

ISSUE PAPER 4

INDIVIDUAL PROTECTION—ALARA PLANNING

I. Introduction

In Staff Requirements Memorandum (SRM) SECY-12-0064, “Recommendations for Policy and Technical Direction To Revise Radiation Protection Regulations and Guidance,” dated December 17, 2012,¹ the Commission directed the U.S. Nuclear Regulatory Commission (NRC) staff to “continue discussions with stakeholders on alternative approaches to deal with individual protection at or near the current dose limit.”

II. Objective

Consider whether revised or additional regulatory requirements and guidance may be appropriate to ensure that cumulative occupational exposures² are examined and that progressive restrictions can be taken as cumulative exposures increase.

III. Background

The NRC’s regulatory framework ensures adequate protection for an occupationally exposed individual by enforcement of the dose limit and the application of the as low as is reasonably achievable (ALARA) principle. Each NRC licensee must develop, document, and implement a radiation protection program commensurate with

¹ SRM-SECY-12-0064 is available on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/>.

² Cumulative dose is the total dose that an occupationally exposed worker receives as a result of repeated exposures to ionizing radiation to the same portion of the body, or to the whole body, over time. (This definition is available on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/basic-ref/glossary.html>.)

the scope and extent of its licensed activities.³ In addition to meeting expressed dose limits, the NRC requires its licensees to apply the ALARA principle to their licensed operations. Title 10 of the *Code of Federal Regulations* (10 CFR) 20.1003, "Definitions," defines the term ALARA as "making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part [10 CFR Part 20, "Standards for Protection against Radiation"] as is practical consistent with the purpose for which the licensed activity is undertaken."⁴ Subpart C, "Occupational Dose Limits," of 10 CFR Part 20 provides the current occupational dose limits. The regulations at 10 CFR 20.1201, "Occupational Dose Limits for Adults," provide the occupational dose limits for adults as the total effective dose equivalent (TEDE) of 50 millisieverts (mSv) (5 rem) per year,⁵ which is based on the recommendations in International Commission on Radiological Protection (ICRP) Publication 26, "Recommendations of the International Commission on Radiological Protection," issued in 1977. ICRP based its selection of a recommended dose limit in ICRP Publication 26 (1977) on a comparison of the radiation risk of fatal cancer to the average annual risk of accidental death in industries generally accepted as having a safe working environment. According to ICRP, such industries, at that time, could be defined as exhibiting an annual mortality risk of approximately 1 person in 10,000 from industrial accidents. The recommended limit was suggested to provide radiation workers with at least that level of protection. The selection of a 50 mSv (5 rem) annual value was based on an assumption that most individuals protected by such a limit would be unlikely to exceed 10 mSv (1 rem) in a

³ See 10 CFR 20.1101(a).

⁴ See the definition of ALARA in 10 CFR 20.1003.

⁵ See 10 CFR 20.1201(a)(1)(i). NRC regulations define the term TEDE as the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). (See the definition of TEDE in 20 CFR 20.1003.)

year. It was actually the radiation risk of 10 mSv (1 rem) that corresponded numerically to the average annual accidental death rate in safe industries.

National Council on Radiation Protection and Measurements (NCRP) Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," issued in 1987, recommends the use of a single dose limit of 50 mSv (5 rem) per year and the elimination of the lifetime cumulative dose formula $D=5(N-18)$, where 5 is the dose in rem, and N is the age of the individual in years. Furthermore, NCRP Report No. 91 recommends as guidance that "the community of radiation users is encouraged to control their operations in the workplace in such a manner as to ensure, in effect, that the numerical value of the individual worker's lifetime effective dose equivalent in tens of mSv (rem) does not exceed the value of his or her age in years." (See page 25 of NCRP Report No. 91.) NCRP Report No. 116, "Limitation of Exposure to Ionizing Radiation," issued in 1993, elevates this guidance to the level of a basic recommendation. The NCRP also noted that the intent of the recommendation was not to suggest that allowing higher annual exposures for younger workers as opposed to older workers simply by virtue of their age is acceptable.

