition)</i> | <p>High contamination area means any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in appendix D of this part.</p> |
| Radioactive Material Area | <i>(no corresponding definition)</i> | <p>Radioactive material area means any area within a controlled area, accessible to individuals, in which items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values provided in appendix E of this part.</p> |

Table 4. Definitions Related to "Contamination" and "Radioactive Material"

2.5 Definitions of Terms Related to Dose and Dose Equivalent

The definitions contained in this section are provided to remind the reader of the technical terminology that describes how dose is measured. Specific terms have been assigned to differentiate the type of measurement to be quantified. A thorough understanding of these terms is not required in order to appreciate the differences in Part 20 vs. Part 835 radiological protection standards.

In Table 5, the definitions are given in a hierarchical format with each definition building on its antecedent. Note that in Parts 20 and 835 there are small differences in the way these definitions are phrased, but that they are equivalent in all other respects.

| TERM | Part 20 Definition | Part 835 Definitions |
|---|--|--|
| Dose | Dose or radiation dose is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section. | Dose is a general term for absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined in this part. |
| Dose Equivalent H_T | Dose equivalent (H_T) means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv). | Dose equivalent (H) means the product of absorbed dose (D) in rad (or gray) in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert). |
| Effective Dose Equivalent H_E | Effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum w_T H_T$). | Effective dose equivalent (H_E) means the summation of the products of the dose equivalent received by specified tissues of the body (H_T) and the appropriate weighting factor (w_T)--that is, $H_E = \sum w_T H_T$. It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this part, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures. The effective dose equivalent is expressed in units of rem (or sievert). |
| Committed Dose Equivalent $H_{T,50}$ | Committed dose equivalent ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake. | Committed dose equivalent ($H_{T,50}$) means the dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert). |
| Committed Effective Dose Equivalent $H_{E,50}$ | Committed effective dose equivalent ($H_{E,50}$) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues. | Committed effective dose equivalent ($H_{E,50}$) means the sum of the committed dose equivalents to various tissues in the body ($H_{T,50}$), each multiplied by the appropriate weighting factor (w_T)--that is, $H_{E,50} = \sum w_T H_{T,50}$. Committed effective dose equivalent is expressed in units of rem (or sievert). |
| Total Effective Dose Equivalent TEDE | Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). | Total effective dose equivalent (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). |

Table 5. Definitions Related to "Dose"

3.0 LIMITS

Table 6 provides a comparison of the limits set by Part 20 and Part 835. Note that the two sets of limits are effectively the same.

As indicated in Table 6, the annual dose limit for members of the public is the same in both Parts, namely 0.1 rem (0.001 sievert). As stated previously, Part 835 is concerned only with those members of the public who enter a controlled area, while Part 20 covers any member of the public. Part 20 also provides a limit of 0.002 rem (0.02 millisievert) in any one hour for the dose in an unrestricted area. There is no corresponding definition in Part 835. Note that while Part 835 is concerned with members of the public who enter a controlled area (as defined in Part 835), the situation is not analogous to Part 20, since Part 20 concerns members of the public outside any restricted area (as defined in Part 20).

| Category | Part 20 Dose Limits | Part 835 Dose Limits |
|---|--|---|
| Occupational (Total Effective Dose Equivalent and Organ or Tissue) | (1) An annual limit, which is the more limiting of: (i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or (ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv). | (1) A total effective dose equivalent of 5 rems (0.05 sievert); (2) The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rems (0.5 sievert); |
| Occupational (Lens of Eye, Skin, Extremities) | (2) The annual limits to the lens of the eye, to the skin, and to the extremities, which are: (i) A lens dose equivalent of 15 rems (0.15 Sv), and (ii) A shallow-dose equivalent of 50 rems (0.50 Sv) to the skin or to any extremity. | (3) A lens of the eye dose equivalent of 15 rems (0.15 sievert); and (4) A shallow dose equivalent of 50 rems (0.5 sievert) to the skin or to any extremity. |
| Public | 0.1 rem (1 millisievert) 0.002 rem (0.02 millisievert) in any one hour for the dose in an unrestricted area | 0.1 rem (0.001 sievert) (no corresponding definition) |

