

# RESULTS OF EVALUATIONS OF THE RELATIONSHIP BETWEEN THE LICENSE TERMINATION RULE AND THE CURRENT CASE-BY-CASE APPROACH FOR CONTROLLING THE DISPOSITION OF SOLID MATERIALS

## 1. BACKGROUND

Certain stakeholders have questioned the regulatory relationship between the License Termination Rule's (LTR's) dose constraint of 0.25 millisieverts per year (mSv/yr) [25 millirem per year (mrem/yr)] and As Low As is Reasonably Achievable (ALARA) for unrestricted use of a site, and existing guidance for controlling the disposition of solid materials on a case-by-case basis, particularly in instances where residual contamination might be removed from an unrestricted-use site after license termination. This issue was identified in SECY-02-0177, along with planned evaluations that are addressed in this attachment. The first evaluation, section 3.1, explains the differences in types of contamination, potential future uses, and exposure pathways between the LTR unrestricted use provisions and controlling the disposition of solid materials under current guidelines. The second evaluation, section 3.2, discusses factors, such as ALARA and effects of mixing and dilution, that realistically would reduce the dose if residual contamination were removed from an unrestricted-use site after the license is terminated.

## 2. ISSUE DESCRIPTION AND DESIRED OUTCOME

2.1 Issue: The relationship is unclear between the LTR's dose constraint of 0.25 mSv/yr (25 mrem/yr) and ALARA for unrestricted use of a site, and existing guidance for controlling the disposition of solid materials on a case-by-case basis, particularly for instances where residual contamination might be removed from an unrestricted-use site after license termination.

2.2 Eventual Desired Outcome: Describe the relationship between the LTR's unrestricted use dose constraint and the existing case-by-case approach for controlling the disposition of solid materials.

## 3. EVALUATIONS OF RELEVANT INFORMATION

### 3.1 Differences between the LTR and the Case-by-Case Approach for Controlling the Disposition of Solid Materials

#### 3.1.1 Differences in regulatory purpose and scope

##### 1) LTR

The LTR established radiological criteria for determining the extent to which lands and structures can be considered to be decommissioned, focusing on protection of persons entering and using decommissioned structures and lands at a site after a license is terminated. The technical analyses supporting the LTR made specific assumptions about the types of materials that may be present at a site when a license is terminated, based upon assessment of exposure to an average member of the critical group from those materials present on lands and structures located within the facility boundary, rather than the future use of those materials at *offsite* locations. Residual radioactivity in solid materials remaining at a site with a terminated license was assumed to be

limited to walls, floors, ceilings, and equipment that are part of the building structure, such as metal beams, embedded piping, ventilation ducts, metal doors, wood trim, and plastic fixtures. Also, the LTR assumed that materials and equipment that were readily removable, such as pumps, valves, and tables, would not be present at the time of license termination, because they would have been previously removed from the site. These assumptions were incorporated into the exposure pathways and scenarios that were used in the technical basis to support the dose constraint of 0.25 mSv/yr (25 mrem/yr). Another assumption was that the group of people that comprises the critical group is located within the facility boundary after license termination, per NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning."

The scope of the LTR purposely did not address clearance of equipment and materials before license termination [see item G.7 of the Federal Register notice for the final rule; 62 FR 39058, dated July 21, 1997]. During the development of the LTR, it was recognized that solid materials remaining at a site could be moved to offsite locations after the license is terminated without further evaluation or control. The technical basis for the LTR assumed that offsite release of materials after license termination would be protective of public health and safety and the environment, based on a dose constraint of 0.25 mSv/yr (25 mrem/yr), as well as the conservatism of the selected on-site exposure scenarios that are evaluated for demonstrating compliance with the dose constraint. However, if licensees use more realistic scenarios instead of the default LTR scenarios, potential offsite exposure scenarios may become important for specific sites. Further discussion of LTR scenarios is provided in section 3.A.iv of this attachment, and more detailed information on realistic scenarios is provided in section 3 of Attachment 6 of this SECY paper.