In 1987, the NRC and other Federal agencies developed a series of recommendations entitled, "Federal Radiation Protection Guidance for Occupational Exposure" (Volume 52 of the *Federal Register*, page 2822 (52 FR 2822); January 27, 1987, accessible through the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML13269A320). This guidance recommends an occupational limit of 50 mSv (5 rem) and emphasizes the use of administrative control and reference levels for carrying out ALARA programs. Section IV, "Discussion," of this document provides more information. Specifically, Recommendation 9 states the following:

Radiation exposure control measures should be designed, selected, utilized, and maintained to ensure that anticipated and actual doses meet the objectives of this guidance. Establishment of administrative control levels (ACLs) below the limiting values for control may be useful and appropriate for achieving this objective. Reference levels may also be useful to determine the need to take such actions as recording, investigation, and intervention. Since such administrative control and reference levels will often involve ALARA considerations, they may be developed for specific categories of workers or work situations. Agencies should encourage the establishment of measures by which management can assess the effectiveness of ALARA efforts, including, where appropriate, local goals for limiting individual and collective occupational doses. Supervision should be provided on a part-time, full-time, or task-by-task basis as necessary to maintain effective control over the exposure of workers.⁶

The ICRP Publication 60, "1990 Recommendations of the International Commission on Radiological Protection," issued in 1991, recommends reducing the occupational dose limit and expressing such a limit as an average and a maximum value to provide flexibility for possible implementation issues while achieving an objective to restrict the cumulative occupational exposure to less than 1 Sv (100 rem). The ICRP selected the 1 Sv (100 rem) level from a range of possible options as a risk-informed judgment that an aggregated risk of 5 percent from fatal cancer, serious nonfatal cancer, estimate of length of life lost from fatal cancer, and serious hereditary effects would be unacceptable. The ICRP also noted that it selected the value under the assumption that, with the application of sound radiation protection practices, the limit would only rarely be approached.

The ICRP Publication 103, "Recommendations of the International Commission on Radiological Protection," issued in 2007, reaffirms the recommended limits for occupational exposure. In addition, these recommendations emphasize the use of optimization, with constraints, below the dose limits. The ICRP recommendations indicate that the constraint is the starting point for optimization and serves as an upper bound on the annual dose that members of the public, or an occupationally exposed

⁶ See 52 FR 2833; January 27, 1987.

individual, should receive from the planned operation of any controlled source of radiation. The ICRP has stated that constraints should not be considered limits and that values for constraints should be established below the dose limit.

The NRC regulations define the term “constraint” as a value above which specified licensee actions are required.⁷ Many licensees are generally familiar with the concept of constraints; however, they may not use that term because the concept is very similar to the use of various types of planning values, such as self-imposed administrative limits, in their programs to ensure that the dose limits are not exceeded. Therefore, many established radiation protection programs already incorporate this concept, at least to some degree.

Internationally, the discussion continues on the appropriate ways to incorporate the concept of constraints, or planning values, into regulatory programs. The International Atomic Energy Agency has added a requirement to establish constraints as part of the International Basic Safety Standards. Similar requirements have been present in drafts of the European Basic Safety Standards Directive. Notwithstanding these requirements, the international community continues to discuss how it would implement and inspect such provisions.

During the 2009–2012 NRC outreach activities to discuss potential changes to the agency’s radiation protection standards, many stakeholders raised questions about the concept of constraints and the relationship of constraints to limits. The current NRC regulatory structure defines a constraint as a level at which a licensee action is required. The NRC applies this provision to airborne effluents from nonreactor facilities. As such, these facilities must evaluate the situation, develop actions to return effluent levels to less than the constraint, and provide a report to the NRC. However, the regulations do consider an effluent release in excess of the numerical value of the constraint a violation.

⁷ See the definition for “constraint (dose constraint)” in 10 CFR 20.1003.

A violation only occurs if these facilities do not implement actions in response to the situation. This approach is similar to the ICRP's description in which a dose in excess of the constraint is not considered a violation; instead, it is considered a point at which the reevaluation of the planning and implementation of the optimization ALARA program is necessary.