Table 6. Occupational Dose Limits and Limits for Members of the Public

A more detailed explanation of the dose limits applied to members of the public and to individuals subject to occupational dose, which includes co-located workers, needs to include a review of the four event probability ranges, as described in RL/REG-98-18, Revision 0, "Regulatory Unit Position on Radiological Safety for Hanford Co-Located Workers." These are reproduced here as Table 7, Radiological Exposure Standards Above Normal Background.

Table 7 specifies four event probability ranges addressing normal operation and credible accident conditions. General guidelines and frequencies, listed for the four event probability ranges, are:

1. Normal events are typical of normal facility operations expected to occur regularly in the course of facility operations; the associated frequency of occurrence during the lifetime of the facility is 1 or more per year. As defined in Table 7, a general guideline for this event probability is that normal modes of operating the facility systems should provide adequate protection of health and safety.
2. Anticipated events are characterized as minor incidents and upsets of moderate frequency that may occur once or more during the lifetime of the facility; the associated probability range is 1×10^{-2} to <1 per year. As defined in Table 7, a general guideline for this event probability range is that the facility should be capable of returning to operation without extensive corrective action or repair.
3. Unlikely events are characterized as more severe incidents that are not expected, but may occur, during the lifetime of the facility; the associated probability range is 1×10^{-4} to 1×10^{-2} per year. As defined in Table 7, a general guideline for this event probability range is that the facility should be capable of returning to operation following potentially extensive corrective action or repair, as necessary.
4. Extremely unlikely events are characterized as events that are not expected to occur during the lifetime of the facility, but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material; the associated probability range is 1×10^{-6} to 1×10^{-4} per year. As defined in Table 7, a general guideline for this event probability range is that facility damage may preclude returning to operation. (Note that a probability of occurrence of 1×10^{-2} per year is equivalent to a frequency of one occurrence in 100 years; 1×10^{-4} per year equates to one in 10,000 years; 1×10^{-6} per year equates to one in 1,000,000 years; recurrence interval treatment.)

| Description | Estimated Frequency of Occurrence f (yr ⁻¹) | General Guidelines | Worker | Co-Located Worker | Public |
|--|---|---|--|---|---|
| Normal Events: Events that occur regularly in the course of facility operation (e.g., normal facility operations); including routine and preventive maintenance activities. | >0.1 | Normal modes of operating facility systems should provide adequate protection of health and safety. | ≤5 rem/yr ≤50 rem/yr any organ, skin, or extremity ≤15 rem/yr lens of eye ≤1.0 rem/yr ALARA design objective per 10CFR835.1002 (b) ⁽¹⁾ | ≤5 rem/yr ≤1.0 rem/yr ALARA design objective per 10 CFR 835.1002(b) ⁽¹⁾ | ≤10 mrem/yr (airborne pathway) ≤100 mrem/yr (all sources) ≤100 mrem/yr (public in the controlled area) ≤25 mrem/yr (radioactive waste) |
| Anticipated Events: Events of moderate frequency that may occur once or more during the life of a facility (e.g., minor incidents and upsets). | 10 ⁻² <f≤10 ⁻¹ | The facility should be capable of returning to operation without extensive corrective action or repair. | ≤5 rem/event ^(2,3) 1.0 rem/event design action threshold ⁽⁴⁾ | ≤5 rem/event ^(2,3) 1.0 rem/event design action threshold ⁽⁴⁾ | ≤100 mrem/event ⁽³⁾ |
| Unlikely Events: Events that are not expected, but may occur during the lifetime of a facility (e.g., more severe incidents). | 10 ⁻⁴ <f≤10 ⁻² | The facility should be capable of returning to operation following potentially extensive corrective action or repair, as necessary. | ≤25 rem/ event ^(2,3) | ≤25 rem/event ^(2,3) | ≤5 rem/event ⁽³⁾ |
| Extremely Unlikely Events: Events that are not expected to occur during the life of the facility but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material. | 10 ⁻⁶ <f≤10 ⁻⁴ | Facility damage may preclude returning to operation. | ≤25 rem/ event ^(2,3) | ≤25 rem/event ^(2,3) | ≤25 rem/event ≤5 rem/event target ⁽³⁾ ≤300 rem/event to thyroid |
| Location of Receptor | | | Within the BNFL TWRS-P Controlled Area Boundary, including 241-AP-106 | The most limiting location at or beyond the BNFL TWRS-P Controlled Area Boundary | The most limiting location along the near river bank/Hwy 240 /southern boundary |