## 2) Case-by-Case Approach for Controlling the Disposition of Solid Materials

Before license termination, solid materials may be controlled by transfer to a licensed facility, for processing or disposal as low-level radioactive waste. Another available disposition option is to evaluate the material for its radiological characteristics and, if the amount of radioactivity is within certain guidelines, it may be released from the site for unrestricted use to offsite locations, which is referred to as "clearance," or it may be released under restricted conditions, referred to as "authorized use" or "conditional clearance." Before release for unrestricted use or under restricted conditions, solid materials are evaluated for their radiological characteristics for the purpose of protecting public health and safety and the environment at offsite locations. Typically, such releases are made at a small fraction of the established level that provides adequate protection of public health and the environment [1 mSv/yr (100 mrem/yr)].

Unlike the radiological criteria for license termination that were established by the LTR, there are no specific requirements, currently contained in 10 CFR Part 20, for the release of solid materials with small or no amounts of radioactivity. Absent a National standard, the disposition of solid materials before license termination are evaluated on a case-by-case basis and, at this time, are not based on extensive supporting regulatory and technical analyses, such as those developed for the LTR. In accordance with Commission direction, the staff is developing technical information in support of rulemaking in this area, but preliminary information from these ongoing analyses are not incorporated into the current case-by-case approach for controlling the disposition of solid materials (see Agreement State Program Letter No. STP-00-0070, dated August 22, 2000). Thus, the technical basis for the existing case-by-case approach for controlling the disposition of solid materials before license termination is not as well developed as the technical basis supporting the LTR.

A major difference between solid material releases before and after license termination is that, during operations and decommissioning, materials are evaluated prior to release, but once a license has been terminated and the site is released for unrestricted use, there are no regulatory requirements on the residual radioactivity that may be present at the site, and remaining materials may be used without restriction. Thus, there are no limitations on releases of lands, structures, or other solid materials that remain at a site after a license is terminated for unrestricted use - the concept of clearance or conditional clearance is not applicable because regulatory control over the material terminated with the license. The license termination decision is based on the assessment that the public will be protected under unrestricted use.

A common thread to solid material releases before and after license termination is that, under both circumstances, solid materials can be moved to offsite locations, where members of the public can be exposed to formerly licensed and controlled materials.

### 3.1.2. Differences in types of materials for release before and after license termination

#### 1) LTR

There are no generally applicable volume, mass, or total radioactivity restrictions on the amount or type of material for the purpose of license termination because the acceptability of a site for license termination is based on compliance with the dose constraint of 0.25 mSv/yr (25 mrem/yr) to an average member of the critical group. Thus, the LTR allows flexibility on a site-specific basis concerning the type of materials and amount of residual radioactivity that may remain in lands and structures, and to a certain extent, equipment and materials that are integral to building structures. It is difficult to predict the type and amount of material that may be released from sites with terminated licenses, because of differences in inventory, future planned use of the site, and other site-specific conditions, but the *type* of license does influence the potential for such releases. Currently, the majority of NRC and Agreement State licensees are users of sealed sources, where the radioactive material is encapsulated - such licensee types do not typically release solid materials either before or after the license is terminated. Licensee types that use or possess solid materials that may become contaminated and released offsite include nuclear power plants, fuel cycle facilities, hospitals, research laboratories, manufacturing facilities, and other licensee types that use or possess radioactive material in an unsealed form.

The amounts and characteristics of the residual radioactivity, in materials that are present at a site at the time of license termination, are documented in final status survey reports, which are submitted to demonstrate compliance with the dose constraint. Consistent with the underlying assumptions of the LTR, the scope of these surveys covers lands and building structures, including equipment that is fixed in a room, such as ductwork and embedded piping. It is expected that items that can be released readily from a room, such as desks or processing equipment, would not be present at the time of license termination, and available for future release offsite.