The current requirements for ALARA appear in 10 CFR 20.1101(b) and 10 CFR 20.1101(d). In the United States, the majority of occupationally exposed individuals receive less than 20 mSv (2 rem) per year as reported to the NRC.⁸ However, a small percentage of individuals receive larger exposures up to, and occasionally above, the NRC's current annual occupational limit of 50 mSv (5 rem). Although nuclear power reactor operators have been successful in reducing individual exposures so that only a very limited number of individuals exceed 20 mSv (2 rem) in a year,⁹ this situation is not the case in other segments of the regulated community. For example, industrial radiographers have a somewhat greater percentage of individuals above the average annual dose level of 20 mSv (2 rem) recommended in ICRP Publication 103 (2007). Stakeholder interactions have led the NRC staff to conclude that some of these individuals may be receiving doses close to the 50 mSv (5 rem) limit over multiple years. Section IV.E of the NRC's Advanced Notice Proposed Rulemaking or Issue Paper 6 entitled, "Reporting of Occupational Exposure" (ADAMS Accession No. ML13347B262), states that detailed information on these cumulative exposures is difficult to ascertain because some segments of the regulated community are not

⁸ See NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2011: Forty-Fourth Annual Report," Volume 33, issued in April 2013 (ADAMS Accession No. ML050110062).

⁹ See NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States," issued in 2009.

required to report occupational exposure, thus making it difficult “to assure that lifetime exposure of workers repeatedly exposed near the limits is minimized.”¹⁰

The regulation at 10 CFR 20.1101(b) requires each licensee to “use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).” The NRC’s current regulations at 10 CFR Part 20 do not include an explicit requirement to plan activities to optimize radiation protection (ALARA planning) or to establish ALARA planning values as part of the licensee’s radiation protection program. In regard to nuclear power reactors, the NRC staff published Regulatory Guide 8.8, “Information Relevant To Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable,” Revision 3, issued in June 1978 (NRC’s Agencywide Documents Access and Management System (ADAMS) Accession No. ML003739549), which provides guidance on methods used to implement the existing ALARA requirements, including detailed ALARA planning for use in the operations of commercial power reactors. However, this level of ALARA planning is not as common in the programs of other types of NRC licensees.

The NRC notes that its implementation and enforcement of its ALARA principles are generally made through specific license conditions instead of through more detailed regulations. Therefore, the agency questions whether additional regulatory requirements are appropriate in order to foster a clear and consistent approach for all types of licensees versus the reliance on license conditions on an individual licensee basis.

¹⁰ See *Federal Radiation Protection Guidance for Occupational Exposure* (hereinafter referred to as the Federal Guidance) (52 FR 2822–2827; January 27, 1987).

In previous requests for comments on radiation protection issues, the NRC staff asked specific questions about various options for individual protection, including possible revisions to the dose limits and possible changes or additions to ALARA requirements. The NRC staff used the results of those discussions to develop SECY-12-0064, "Recommendations for Policy and Technical Direction To Revise Radiation Protection Regulations and Guidance," dated April 25, 2012. The SRM-SECY-12-0064 includes, among other things, direction to not change the existing limit of 50 mSv (5 rem). However, the Commission recognized the importance of maintaining exposures ALARA and the implications of cumulative exposures over an occupationally exposed lifetime. Therefore, the Commission directed the staff to continue discussions with stakeholders on alternative approaches to deal with individual protection at or near the current dose limit.

IV. Discussion

The NRC is currently examining possible mechanisms for addressing individual protection at or near the current occupational dose limit of 50 mSv (5 rem) per year. One potential mechanism for achieving this goal is to revise the regulation at 10 CFR 20.1101, "Radiation Protection Programs," to include additional requirements for implementing ALARA. Furthermore, reducing exposures through consistent ALARA implementation is a straightforward method to address concerns about a worker receiving a cumulative occupational dose at or near the dose limit over a number of years.

In addition, the NRC is interested in other proposals for addressing individual protection at or near the current dose limit. During previous public interactions, some stakeholders expressed an interest in strengthening the current ALARA requirements, whereas others expressed opposition to any additional requirements. The stakeholders

who were opposed to additional ALARA requirements expressed concerns that such additional requirements would become de facto limits and would inhibit the flexibility of licensees to deal with specific operational circumstances.