Table 7. Radiological Exposure Standards Above Normal Background

- 1 In addition to meeting the listed design objective of 10 CFR 835.1002(b), the inhalation of radioactive material by workers and co-located workers under normal conditions is kept ALARA through the control of airborne radioactivity as described in 10 CFR 835.1002(c).
- 2 In addition to meeting the listed worker and co-located worker exposure standards for accidents, the Worker Accident Risk Goal is satisfied through the calculation of the risk from accidents with accident prevention and mitigation features added as necessary to meet the Goal.
- 3 In addition to meeting the listed exposure standards for accidents, BNFL's Inc. approach to accident mitigation is to evaluate accident consequences to ensure that the calculated exposures are far enough below standards to account for uncertainties in the analysis, and to provide for sufficient design margin and operational flexibility.
- 4 When a calculated accident exposure exceeds this threshold, then appropriate actions are taken. These include carrying out a less bounding (i.e., more realistic) evaluation to show that the accident consequences will be below the threshold or evaluating additional safeguards for cost-effectiveness and/or feasibility. This threshold is not a limit; it does not require the implementation of additional preventive or mitigative features if they are not both cost-effective and feasible.

The additional category of worker has implications with regard to the design and construction of structures, systems, and components (SSCs) of the TWRS-P facility, but does not establish a different set of radiation exposure standards (limits) or a different threshold for monitoring these workers. As may be observed by review of Table 7, for all categories of events, the limits are the same for facility workers and for co-located workers (with the exception that facility workers are subject to the additional limits of ≤ 50 rem/yr to any organ, the skin, or extremity, and ≤ 15 rem/yr to the lens of the eye).

The benefit of using the co-located worker category is that it allows the TWRS-P facility to treat these workers as individuals subject to occupational dose, rather than as members of the public, under accident conditions. Therefore, in the design and construction of TWRS-P facility SSCs, the "offsite" consequences (i.e., the radiation doses to individuals beyond the boundaries of the TWRS-P facility) are permitted to be greater for the nearby co-located workers than would be the case if these personnel were considered to be members of the public.

For the category of normal events, which have a frequency of occurrence of 1 or more per year, and are considered to have the lowest consequence in terms of harm, co-located workers will seldom, if ever, receive any additional radiation exposure from the TWRS-P facility. However, operation under non-normal conditions, i.e., with releases above ALARA levels, may add to the exposure received by co-located workers. It should be noted that co-located workers will continue to be subject to the same limits as the worker, so that any exposure received due to operation of TWRS-P (under non-normal conditions) is added to that received from the duties performed in the facility in which their occupational exposure is normally received.

DOE regulations pertaining to occupational radiation protection (Part 835) provide some specificity beyond that found in NRC regulations (Part 20), due to the inclusion of certain definitions in Part 835, including those for "General employee" and "Radiological worker." The importance of these additional definitions in the regulation of the TWRS-P facility is explained in RL/REG-98-18, Revision 0, "Regulatory Unit Position on Radiological Safety for Hanford Co-Located Workers." This document points out that a person can be occupationally exposed even though he or she is not a radiological worker. Excerpts from RL/REG-98-18 are included in Appendix A.

