IRRADIATED REACTOR COMPONENTS: PROCESSING AND PACKAGING METHODOLOGY FOR VOLUME EFFECTIVENESS

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ABSTRACT

Proper disposal of irradiated components requires a flexible project management approach to assure that costs and schedules are maintained within their respective goals. The processing, packaging, and transportation of these components is an expensive and time consuming task for a nuclear generating station. Unfortunately, the infrequent demand for these services prevent utilities from installing a dedicated team to efficiently and cost-effectively accomplish these projects.

Chem-Nuclear Systems, Inc. (CNSI) has developed new equipment and packaging methods to achieve the optimum combination of components, volume reduction, and packaging efficiency using a variety of casks. The use of consolidation equipment to reduce irradiated hardware envelope volumes by as much as a factor of ten and improving packaging efficiency by taking advantage of self absorption characteristics of the irradiated components assures that the total project costs will be minimized.

This paper presents descriptions of the project management matrix, equipment, liners, packaging and transportation combinations employed by CNSI to consolidate and dispose of irradiated reactor components.

PROJECT MANAGEMENT

The project management provided for an irradiated component consolidation project is extremely critical due to the complex nature of these projects. Dedicated management staff fully knowledgeable within their area of responsibility are necessary to assure that time schedules and regulatory compliance are maintained. A single management staff approach has generally been found to lack sufficient experience to cover all aspects of the project.

An integrated company approach to staffing is recommended. Figure 1 shows the recommended staffing requirements. Each staff position has specific responsibilities which assures that the required resources are available to support the project. The staffing can be divided into the following groups:

- Project Management- The project management team consists of the Operations Manager, Project Manager and Project Supervisor.
- Support Resources - The recommended support functions include; Quality Assurance, Regulatory Compliance, Cask Engineering, Process Engineering, Fabrication (Maintenance), Transportation and Contracts Administration.
- Waste Characterization and Classification.

The above management scheme provides expertise in the major areas which have a direct bearing upon the success of the project. The Operations Manager provides the corporate overview of the entire project. The Project Manager is responsible for liaison between the field operations and the support resources including waste characterization and classification. The Project Supervisor is responsible for the daily field operations.

Our experience has shown that the use of permanent management personnel for staffing results in vastly improved efficiency and customer relations. In some cases when demand exceeds availability of field personnel, subcontract personnel may be used to supplement the staff. Subcontract personnel must be qualified under the same security and training programs as permanent employees.

It is recommended that waste characterization and classification as required by 10 CFR 61 be performed by an independent third party. Programs employing either direct sampling or activation analysis have been found to be acceptable for this function. The merits and deficiencies of each methodology should be established prior to the issuance of the work scope with the licensee selecting the desired methodology.

The philosophy of total professional integrated management provides a system of checks and balances to assure, compliance with procedures, regulatory compliance, and the efficient and safe operations of the project.

CONSOLIDATION EQUIPMENT

Chem-Nuclear Systems, Inc. (CNSI) has an ongoing development program for consolidation equipment. During the past four years CNSI has evaluated several technologies including plasma arc, reciprocating saws, bandsaws, shears and presses. Table I lists the evaluation for each technology. Based upon the results of these evaluations CNSI has developed equipment employing the shear and press technologies.

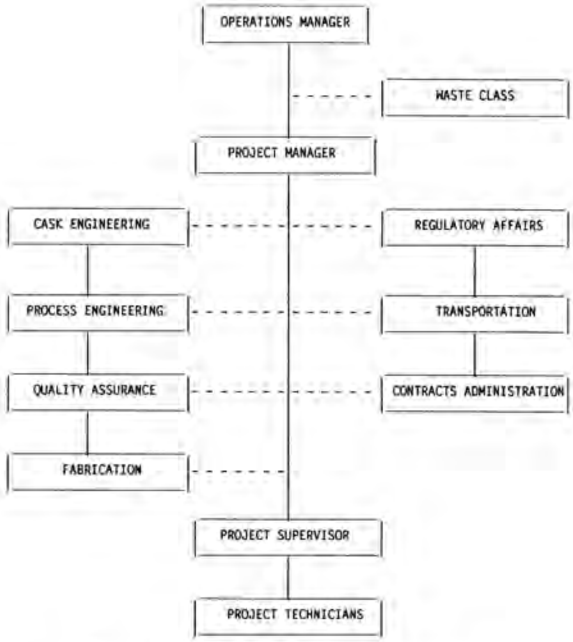

Fig. 1. Project Staffing Requirements.

TABLE I

Consolidation Equipment Evaluations.

TYPE OF EQUIPMENT	EVALUATIONS
Plasma Arc	High energy consumption, generates excessive debris, requires additional training, low initial investment, low maintenance costs.
Reciprocating Saws	Low initial investment, medium maintenance costs, low productivity, generates excess debris.
Band Saws	Limited application due to physical constraints, low productivity, generates excessive debris.
Abrasive Saws	Hazardous operation, excessive debris, excessive contamination of equipment, high maintenance costs, high initial investment.
Shear/Presses	Medium initial investment, high productivity, generates very little (if any) debris, volume reduction maximized, medium maintenance costs.

