WORKER DOSE AFTER 10CFR61

Michael T. Ryan, Ph.D., C.H.P.
Director of Regulatory Affairs
Chem-Nuclear Systems, Inc.
P.O. Box 726
Barnwell, South Carolina 29812

ABSTRACT

With the execution and implementation of 10CFR61 into low-level waste management practices at Chem-Nuclear's facility in Barnwell, particular attention has been paid to occupational radiation exposure. The concern for occupational radiation exposure arose from the segregation of higher activity waste as required in 10CFR61. The implementation of separate waste burial trenches (for Class A, B, C wastes) at Barnwell included operational review, procedure modification, ALARA review, and operational health physics monitoring to ensure the effective control.

In this paper a detailed statistical assessment of occupational radiation exposure in a variety of work groups is presented. In general, the implementation of 10CFR61 has not had an adverse impact. There are no statistical significant increases in overall radiation exposure. This paper provides a detailed statistical assessment of radiation exposure and accounts for waste volumes and total radioactivity contained in buried wastes.

The experience at Chem-Nuclear will be compared to engineering low-level waste burial facilities in Europe.

INTRODUCTION

The issue of low-level radioactive waste management continues to be an issue at local, state, regional, and federal levels. The areas of concern include technical, public, and political aspects.

Technically, the management of low-level radioactive waste burial is based on the performance criteria presented in 10CFR61 Parts 40 through 44. These performance objectives are reproduced below.

61.40 General Requirement

Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the performance objectives in 61.41 through 61.44.

61.41 Protection of the General Population From Releases of Radioactivity

Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

61.42 Protection of Individuals From Inadvertent Intrusion

Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contracting the waste at any time after institutional controls over the disposal site are removed.

61.43 Protection of Individuals During Operations

Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in Part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by 61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as is reasonably achievable.

61.44 Stability of the Disposal Site After Closure

The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.

The objectives address performance with regard to environmental protection (Part 61.41 and 61.42), site performance over the long term (Part 61.44), and protection of workers (Part 61.43). In particular, the radiation protection of workers, under the requirements of 10CFR Part 20, have been carefully considered because the largest fraction of dose associated with the operational and environmental impact of a low-level waste burial facility are associated with exposure of workers during burial operations.

Implementation of 10CFR61

In January 1984 burial techniques which accommodate the waste classification system of 10CFR61 were put into effect. Three trenches are now and have been in use since to accommodate these changes. The first of these three trenches is defined as a Class A waste trench in which Class A waste, mainly unstable waste, is placed. This Class A unstable waste is mainly dry, active, solid waste (DAW). The second of these three trenches is to accommodate Class B and Class C waste. It is similar in design to the Class A waste trench except for width. The width is reduced to decrease scattered radiation to workers in the vicinity of the land surface. The third trench is a Class C waste trench designed for Class C waste only and is used mainly for irradiated hardware. A Class C trench is operated in a semi-remote manner. Waste is placed and covered immediately to reduce worker exposure to a minimum. Operational procedures, ALARA review and health physics were all carefully considered in the adoption of this three trench system. Particular attention was paid to the potential for increases in radiation exposure to workers due to the segregation of the higher activity wastes in the Class B and Class C waste trench. In the past, Class A waste with small quantities of radioactive material were used to self shield the higher activity wastes in a one trench operation.

The salient feature to this three trench approach is that worker proximity to Class B and Class C waste has been reduced significantly. In both the Class B trench and the Class C, irradiated component trench, careful procedural control severely limits worker proximity to waste packages.

General Waste Characteristics

In reviewing radiation exposure it is first important to identify the volumes and activities of materials received. Table I shows the total number of curies received for the two years prior to and two years after the implementation of 10CFR61. The total volume is also shown.

It is important to note that the total radioactivity has increased by a factor of approximately 1.7 while the volume has remained essentially constant over the period. This increase in average specific activity is also a potential source of increased radiation exposure to workers.