The NRC staff believes that the objective of any additional regulatory requirements should be to ensure the accurate monitoring of an individual's cumulative occupational dose and to ensure that progressive measures to reduce dose are taken, if necessary, as the cumulative dose increases. If the NRC determines that additional regulatory requirements are necessary to limit the cumulative occupational dose, this objective could be achieved through either performance-based requirements, such as ALARA; prescriptive requirements; or both. Performance-based requirements express or describe the particular outcomes that must be achieved while leaving some discretion to a licensee on the specific mechanisms used to achieve those outcomes. On the other hand, prescriptive requirements specify a particular methodology or action that is necessary for compliance.

The establishment of ALARA planning values in ACLs, relative to the implementation of the ALARA principle, is not a new concept. The Federal Guidance (52 FR 2822; January 27, 1987 (ADAMS Accession No. ML13269A320)) provided a set of recommendations that incorporates this concept. The NRC and several other Federal agencies developed these recommendations, which were approved by President Reagan on January 20, 1987. These recommendations stated that the "Federal radiation guidance can address only the broad prerequisites of an effective ALARA program...authorities may find it useful to establish or encourage the use of...administrative control levels specifying, for specific categories of workers or work

situations, dose levels below the limiting numerical values recommended in this guidance.”¹¹

In the discussion that follows, the term ACL will have the same meaning as that used in the Federal Guidance.¹² For purposes of this discussion, the NRC staff is not using the term “constraint” to differentiate the proposals from existing requirements and language in which that term is already applied.

The NRC’s regulatory framework establishes requirements for radiation protection programs and for ALARA. The NRC regulation at 10 CFR 20.1101(a) states that “each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of this part.” The NRC regulation at 10 CFR 20.1101(b) states that “the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).”

The control of cumulative exposure is not a new issue. In fact, the issue was raised during the rulemaking process that led to the 1991 amendments to 10 CFR Part 20.¹³ At that time, a few commenters believed that a limit should be

¹¹ See 52 FR 2827; January 27, 1987.

¹² The Federal Guidance defines an ACL as a requirement “determined by a competent authority of the management of an institution or facility. They are not primary limits and may therefore be exceeded upon approval of competent authority or management, as situations dictate.” (See Footnote 7 in 52 FR 2833; January 27, 1987.) The Federal Guidance defines the term “reference levels” as follows:

Reference levels are not limits, and may be expressed in terms of any useful parameter. They are used to determine a course of action, such as recording, investigation, or intervention, when the value of a parameter exceeds, or is projected to exceed, the reference level. (See Footnote 8 in 52 FR 2833; January 27, 1987.)

¹³ See 56 FR 23360; May 21, 1991.

established on the cumulative total dose that can be received by any individual in a lifetime. In the Statements of Consideration for the 1991 final rule, the Commission stated that it had considered the use of a lifetime dose limit but had rejected it.¹⁴ In doing so, the Commission noted that the annual dose limit provides a de facto limit on cumulative exposures and stated that an actual cumulative lifetime dose limit could act to limit employability. The Commission noted that this issue, in turn, raised questions concerning the right of an individual to pursue employment in a chosen profession. If an individual depleted the “dose bank” provided by a lifetime dose limit, he or she might have difficulty obtaining future employment using ionizing radiation.¹⁵ The NRC staff continues to support this position and does not plan to consider a lifetime limit.

National and international recommendations and standards provide a number of possible approaches to addressing individual protection. ICRP recommended an approach to limit the average dose over a 5-year period in addition to the annual maximum dose limit. The NCRP model suggests the use of a dose value indexed to the age of the individual. Yet another possible approach would be to place no other restrictions on the occupational exposure until some cumulative total is reached. Both ICRP and NCRP have based their recommendations on the avoidance of cumulative exposure of 1 Sv (100 rem) or more. The NRC’s records of occupational exposure are based on reports received from licensees that must report according to 10 CFR 20.2206, “Reports of Individual Monitoring.” This information indicates that 0.035 percent of individuals have exceeded a 0.5 Sv (50 rem) cumulative exposure, and 0.007 percent have exceeded a cumulative exposure of 0.75 Sv (75 rem). These cumulative levels

¹⁴ See 56 FR 23368; May 21, 1991.

