SHORT-TERM AND LONG-TERM STRATEGIES FOR NPP KRSKO RADWASTE MANAGEMENT

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ABSTRACT

All radioactive waste generated by the Nuklearna Elektrana Krško (NEK) has been stored in a temporary storage building located at the site. In 1987, the plant owner embarked upon a program to develop and operate a low-level repository for permanent disposal of NEK waste by 1992. However, due to institutional and political considerations the schedule for the repository program has been substantially delayed. As a result, the plant owner has developed new strategies for the plant systems modifications as needed to cope with the shortage of the much needed storage and disposal space. This paper contains a presentation of these strategies and summarized the process which was used to develop them.

INTRODUCTION

Nuklearna Elektrana Krško is a 632 MWe Pressurized Water Reactor (PWR) power plant which has been in operation since 1981. NEK is the only operating nuclear power plant in Yugoslavia. Since the initial startup in 1981, the plant waste processing equipment has been subject to no significant upgrade except a minor modification to expend the capacity of the existing drum storage facility. NEK estimates that the present storage capacity will reach its limit by mid-1991 or sooner. Because of the recent setback in the repository development program and the depletion of its on-site storage space, NEK has now adopted the following priority for its waste management strategy: Waste generation reduction, on-site storage capacity expansion, and repository development.

In 1989, NEK conducted an evaluation of the current radwaste management practice and developed short-term and long-term plans for its upgrade. The evaluation scope covered the existing liquid and solid radwaste systems, survey of industry experience, and development, evaluation and recommendation of alternative waste reduction strategies. The major goal and objective identified for the evaluation was the reduction of the waste generation rate from 1,100 drums/year to 600 drums/year in the near future.

The evaluation was performed using a system engineering approach and consisted of studies of existing systems, and identification, selection and evaluation of alternative technologies. The systems approach is a systematic and structured process of problem solving that focuses on understanding the system requirements throughout a system life cycle. Figure 1 represents the operationalization of the systems approach applicable to the study.

STUDY OF EXISTING SYSTEMS

The waste systems and functions that were evaluated as part of this study include systems discharging waste to liquid radwaste system, liquid radwaste system and solid waste system. Detailed evaluation criteria was developed and used for the existing systems evaluation. These criteria addressed the following major points: Capacity adequacy, redundant component availability, performance adequacy, recycling ability, system reliability, protection against accidental release of liquids, ALARA compliance, ease of operation, ease of maintenance and minimization of discharge to environment.

IDENTIFICATION AND DESCRIPTION OF AVAILABLE ALTERNATIVES

Evaluation of the NEK radwaste management practice resulted in the identification of the areas requiring equipment and/or operational modification. These area are: Boron recovery system, floor drain system, reactor coolant drain tank processing, abatement of sludges in the floor drain tank and waste holdup tank, resin storage tank and resin transfer system, spent resin handling system, DAW treatment, decontamination and oil handling.

After identifying the problem areas, a worldwide survey was conducted to identify proven technologies and waste management practices available to address these problems. Based on this survey, several treatment options were developed for each waste stream.

A preliminary screening process was used to narrow down the number of final options. The primary criterion used during the initial screening was the equipment/system operating history, since a decision was made to utilize proven technologies with good performance records. The following three screening criteria were also used: Operating history, acceptability and performance features. Each treatment option was given a score from 1 to 4, with 1 being the lowest and 4 the highest. The application of the initial screening criteria resulted in a limited set of acceptable technologies.

Each of the acceptable technologies were evaluated using 18 (eighteen) detailed technical evaluation criteria. To rank the treatment technologies, a weighted

