COMPARISON OF RADIATION PROTECTION PROGRAMS AT U.S. POWER REACTORS, URANIUM MILLS, AND LOW-LEVEL WASTE DISPOSAL SITES

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Abstract

The accident at the Three Mile Island nuclear power reactor in March 1979 and subsequent investigations identified serious concerns involving several aspects of radiation protection programs in general. Battelle, Pacific Northwest Laboratories was contracted by the United States Nuclear Regulatory Commission to characterize and evaluate radiation protection programs at power reactors, uranium mills and commercial low-level waste disposal sites in the United States. These evaluations were termed appraisals because they were structured to facilitate an integrated look at the total radiation protection programs, delve into areas for which explicit regulatory requirements did not exist, and emphasize evaluation of capability and performance rather than compliance with regulations.

This paper contains some of the results of 48 power reactor appraisals, 10 uranium mill appraisals and 3 commercial low-level waste disposal site appraisals. The appraisal scope and methodology as well as summary findings and conclusions will be discussed. It was observed from this effort that there is a difference in the adequacy of radiation protection programs as compared between the three types of nuclear facilities. It was observed, based on the risks involved, that the program elements at low-level waste disposal sites and power reactors were substantially better than at the uranium mills.

Introduction

On March 28, 1979, Unit 2 of the Three Mile Island (TMI) Nuclear Power Plant experienced the most severe accident in the operating history of commercial nuclear power plants in the United States. Preparation for such an event by the station staff and the radiation protection group was deficient in several respects that led to a less-than-satisfactory response to a real radiological emergency situation (NUREG-0600).

As a result of the Three Mile Isalnd accident and the resultant problems identified in the radiation protection program, the Nuclear Regulatory Commission (NRC) undertook a major effort to analyze the radiation protection programs at 48 commercially operated nuclear power plants and 10 NRC licensed uranium mills. This effort, called

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the Health Physics Appraisal Program (HPAP), was initiated to determine whether the nuclear power plants and uranium mills had adequate radiation protection programs and whether they had incorporated the lessons learned from the TMI accident in the area of radiation protection. A second objective was to identify generic radiation protection problems in order to make improvements in NRC regulations, requirements, and guidance. The NRC contracted with the Pacific Northwest Laboratory (PNL) to accomplish this task.

The concept in developing the Health Physics Appraisal Program was to institute a means for performing a comprehensive evaluation of the overall adequacy and effectiveness of the licensees' total health physics programs. Whereas the previous inspection program was more compliance oriented and led to the inspection of health physics programs by discrete subject areas, the appraisal program was structured to facilitate an integrated look at the total program. The criteria for evaluating the licensees' program elements were taken from technical specifications, NRC rules and regulations, and NRC regulatory guides, as well as ANSI* standards and ICRP/ICRU** recommendations, and in some cases where no published guidance was available, the professional judgment of the appraisal team members.

The NRC also contracted with PNL to ensure that current and future exposures were maintained "as low as reasonably achievable" (ALARA) at the three operating commercial low-level waste (LLW) disposal sites in the U.S. To accomplish this task PNL also used a HPAP approach to gather information and make an evaluation of program adequacy. The criteria for evaluating the licensee's program elements were again taken from the guides mentioned above and 10CFR61 (Licensing Requirements for Land Disposal of Radioactive Waste).

Health Physics Appraisal Program

The HPAP was structured using a systematic methodology that consisted of analytical trees with applicable questions for each tree. The analytical trees provided a graphic depiction that aided in the deductive analysis of a total system and provided a logic display of interrelationships. The questions were designed to define the scope of the appraisal and to ensure consideration of the essential elements of a radiation protection program. The questions were not an all-inclusive listing of significant items. Thus the HPAP teams were expected to use professional judgment and be flexible, as the need arose, in the application of the guidance and use of the analytical trees.