¹⁵ See 56 FR 23368; May 21, 1991.

could be possible levels at which additional restriction on annual exposure might be undertaken so that the likelihood of exceeding 1 Sv (100 rem) is reduced.

Before the 1991 amendments to 10 CFR Part 20, NRC regulations required licensees to meet quarterly and annual dose limits and a formula with cumulative exposures limited to $5(N-18)$, where 5 was the dose in rem, and N was the age of the individual in years.¹⁶ When the single value of 50 mSv (5 rem) was established as the occupational dose limit in 1991, the NRC removed the requirement for licensees to monitor an individual's cumulative exposure from the regulation. Such a recordkeeping requirement was not considered necessary because the control of exposure was based on a single year without reference to previous years. One of the implications of the current ICRP and NCRP recommendations is that some record of cumulative exposure could be necessary to demonstrate compliance. Certain stakeholders have previously noted that the need to track cumulative exposure was a concern for adopting the ICRP's recommendations for occupational dose limits. To varying degrees, this concern would also apply to the possible approaches for cumulative exposure as a part of a radiation protection program.

During previous stakeholder interactions, a number of comments received suggested that a change to the dose limit would significantly impact some types of licensed use, including medical diagnosis and treatment, radiopharmacy, and industrial radiography. The Commission has concluded that the annual occupational dose limit should remain at 50 mSv (5 rem). The NRC staff recognizes that similar concerns may exist for one or more of the options discussed below for addressing cumulative exposure. Therefore, the staff is specifically interested in quantitative information to

¹⁶ The former regulation at 10 CFR 20.101(b)(2) states that "the dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed $5(N-18)$ rem, where N equals the individual's age in years at his [or her] last birthday."

support the development of a regulatory analysis that would support any proposed regulatory requirements and guidance.

Licensees' ALARA programs are influenced by a number of factors, including the types of activities; the size and location of radiological sources; the extent to which time, distance, and shielding can be used while accomplishing the intended use of the radioactive materials; and other factors. External factors also affect the trends in occupational dose performance by licensees. The trend to decreased individual exposure in the nuclear power reactor community is seen as a result of a concerted effort to reduce exposures to ALARA. Significant information sharing of best practices exists within this licensee community, and external factors, such as industry ranking and insurance, have provided a significant incentive to reduce exposures. As a result, these licensees exhibit strong radiation control programs with detailed planning of activities that will incur radiation exposure. The approach used in these facilities is a good example of the approach recommended by the ICRP for optimization of protection and the implementation of dose constraints, although those terms are not used.

Unlike nuclear power reactor licensees, industrial, commercial, and academic licensees do not have a culture of sharing radiation protection best practices and do not have external factors of comparative performance ranking across the industry that give an incentive to reduce exposures to ALARA. In fact, exposures are, in many cases, driven by the number of jobs, the number of patients treated, and the limited opportunities to provide substantial shielding of the source. Furthermore, many smaller licensees do not have radiation protection programs with the structure and planning approach typically in large facilities and do not necessarily have the resources available for striving to keep exposures well below the limits.

The NRC staff notes that ALARA cannot be a "one size fits all" requirement. Each licensed use presents its own set of hazards and opportunities for radiation

protection, and licensees have a wide range of sophistication in the radiation protection program. The use of planning values, the increased review of activities and circumstances that cause exposure, and higher level management approval of any doses approaching or exceeding a planning value presuppose a relatively well-established program and predictable working environments.

The NRC expects the costs associated with possible changes to radiation protection programs and ALARA to include changes in programs, procedures, monitoring, recordkeeping, and reporting. The staff recognizes that licensees may feel the need to modify their programs, even if exposures are already below the dose limits, to ensure that the criteria would not be exceeded.

In addition, the NRC staff has become increasingly aware that occupational exposures may be received by an individual from multiple licensees during the course of a year. The NRC regulation at 10 CFR 20.1201(f) requires the licensee to “reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person.” Corresponding recordkeeping requirements appear in 10 CFR 20.2104, “Determination of Prior Occupational Dose.” These recordkeeping requirements are written from the perspective of sequential employment, not concurrent employment. The NRC staff believes that situations occur in which individuals are receiving concurrent occupational exposures, particularly in fields, such as medical diagnosis and treatment, in which physicians commonly have privileges to practice in multiple institutions. Furthermore, such situations may include licensees in different regulatory jurisdictions, such as in multiple Agreement States. Although the staff believes that interpretation of the current regulation should apply to concurrent exposure, a clarification to ensure that concurrent exposures are reported to the other licensee may be appropriate. This information is

important to ensure that the annual occupational dose limit for an individual is respected and that cumulative exposure is considered.

