NCRP REPORT NO. 141 AND ITS ROLE IN THE DISPOSITION OF SOLID MATERIALS

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ABSTRACT

The National Council on Radiation Protection and Measurements (NCRP) published its Report No. 141 on managing potentially radioactive scrap metals that are generated in regulated facilities. The report is intended to provide guidance on formulating a national policy toward managing scrap metals generated in facilities that are regulated with radiological concerns. Such metals have been generated during decades of operation in support of nuclear weapons programs, civilian nuclear applications, and other applications involving the production, use, or processing of radioactive materials, as many facilities in the United States have reached the end of their useful lives. Additional facilities are expected to reach a similar status in the near future. Adding to the total are facilities that produce natural resources, such as petroleum and natural gas. The radioactive contents in the materials resulting from these operations may include naturally occurring radioactive materials (NORM) or technologically enhanced NORM (TENORM). The report evaluates several options and suggests a strategy for managing the disposition of such scrap metals. To this end, the report identifies clearance as an important disposition option and provides a radiation protection framework by which release standards can be developed. It further advocates the establishment of a national and international consensus regarding the release of these materials, particularly in light of the issues associated with orphan sources (i.e., lost or abandoned radioactive devices) and the magnitude of potential contamination involved; accordingly, there is currently considerable resistance by mills to accept scrap metals that may contain radionuclides. Furthermore, the national consensus must also take into account the negative public sentiment toward recycling such scrap metals.

INTRODUCTION

Large stockpiles of the surplus materials (such as scrap metal) and waste (such as debris, soil, etc.) that may contain low levels of radioactivity are being generated as an increasing number of nuclear facilities have become decommissioned in the past two decades. Associated with these materials are billions of dollars in the estimated costs for disposal of these materials at a licensed low-level radioactive waste (LLRW) burial facility [1,2]. Substantial cost savings could be realized if other disposition options involving lesser regulatory constraints are exercised [3]. It is also obvious that reuse and recycling of certain materials (such as scrap metal or concrete) can become an attractive alternative to generators, because it avoids expensive disposal costs and also helps recover potential market values by sales as commodities.

However, the approach to effectively addressing the disposition of these materials has been largely impeded by the lack of a well established regulatory process. Current regulation on managing radioactive materials (including wastes) is part of the overall regulatory scheme governing the operations of nuclear facilities and their related activities, which is covered under the Atomic Energy Act (AEA) of 1954 (Public Law [P.L.] P.L. 83-703, codified as amended 42 U.S.C. 2011-2297) and its subsequent amendments. Although provisions for regulating these materials have been well established under the AEA, a systematic approach to releasing such materials, either based on risk or otherwise, has not been well developed. Thus, with few exceptions, unless it can be proven otherwise, such materials must be treated as if they were radioactive, from the regulatory standpoint, regardless of the levels of any radionuclides present in them. This is obviously undesirable when it comes to formulating a comprehensive disposition management approach.

The AEA does not, however, govern activities that primarily involve contact with naturally occurring radioactive material (NORM) and technologically enhanced NORM (TENORM), as exemplified by industrial activities involving petroleum or phosphorous extraction. NORM or TENORM is not regulated by the U.S. Nuclear Regulatory Commission (NRC), but by individual states.

In an attempt to address the related management issues, the National Council on Radiation Protection and Measurements (NCRP) established Scientific Subcommittee 87-4 (hereafter referred to as "the Committee"), which began its deliberation in 1998 and concluded with a publication that was issued as NCRP Report No. 141, Managing Potentially Radioactive Scrap Metal [4]. The report addresses three major areas: (1) estimating scrap metal inventories and the magnitude of the problem, (2) evaluating the current practices and viable options, (3) providing a radiation protection framework for clearance of materials, (4) identifying the related issues, and (5) making major findings and recommendations. The report offers to clarify some important issues surrounding the regulatory process of establishing the national policy, especially on clearance, on the disposition of solid materials from regulated facilities.

POTENTIALLY RADIOACTIVE SCRAP METAL

In the United States and worldwide, large amounts of scrap metals arise primarily from decommissioning defense nuclear weapons production facilities and commercial nuclear power plants. Another significant quantity is generated by industries involved in the exploration and extraction of natural resources such as petroleum or natural gas. Metals from the latter operations are solely concerned with the presence of NORM or TENORM.

Since only a portion of the scrap metal had been in contact with or in proximity of radioactive materials, it is expected that much of it will be free of contamination. Nonetheless, because it originated through the dismantlement of facilities that were associated with the use or processing of radioactive materials, it is referred as "potentially radioactive scrap metal" (PRSM). In general, PRSM includes all suspect or contaminated metal within a facility, if it cannot be otherwise classified under existing laws or regulations.