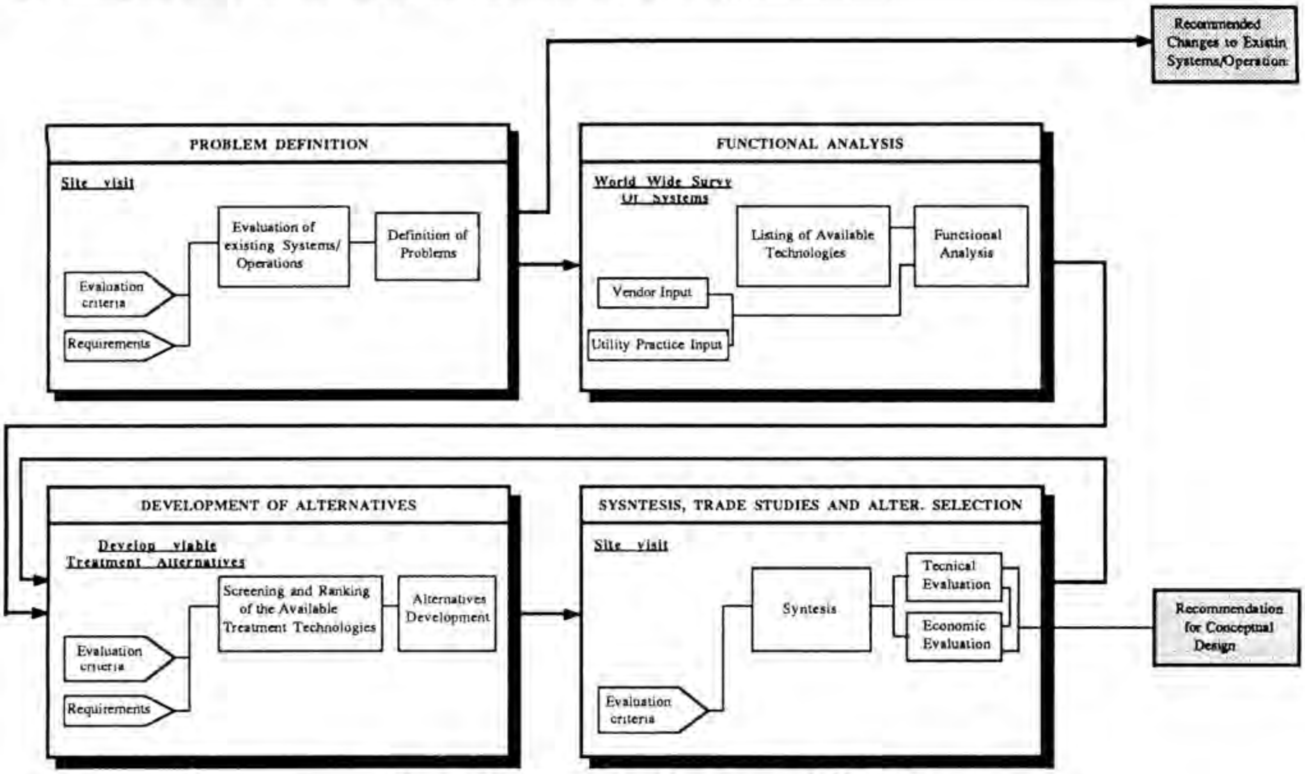

Fig. 1. Systems Engineering Approach Block Diagram.

scoring method similar to initial the screening process was used. A figure-of-merit (FOM) method was used to grade a given component and/or system with respect to a particular assessment criterion. The methodology used ensures that the preferred treatment options are subjected to detailed technical evaluations to select a recommended final option that is best suited to the plant needs.

It should be noted that the comparison of the various composite scores did not finalize the selection process. The objective of this rating system was to provide a semi-quantitative method to compare the relative technical merits of each treatment option. By assigning numerical values for the criteria used to rate a processing method/system, a quantitative expression for the comparative worth of the option was generated in order to compare processes. To compensate for potential subjectiveness of the FOM methodology, quantification of the selected criteria was done by a team of three (3) individuals with expertise in radwaste system design, operation and maintenance.

SELECTION OF PREFERRED ALTERNATIVES

As indicated, the most important goal of the plant waste modification is to reduce the current high waste generation rates as soon as possible. Because some of the technologies can be implemented with an immediate result, while others require a lengthy execution cycle, the overall implementation program was divided into a short-term strategy and a long-term strategy.

SHORT-TERM STRATEGY MODIFICATIONS

Options that can be implemented in the immediate future are grouped into an integrated waste management practice named "short-term strategy." Major modifications proposed for this strategy are:

Boron Recycle System (BRS)

Results of the evaluation suggested that the present concentrates throwaway mode be changed to recovery mode so that concentrated boric acid can be recycled for reuse in the primary system shimming operations. Modifications required for changing to this recovery mode include the addition of a new concentrates storage tank, pumps and related equipment. It is estimated that the proposed changes will result in a reduction of 238 drums of process waste each year.

