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Work Performed Under Contract DE-AC09-79 ET 47921

ALLIED-GENERAL NUCLEAR SERVICES
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Printed in the United States of America
Available from
National Technical Information Service, U. S. Department of Commerce
5825 Port Royal Road, Springfield, Virginia 22151

Price: Printed Copy \$ 4.00 ; Microfiche \$3.00

AGNS
Allied-General Nuclear Services

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AGNS-47921-TPR-3

Distribution
Category UC-85

AFR/DESIGN AND LICENSING
INFORMATION/BNFP AS A MODEL

TECHNICAL PROGRESS REPORT

January 1980 - March 1980

MASTER

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April 25, 1980

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PREPARED FOR THE
DEPARTMENT OF ENERGY
WASTE AND FUEL CYCLE TECHNOLOGY OFFICE
UNDER CONTRACT DE-AC09-79ET47921

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ABSTRACT

AFR SPENT FUEL STORAGE PROGRAM

Work on this project is focused on developing design and licensing information for the model facility. Three major subcontracts have been approved by DOE and the design effort is progressing satisfactorily on the security system, rack design, and the soils structural and seismic design which these contracts cover.

Licensing activities are progressing satisfactorily. About 50% of the Environmental Report is drafted and issued for preliminary review. Approximately 15% of the Safety Analysis Report has been drafted.

FOREWORD

This Quarterly Report describes the technical status of work performed by Allied-General Nuclear Services (AGNS) in providing design and licensing information preparatory to conversion of a nuclear fuel reprocessing plant's fuel receiving and storage facility to an away-from-reactor (AFR) spent fuel storage facility using the Barnwell Nuclear Fuel Plant as a model.

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TECHNICAL PROGRESS REPORT
January 1980 - March 1980

TASK OBJECTIVES

The contractor shall furnish design and licensing information preparatory to conversion of a nuclear fuel reprocessing plant's fuel receiving and storage facility to an away-from-reactor (AFR) spent fuel storage facility using the Barnwell Nuclear Fuel Plant as a model.

SUB-TASK 1.1 - FACILITY MODIFICATIONS

Principal Areas of Investigation

Preparation of a design package for fuel receiving modifications to the model facility.

Status Summary

The major effort this report period was directed at preparing engineering designs for the various facility modifications. A total of 16 designs have been completed and 13 are in progress. The structural modification and seismic study contract has been signed with Bechtel. A kick-off meeting was held in Bechtel's offices on March 13 and a meeting between Bechtel and NES was held on April 17 to arrange for seismic information interface between both parties.

Technical Progress

Implementation Concepts

- Provide detail design packages for modifications to the existing FRSS Facility which are required to adapt the model facility to an AFR mode and/or improve the operation of the existing facility.
- Engineering studies and designs will be developed for the building extension structure, crane extension, transfer canal connections, and soils studies required for proposed expansion pools.
- Other major design jobs will involve the crane systems, cask working platform, leaker can handling system, HVAC, pool water, and waste handling systems.
- A report will be provided summarizing the jobs included, documents developed, estimated cost, construction approach, major procurement required, and the schedule for material delivery and installation.

Progress to Date

Sub-Task 1.1.1 - Modifications to Model Facility

Ten of the 32 items in this portion of the modifications have been designed.

Cost estimates, procurement, and construction schedules are being prepared.

Design is proceeding on the following items:

- Cask Head Supports
- Pool Filter Shielding
- Filter Blowdown/Waste Accumulator
- Caustic to Deionization Systems
- Off-Gas System
- Leak Detection Sump Modifications
- Truck Bay Lighting.

Sub-Task 1.1.2 - Subsystem Designs within FRSS

Six of the 34 (two jobs were cancelled) items in this portion of the modifications have been designed.

Cost estimates, procurement, and construction schedules are being prepared.

Design is proceeding on the following items:

- Canister Crane Limit Switch
- Design Crane Accessories
- Crane Anti-Collision System
- Liquid Waste Handling
- Spare Parts Study.

Sub-Task 1.1.3 - FRSS Structure Modifications

The contract with Bechtel for structural modifications, soils studies, and seismic analysis was signed.

- A kick-off meeting was held in Bechtel's office on March 13, 1980, and Bechtel is proceeding with the following tasks:
 - Fuel Transfer Canal - Reviewed existing FRSS design and prepared a preliminary design of the flexible joint connecting the FRSS with the new transfer canal.
 - Seismic Analysis - A soil-column analysis has been run and a parameter study to reduce the number of soil layers in the model has been started. Review of the design drawings, previous seismic

models, and construction procedures has been started to study the configuration of the finite element models.