V. Proposals

The current regulations do not require licensees to have a structured ALARA planning process. Therefore, the NRC is considering developing a requirement for ALARA radiation protection planning. This additional ALARA planning requirement would provide a basis to (1) ensure that licensees have an ongoing process to review radiation exposures, (2) consider whether changes are necessary and practical to reduce exposures, and (3) ensure the implementation of appropriate programmatic changes.

In conjunction with developing a requirement for ALARA planning, the NRC is considering developing a mechanism to address added protection when an individual occupational worker nears his or her annual dose limit and the establishment of a cumulative dose criterion to control doses that an individual worker may receive over a multiple-year period. In this regard, the NRC would require each licensee, as a part of its radiation protection program, to establish mechanisms to examine cumulative occupational doses, and to implement control measures limiting additional doses if an occupational worker approaches his or her cumulative dose criterion. If the NRC ultimately issues such a requirement, it would develop associated guidance to address the various types of licensed activities.

Specifically, regulatory guidance could describe the types of methodologies that the NRC staff could consider acceptable to meet the regulatory requirement of controlling dose as an individual occupational worker approaches his or her annual dose limit or his or her cumulative dose criterion. The NRC is considering using various methodologies that are based on national and international recommendations. In one

potential methodology, a licensee could use the recommendations in ICRP Publication 103 (2007) for an average dose over a 5-year period of 20 mSv (2 rem) as an ACL. If no individual at the licensed facility exceeded the ACL on an annual basis, the licensee would not need to take any additional actions other than the continued monitoring of exposures. However, if an individual exceeded the ACL in any particular year, the licensee could commit to tracking and limiting the dose of that individual over a 5-year period; the licensee would need to maintain the cumulative occupational dose records during this period.

A second potential methodology for establishing an ACL could be based on the NCRP Report 116, "Limitation of Exposure to Ionizing Radiation," which recommended an age based cumulative dose restriction. The NCRP Report 116 recommended an occupational dose limit of 50 mSv (5 rem) per year and a cumulative occupational dose limit of 10 mSv (1 rem) times the individual's age in years. Therefore, a licensee could establish an ACL at the 10 mSv (1 rem) level, and if this level is exceeded in any one year, the licensee would apply cumulative dose tracking to ensure that the cumulative age based dose limit for the individual is not exceeded.

In a third potential methodology, a licensee could establish an ACL based on lifetime exposures instead of the yearly approach to dose limits as in ICRP or NCRP recommendations. Under this approach, a licensee could commit to tracking the cumulative occupational doses for each worker and to applying specific additional restrictions if the cumulative occupational dose exceeded a set lifetime cumulative ACL value. Example values of cumulative ACL, such as 0.5 Sv (50 rem) or 0.75 Sv (75 rem), over the worker's lifetime could serve as appropriate fractions of the upper (tolerable) cumulative lifetime dose limit found in the ICRP and NCRP recommendations. This approach could work in conjunction with regulations for cumulative occupational

dose recordkeeping requirements to ensure that licensees took appropriate actions if dose limits are exceeded.

The preceding methodologies are presented as possible approaches for implementing a general performance requirement. Alternatively, the regulation could specifically incorporate one or more of these methodologies as a new prescriptive requirement. For example, the NRC could establish a regulation that would require a licensee to maintain the cumulative exposure record for any individual permitted to exceed 20 mSv (2 rem) in a year; this approach would provide the basis for examining cumulative exposures during NRC inspections to determine whether individuals were receiving significant cumulative exposure. In addition, the NRC could establish a regulation that would require a licensee to ensure that any individual's occupational exposures do not exceed 20 mSv (2 rem) in a year if the cumulative occupational exposure exceeds 30 mSv (3 rem). This provision would specifically direct additional restriction on occupational effective dose for situations in which individuals were receiving significant cumulative exposures. As described in the third methodology above, cumulative dose values could be 0.5 Sv (50 rem) or 0.75 Sv (75 rem). This type of provision would work in conjunction with a requirement for maintaining records of cumulative exposures to ensure that licensees are taking the appropriate actions. The NRC is interested in obtaining comments on the use of a performance or prescriptive approach, the rationale stating why one approach is preferable over the other, and any other alternatives that the NRC should consider as acceptable.