After license termination for unrestricted use, formerly licensed materials at a site become available for release to offsite locations without restriction. This includes residual radioactivity that is associated with buildings or fixed equipment that could be dismantled. The quantity of material and number of releases that may occur to offsite locations may be small or large and may occur over a short or long period. Sites with terminated licenses may stay undisturbed indefinitely or

may be used for other purposes immediately, such as commercial, land-development, or agricultural purposes. Such development can result in materials being moved offsite for a variety of future uses, such as direct reuse, recycling, or disposal in a landfill. Although estimates of the total volume of material or amount of residual radioactivity present at license termination are not required, all sites must meet the same dose constraint, to ensure protection of public health and safety and the environment, thereby limiting excessive amounts of residual radioactivity that could potentially be released offsite, and ensuring protection of public health and safety and the environment.

## 2) Case-by-Case Approach for Controlling the Disposition of Solid Materials

Before license termination, a variety of solid materials may be released from licensed sites, ranging from small releases of material with little or no radioactivity in or on it, to larger releases. During the operational phase of a licensed facility, releases of solid material with little or no residual radioactivity can occur on a daily basis when commonplace items are moved in and out of the site, such as tools, briefcases, scaffolding, ladders, equipment, ordinary trash, and other items once they are obsolete or no longer useful. Operational releases of solid material can also occur when buildings are renovated or razed, resulting in offsite releases of lumber; roofing materials; metals, such as I-beams, rebar, service and processing equipment; concrete in the form of walls, floors, ceilings, or rubble; soils; and other materials that would be present at a typical industrial site. Larger amounts of these types of materials may be released during the decommissioning phase, as the facility is prepared for license termination.

In general, it is expected that the amount of material remaining at a site that meets the radiological criteria of the LTR is likely greater than the amount of material released offsite under the current case-by-case approach to clearance. However, this generalization depends on the decommissioning approach taken for license termination, which can influence potential releases to offsite locations before or after license termination. Currently, the staff is developing information on the inventory of materials that are candidates for release under the current case-by-case approach, as well as other regulatory alternatives, as part of the technical basis for rulemaking on controlling the disposition of solid materials.

### 3.1.3 Differences in assessment of potential future uses

#### 1) LTR

As discussed above, although there are no generally applicable volume, mass, or total radioactivity restrictions on the amount or type of material that can be released from a site after license termination for unrestricted use, the residual radioactivity in materials present at a site at the time of license termination is evaluated as part of the license termination process, to ensure compliance with the dose constraint of 0.25 mSv/yr (25 mrem/yr) to an average member of the critical group. The technical basis for the LTR assumed that public health and safety and the environment would be protected if offsite release of materials occurred after license termination, based on this dose constraint. In addition, the two on-site exposure scenarios that are typically used for demonstrating compliance with the dose constraint have been considered sufficiently conservative to be protective of public health and safety and the environment from potential offsite releases after license termination. However, licensees typically do not evaluate these materials for potential future use at offsite locations, nor does the LTR require such evaluation. Consistent with the

technical basis developed for the LTR, if a license is terminated for unrestricted use, there are no requirements for controlling its future use, and the materials residing at the site can be used for any purpose, without restriction, including use at offsite locations.

## 2) Case-by-Case Approach for Controlling the Disposition of Solid Materials

Similar to offsite releases that may occur after license termination, currently there are no generally applicable volume, mass, or total radioactivity restrictions on the amount or type of material that can be released from a site before license termination. However, a difference between unrestricted releases before and after license termination is that material releases before license termination are evaluated for compliance with existing criteria for controlling the disposition of solid materials, whereas after license termination, there are no requirements for further evaluation. As discussed in the next section, the current case-by-case approach for controlling the disposition of solid materials requires an evaluation of the radiological characteristics of the material before release. Radiological surveys or process knowledge are used to evaluate offsite releases before license termination. Additional evaluations are required for planned releases of solid materials with volumetric contamination before license termination, that include a specific evaluation of potential offsite doses.