- Soil and Liquifaction - The geotechnical group has recommended dynamic soil properties for the finite element model and has started the technical specifications for the subsurface investigations and laboratory testing.
- A meeting was held in Bechtel's offices with Nuclear Energy Services personnel on April 17, 1980, to provide a scope and schedule of the seismic data requirements which will interface with Bechtel's seismic analysis program and the NES rack design.

SUB-TASK 1.2 - HIGH-DENSITY FUEL STORAGE RACKS

Principal Areas of Investigation

Preparation of a design package for high-density fuel storage rack configuration for the model storage facility.

Status Summary

The work performed during this quarter included:

- Selection of a fuel rack subcontractor for design and analysis services - Nuclear Energy Services, Inc. (NES) of Danbury, Connecticut.
- Continued evaluation of rack poison requirements and suitable materials.
- Initiated coordination meetings between AGNS, NES, and Bechtel (the seismic consultant). A preliminary evaluation of pool floor and wall loadings was developed.
- Preliminary evaluation of double-tiering concepts and the application of disassembled/canned fuel.

Technical Progress

Implementation Concepts

- Prepare a specification package for high-density storage racks.
- Evaluate vendor-provided data on specific high-density storage rack designs and configurations.
- Develop engineering data on high-density storage racks suitable for Nuclear Regulatory Commission (NRC) licensing actions.

- Identify, develop, and report on a design for existing pool modifications required to accommodate high-density racks using currently licensed technology.
- Develop a planning schedule for high-density storage rack utilization.
- Submit final report to the Savannah River Spent Fuel Project Office.

Progress to Date

A detailed technical evaluation was performed on the five proposals received concerning design and analysis of high-density spent fuel racks for the BNFP pools. The vendor selected for this work is Nuclear Energy Services, Inc. (NES) of Danbury, Connecticut. Their experience has included work in 13 spent fuel rack applications. In addition, they have designed, analyzed, and have been directly connected with the NRC licensing of a double-tiered, high-density spent fuel rack.

The structural/seismic evaluation of the facility including the pool and spent fuel racks is being performed by Bechtel and NES. Preliminary loadings on the pool, which are imposed by the stored fuel, was supplied by NES. Table 1 summarizes the data which will be utilized by Bechtel to develop seismic spectra. The seismic data will be made available to NES in mid-summer to evaluate the structural effect on the racks and the fuel.

Selection of the neutron poison configuration for this application requires specific knowledge of the operational environment. Typically, this environment is less severe for an AFR application than for a reactor spent fuel pool, since fuel aging effects can be included. The candidate materials listed in Table 2 all utilize B C in various forms. The radiation stability of the material is a strong factor in the ultimate selection. The relative gamma dose rate was estimated for four different scenarios and is presented in Table 3. It appears that these values can be accommodated by most of the poison configurations under study. Case A is typical of a "worst" case reactor application and, similarly, Case B is a worst case for an AFR. Case B is approximately 20% as severe a dose as for Case A. The technical evaluation of the suitability of the poison will continue during this next quarter.

A double-tiered rack (fixed-design) could be employed in the deep (60-foot) pool regions of the BNFP and would considerably expand the possible storage space. Figure 1 is a photograph of the fabricated design which is now being installed at the LACBWR reactor fuel pool in Lacrosse, Wisconsin.

SUB-TASK 1.3 - SECURITY SYSTEM

Principal Areas of Investigation

Preparation of a security system design package for a model AFR Facility.

Status Summary

The major effort this period has been directed at orienting the security consultant to the site and site specific requirements. Work is progressing well on Preliminary Security System Design.

Several sections of the Physical Protection and Safeguards Contingency Plans have been written. The security system design criteria are being developed simultaneously with the Preliminary System Design.

Technical Progress

Implementation Concepts

- Identify governmental regulations applicable to security system requirements for AFR spent fuel storage.
- Develop design criteria for an AFR security system that conforms to the governmental regulations identified above.
- Prepare a design of an AFR security system that meets the design criteria specified above.
- Provide a report covering preliminary plans and programs for safeguards contingency, site security, and security personnel training. These items are presently required for licensing action by NRC.

Progress to Date

Several working meetings have been held with Security Consultant personnel. These meetings have been directed mostly at orienting the consultant with the site and site specific requirements.

