CRITERIA FOR EVALUATION OF INTERIM RADWASTE SOLIDIFICATION SYSTEMS

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ABSTRACT

The selection of a permanent volume reduction and/or solidification system has become increasingly complex and difficult for utilities over the years. Factors affecting the selection include the system capital cost, projected transportation costs, projected burial costs and on-site storage options. Complicating the evaluation are the increase in emerging radwaste technologies, uncertainties in future regulations and uncertainties associated with the establishment of regional compacts, such as burial site location, cost of burial and volume allotments.

The complexity of this evaluation has led some utilities to delay the selection of a permanent system and to seek other less expensive short term solutions. Other utilities have made the difficult decision to purchase a permanent system but find themselves in need of temporary waste processing capability until their permanent system becomes operational, which can take as long as five years.

This paper outlines the criteria for evaluating interim radwaste options versus permanent facilities and explains why Duke Power Company has elected to utilize an interim portable volume reduction (VR) service at Duke's Oconee Nuclear Station in South Carolina.

INTRODUCTION

This paper describes the economic and technical criteria used to evaluate an interim volume reduction/solidification system for use at Duke Power Company's Oconee Nuclear Station.

The opportunity for considering the VR option was identified early in the development of a plan for the potential chemical cleaning of the Oconee Steam Generators. This paper does not detail either the chemical cleaning plan or the permanent radwaste facility at Oconee, but a brief description of each activity is necessary to understand the use of an interim VR option.

Finally, a description of some of the plant interfaces and challenges encountered to date is presented. The plant physical interface and impact on plant personnel resources is an area frequently overlooked in evaluations or at best considered as universally applied or as "sunk costs". However, it is found that an adequate consideration of plant interfaces can have dramatic impact both on economics and schedule of a proposed modification. An early and accurate identification of plant interfaces is necessary in establishing the road map for successful completion of such a project.

BACKGROUND AND HISTORICAL DEVELOPMENT

The Oconee Nuclear Station has operated since 1974 with an interim radwaste facility in support of the original plant system. This interim facility has served well but ultimately will be replaced with a more permanent facility in 1986. The current interim facility includes tanks, an evaporator, and is augmented by a mobile cement solidification system. The permanent facility will include tanks, demineralizers, filters, a crystalizer, a liquid volume reduction system, a solids incinerator and a solidification system. The high capital cost of a permanent facility is recovered over the facility life due to the expected savings in transportation, burial costs, and burial allotment for reduced volumes.

Steam Generator tube degradation as indicated by eddy current testing has resulted in an increasing number of plugs required in the Oconee Unit 1 steam generators in recent years. The coincidence of lumps of magnitite with degradation indications as a function of elevation has led to the recommendation that a chemical cleaning be undertaken. Unit 2's steam generators are exhibiting an increase in pressure drop which is associated with fouling. Again, the recommended solution is chemical cleaning.

In March 1981 a multi-discipline, multi-department task force within Duke received management's directive to develop and implement a plan to accomplish chemical cleaning of the steam generators for both Unit 1 and Unit 2 of Oconee. Chemical Cleaning Task Force recommendations resulted in a four phase chemical cleaning plan.

Phase I (Solvent Development) is a joint Duke Power/Arkansas Power activity to qualify the EPRI solvent by material specific testing at B&W's Alliance Ohio facility. Phase II (Hardware Design) is the design of mechanical process systems to fill, soak, and drain the steam generators. Duke has contracted with NUS to develop this system design. Phase III (Cleaning Implementation) is the implementation phase which includes plant modifications, equipment placement, the cleaning activity, and restoration of the unit. Phase IV (Waste Treatment) is waste disposal of radioactive cleaning and flush solutions.

As the cleaning plan was developed, it was recognized that there were two disposal alternatives that could be exercised. The EDTA based cleaning solution could either be burned or buried. Fossil boiler cleaning solutions are routinely burned in the boiler; however radioactivity is anticipated in this cleaning solution. Given the uncertainties associated with future incinerator licensing, the difficulties of past licensing efforts to allow on-site burning of oil with low levels of radioactivity and very restrictive possible liquid shipments for burning off-site, the burning option was abandoned in favor of burial.

In considering the burial option of waste disposal, four treatment options were examined. The first treatment was development of chemical separation techniques to produce an EDTA stream, an iron precipitate stream, a radioactive sludge stream and a clean water stream. Ultimately unproven technology, high cost of proposed development and a healthy doubt based on experience that complete segregation could be achieved resulted in rejection of this option. The second option considered was on-site storage of the solvent waste until the completion of the permanent radwaste facility with subsequent volume reduction, solidification, transportation and burial. On-site space considerations, the large volume of waste being potentially generated from cleaning four steam generators, the temporary nature of the design of chemical cleaning systems and the nature of the solvent resulted in either high economic penalties or undesirable site impact. The third and fourth options are the subject of the economic and technical evaluation criteria sections presented below. The option to simply solidify the chemical cleaning wastes using the current mobile cement system was certainly technically sound, but the large volumes involved and the associated high transportation and burial costs resulted in a closer look at a proposed new technology.