Regarding the fate of materials that are released for unrestricted use before license termination, they may end up in the same location or be used for similar purposes as those materials moved from a site after license termination. Materials released before license termination under restricted conditions may also have similar fates as those released without restriction before or after license termination. An example is concrete that is dispositioned from a site and buried in a landfill, to reduce the amount of residual radioactivity before license termination. After the license is terminated, additional concrete from remaining structures or rubble may also be moved offsite for burial at a landfill. Metal is another example of a material that, in the form of processing or service equipment, may be removed from the site during decommissioning, or become available for offsite release when building structures are demolished after the license is terminated. In both circumstances, the fate of the metal may be similar, such as recycling or disposal in a local landfill. Thus, from the perspective of a potential recipient at an offsite location, releases before and after license termination may be similar in their material characteristics and origin.

### 3.1.4 Radiological criteria and dose modeling

#### 1) LTR

For solid materials with residual radioactivity that remain at the site after the license is terminated, a dose assessment is performed to ensure compliance with a dose constraint of 0.25 mSv/yr (25 mrem/yr) to the average member of the critical group from all exposure pathways and demonstration that the residual contamination levels are ALARA. This dose constraint is considered protective of public health and safety and the environment, and the appropriate allocation of the public dose limit for license termination, which is assumed to occur once for a U.S. Nuclear Regulatory Commission (NRC)-licensed facility.

The amount of residual radioactivity in lands and structures, that is present at the time of license termination, is evaluated *in toto* and correlated to the dose constraint by evaluating three exposure

scenarios for unrestricted release of a site. The technical basis developed for the LTR analyzed exposure pathways for average members of the critical group at decommissioned facilities. The main scenarios considered for future site use were: (a) full-time residence and farming at a decommissioned site; (b) exposure while working in a decommissioned building; and (c) renovation of a newly decommissioned building. These exposure scenarios are considered by the staff to be conservative and therefore tend to overestimate the dose from a site with a terminated license. A result of conservative dose assessment methods can be the reduction in the amount of residual radioactivity remaining at a site with a terminated license, which, in turn, would be available for future release to offsite locations.

For those licensees that do not use default license termination criteria and rely on site-specific modeling, there can be variability in the amount and concentration of residual radioactivity that remains at sites, because of several site-specific factors, including the application of ALARA. Application of this risk-based approach can lead to variability in the amount of residual radioactivity remaining at the time of license termination, but is considered protective of public health and safety and the environment, because a common dose constraint is applied to all sites. Also, for licensees proposing to use more realistic scenarios instead of the generic scenarios in the LTR analysis, the critical group may not exist on-site, but may be future users of recycled materials from the site after the license is terminated, as discussed in Attachment 6 of this paper. It is noted that the LTR requires the dose to an average member of the critical group be less than 0.25 mSv/yr (25 mrem/yr), but does not specify whether the average member of the critical group must be located on-site or offsite. Consistent with the technical underpinnings of the LTR, current staff guidance for implementing the LTR does not incorporate a specific recommendation to analyze potential impacts from offsite releases of residual radioactivity at a site with a terminated license.

## 2) Case-by-Case Approach for Controlling the Disposition of Solid Materials

Before the establishment of the LTR, radiological criteria for license termination and for controlling the disposition of solid materials were similar for many cases, and some sites grandfathered under the Site Decommissioning Management Plan (SDMP) Action Plan continue to apply these criteria. Two examples are Regulatory Guide 1.86, entitled "Termination of Operating Licenses for Nuclear Reactors," and Fuel Cycle Policy and Guidance Directive FC 83-23, entitled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Byproduct, Source or Special Nuclear Materials Licenses." The table of surface contamination criteria contained in these documents has been used by licensees for demonstrating that solid material with surface contamination can be safely released with no further regulatory control. The criteria do not include an upper limit on the amount of solid material with surficial contamination that can be released for unrestricted use.

