ASSESSMENT OF THE BENEFITS AND IMPACTS IN THE U.S. NUCLEAR POWER INDUSTRY OF HYPOTHESIZED LOWER OCCUPATIONAL DOSE LIMITS

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ABSTRACT

The International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements have issued recommendations that would limit occupational exposure of individuals to doses lower than regulatory limits contained in the Nuclear Regulatory Commission's 10 CFR Part 20, "Standards for Protection Against Radiation." Because of this situation, there is interest in the potential benefits and impacts that would be associated with movement of the NRC regulatory limits toward the advisory bodies' recommendations.

The records of occupational worker doses in the U.S. commercial nuclear power industry show that the vast majority of these workers have doses that are significantly below the regulatory limit of 50 mSv (5 rem) per year. Some workers' doses do approach the limits, however. This is most common in the case of specially skilled workers, especially those with skills utilized in support of plant outage work. Any consideration of the potential benefits and impacts of hypothesized lower dose limits must address these workers as an important input to the overall assessment. There are also, of course, many other areas in which the benefits and impacts must be evaluated. To prepare to provide valid, constructive input on this matter, the U.S. nuclear power industry is undertaking an assessment, facilitated by the Nuclear Energy Institute (NEI), of the potential benefits and impacts at its facilities associated with hypothesized lower occupational dose limits. Some preliminary results available to date from this assessment are provided.

BACKGROUND

On May 21, 1991, the U.S. Nuclear Regulatory Commission (NRC) published the revised 10 CFR Part 20[1] that is based on the 1977 recommendations of the International Commission on Radiological Protection (ICRP)[2]. The revised Part 20 includes an occupational dose limit of 50 mSv (5 rem) per year. Implementation of the revised Part 20 was required of all NRC licensees as of January 1, 1994.

In 1991, the ICRP published new recommendations[3] that include limitation of occupational dose to 100 mSv (10 rem) in 5 years, not to exceed 50 mSv (5 rem) in a year. The National Council on Radiation Protection and Measurements (NCRP) published new recommendations[4] in 1993 that include limitation of an individual's cumulative lifetime dose to 10 mSv (1 rem) times the individual's age (in years), not to exceed 5 rem in a single year. The new recommendations would have the effect of limiting an individual's lifetime risk from occupational exposure to approximately 3×10^{-2} (NCRP) and 4×10^{-2} (ICRP).

In its issuance in 1991 of the revised Part 20, the NRC acknowledged the pending recommendations of the ICRP and NCRP that were not being addressed in the revised regulation. The NRC expressed its intent to consider these recommendations at a future date following final publication by the ICRP and NCRP. The NRC has requested that a preliminary study be made by the Brookhaven National Laboratory (BNL) to analyze the potential impacts of lower dose limits on NRC licensees. This could provide a portion of the technical bases for making future decisions on regulatory limits. The results of that study have been published in draft form for comment as NUREG/CR-6112, "Impact of Reduced Dose Limits on NRC Licensed Activities."[5]

The draft NUREG includes the results of a survey made by BNL of NRC licensees to assess potential impacts of lower occupational dose limits. The draft NUREG also includes an historical background on previous reductions in

regulatory occupational dose limits, as well as a review of existing literature on recent occupational dose data and trends in various U.S. nuclear industries. As such, the draft NUREG provides the an up-to-date and comprehensive overview of the potential effects of hypothesized lower occupational dose limits

The NRC has published the draft NUREG and is soliciting further comments from interested parties regarding potential impacts of the different hypothesized lower occupational dose limits discussed in the draft NUREG.[6] In the draft NUREG, the NRC makes the assessment that a relatively small number of licensees responded to questionnaires and surveys, thereby limiting the extent to which the survey results can be assumed to be an accurate representation of the potential impacts of hypothesized lower occupational dose limits.

To support preparation of valid, constructive input to NRC on the matter of lower occupational dose limits, the U.S. nuclear power industry is undertaking an assessment, facilitated by the Nuclear Energy Institute (NEI), of the associated potential benefits and impacts at its facilities. Preliminary results available from this assessment are presented in this paper.

ISSUE

The issue being assessed by the nuclear power industry is what effects lower occupational dose limits consistent with NCRP or ICRP recommendations would produce, in terms of potential benefits and impacts that would ensue. To provide focus to the nuclear power industry's approach to the issue, it has been segmented into three questions as discussed below.

Will lower dose limits provide a substantial improvement to the protection of worker health and safety ?