The NRC is also considering whether an additional requirement is necessary to address the question of concurrent occupational doses of an individual working at multiple licensed facilities. Situations may occur in which workers receive occupational exposures at more than one facility concurrently. One approach could be to expand the scope of 10 CFR 20.2104(a) to cover workers' concurrent employment by two or more

licensees during the same period of time (e.g., a weekday shift at one licensee's facility followed by a weekend shift at another licensee's facility). Presently, the regulations require licensees to determine the yearly occupational doses received by its workers. In this regard, 10 CFR 20.2104(c) could be revised to add the phrase "and any concurrent" to statements that now only specify the individual's most recent employer. Concurrent employment by occupational workers may present challenges for the NRC to ensure that the worker's annual and cumulative doses are accurately monitored and reported. For instance, in the medical area, physicians may have practice privileges at multiple institutions. These institutions may well be different licensees; if they are located in different jurisdictions, they could be subject to review by different regulatory authorities. Examples are physicians practicing in the Maryland, VA, and in the District of Columbia. A physician may have a medical practice involving the use of radioactive materials and may work concurrently in Washington, DC (an NRC jurisdiction); Alexandria, VA (an Agreement State jurisdiction); and Bethesda, MD (a different Agreement State jurisdiction). Therefore, this physician could be receiving concurrent occupational exposures at facilities in three different jurisdictions. Currently, a regulatory requirement to obtain an assessment of this individual's annual or cumulative occupational exposure has not been established.

As discussed previously, before the 1991 amendments to 10 CFR Part 20, the NRC regulatory framework included the formula $5(N-18)$, where N represents the person's age in years, for calculating a worker's lifetime dose limit. As part of the implementation of this former regulation,¹⁷ workers were required to provide NRC Form 4, "Cumulative Dose History Report," when reporting to a new facility; however, the 1991 amendments to 10 CFR Part 20 removed this requirement and the lifetime dose

¹⁷ See 10 CFR 20.101(b)(2) (1990).

limit formula *5(N-18)* from the regulation. The Statements of Consideration for the 1986 proposed rule (which led to the 1991 final rule) explains that a proposal to eliminate the lifetime dose limit formula would reduce annual and lifetime doses to occupational workers.¹⁸ As a result, a requirement for a licensee to receive a cumulative dose history report (NRC Form 4 or equivalent) for a new employee has not been established.

The various types of radioactive material licenses pose different challenges to the control of occupational doses (e.g., industrial radiography and nuclear medicine). In some situations, the design and operation associated with the use of radioactive material limit the occupational dose. Conversely, some uses of radioactive materials can result in significant occupational doses that may be near the annual dose limit. Therefore, the spectrum of radioactive material licenses presents a wide range of challenges and opportunities for reducing occupational doses in accordance with the ALARA provisions, especially when exposures approach the dose limits. The NRC is seeking an understanding of how to ensure that a greater focus is placed on keeping occupational doses ALARA consistent with the wide range of uses of licensed radioactive materials. In addition, the NRC is pursuing an understanding of the potential impacts of the methodologies previously discussed, including any potential difficulties associated with their implementation if they become requirements through rulemaking. The NRC staff believes that additional input from the public, the regulated community, and other stakeholders is necessary to understand the implications of potential options on this issue.

¹⁸ See 51 FR 1092–1121; January 9, 1986. Table 5, “Principal Concerns and Benefits of the Proposed Revision of 10 CFR Part 20,” of the proposed rule indicates that application of the *5(N-18)* age-prorated cumulative dose limit led to higher rates of annual and cumulative exposure to workers than that of the 5-rem annual effective dose limit that was later adopted in the 1991 rulemaking.