Interim volume reduction systems which were evaluated each had a proposed contract life consistent with the time frame of the chemical cleaning activities, were temporary (transportable) in nature and consistent with the startup of the permanent facility. In addition, the proposed equipment was sized to process both the chemical cleaning and normal plant wastes.

Thus the selection of the Transportable Volume Reduction (TVR) option resulted. The TVR, although primarily based on favorable economics and acceptable technology, also benefits from timeliness both in terms of availability and contract life.

ECONOMIC CRITERIA

An economic evaluation was performed for the Oconee Nuclear Station based on the yearly output of boric acid concentrates and expected steam generator cleaning waste volumes. Six primary sources of cost are associated with radwaste solidification systems.

1. Installation
2. Service
3. Processing
4. Operator
5. Transportation
6. Burial

Installation costs vary depending on system requirements and on availability of plant services and facilities. Service cost is defined as the fixed rental cost for exclusive use of the TVR System. Processing costs include the use of binder materials, reagents and use time while processing. Operator costs cover the expenditures associated with manpower requirements, personnel supplied by the system (including transfer of the solidified waste to the transport vehicle), ordering all processing and packaging materials, and maintaining the system. Transportation costs were the charges incurred for shipping the solidified waste from Oconee to appropriate burial sites. These charges were based upon payload, mileage, and transportation fuel surcharge. The resultant expenditures for shipping the waste revealed that the solidification matrix highly affected transportation cost. The shipment is limited by the legal weight classification. A hi-density matrix reaches the payload limit sooner than a low-density matrix which allows more volume of waste to be transported per shipment. Burial costs were derived from the rates established at various burial sites.

TECHNICAL CRITERIA

The technical evaluation was developed to assist in the decision-making process. The eighteen criteria listed below were selected as those which were judged to envelop the characteristics of a portable volume reduction system:

1. Remaining Technical Development
2. Simplicity of Design
3. Simplicy of Control
4. Maintainability
5. ALARA Design Philosophy and Potential for Radiation Exposure
6. Volume Reduction
7. Proposed System Operation History
8. Soundness of Underlying Component Technology
9. Completeness of Overall Scope
10. Licensing
11. Specialty Knowledge and Skills Factors
12. Decontamination Design
13. Chemistry Control Requirements for System
14. Impact on Plant Supporting Services
15. Availability
16. Degree of Preassembly
17. Binder Adaptability
18. Generation of Additional Waste Process Requirements

These criteria were divided into three categories and assigned a weighting factor based on importance. Each volume reduction system was evaluated and assigned a score from 1 to 4 on each criterion, with 4 being the highest. The scores in each category were added together and multiplied by the category's weighting factor. The total sum for the three categories resulted in the systems overall score.

The above evaluation was then carried out for a straight-solidification system and compared to the volume reduction system results. Because the straight-solidification technology is well developed and functioning on site, it received higher technical credit than the volume reduction systems.

PLANT INTERFACES

A typical volume reduction system requires several plant interfaces:

1. Binder Storage Tanks
2. Shielding
3. Materials Handling
4. Load Bearing Pads
5. Spill Curbs for Liquid Containment
6. Electricity
7. Air
8. Cooling Water
9. Demineralized Water
10. Ventilation
11. Steam
12. Waste Feed
13. Temporary Container Storage
14. Fire Protection

Items 1-4 above have been identified as those interfaces which require the most effort to establish. Binder storage tanks may present problems because solidification media require special conditions for maintaining thermal stability. The amount of shielding needed is determined by the source strength of radioactive waste materials. In addition, adequate shielding must be supplied to limit personnel radiation exposure to ALARA. Shielding must be incorporated into the material handling system to minimize worker exposure during waste transfer. In addition to exposure, the material handling design must be capable of moving the container during the filling, sampling, decontaminating, and loading sequence. Load bearing pads should be designed to support, level, and constrain (if necessary) the system housing. Finally, piping and electrical lines should be designed for ease of installation.

SUMMARY AND CONCLUSIONS

It is not the purpose of this paper to promote one technology or vendor over another, or to suggest dissatisfaction with either permanent facilities or with the historical use of non VR mobile solidification systems. It should be noted however, that as a result of the sequence of option decisions described above, Duke will look closely at the modular concept of the TVR as an option in addition to mobile services and permanent installations for future needs.

In considering future applications of radwaste technologies for treating solid, liquid and gaseous waste streams, a great deal of emphasis will be placed on reducing the high capital costs of permanent installations, reducing the dependence on services and maximizing the use of new technologies as they are developed. The self-contained module which can be purchased or leased at option, can be removed and replaced with later technologies and still provide adequate service. This flexibility may well fit the current pattern of economic restrictions and rapidly changing radioactive waste treatment technology.