Of primary importance in answering this question is to identify the population of workers that might be affected by lower dose limits and the nature of the effects on them. In particular, we are interested in the extent to which individual worker doses would be limited below the levels presently being experienced under the current regulatory dose limits and industry practices to maintain exposures as low as reasonably achievable (ALARA). We must also try to understand how continued employability of individuals may be affected by lower dose limits. We set out to determine this by reviewing available data and by surveying utilities that operate nuclear power facilities. In the survey we requested dose data and other information regarding workers whose 1993 annual dose exceeded 20 mSv (2 rem) or whose cumulative lifetime dose exceeded 0.25 Sv (25 rem) as of 1993 to characterize the affected worker population and discover trends.

The otherwise available records of occupational doses show that the vast majority of U.S. nuclear power plant workers receive doses that are significantly less than the current regulatory occupational dose limit of 50 mSv (5 rem) in a year.[7] For example, the data indicate that more than 99% of nuclear power plant workers monitored in 1990 received less than 2 rem annual dose, which is comparable to the average annual dose implied by the ICRP dose limitation recommendations. The data also indicate that average annual occupational doses have been generally declining.

Draft NUREG/CR-6112 provides data that indicate that only a small fraction of workers have received lifetime doses that exceed their age. Other available data show that few workers' lifetime doses approach or exceed the 70 rem or 100 rem values that are implied by the recommendations of the NCRP and ICRP.[8] However, the data are sparse and do not provide specifics on the types of workers involved or recent lifetime dose trends. Also, there does not appear to be published data regarding the doses of U.S. nuclear power plant workers for 5 year periods (i.e., comparable to the ICRP dose limitation recommendations).

Additional data are being sought to support a more detailed assessment of whether lower occupational dose limits, consistent with ICRP or NCRP dose limitation recommendations, would provide a substantial improvement to the protection of worker health and safety.

Will lower occupational dose limits result in an increase in collective dose ?

Lower occupational dose limits may result in the need to increase the number of workers, e.g., to address the situation of specific work groups that become constrained by the lower limits. Such situations may involve inefficiencies, such as the use of multiple workers to complete the task, that result in higher collective doses. Limiting individual doses must be considered relative to the potential for increases in collective dose. It is therefore necessary to characterize the specific work groups that may be constrained and the potential effects, including collective dose impacts, of addressing the constraints. Further dose reduction measures, consistent with the ALARA approach, would also be considered and will have an impact on collective dose.

Draft NUREG/CR-6112 concludes that "there would be minimal impact on collective doses ..." under the NCRP dose limitation model of 50 mSv (5 rem) per year and lifetime dose not to exceed age (in years), and that a "grandfather clause" allowing up to 20 mSv (2 rem) per year after exceeding the lifetime dose limit "... may be required for perhaps less than 1000 workers." However, the related survey responses tabulated in the draft NUREG appear somewhat ambiguous regarding potential increases in collective dose. None of the nuclear power industry respondents expected an increase in collective dose with an annual dose limit of 5 rem per year and lifetime dose limit of age in rem; at the same time, most of the nuclear power industry respondents expected collective dose to increase with an annual dose limit of 2 rem per year and a lifetime dose limit of age in rem, which is analogous to the use of the "grandfather clause" option. Also, available data regarding lifetime dose trends are not sufficient to determine whether a limit on lifetime dose would increase collective dose as a potentially increasing population of workers approach cumulative lifetime doses equal to their age.

To develop an answer regarding whether lower dose limits will result in larger collective doses, we surveyed to identify which work groups may be constrained by lower dose limits and asked whether the number of workers might be increased to accommodate the lower limits and whether related potential inefficiencies (e.g., due to multiple work crew changeouts) may lead to increased collective dose. We will also look at lifetime dose trends to determine, if possible, the extent of the potential population of workers that over time may approach cumulative lifetime doses equal to their age.

What degree of impacts on licensees will result from lower occupational dose limits ?

The degree of impacts resulting from lower occupational dose limits may vary substantially between nuclear power licensees due to differences in operating and maintenance history, source terms, and a number of other factors. This variation is apparent in the summary of survey responses from nuclear power licensees that are provided in draft NUREG/CR-6112. Cost estimates provided in the responses regarding potential facility modifications and changes to radiation protection programs to accommodate lower dose limits vary over several orders of magnitude. The data provide little insight into how the cost estimates were derived and what assumptions were used, which makes difficult any attempt to project the extent of potential impacts for the industry as a whole. Also, there may be other types of impacts that need to be considered, in addition to the potential for facility modifications or changes to radiation protection programs that are specified in the draft NUREG. Likewise, other available data[8,9] regarding potential impacts associated with lower dose limits are either too general or otherwise not directly applicable* to making projections of impacts on an industrywide basis.