Radiological criteria for surface contamination on materials were based principally on the capabilities of readily available instrumentation at the time the guidance was developed and therefore are not dose- or risk-based, or developed through exposure pathway and dose modeling. According to information contained in Inspection and Enforcement Circular No. 81-07, "Control of Radioactively Contaminated Material," doses from releases of material and equipment with surface contamination are less than 0.05 mSv/yr (5 mrem/yr). Currently, a comprehensive exposure pathway and dose modeling methodology is under development by the staff that, when completed, could be used to provide an updated estimate of hypothetical doses associated with the current case-by-case approach for controlling the disposition of solid materials.

As discussed above, 10 CFR Part 20 does not currently contain specific requirements for the release of solid materials with small or no amounts of radioactivity. At materials sites, solid material releases with surface contamination is generally authorized on a case-by-case basis by incorporating existing regulatory guidance or other case-specific criteria into specific license conditions. At reactor sites, solid material is controlled by using the existing "no-detectable" policy outlined in HPPO-71 of the "Health Physics Position Data Base," NUREG/CR-5569, as improved by current industry practice. In summary, if a reactor licensee conducts appropriate surveys and does not detect licensable material above natural background levels, the solid material in question does not have to be treated as waste. Thus, when solid material with surficial radioactivity is released before license termination, both reactor and materials licensees must first survey it and disposition the material in accordance with applicable conditions. Although this approach adequately protects public health, safety and the environment at a fraction of the established level of 1 mSv/yr (100 mrem/yr), the lack of established radiological criteria for controlling the disposition of solid materials could result in inconsistent release levels because not all licensees use the same criteria, survey instruments, or procedures to monitor solid material releases.

For solid materials that contain slight levels of volumetric contamination, industry practice over the years has been to request approval on a case-by-case basis to release materials to offsite locations before license termination. Such requests have included comparatively large volumes of material, which have been reviewed as requests for alternate disposal procedures, under 10 CFR 20.2002. Both reactor and materials licensees have used this process to seek approval for the unrestricted release of material, which typically involve the burial of solid materials on the licensee's site, or disposal at a nearby landfill. Licensees are required to identify and describe the waste, the disposal site, pathways of exposure, and calculate doses to members of the public and workers, that are specific to the request. Proposed offsite releases of solid material with volumetric sources of contamination are evaluated by applying the guideline that maximum annual doses should not exceed a small fraction of the annual public dose limit of 1 mSv/yr (100 mrem/yr). For most cases, requests are approved on a case-by-case basis under a criterion of a "few mrem/yr," rather than use of LTR or SDMP Action Plan criteria.

Although there are similarities in the exposure scenarios used in dose-modeling studies for clearance and the LTR, such as building occupancy and land use, there is a fundamental difference between the two approaches. The technical basis for the LTR assumes that an individual may be exposed by residual radioactivity which resides at a single fixed location under three conservative and probable scenarios. Regarding the current case-by-case approach for controlling the disposition of solid materials, an individual may come into contact with previously regulated materials in dozens of scenarios at offsite locations, such as use of consumer products, handling of released materials by workers in other industries, and residence near a local landfill, etc. Consequently, the concentration of residual radioactivity in materials that are candidates for release under the LTR and clearance may differ, because of differences in the two sets of dose-modeling assumptions and the application of different risk goals.

After the license is terminated, technical differences between the analyses become less important because materials that are released offsite after license termination can have fates similar to materials released to offsite locations before license termination. Exposure scenarios and dose modeling for clearance could be applicable conceptually to offsite releases after license termination. Understandably, assumptions used in the dose modeling for clearance would need

to be reviewed for applicability to offsite releases after license termination, such as the amount and duration of releases, and the extent of mixing with non-impacted materials in offsite locations, etc. For example, releases made before license termination are surveyed to ensure compliance with applicable clearance criteria, but absent such controls after license termination, a greater inventory of materials could be released in a shorter period of time than would be possible if the material had been released before license termination.