A review of the physical and metallurgical parameters of irradiated components comprising the major portion of waste being generated showed that the equipment required more versatility and flexibility than could be provided with a single unit. Therefore, CNSI has fabricated two crusher/shear devices.

The smaller unit is employed primarily for PWR generated irradiated components such as burnable poison rod assemblies (BPRA), reactor control cluster assemblies (RCCA)d and thimble plugs. The unit has the following specifications:

- Set-up Area - 1.9M x 1.9M (6.2 ft x 6.2 ft)
- Weight - 816 Kg (1800 lbs)
- Maximum Pressure - 45360 Kg (50T)
- Receiver Dimensions - 35.5 cm x 30.5 cm x 20.3 cm (14 in x 12 in x 8 in)
- Power Requirement - 120 Vac, 20 Amps
- Hydraulic Fluid - water
- Cycle Time - 120 seconds

The larger unit is employed for BWR generated components such as control rod blades (CRB), flow channels and poison curtains. The unit has the following specifications:

- Set-up Area - 1.9M x 2.5M (6.2 ft x 8.2 ft)
- Weight - 3,084 Kg (6800 lbs)
- Maximum Pressure - 90719 Kg (50T)
- Receiver Dimensions - 40.6 cm x 35.5 cm x 20.3 cm (14 in. x 14 in. x 8 in.)
- Power Requirements - 460 Vac, 3 phase, 100 Amps
- Hydraulic fluid - water
- Cycle Time - 30 seconds
- Self Contained Filter System

Both units are designed to minimize contamination build-up and maintenance problems. Typical volume reduction factors obtained with these units ranges from 5-10.

Other irradiated component processing equipment developed to date includes a stellite bearing punch, LPRM cutters and a scissor cutter for incore instrumentation. In each case weight, ease of maintenance, reliability and ease of operation were considered in the design.

The ability to design and fabricate site specific equipment and handling tools is highly recommended. Pneumatically actuated grapples have been found to be an extremely effective means of increasing productivity over manual grapple devices.

PACKAGING PLAN

The packaging plan including processing methodologies will have a direct bearing on project costs. The value of the packaging plan is dependent upon the type and detail of the irradiated hardware information available. As a minimum the following information should be provided:

- Detailed inventory of irradiated components.
- Dose profiles typical of each type of component.
- Drawings including metallurgical data for each type of component.
- Irradiation histories for each type of component.
- Radiochemical analysis of the Spent Fuel Storage Pool including transuranics and all listed 10 CFR 61 isotopes.
- Plan and elevation drawings for the Spent Fuel Storage Pool and the surrounding floor area.

Dose profiles of all components and/or waste classification of all components prior to on-site operations can reduce the project time frame by as much as several weeks depending on the types and volume of irradiated components to be processed.

The packaging plan should address the following areas:

- Type and number of liners (packages) to be used.
- Dose rate and curie limitations for each type of liner as related to the planned transportation cask.
- A description of the processing and loading methodologies to be used.
- A description of the component inventory control procedure to be used.
- A description of how waste classification will be determined and controlled to assure acceptable packaging.
- The project records/documentation program.

Experience has shown that detailed descriptions of the irradiated components can result in project savings of as much as 20% when provided prior to the development of the packaging plan.

LINER AND CASK SELECTION

The selection of liner(s) and cask(s) for a specific project is dependent upon the following factors:

- Volume of irradiated components
- Dose rates of the components
- Waste classification of the components
- Physical dimensions of the components before and after consolidation

As a general rule, the liner with the largest internal volume and cross sectional opening can be loaded with the highest waste volume per unit of internal volume. In addition large liners provide certain advantages resulting from component shielding and distance to increase acceptable dose rates. The later factor can be used specifically when employing the CNS 3-55 Type B Cask.

The shielding of the CNS 3-55 Cask limits liner dose rates to 8,000 to 10,000 R/hr. However, when the liner packaging methodology places the highest dose rate material in the center of the liner surrounded by lower dose rate material the dose rate limitation is reduced. Material with dose rates exceeding 20,000 R/hr have been successfully packaged, transported and disposed of in this manner.

An additional consideration in selecting casks is the availability of approved personnel barriers. Personnel barriers can increase acceptable dose rates by as much as 10% depending upon the isotopic composition of the material. Experience has shown this to be true for the CNS 3-55, CNS 8-120B and CNS 1-13G Casks.

Other Type B casks available include the FSV, IF300, CNS 1-13C, TN-8, NAC and NL 1/2. The casks should be evaluated on a project specific basis to determine the most economical means of completing the project.

SUMMARY

Many factors contribute to the success of an irradiated component consolidation project. These factors include:

- Waste characterization and classification
- Resource support availability
- Management approach
- Equipment availability, flexibility and reliability
- Volume reduction and packaging considerations
- Transport considerations

The complexity of these projects and the sometimes limited experience of station personnel often limit station participation. A qualified vendor will supply dedicated and knowledgeable personnel, reliable equipment, and transportation. This results in shorter project time frames and lower project costs while assuring regulatory compliance.