Liquid Radwaste System (LRS)

It is proposed that the present liquid waste stream evaporation mode be abandoned in favor of liquid waste segregation and demineralization followed by discharge. The proposed approach involves segregating liquid waste into clean and dirty waste streams. Clean waste, such as the reactor coolant drain tank effluents, is routed to the BRS for recovery and recycle. Dirty waste, such as auxiliary building floor and equipment drains, is processed through a demineralization process and discharged. This option will provide maximum volume reduction benefit only if it is implemented in conjunction with operating the BRS in the proposed recovery mode. Modifications required to implement this change include the addition of a portable demineralizer system, a resin storage tank and two new concentrates storage tanks, pumps and related equipment. It is estimated that the proposed changes will result in a reduction of 271 drums of process waste each year.

Solid Radwaste System

It is proposed that the present vermiculite/cement solidification system be replaced with: (1) A HIC resin dewatering system, and (2) a small portable cement solidification system. If this option is adopted, a reduction of 60 drums per year can be expected. This modification will require installation of a portable resin dewatering and a portable cement solidification system at the existing waste solidification room. Also needed are a shielded fork lift truck and a portable drum shield. The use of 265-liter square drums for solidifying the evaporator concentrates can further reduce the disposal space requirements.

Dry Active Waste Handling

The addition of a sorting capability for compressible and non-compressible dry active waste (DAW) is proposed. Furthermore, it is recommended that DAW be packaged in large metal boxes to reduce storage space requirements. The additional equipment required to implement this modification is a DAW sorting table/glove box and a high pressure box compactor. These can be housed in the existing radwaste storage building. If this option is adopted, a reduction of 31 m^3/year of DAW per year can be expected.

Miscellaneous Modifications

It is recommended that the sludge be characterized to determine whether its source is precipitated material (generated by chemistry changes in the tank) or suspended solids (such as dirt, dust and corrosion particles) contained in the influents. This data should be used during the selection of a filter element for the portable filtration skid. To further abate the sludge build-up problem, it is proposed that the evaporator concentrates pump suction line be modified to allow removal of the evaporator bottoms tank sludge by the evaporator concentrates pump.

Oil-Handling

It is proposed that the contaminated oil stored in the drums in the auxiliary building by incinerated by the auxiliary boiler or other boilers at NEK. An impact assessment is needed to demonstrate that dose impact from this practice is negligible and that it will not effect off-site dose limits. In the U.S., several plants have opted this approach. The current method of storing drums in the auxiliary building is considered a fire hazard situation and should be avoided. It is proposed that the oil drums be relocated to a fireproof structure in the yard.

LONG-TERM MODIFICATIONS

Provision of an additional space to house the required state-of-art waste management equipment is studied. A new structure contiguous to the existing auxiliary building is found to be the most feasible choice. Hence, modifications which include provision of a new building are grouped in an integrated waste management program named "long-term strategy" modifications. Major modifications proposed for the long-term strategy are:

DAW Processing

It is proposed that all DAW processing functions be relocated to the new building. Furthermore, it is proposed that DAW processing functions be expanded to include decontamination technologies and a new sorting table and accessories to allow segregation for contaminated and non-contaminated DAW. These new processing functions could reduce the DAW generation rates by an additional 20-25%.

Laundry System

It is proposed that the laundry system be relocated to the new building to improve operation and to allow the addition of dry cleaning and respirator cleaning capabilities. The use of dry cleaning units could substantially reduce, if not eliminate, discharge to the Sava River from the laundry tank.

Solid Waste System

Installation of a permanent waste packaging system is proposed. This includes a remotely-operated solidification/dewatering and the associated material handling system.

Improved Evaporator

To improve radwaste system operability, maintainability and ALARA, a new state-of-the-art evaporator to replace the existing liquid radwaste system evaporator is proposed. Using a new evaporator, a higher percentage of radionuclides is removed during the evaporation process. This results in less radioactivity discharge to the Sava River.

Concentrates and Spent Resin Tanks

The addition of concentrates and spent resin tanks in the new building is proposed. An increase in the present tankage capacities is needed to improve plant reliability during abnormal conditions involving the shortage of LLW storage space. Also, the addition of concentrates tank permits the cleanup and discharge of this waste using a selective ion exchange process which is currently under development.

CONCLUSION

The proposed short-term modifications will meet the NEK goals for reducing the current 1,100 drums per year to 600. Figure 2 shows a breakdown of the waste volume in areas of expected reduction. An additional 20% reduction in the DAW and 5% reduction in the overall process waste volumes are estimated for the long-term modifications.