In general, projected dose estimates from the current case-by-case approach for controlling the disposition of solid materials before license termination appear to be consistent with the LTR dose constraint, based on the fractional allocations of the public dose limit or risk from radioactivity released to the public. A difference between these allocations is that the lower dose limit associated with the current case-by-case approach for controlling the disposition of solid materials accounts for multiple releases of materials and equipment that may occur over the operating and decommissioning phases of a license, whereas the release of lands and structures under the LTR accounts for a single, and most likely larger, release of material for unrestricted use at the time of license termination. The existing risk-informed/performance-based graded approach to managing the release of materials under the LTR and the current case-by-case approach for controlling the disposition of solid materials addresses the need for adequate protection without undue burden on operator and regulatory resources.

### 3.2. Factors that realistically would reduce the dose below 0.25 mSv/yr (25 mrem/yr) if material were removed from an unrestricted-use site after the license is terminated

#### 3.2.1 Dose reduction by ALARA and mixing

##### 1) LTR

As discussed above, the LTR dose constraint is based on an all-pathways dose limit of 0.25 mSv/yr (25 mrem/yr) to an individual occupying the site after license termination plus ALARA. As part of the license termination process, ALARA analyses are conducted on a site-specific basis to reduce the dose from residual radioactivity. Staff experience with license termination plans indicates that this requirement effectively reduces that amount of residual radioactivity remaining at the time of license termination.

The technical basis for the LTR recognized that individuals residing or working at a decommissioned site would actually receive doses substantially below the constraint level because of ALARA considerations, dose-modeling assumptions, and other factors inherent to the decommissioning process itself. Staff experience with decommissioning casework, involving a variety of facility types over many years, indicates that certain decommissioning practices reduce the residual radioactivity to levels much lower than the dose constraint at the time of license termination. For example, cleanup of concrete by scabbling frequently removes a layer of concrete that contains a large fraction of the residual radioactivity. The final report of the "Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities," NUREG-1496, assumed that removal of a layer of concrete by scabbling will result in doses at levels from 2 to more than 10 times lower than a constraint value. For many decommissioning sites, this is similar for soil removal, which oftentimes involves over-excavation. Another decommissioning practice at some sites is reliance on residual radioactivity levels well below the dose constraint to increase statistical confidence in



final status surveys for compliance purposes, thereby simplifying the survey process and reducing costs. These factors, combined with inherent conservatism in dose modeling, can reduce residual radioactivity at a site with a terminated license to levels that are a fraction of the LTR dose constraint.

Another consideration is that movement of material containing residual radioactivity after license termination will likely include commingling with other material that has very little or no residual radioactivity from licensed operations. For example, if dirt or concrete is moved to an offsite or other on-site location, the concentration of residual radioactivity will likely be significantly diluted in the resulting mixture of materials. Also, if materials remaining at sites with terminated licenses are disposed of in local landfills, there would be mixing with large amounts of other materials, which would further dilute the concentration of residual radioactivity.

This combination of on-site and offsite factors likely reduces the concentration of residual radioactivity to levels that correspond to a fraction of the LTR dose constraint, should materials be moved from a site after the license is terminated.

## 2) Case-by-Case Approach for Controlling the Disposition of Solid Materials

ALARA evaluations have also been performed in the existing case-by-case approach for controlling the disposition of solid materials. For example, ALARA is considered when evaluating authorized releases under restricted conditions in accordance with 10 CFR 20.2002. Similar to the LTR discussion above, the same factors can apply to clearance, such as survey approaches, and offsite and onsite mixing and dilution.

## 4. RECOMMENDATIONS

The staff recommends describing the relationship between the LTR's unrestricted-release dose constraint and the existing case-by-case approach for controlling the disposition of solid materials. The staff's qualitative judgment, at this time, is that the LTR is protective of public health if materials are removed from a site after license termination for unrestricted use, mainly due to the conservatism in the LTR technical basis and current dose-modeling assumptions, ALARA considerations, and the effects of mixing when residual radioactivity is moved to other locations. This should be clarified in a Regulatory Issue Summary.

Note that insights from the ongoing technical development associated with the rulemaking effort on controlling the disposition of solid materials can be used in the development of a rationale to further explain the relationship between criteria in the LTR and those for controlling the disposition of solid materials, and support the current view that the LTR is protective of offsite releases after license termination for unrestricted use.