A document which explains the use of the categories of "Facility Worker," "Co-Located Worker," and "Public" is BNFL-5193-RES-01, Rev. 0, August 28, 1997, "Radiological and Nuclear Exposure Standards for Facility and Co-Located Workers." These terms are defined in Section 3.0 "Development of the BNFL Approach to Compliance with Table 1 of DOE/RL-96-0006," which is excerpted in Appendix B.

4.0 Monitoring Thresholds

Generally speaking, the NRC requires monitoring of adults likely to receive in excess of 10 percent of the occupational dose limits, while the DOE requires monitoring of adults likely to receive in excess of 2 percent of the occupational dose limits. For whole body exposure, these equate to 500 mrem and 100 mrem, respectively.

Table 8, "Monitoring Thresholds," provides information from Part 20 and Part 835 relevant to the monitoring of individuals subject to occupational dose and members of the public. These Parts also contain information about monitoring exposure to minors and declared pregnant women (in Part 20) or declared pregnant workers (in Part 835).

| Section in 10 CFR: | Part 20 | Part 835 |
|--------------------|---|--|
| | §20.1502 Conditions requiring individual monitoring of external and internal occupational dose. | §835.402 Individual monitoring. |
| | Each licensee shall monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this part. As a minimum -- | <i>(no corresponding text)</i> |
| External | <p>(a) Each licensee shall monitor occupational exposure to radiation from licensed and unlicensed radiation sources under the control of the licensee and shall supply and require the use of individual monitoring devices by--</p> <p>(1) Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in §20.1201(a),</p> <p>(2) Minors likely to receive, in 1 year, from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv), a lens dose equivalent in excess of 0.15 rem (1.5 mSv), or a shallow dose equivalent to the skin or to the extremities in excess of 0.5 rem (5 mSv);</p> <p>(3) Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv);² and</p> <p>(4) Individuals entering a high or very high radiation area.</p> <p>² All of the occupational doses in §20.1201 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded.</p> | <p>(a) For the purpose of monitoring individual exposures to <i>external</i> radiation, personnel dosimeters shall be provided to and used by:</p> <p>(1) Radiological workers who, under typical conditions, are likely to receive one or more of the following:</p> <p>(i) An effective dose equivalent to the whole body of 0.1 rem (0.001 sievert) or more in a year;</p> <p>(ii) A shallow dose equivalent to the skin or to any extremity of 5 rems (0.05 sievert) or more in a year;</p> <p>(iii) A lens of the eye dose equivalent of 1.5 rems (0.015 sievert) or more in a year;</p> <p>(2) Declared pregnant workers who are likely to receive from external sources a dose equivalent to the embryo/fetus in excess of 10 percent of the limit at Sec. 835.206(a);</p> <p>(3) Occupationally exposed minors likely to receive a dose in excess of 50 percent of the applicable limits at Sec. 835.207 in a year from external sources;</p> <p>(4) Members of the public entering a controlled area likely to receive a dose in excess of 50 percent of the limit at Sec. 835.208 in a year from external sources; and</p> <p>(5) Individuals entering a high or very high radiation area.</p> |

Table 8. Monitoring Thresholds

| Section in 10 CFR: | Part 20 | Part 835 |
|--------------------|---|---|
| Internal | <p>(b) Each licensee shall monitor the occupational intake of radioactive material by and assess the committed effective dose equivalent to --</p> <p>(1) Adults likely to receive, in 1 year, an intake in excess of 10 percent of the applicable ALI(s) in table 1, Columns 1 and 2, of appendix B to §§20.1001-20.2400; [see note in last row of this table]</p> <p>(2) Minors likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.1 rem (1 mSv); and</p> <p>(3) Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 0.1 rem (1 mSv).</p> <p>(no corresponding text)</p> | <p>(c) For the purpose of monitoring individual exposures to <i>internal</i> radiation, internal dosimetry programs (including routine bioassay programs) shall be conducted for:</p> <p>(1) Radiological workers who, under typical conditions, are likely to receive a committed effective dose equivalent of 0.1 rem (0.001 sievert) or more from all occupational radionuclide intakes in a year;</p> <p>(2) Declared pregnant workers likely to receive an intake or intakes resulting in a dose equivalent to the embryo/fetus in excess of 10 percent of the limit stated at Sec. 835.206(a);</p> <p>(3) Occupationally exposed minors who are likely to receive a dose in excess of 50 percent of the applicable limit stated at Sec. 835.207 from all radionuclide intakes in a year; or</p> <p>(4) Members of the public entering a controlled area likely to receive a dose in excess of 50 percent of the limit stated at Sec. 835.208 from all radionuclide intakes in a year.</p> |
| | <p>[note: 1 ALI = 5 rem, or 5000 mrem for whole body exposure; therefore 10% of the limit (1 ALI) = 500 mrem; also 1 ALI = 50 rem, or 50 000 mrem for the maximally exposed organ; therefore 10% of the limit (1 ALI) = 5 rem = 5000 mrem]</p> | |