To implement the HPAP, eight power reactor appraisal teams were formed. The basic team was composed of three to five professional health physicists, including a senior NRC health physics inspector as a team leader, one contractor health physicist, and one PNL health physicist. On some of the appraisals, other NRC health physicists served as additional members. The inclusion of a contractor and PNL health physicist added an extra dimension of perspective and proved beneficial. The Mill Appraisal Program involved two appraisal teams each consisting of one NRC inspector as team leader, one health physicist from the NRC's Uranium Recovery Licensing Branch, and two

*American National Standards Institute

**International Commission on Radiological Protection/International Commission on Radiation Units and Measurements.

health physicists from PNL. Finally, the LLW disposal site appraisals involved one appraisal team consisting of three to four PNL health physicists.

A team approach was selected for several reasons. Because of the broad scope of the program, it would have taken too long for a single individual to perform the inspection and complete the appraisal schedule. Furthermore, the interaction between members was particularly desirable because many evaluations were necessarily based on professional judgments. Also, the interchange of concerns among team members and discussion of apparent weaknesses often helped clarify the real problem area or cause of the symptomatic deficiency. For purposes of the appraisal the areas of the health physics program evaluated were:

- radiation protection organization, and management;
- personnel selection, qualification and training;
- exposure control, external and internal;
- respiratory protection;
- surveillance;
- radioactive-waste management (tailings management for mills);
- ALARA program; and
- facilities and equipment.

One or more analytical trees with corresponding questions were developed for each of these major parts. The analytical trees start with a single desirable condition and systematically proceed through lower levels or tiers until all important factors, which produce the major conditions, are specified. The interfaces between areas are important in the evaluation process. To properly evaluate areas where transfers are noted, data collected from one area must be "transferred" to another and considered in the evaluation of both areas. The result is that, in a systematic way, one can assess the true impact of a particular event, and provide greater assurance that a given area is, in fact, adequate or inadequate.

Deficiencies or weaknesses were considered significant when the finding had a direct effect on the level of protection provided or was a critical element that was required for judging whether that portion of the program was acceptable. Isolated instances and minor items were not judged as representing a significant finding. However, if a number of deficiencies were found within a particular phase of the program, then a significant finding may have been warranted for that phase. In instances where the deficiency or weakness required immediate attention, the problem was discussed with licensee management and definitive corrective actions were agreed upon.

Findings

The HPAP inspections indicated that a number of weaknesses in the radiation protection programs, similar to those identified at TMI, did exist at many of the currently operating nuclear facilities. The most frequently encountered weaknesses are outlined below.

- inadequate health physics staffing levels;
- lack of adequate training for workers and health physics staff;

- lack of procedures;
- inadequate dose verification;
- inadequate calibration programs;
- failure to fully implement respiratory protection programs; and
- lack of formal ALARA programs.

Conclusions

In reviewing those programs considered to be good, three main ingredients were present. A management attitude existed that saw beyond merely meeting regulatory requirements but insisted upon and encouraged the development of a quality program with health and safety consciousness among all employees. Second, the qualifications and training of the radiation protection manager (RPM) and radiation safety officer (RSO) are of prime importance. A qualified RSO or RPM can often conduct a quality program even with a minimum of manpower, equipment, and full management support. Lastly, most licensees had implemented some portion of an ALARA program, usually not formally documented; and engineering modifications, procedural changes and housekeeping efforts had been used to provide contamination control and reduce personnel exposure.

In general the radiation protection programs at power reactors, uranium mills, and LLW disposal sites were found to be adequate. However, it was also observed that if any one of the three groupings needed more attention it was the uranium milling industry. This may be attributable to the fact that until recently it has been considered part of the chemical industry and not the nuclear industry. Therefore, in many cases health physics has taken a backseat to other aspects of the operations. More formalized additional efforts are desirable at mills. The weaknesses identified in ALARA and worker training programs indicate lack of management attention and commitment to these areas. Management attention and improvements in these programs could result in further exposure reduction, improved worker education and attitude, and a positive effect upon other mill programs. Licensee management is therefore responsible for and has a major role in the further development of radiation protection programs.

References

NUREG-0855-1981, "Health Physics Appraisal Program."

NUREG-0833-1982, "Uranium Mill Appraisal Program."

NUREG/CR-3125-1983, "Current Practices for Maintaining Occupational Exposures ALARA at Low-Level Waste Disposal Sites."