In general, the majority of volume of low-level waste is Class A, approximately 95%, which is lowest in specific activity. Class B and Class C wastes comprised 5% and 1% respectively in 1985. Data for other years is not yet available but is not expected to be drastically different from these values. Table I gives typical volumes by waste class for 1985, and while percentages may vary slightly from year to year, wide variations are not expected. Most of the radioactivity is associated with Class B and Class C wastes.

Occupational Radiation Exposure

The occupational radiation exposure compilation for 1982 through 1985 is given in Table II. This time period covers the two years prior and two years since the implementation of 10CFR61 burial techniques as a function of waste classification. Nine categories of workers are shown. The four groups with the highest exposures are Radwaste Technicians, Equipment Operators, Health Physics Technicians and Quality Assurance Inspectors. These groups have the highest proximity to waste burial activities. Further, these groups have remained fairly constant in size over the four year period. Monthly averages include workers who worked less than a full year.

The mean annual doses averaged for the two years prior to the implementation of 10CFR61 are compared to the mean annual doses averaged for the two years after 10CFR61 for the four groups with significant exposure. This comparison is given in Table III. These data indicate that a reduction in radiation exposure to workers has occurred which is on the order of 25-30%.

TABLE I

Total Activity and Volume Received at CNSI Facility in Barnwell

Total Activity for 1982 - 1985

1982	273,962	CURIES
1983	383,405	CURIES
1984	385,079	CURIES
1985	460,590	CURIES

Total Volume Excluding Pallets 1982 - 1985

1982	1,206,235	CU.FT.
1983	1,215,007	CU.FT.
1984	1,214,054	CU.FT.
1985	1,202,775	CU.FT.

Percentage of Total Volume by Waste Class (1985)

Class A	94%
Class B	5%
Class C	1%

TABLE II

STATISTICAL ASSESSMENT OF OCCUPATIONAL RADIATION EXPOSURE
(Average Doses Are Per Man)**

	1982	1983	1984	1985
HP Technicians				
Avg Annual Dose	0.500 ± 0.393	0.543 ± 0.271	0.447 ± 0.120	0.311 ± 0.267
Avg Monthly Dose	0.052 ± 0.039	0.041 ± 0.023	0.034 ± 0.013	0.029 ± 0.024
Radwaste Technicians				
Avg Annual Dose	0.897 ± 0.729	1.140 ± 0.599	0.761 ± 0.511	0.683 ± 0.370
Avg Monthly Dose	0.090 ± 0.054	0.092 ± 0.048	0.070 ± 0.039	0.057 ± 0.033
Equipment Operators				
Avg Annual Dose	0.923 ± 0.540	0.942 ± 0.437	0.765 ± 0.318	0.553 ± 0.306
Avg Monthly Dose	0.077 ± 0.045	0.073 ± 0.037	0.058 ± 0.029	0.046 ± 0.026
Supervisors				
Avg Annual Dose	0.077 ± 0.183	0.097 ± 0.171	0.037 ± 0.064	0.037 ± 0.072
Avg Monthly Dose	0.006 ± 0.013	0.011 ± 0.017	0.004 ± 0.005	0.003 ± 0.006
QA Inspectors				
Avg Annual Dose	0.203 ± 0.153	0.153 ± 0.122	0.165 ± 0.155	0.095 ± 0.052
Avg Monthly Dose	0.021 ± 0.016	0.017 ± 0.015	0.015 ± 0.012	0.010 ± 0.006
Security				
Avg Annual Dose	0.017 ± 0.026	0.017 ± 0.010	0.040 ± 0.030	0.009 ± 0.010
Avg Monthly Dose	0.001 ± 0.002	0.002 ± 0.002	0.003 ± 0.003	0.001 ± 0.001
Site Mechanics				
Avg Annual Dose	0.173 ± 0.244	* ± *	0.183 ± 0.022	0.067 ± 0.037
Avg Monthly Dose	0.015 ± 0.021	0.042 ± 0.036	0.014 ± 0.002	0.007 ± 0.003
General Maintenance				
Avg Annual Dose	0.016 ± 0.022	0.024 ± 0.027	0.033 ± 0.023	0.016 ± 0.024
Avg Monthly Dose	0.001 ± 0.002	0.002 ± 0.002	0.003 ± 0.002	0.001 ± 0.002
Contractors				
Avg Annual Dose	0.059 ± 0.065	0.031 ± 0.020	0.071 ± 0.024	0.054 ± 0.037
Avg Monthly Dose	0.005 ± 0.005	0.002 ± 0.002	0.007 ± 0.003	0.005 ± 0.003

* Mean not calculated.