Table 8. Monitoring Thresholds (Continued)

Appendix A

Excerpts from RL/REG-98-18, Revision 0, September 16, 1998,
"Regulatory Unit Position on Radiological Safety for Hanford Co-Located Workers"*Excerpt from "3.0 RU POSITION"*

The classification of an individual as a CLW is also found in a DOE safety analysis report¹¹ and a proposed standard.¹² In the DOE proposed standard for accident analysis, the CLW is defined as a worker in a fixed population outside the day-to-day process safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located some distance from the reference facility area.¹³

Although the CLW classification is not found in DOE rules, definitions for a general employee and a member of the public in the DOE rule 10 CFR 835, Occupational Radiation Protection, provide the basis for the RU position that CLWs are considered a subset of workers rather than as members of the public.¹⁴ A general employee is an individual who is either a DOE or DOE contractor employee, an employee of a subcontractor to a DOE contractor, or a visitor who performs work for or in conjunction with DOE or utilizes DOE facilities.¹⁵ As a worker at an independent facility area, a CLW is a general employee under that activity and may receive an occupational exposure. A member of the public means an individual who is not occupationally exposed to radiation or radioactive material.¹⁶ An individual is not a "member of the public" during any period in which the individual receives occupational exposure.¹⁷ A CLW should not be classified as a member of the public, because CLWs may receive occupational exposure under 10 CFR 835.

¹¹ Method for the Assessment of Worker Safety Under Radiological Accident Conditions at Department of Energy Nuclear Facilities, EH-12-94-01, Vol. 2, Appendixes, June 1994.

¹² DOE Standard Definitions and Criteria for Accident Analysis, DOE-DP-STD-3005-93 Proposed, U.S. Department of Energy, Defense Programs, Washington, D.C., March 5, 1993.

¹³ Ibid.

¹⁴ Title 10 Code of Federal Regulations Part 835, Occupational Radiation Protection, Final Rule, U.S. Department of Energy, December 1993.

¹⁵ 10 CFR 835.2 Definitions, General employee, December 1993.

¹⁶ 10 CFR 835.2 Definitions, Member of the public, December 1993.

¹⁷ Ibid.

Excerpt from 4.1 "THE 10 CFR 835 DEFINITIONS OF REGULATORY TERMS"

The DOE rule 10 CFR 835 defines several regulatory terms that affect the classification of an individual as a CLW in the documents establishing the RU regulatory program including DOE/RL-96-0006.²² These terms are Occupational exposure, General employee, Radiological worker, and Member of the public.

Occupational exposure means an individual's exposure to ionizing radiation (external and internal) as a result of that individual's work assignment. Occupational exposure does not include planned special exposures,²³ exposure received as a medical patient, background radiation, or voluntary participation in medical research programs.²⁴ It is important to note that the definition of occupational exposure does not specify the source of the exposure, but rather that the exposure is a result of the individual's work assignment. It is also important to note that a person need not necessarily be a radiological worker (defined below) to receive an occupational exposure. The individual's exposure on a work assignment is the sum of the dose received from any radioactive materials present in the facility where the work is performed as well as any dose received from radioactive materials or effluents from other nearby facilities. The DOE annual permissible occupational dose limit for a individual conducting a DOE activity is 5 rem total effective dose equivalent. The content of a DOE contractor's radiation protection program is required to include formal plans and measures for applying the as low as reasonably achievable (ALARA) process to occupational exposure.²⁵