To help answer the question of the extent of impacts on nuclear power plant licensees from lower occupational dose limits, in addition to obtaining data regarding specific work groups and tasks that may be impacted, we are surveying for additional related information, e.g., administrative dose guidelines and $/person-rem values used in ALARA cost benefit analysis, to support a more broad and detailed assessment.

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* For example, the Atomic Industrial Forum (AIF) "Study of the Effects of Reduced Occupational Radiation Exposure Limits on the Nuclear Power Industry" provides sophisticated methods for assessing impacts, but only considers various quarterly dose limits, and does not consider annual or lifetime dose limits.

APPROACH

NEI has formed an Ad Hoc Advisory Committee (AHAC) of radiation protection professionals from more than 20 nuclear power utilities and nuclear steam supply system (NSSS) vendors to assist in performing an in-depth assessment of the potential benefits and impacts of hypothesized lower occupational dose limits on the nuclear power industry. Two surveys have been developed and widely distributed within the nuclear power industry to obtain specific data regarding nuclear power industry worker dose trends and potential impacts. Specific data being requested in the surveys include the following:

1. Survey on Worker Dose Trends

    a. Workers whose lifetime dose exceeded 25 rem as of 1993 and
    b. Workers whose annual dose exceeded 2 rem in 1993:
        - Date of Birth
        - Work Group
        - Utility or Non-utility
        - Lifetime Dose
        - 1993 Annual Dose
        - Total Dose for 1988-92 (if available)

2. Survey on Potential Impacts

    a. Work Groups Potentially Impacted
    b. Jobs/Tasks Potentially Impacted
    c. Administrative Dose Guidelines
    d. $/Person-Rem Values for Cost-Benefit Analysis
    e. Major Dose Reduction Initiatives

The AHAC will assist NEI in assessing the survey results and developing a nuclear power industry perspective on potential benefits and impacts related to hypothesized lower occupational dose limits. Following broad review of the perspective by industry, input will be provided to the NRC in response to its request for comments on the draft NUREG.

PRELIMINARY RESULTS

To date, we have received 50% of the responses to the survey on worker dose trends. We have compiled the data in a statistical analysis database and have developed preliminary results to validate the approach taken to consider some of the questions related to worker doses. Selected preliminary data are provided below. Table 1 shows projected dose trends for nuclear power plant workers monitored in 1993. The numbers have been rounded to 2 significant figures and do not account for potentially redundant data for workers not directly employed by the utility (i.e., non-utility workers) who may have worked for and been reported by several respondents as being monitored in 1993. These data will be refined when the balance of responses have been received. Figures 1, 2, and 3 show the actual data (i.e., not projected) from the survey responses regarding the workers whose lifetime doses exceed their age sorted by work group, age, and dose range, respectively. Because the data are preliminary, specific conclusions are not yet presented. The survey on potential impacts was recently sent out to the industry with responses due back in several weeks, therefore, preliminary data from that survey are not yet available.

CONCLUSION

A survey of nuclear power industry worker dose information is warranted to assess what effects lower occupational dose limits consistent with NCRP or ICRP recommendations would produce. This is because the available data limit the detailed assessment appropriate to making decisions on whether to establish such regulatory requirements. The potential benefits and impacts important to that assessment can be defined by addressing the questions detailed

above. NEI is pursuing data collection and its assessment in order to provide nuclear power industry perspectives to the NRC in response to its request for public input on this subject.

Table 1. U.S. nuclear power plant workers monitored in 1993 (projected from preliminary data)

Group	No. of Workers
Monitored - Total	180,000
Monitored - with Measurable Dose	100,000
Annual Dose > 2 rem	2,000
Lifetime Dose (rem) > Age (years)	700
• Annual Dose > 1 rem	100
• Annual Dose > 2 rem	25