** Deviations are experimental standard deviation among group members.

TABLE III

COMPARISON OF AVERAGE ANNUAL DOSES

PRIOR TO AND AFTER IMPLEMENTATION OF 10CFR61

	PRIOR 10CFR61	POST CFR61	% REDUCTION
Radwaste Technicians	1018	722	29%
Equipment Operators	731	659	10%
Health Physics Technicians	521	379	27%
Quality Assurance Inspectors	178	130	27%

Annual dose per worker	FRANCE	1,000 to 2,000 mRem per year
	GERMANY	3,000 per year projected

This trend is maintained for workers working a full year as well as workers who worked partial years. This reduction has been associated with the implementation of more remote waste handling and placement methods, particularly for Class B and Class C wastes. These reductions have been realized in spite of increases in total radioactivity received and average specific activity of waste.

It is important to note that these data should be interpreted to indicate a trend and should not be taken as a quantitative assessment of dose reduction. While these results are very encouraging, the relatively small number of workers in various groups, the limited time over which data is available, and the changing characteristics of low-level waste make quantitative interpretation difficult. The trend, however, indicates that the implementation of shallow land burial techniques which accommodate the waste form and waste classification requirements of 10CFR61 have had a positive effect on dose reduction for workers.

Discussion and Conclusion

The data presented above indicate a downward trend in occupational radiation exposure in association with the implementation of disposal techniques which accommodate the requirements of 10CFR61. During the same time period, the basic charge per cubic foot (exclusive of taxes and other added charges) has increased 49%. These increases are mainly associated with the implementation of the 10CFR61 techniques.

In the future, it is anticipated that low-level waste management methods will change to include additional engineered barriers such as concrete structures for entombment, retrievable waste placement and more sophisticated monitoring techniques. While current experience in the United States is limited to shallow land burial, the European experience has included some of these alternate disposal techniques. The Center de LaMarche in France is such a facility (1), and it has been reported that the average worker received 1000 to 2000 mRem/yr in 1985 (2). In addition, an average dose of 3000 mRem/yr is expected at the German granite facility.

It is most important to evaluate proposals for enhancement of engineered burial techniques with regard to worker exposure. The total risk of any

REFERENCES

1. Hutchison, C. and Marque, Y., "Low-Level Radioactive Waste Disposal in France: Past Experience and Future Plans," presented at A Radioactive Exchange Decisionmakers' Forum, Wild Dunes, Charleston, South Carolina, June 1985.

2. Matuszek, John M., "Safer Than Sleeping With Your Spouse -- The West Valley Experience," preprint American Chemical Society Annual Meeting, New York, 1986, to be published (accepted) in Environmental Science and Technology.

radioactive waste technology includes potential risk to the environment, the public and the workers. The selection of an enhanced waste disposal technology should be made so that total risk is maintained at acceptable levels and that the reduction in environmental risk from alternate technologies does not increase the risk to workers. The European experience seems to indicate that engineered disposal results in average worker doses which are significantly higher than those at the CNSI facilities in Barnwell where shallow land disposal methods consistent with 10CFR61 have been implemented. A balanced assessment of total risk will be essential to the selection of the most effective low-level radioactive waste management methods. Such an assessment is important in the evaluation of proposed enhanced technologies for low-level radioactive waste disposal.

It is important to remember that the performance criteria given in the beginning of this paper address radiological impact on the public, on the intruder, on the environment over a performance period of 500 years and on workers. All impacts of engineered low-level waste technologies should be carefully evaluated so the total radiological risk can be effectively managed.