Estimating the inventory of PRSM is a rather challenging task. First, a systematic method of estimating the scrap metal inventory does not exist. Second, reporting on the scrap metal inventory has been sparse and has not been systemized for decommissioning activities. Third, very few comprehensive studies exist, since "complex-wide" decommissioning experience is so limited. Therefore, PRSM inventory information relies primarily on the following sources: (1) existing radioactive metal inventory studies [5,6], (2) estimates from ongoing decontamination and decommissioning (D&D) projects [7,8] and (3) projections of future D&D projects [1,9,10,11,12]. In all, it was estimated that the total PRSM in the United States amounts to about 9 million metric tons; about 4 million metric tons is attributed to NRC-licensed facilities, 2 million to U.S. Department of Energy (DOE) facilities, and 3 million to NORM- or TENORM-related facilities.

The PRSM inventory can be classified by the expected concentrations of radioactive material (activity level) and the nature of contamination. Both factors depend on facility design, operating history, maintenance, radioactive decay time, and the decommissioning strategy. For purposes of this report, PRSM has been divided into four general categories [1]: (1) scrap metal that is suspected of being radioactive but that could actually be clean (suspect radioactive), (2) metal with surface contamination that is removable (surface contamination – removable), (3) metal with surface contamination that is fixed in place (surface contamination – fixed), and (4) metal with in-depth contamination due to neutron or particle activation (activated). It is important to note that the majority of the PRSM inventory is actually not contaminated; much of it is merely suspected of being contaminated. More than 75% of the total metal mass, for example, falls in the categories of suspect radioactive or removable surface contamination.

MANAGEMENT OPTIONS AND APPROACH

Disposition Alternatives and Strategy

The disposition of PRSM presents a major challenge to the operators of facilities that are associated with the production of either man-made radioactive materials or NORM (or TENORM). Above all, the goal should be to protect human health and the environment while minimizing waste as a means to prevent pollution. It is commonly accepted as good environmental and public health policy that the amount of waste that must be sent to disposal should be minimized. Observance of such practices has been strongly endorsed by the U.S. Congress in the Pollution Prevention Act of 1990 (P.L. 101-508, codified at 42 U.S.C. 13101-13109). On the basis of this guidance, the approaches to managing PRSM should be based on a comprehensive spectrum of viable options, ranging from disposal at a licensed radioactive facility to recycling for various end uses.

On the basis of management considerations and past practices, a number of basic disposition options for PRSM have been identified. All the options have been used in the United States to some extent, but with varying degrees of success. While some of the options remain within the regulated environment with radiological control, others entail the release from control by means of a concept such as clearance. In all cases, however, the primary decision that must dictate the selection of an option is that it represents a means of disposition that can be accomplished with prudent protection of human health and the environment. These options include: (1) disposal at licensed LLRW facilities, (2) on-site storage, (3) recycle for internal use, (4) disposal at RCRA landfills, (5) release to general commerce.

Depending on the metal type, quality, radiological characteristics, cost constraints, or other factors, the options discussed above can be considered for disposition of PRSM. For example, for scrap metal with relatively high concentrations of radionuclides that are not easily removed or that cannot be removed at all, the proper choice for disposition would be a licensed radioactive waste disposal facility. For metals that contain radionuclides with relatively short half-lives or for those awaiting future decisions, the option to store them on site appears to be reasonable. For those containing some radioactive materials that can be safely recycled for use within the industry (or within the generator community for continued control), the option for internal recycling would be viable. For metals that contain none or minimal concentrations of radioactive materials but otherwise have no recycling value, the options would be either disposal at hazardous waste landfills or sanitary landfills for nonhazardous wastes. For metals that have been determined to have met the clearance standards and for which the particular scrap metal might represent a valuable resource, release to general commerce for recycling might be a viable option. If the metal also contains hazardous materials, it could be disposed of as low-level mixed waste.

Regulatory Needs and Recent Policy-Making Activities

The disposition options available under current regulations are rather fragmented and do not form a comprehensive basis for sound PRSM disposition decisions. In particular, the lack of national release standards for materials containing very low levels of residual radioactive contents presents a major obstacle to a viable release option. The nation is in need of regulatory policies that address whether

PRSM can be used for recycling in general commerce or disposed of as nonradioactive waste at U.S. Environmental Protection Agency (EPA)- or state-permitted burial facilities.