General employee means an individual who is a DOE or DOE-contractor employee, an employee of a subcontractor to a DOE contractor; or a visitor who performs work for or in conjunction with DOE or utilizes DOE facilities.²⁶ It is important to note that the individuals who are not general employees and who do not conduct work may be exposed to radiation and radioactive material during direct on-site access at a DOE site or facility. Part 835 has annual radiation dose limits for these individuals.²⁷ Any general employee may receive an occupational exposure. For example, the general employee who fills the soda machine at a DOE facility may be occupationally exposed. An example of a general employee in the category of a visitor utilizing DOE facilities is a Native American who may perform traditional ceremonies at Hanford. The DOE annual permissible occupational dose limit for an individual conducting a DOE activity is 5 rem total effective dose equivalent. While it is true that additional radiation protection provisions are required for individuals likely to be routinely occupationally exposed

²² 10 CFR 835.2 Definitions, December 1993.

²³ 10 CFR 835.204 Planned special exposures, December 1993.

²⁴ 10 CFR 835.2 Definitions, Occupational exposure, December 1993.

²⁵ 10 CFR 835.101(c) Radiation protection programs, December 1993.

²⁶ 10 CFR 835.2 Definitions, General employee, December 1993.

²⁷ 10 CFR 835.208 Limits for members of the public entering a controlled area, December 1993.

above 0.1 rem (100 mrem) per year total effective dose equivalent,²⁸ the limit of 5 rem applies to all general employees.

Radiological worker means a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (100 mrem) per year total effective dose equivalent.²⁹ 10 CFR 835 has requirements for provisions for radiological workers such as training, monitoring, and records.³⁰ It is important to note that a general employee may be a radiological worker if compliance to the additional requirements is achieved. For example, the general employee who performs maintenance activities at a DOE facility would be a radiological worker if the individual is likely to be routinely occupationally exposed above 0.1 rem (100 mrem) per year total effective dose equivalent; assuming compliance with the provisions of the Contractor's ALARA program.

Member of the public means an individual who is not occupationally exposed to radiation or radioactive material. An individual is not a "member of the public" during any period in which the individual receives occupational exposure.³¹ It is important to note that no individual is considered to be a member of the public during any period when he or she is receiving an occupational exposure.³²

Reference

U.S. Department of Energy, Richland Operations Office, Office of Radiological, Nuclear, and Process Safety Regulation of TWRS Privatization Contractors, "Regulatory Unit Position on Radiological Safety for Hanford Co-Located Workers," RL/REG-98-18, Revision 0, September 16, 1998

²⁸ 10 CFR 835.902 Radiological workers; §835.402 Individual monitoring; and, §835.702 Individual monitoring records, December 1993.

²⁹ 10 CFR 835.2 Definitions, Radiological worker, December 1993.

³⁰ 10 CFR 835.902, §835.402, and §835.702, respectively, December 1993

³¹ 10 CFR 835.2 Definitions, Member of the public, December 1993.

³² Ibid.

Appendix B.

Excerpts from BNFL-5193-RES-01, Rev. 0, August 28, 1997,
Radiological and Nuclear Exposure Standards for
Facility and Co-Located Workers

Excerpt from 3.0 "Development of the BNFL Approach to Compliance with Table 1^a of DOE/RL-96-0006"

3.5.1 Facility Worker

The facility worker is located at the most limiting location within the BNFL contractor-controlled area as defined in DOE/RL-96-0006.

Section 6.0, "Glossary," of DOE/RL-96-0006 defines the controlled area as the following:

The physical area enclosing the facility by a common perimeter (security fence). Access to this area can be controlled by the Contractor. The controlled area may include identified restricted areas.