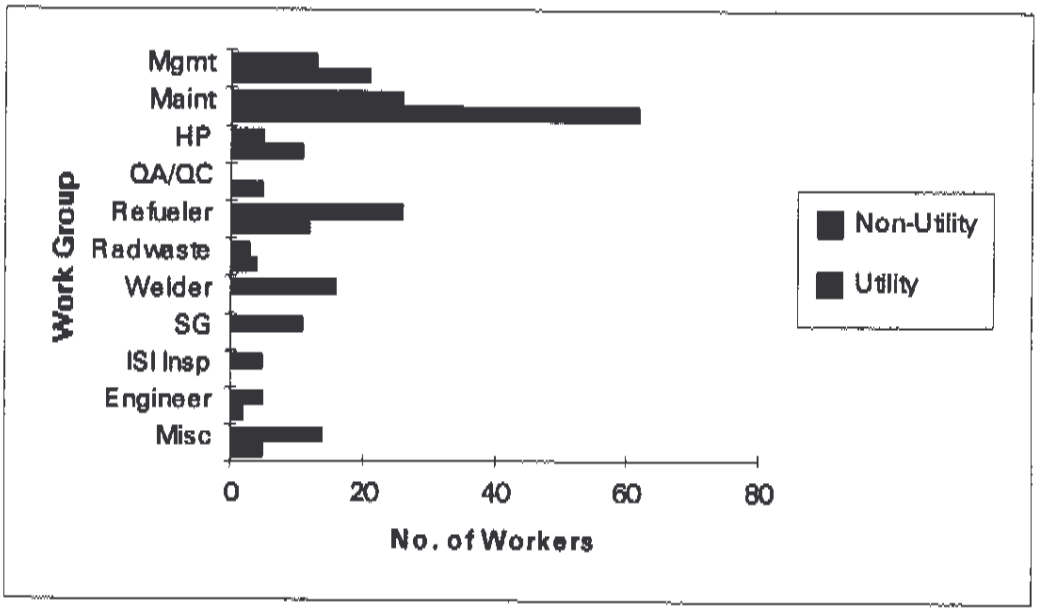

Figure 1. U. S: Nuclear power plant workers with lifetime dose > age sorted by work group

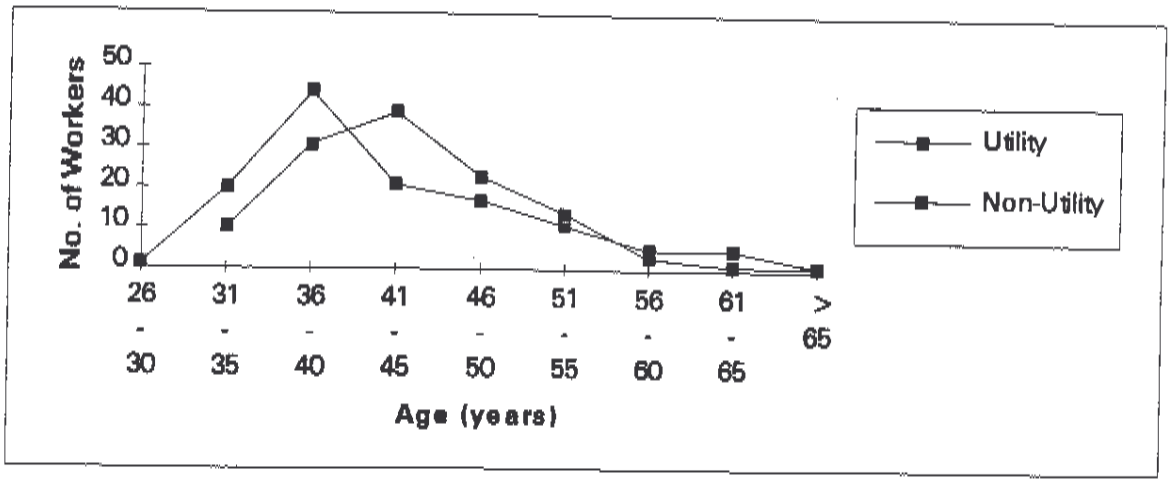

Figure 2. U.S. nuclear power plant workers with lifetime dose greater than age sorted by age group

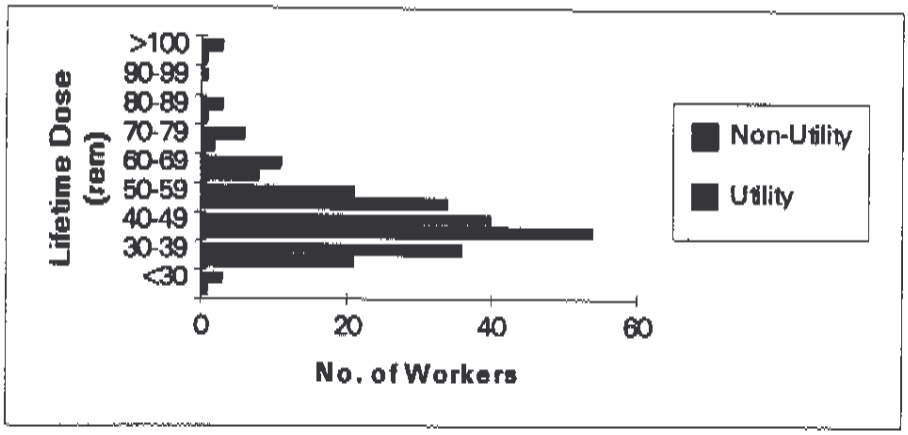

Figure 3. U. S. nuclear power plant workers with lifetime dose greater than age sorted by dose

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