Such a need has long been recognized by regulators, the nuclear industry, and other industries associated with the production of radioactive materials. In fact, materials containing surficial residual radionuclides have been released routinely on the basis of existing guidance, including guidance issued by the NRC in Regulatory Guide 1.86 [13] and similar guidance found in DOE Order 5400.5 [14]. Such guidance, however, is limited to the release of materials with surface contamination. Furthermore, it is based largely on the detection capabilities of radiation instrumentation and bears little or no relationship to any established dose or risk criterion. Release of materials with volume contamination has been difficult because of the lack of guidance and can be conducted only on a case-by-case basis. As a result, there have been several attempts by regulatory agencies to establish consistent and uniform standards.
Such regulatory activities include the U.S. Nuclear Regulatory Commission's renewed effort to make rules for the release of solid materials from its licensed facilities ([15] and DOE's effort to prepare a programmatic environmental impact statement regarding the disposition of scrap metal generated by its facilities ([16]. In addition, through the Conference of Radiation Control Program Directors, Inc. (CRCPD), the states are in the process of establishing standards for the disposition of TENORM.

FRAMEWORK AND APPROACH TO DEVELOPING RELEASE STANDARDS

Concept of Controlling Releases

To avoid the imposition of excessive regulatory procedures, certain practices and/or radiation sources involving small quantities of radioactive materials are usually excluded from the scope of regulation because of their specific usage and because the associated social impacts have been determined to be insignificant. This exclusion process has been accomplished through three approaches: (1) exemption – control was not imposed from the outset following thorough deliberation (such as smoke detectors or other exempted radioactive materials [17]); (2) clearance – control was subsequently removed from the existing practice by authorization (the process of clearance is analogous to effluent releases); or (3) de minimis – control was deemed unwarranted because the anticipated doses (or risks) were found to be trivial. All three approaches have been practiced in society, resulting in various degrees of public awareness and success. They pertain to granting relief by not imposing or by removing regulatory control. Clearance and de minimis are the two approaches to be considered for the disposition of PRSM. Obviously, should the de minimis level be used as the criterion for developing clearance standards (a current trend favored by several national and international standards-developing bodies), then the two approaches would become indistinguishable.

Clearance as a form of controlled release of PRSM is analogous to the release of airborne or waterborne radioactive effluents from installations associated with the production and use of radioactive materials. Such releases are an integral component of routine operations. Examples of this type of regulation include two national standards developed by the EPA: (1) national emission standards (40 CFR Part 61) to support the Clean Air Act and (2) environmental standards for the uranium fuel cycle (40 CFR Part 190, Part B) for controlling planned discharges from nuclear fuel cycle facilities. The Clean Air Act includes provisions to control radioactive releases to the atmosphere, and regulations under the Safe Drinking Water Act include limits on the concentrations of radioactive materials in drinking water.

Development of Clearance Standards – A Risk-Based Approach

The term clearance refers to a process for certifying the removal of control from an existing practice when the potential dose levels to the critical group satisfy certain constraints or when authorized by the regulator. It is the Committee's view that a few tens of microsieverts per year to an average member of the critical group would be an appropriate dose criterion for setting clearance standards. This suggested dose level represents only a fraction of the recommended annual dose limit of 1 mSv [18] and is well within the International Commission and Radiological Protection's (ICRP's) recommended annual dose constraint of 0.3 mSv from a single source [19]. Should competent authorities opt to use an individual annual dose of 10 μSv as the criterion, development of clearance standards would be set at the "trivial dose" or the "negligible individual dose" (NID) level [20] below which further effort to reduce the dose is considered unwarranted, thus relieving its further consideration in the collective dose assessment. This dose level is 1% of the annual dose limit of 1 mSv and is about 0.3% of the average annual dose (i.e., 3.0 mSv y^{-1}) received by a member of the public in the United States [21]. An estimated annual individual risk level of 5×10^{-7} latent cancer fatalities corresponds to a dose level of 10 μSv. The NCRP has recommended the use of this same dose constraint as the criterion to establish an exempt category for hazardous or radioactive wastes [22]. Note that using the NID as the dose criterion for clearance will effectively render clearance standards to be developed at the de minimis level.

Clearance of PRSM that contains residual radioactive materials will require, through dose assessment, the establishment of activity concentrations for both surficial and volumetric sources. The clearance levels should be based on an analysis that includes plausible scenarios for unrestricted release. In practice, these scenarios can be described under the alternatives of reuse, recycle, or disposal.

Recent Activities

Recent activities to develop clearance methods and standards have been conducted by the International Atomic Energy Agency [23], the European Commission [24], and the Health Physics Society Standards Committee for the American National Standards Institute [25]. These clearance standards are generally in agreement, such as using 10 μSv y^{-1} as the dose criterion, and have shown a distinct category aside from LLRW [4]. However, some differences do exist. The variations, in general, are not caused by the selection of dose criteria or fundamental approaches taken by the developing organizations. Rather, they originate from several sources of uncertainty based on institutional or technical judgments about the subject issues of various nations. Continued efforts are therefore essential in developing a set of uniform and consistent international clearance standards. It is imperative that the standards be carefully evaluated for incorporation by regulators in future rulemaking efforts. It is also important that such rulemaking efforts be conducted with the participation and consensus of national and international regulatory authorities, affected industries, workers, and the public.