The controlled area for TWRS-P that is used to define the location of the facility worker, is that land leased by DOE to BNFL Inc. for the TWRS-P Project and land associated with Tank AP-106. The controlled area may include land beyond the TWRS-P facility security fence if that fence is located within the leased area, because BNFL would have control of that area between the fence and the boundary of the leased land.

3.5.2 Co-Located Worker

Section 6.0, "Glossary," of DOE/RL-96-0006 defines the co-located worker as the following:

An individual within the Hanford Site, beyond the Contractor-controlled area, performing work for or in conjunction with DOE or utilizing other Hanford Site facilities.

For evaluation of the TWRS-P facility design to the exposure standards of DOE Table 1, the location of the co-located worker is either at the BNFL controlled area boundary or beyond that boundary if such a location results in higher exposure. For a ground-level release, the location of the co-located worker is considered no closer than 100 m from the release point.

3.5.3 Public

The location of the public (i.e., the offsite receptor) for the purpose of establishing compliance with the last column of DOE Table 1 of DOE/RL-96-0006, is established at the most limiting radiological exposure location along the near bank of the Columbia River, Highway 240, and a southern boundary as shown in Figure 1. This area includes land for which it is reasonable to

^a Table 1 of DOE/RL-96-0006 has the same format as Table 7 in the report; when DOE/RL-96-0006 was issued, Table 1 had not been completed. The version used here as Table 7 is taken from RL/REG-98-18, Revision 0, "Regulatory Unit Position on Radiological Safety for Hanford Co-Located Workers," September 16, 1998, Exhibit 1: Table 2-1, "Radiological Exposure Standards Above Normal Background."

assume DOE will retain the right to control activities and limit access under accident conditions for the operating life of the TWRS-P facility. Specifying the near river bank excludes the Columbia River for which DOE does not control activities (DOE-RL 1995). Specifying Highway 240 excludes the Arid Lands Ecology Reserve of which DOE might relinquish control during the operating life of the TWRS-P facility. The southern boundary serves to exclude the Washington Public Power Supply System's WNP-2 commercial nuclear power plant (whose workers should be considered members of the public), and the Hanford Site 300, 400, and 1100 Areas. The BNFL Inc. TWRS-P 400 Area includes the Fast-Flux Test Facility. In footnotes 10 and 12, DOE Table 1 of DOE/RL-96-0006 makes reference to 10 CFR Part 72, "Licensing Requirements for the Independent Spent Fuel (ISFSI) and High Level Radioactive Waste," and 10 CFR Part 100, "Reactor Site Criteria," to relate to the public exposure standards for unlikely and extremely unlikely events. While the siting requirements and guidance of Parts 72 and 100 are not applicable to the TWRS-P facility, the requirements for establishing the location of the offsite receptor in these two cited regulations are useful for locating the offsite receptor for a waste processing facility such as TWRS-P. Section 72.106, "Controlled Area Boundary of an ISFSI or Monitored Retrievable Storage (MRS)," includes the following statements relative to the boundary to be assumed for the evaluation of radiological exposure to the public:

The minimum distance from the spent fuel or high-level radioactive waste handling and storage facilities to the nearest boundary of the controlled area shall be at least 100 meters.

The controlled area may be traversed by a highway, railroad or waterway, so long as appropriate and effective arrangements are made to control traffic and to protect public health and safety.

Part 100 of the Title 10 CFR 100 establishes a guideline value of 25 rem for 2 hr at the exclusion area boundary. For the exclusion area, 10 CFR 100.3, "Definitions," states the following:

(a) Exclusion area means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

As can be seen from the above excerpts, the assumed location for the offsite receptor for TWRS-P satisfies the requirements of 10 CFR Part 72 and 10 CFR Part 100. In addition, the proposed southern boundary takes advantage of the road junction at the Wye barricade (Figure 1) for control of access to the site during accident conditions.

Reference

BNFL Inc., "Radiological and Nuclear Exposure Standards for Facility and Lo-Located Workers, BNFL-5193-RES-01, Rev. 0, August 28, 1997