A projected plan has been developed with our Security Consultant to provide design constraints and guidance.

Several sections of the Physical Protection and Safeguards contingency plans have been drafted and are being reviewed by AGNS.

Some discussions have taken place on the Guard training and qualification plan. Since this plan is dependent on the Physical Protection Plan and Safeguards Contingency Plan, the work has been very limited.

The Security System Design Criteria are being developed in conjunction with a Preliminary Security System Design.

SUB-TASK 1.4 - LICENSING DOCUMENTATION

Principal Areas of Investigation

Preparation of licensing-related documents required by the NRC for a spent fuel storage application.

Status Summary

Some minor schedule perturbations have occurred; however, overall progress is satisfactory. Approximately 15% of the ASAR and 50% of the ER have been drafted. The report on the Chem-Nuclear fault was issued.

Technical Progress

Implementation Concepts

- Prepare and refine basic licensing-related documentation required by NRC for an AFR Spent Fuel Storage Facility. Five major subsystems will be evaluated:
 - (a) Application for Licensing
 - (b) Technical Description
 - (c) Environmental Report
 - (d) Emergency Plan
 - (e) Decommissioning Plan.
- Provide a report incorporating all of the above documents to the Savannah River Spent Fuel Project Office.

Progress to Date

Approximately 50% of the Environmental Report has been drafted.

Approximately 15% of the ASAR has been drafted.

The Chem-Nuclear fault report was issued.

The meteorological tower is back in service and collecting data. Some anomalies have been observed and debugging is underway.

A meeting with DuPont personnel was held to review probable licensing time requirements. Good agreement on schedule was reached.

TABLE 1

PRELIMINARY LOADS FOR FUEL STORAGE POOL STRUCTURE

Maximum Load Summary

	Maximum Horizontal Reaction Load Kips		Maximum Vertical Reaction Load Kips		
	<u>O.B.E</u>	<u>D.B.E</u>	<u>D + L</u>	<u>D + L + OBE</u>	<u>D + L + DBE</u>
<u>Fuel Storage Pool</u>					
Movable Racks Laterally Braced at Base Elevation	6816	7498	5888	8243	8832
Movable Racks Lateral Loads Transmitted to the Tubes Maximum Hori- zontal Load for Each Tube (Post) at Base Elevation	71	78			
<u>CUP</u>					
Laterally Braced Single-Tier Rack	1531	1684	1546	1933	2087
Horizontal Load at Upper and Lower Lateral Bracing Level	765	842			
Laterally Braced Two-Tier Rack	3061	3367	3092	3865	4175
Horizontal Load at Upper and Lower Bracing Level	765	842			
Horizontal Load at Mid-Height Bracing Level	1531	1684			

TABLE 2

CANDIDATE POISON MATERIALS

<u>Name</u>	<u>Supplier</u>	<u>Description</u>
Boral	Brooks & Perkins	Aluminum/Boron Carbide Composite
Boraflex	Brand Industrial Services	Flexible "Rubber Like" Material
Cartech	Carpenter Technology	Alloyed Stainless Steel
B ₄ C		
• Resin	Carborundum	"Cermet" Material
• Sheet		Nuclear "Sandpaper"
• Metal Laminate		Bond to Stainless Steel

TABLE 3

POISON MATERIAL RADIATION DOSE

	<u>Gamma Radiation MeV/cm²</u>	<u>Absorbed Dose, Rads (Stainless Steel)</u>	<u>Normalized to Case A</u>
Case A	3.8×10^{20}	1.7×10^{11}	1.000
Case B	7.2×10^{19}	3.2×10^{10}	0.188
Case C	4.0×10^{19}	1.8×10^{10}	0.106
Case D	1.2×10^{19}	5.4×10^9	0.032

Average Burnup - 29,000 MWd/MTU

Specific Power - 32,000 kW/MTU

Case Description - Based on 40-year life.

Case A (at Reactor) - Fuel placed into fuel slot at age zero - removed after one year - 40 times.

Case B (AFR) - Fuel placed into fuel slot at age one year - removed at age two years - 40 times.

Case C (AFR) - Fuel placed into fuel slot at age one year - removed at age six years - 8 times.

Case D (AFR) - Fuel placed into fuel slot at age one year - removed at age 41 years - 1 time.

DOUBLE-TIERED, HIGH-DENSITY SPENT FUEL RACK

FIGURE 1

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