CONCLUSIONS OF NCRP REPORT NO. 141

Findings and Recommendations

The NCRP Report No. 141 [4] concluded with the following findings and recommendations in addressing the management of potentially radioactive scrap metal.

Findings

1. The management of PRSM will require a comprehensive and multifaceted approach,

2. National guidance on pollution prevention forms a sound basis for PRSM management,

3. The current regulatory system focuses only on waste management,

4. There is an urgency to establish consistent national/international policies and standards, and

5. Concerns of the metal industry and the public must be adequately addressed.

Recommendations

1. Comprehensive and consistent national and international risk-based policies for managing PRSM need to be developed,

2. A set of uniform clearance standards to address national and international concerns needs to be developed,

3. The standards should include NORM and TENORM,

4. Regulatory control over orphan sources must be improved, be harmonized,

6. The use of licensed mills/brokerages as "clearing houses" for recycling should be encouraged,

7. New technologies and/or plant designs to reduce metal contamination should be developed, and

8. Steps should be taken to enhance public understanding of the clearance process.

Such recommendations have been consistent with the findings of recent reports. In particular, NCRP Report 139 [22] on the risk-based classification of radioactive and chemical wastes, the report by the National Academy of Sciences/National Research Council (NAS/NRC) on the alternatives of controlling the release of solid materials from NRC-licensed facilities [3], and the recent NAS/NRC effort on low-activity radioactive waste [26]. Moreover, the U.S. NRC is on a course of rulemaking to set clearance standards. As a separate effort, the U.S. EPA is issuing an advance notice of proposed rulemaking for the management of low-activity radioactive waste [27].

Remaining Issues

International Standards

Since scrap metal is a commodity in international trade, it is important that international agreement be reached concerning release standards. Such a collaborative effort will not only eliminate potential trade barriers, but will also help solidify acceptance of the standards by the public. Such an effort has been strongly advocated by NCRP [4] and NAS/NRC [3].

Residual Liability

Since clearance is a process that effectively "de-licenses" the materials from the regulatory regime, potential residual liabilities may remain once the materials are released. Such concerns have been exacerbated by the occasional discoveries of orphan sources (i.e., uncontrolled licensed radioactive devices) and the accidental melting of such sources at steel mills [28]. Accordingly, the metal industry has opposed the clearance initiative [29], and in defense against potential radioactive contamination, sensitive radiation detectors have been installed to screen out the contaminated metals.

Negative Public Perception

For years, radiation from man-made sources generally has struck fear in the public's mind [30,31]. Such a negative public attitude has manifested itself in regard to the recycling of scrap metal that could have been contaminated with radioactive materials. Although such concerns are largely based on perception, it is important that they be fully understood, evaluated, and resolved by regulators in formulating a national policy on the disposition of PRSM.

SUMMARY AND CONSLUSIONS

The current regulatory system for disposition of low-activity radioactive waste is largely origin-based, in that it was designed to specifically control wastes according to where they originated rather than how hazardous they are. A recent NAS/NRC report [26] characterized the current system as “a regulatory patchwork evolved over almost 60 years.” The potentially radioactive scrap metal (PRSM), reported to be up to 9 million metric tons, is encountering this regulatory dilemma regarding its disposition options.

PRSM differs from conventional radioactive waste in two ways: (1) the majority of the inventory is merely suspected of radioactive contamination and may be in fact free from contamination, and (2) it is not “waste” if determined to be suitable for reuse or recycle. For these reasons, clearance of such materials appears to be a reasonable option. This requires the establishment of a regulatory process to “certify” releases that entails a regulatory framework accompanied by a set of criteria. The NCRP Report No. 141 [4] reaffirms such a concept and also recommends an individual dose level in the order of 10 μSv/y as a dose constraint for setting clearance standards. This dose level is consistent with what has been termed by the NCRP as the Negligible Individual Dose (i.e., a de minimis level [20]). The approach has been characterized as being analogous to the current regulatory control over gaseous and liquid effluent releases from nuclear facilities. However, since scrap metal is a commodity that has been traded worldwide, a consistent international clearance standard is highly recommended.

Notwithstanding the basis for developing the clearance framework and process, it has been recognized that many of the remaining issues pertain to implementation. In this regard, for example, the metal industry has also established a stringent measure to screen out radioactive materials, utilizing sensitive radiation detectors. To this end, the NCRP report [4] suggests conducting releases only through licensed mills/brokerages as “clearing houses” and supporting the industry in controlling orphan sources. What remains to be accomplished is the more challenging work of communicating with the public and other stakeholders. For this, it is essential to continue to engage them in meaningful dialogue when a complete framework and implementation scheme is fully developed.

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FOOTNOTES

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