However, the projected volume reduction takes into account improved organizational and administrative procedures for the radwaste management systems. These procedures must be worked out and implemented along with the proposed modifications.

An economic analysis (present worth analysis) of the 30 years' lifetime operating cost based on the U.S. economic factors is conducted. Results show that the present worth of the current practice and the short-term strategy modification is approximately \$14 million and \$6 million, respectively. This potential cost savings of \$8 million justifies the proposed expenditure of \$3-4 million for the short-term strategy modifications.

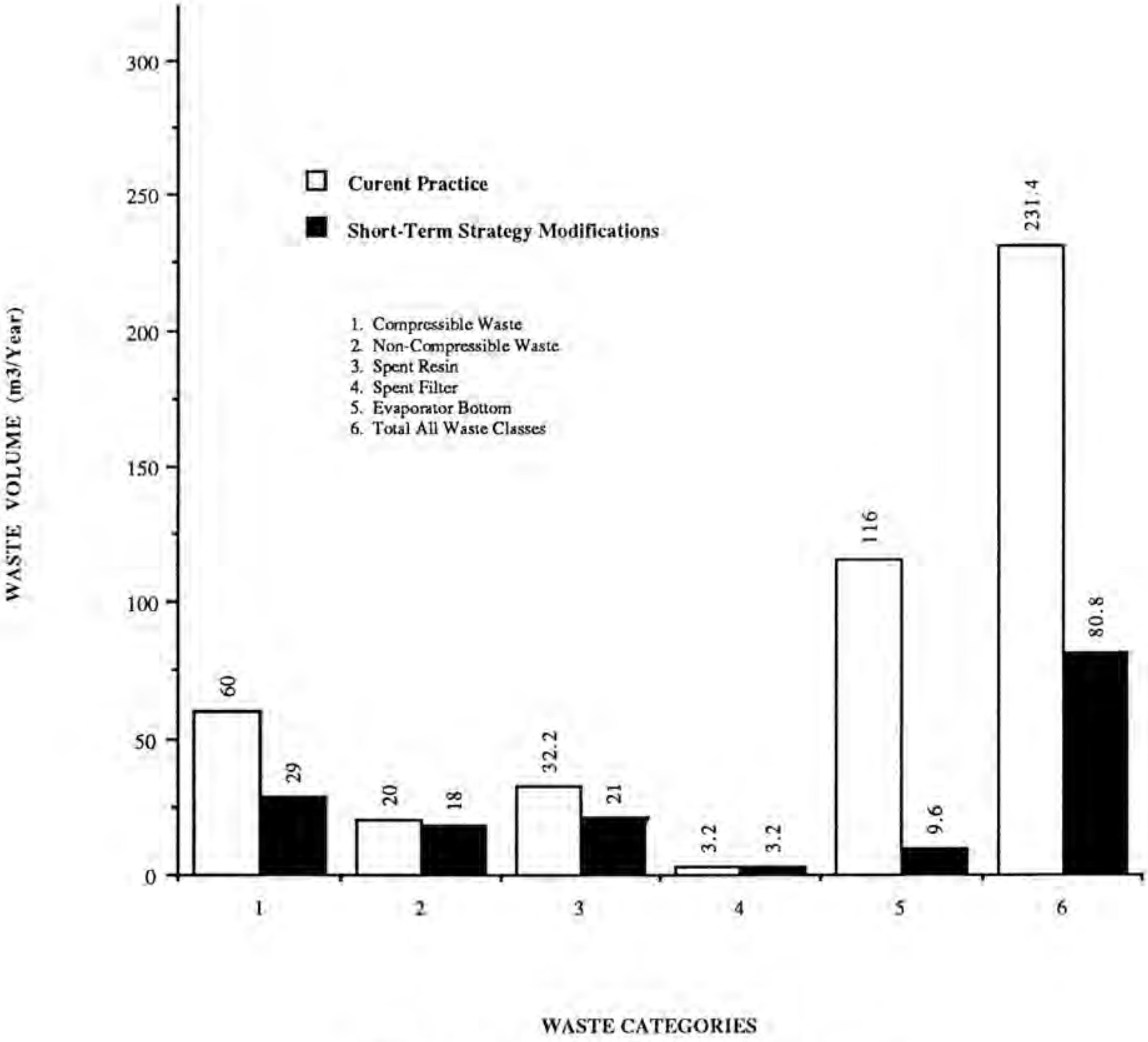

Fig. 2. Waste Volume (m3/Year)/Waste Categories.