UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	Orano Federal Services, LLC	**Date Submitted**	*7/3/20*
Project Title	*Optimization Study for Off-Loading the Shearon Harris Spent Nuclear Fuel Pool using Transportable, Aging and Disposal (TAD) Canisters – Phase 2* **(ORANO_TAD2)**	**Planned Starting Semester**	Fall 2020

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	3	Electrical	2
Computer		Systems	2
Other ( )			

Company and Project Overview:

Headquartered in Washington, D.C., Orano USA is a leading technology and services provider for decommissioning shutdown nuclear energy facilities, used fuel management, federal site cleanup and closure, and the sale of uranium, conversion, and enrichment services to the U.S. commercial and federal markets. With its parent company Orano, Orano USA has more than 30 years' experience in decontaminating and dismantling nuclear facilities, and more than 50 years' experience securely transporting and storing used nuclear fuel (UNF). Prior to a global rebranding in January 2018, Orano USA was AREVA Nuclear Materials.

The Orano Federal Services business combines the capabilities, technologies and resources from multiple Orano companies to serve the United States Department of Energy (DOE) and its subcontractors in all phases of the nuclear fuel cycle. Orano Federal Services provides key services as an active member in various projects that support DOE's five strategic services**:** Environmental Management (EM)**,** Nuclear Energy (NE)**,** Office of Science (SC)**,** Office of Energy Efficiency & Renewable Energy (EERE), and National Nuclear Security Administration (NNSA)**.** Orano Federal Services currently is a contract team member of the following significant projects: the High Burnup (HBU) Demonstration Project; the Atlas railcar designed to ship UNF in transportation casks; the Yucca Mountain repository program (dormant); the Tank Operations Contract (TOC) at Hanford; et al. In anticipation of the need for removing UNF from spent fuel pools (SNF) in the future for either interim storage at a consolidated interim storage facility (Waste Control Specialists facility in Texas) or permanent disposal in a repository (e.g., Yucca Mountain), Orano is proposing to examine the use of welded dry shielded canisters (DSCs) or transportable, aging, and disposal (TAD) canisters with transportation casks such as the MP197HB.

The first phase of this project involved examining the means for emptying the SFPs at Duke Energy's Shearon Harris Nuclear Power Plant in New Hill, NC. Unlike other nuclear power plants in the U.S., the Shearon Harris SFPs are not nearing capacity and hence do not require UNF to be off-loaded into dry storage systems located on an on-site Independent Spent Fuel Storage Installation (ISFSI). This is because the Shearon Harris SFPs were sized to handle the UNF from up to 4 reactors, however only one reactor was built. This net oversized SFP became further utilized by Duke Energy's predecessor Progress Energy/Carolina Power & Light to move UNF from three other reactors whose SFPs were growing full (Robinson and Brunswick I & II nuclear power plants). Hence, the UNF in the Shearon Harris SFPs is a mix of both pressurized water reactor (PWR) fuel from Shearon Harris and Robinson and boiling water reactor fuel (BWR) from Brunswick I & II. This unusual mix creates an interesting problem in that it requires both a BWR TAD, which can hold 44 fuel assemblies, and PWR TAD, which can hold 21 fuel assemblies, to empty the SFPs.

In the second phase of this project, Orano is interested in expanding the 3D printing activities performed under the first phase of this project that included both 3D printing in plastic and metal the TAD canisters and in some cases, the TAD baskets. The two opportunities Orano is interested in pursuing includes: (1) examining the capability to 3D print plastic/metal honeycomb impact limiters as currently proposed for the transportation cask for the TAD and (2) examining the capability to 3D print metal canisters and their baskets with dissimilar materials to allow for instruments designed to operate inside the welded canister and send a signal through the dissimilar metals while not requiring a penetration through the wall of the canister.

Project Requirements:

This project is a Phase 2 of the ORANO_TAD project that was started in Fall 2019. That project examined the approach needed to empty the Shearon Harris SFPs using BWR and PWR TADs. The project team considered the inventory at the facility and based on safety requirements determined an optimization scheme for off-loading of the UNF's from the SFP's and started design work for improved TAD canister designs. The TAD canister designs were 3D printed using a combination of metal and plastic printing. The optimization design and analysis was completed. The 3D printing scope was partially completed.

Phase 2 will complete the Phase 1 3D deliverables and add new design scope for examining the feasibility of 3D printing impact limiters for these cask systems and the potential for 3D printing with two different types of metals to allow signals to be passed from one side of the metal to the other without having penetrations through the metal. Impact limiters for these cask systems are currently fabricated from redwood or aluminum. The redwood is very difficult to procure (basically got to wait for a tree to fall) and the aluminum is welded into a honeycomb-type labyrinth which is difficult and expensive to fabricate. The Orano thought process is to have the team: (1) utilize Solid Works to complete the 3D printings identified from Phase 1 and analyze the results from those printings to inform the rest of the project; (2) assess the potential for 3D printing of impact limiters (first scaled down versions and then evaluate potential for full scaled versions) and offer alternative designs that perform the same protection as those for transportation cask systems; and (3) assess the potential for 3D printing with two (or more) different metals first as a flat sheet and then as a spent fuel canister, which does not compromise the containment function of the canister, but may allow

for the different metals to be used to transmit a signal from a remote operated measurement device (e.g., self-powered thermocouple or pressure transducer) located inside the canister to a reader located outside of the canister.

Expected Deliverables/Results:

- A report documenting the above activities.
- 3D printed parts from Phase 1 for the TAD, analyzed and evaluated to inform the design of the Phase 2 designs
- Design, build, analyze, and test 3D printed Phase 2 parts for: (1) a honeycomb impact limiter for a TAD transportation cask; (2) a plate of dissimilar 3D printed metals to demonstrate signal transmission; and (3) a 3D printed metal TAD canister with dissimilar metals and an internal basket.

Disposition of Deliverables at the End of the Project:

Work product is displayed at the last Expo and then results and any developed materials handed over to Orano following the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Solid Works
- Interest in design of parts for 3D printing plastics and metals