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Development of a U.S. Rail Transport Capability for Spent Nuclear Fuel and High-Level Waste – 16623

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ABSTRACT

The U.S. Department of Energy, Office of Nuclear Energy (DOE-NE) is laying the groundwork for implementing an integrated nuclear waste management system. This includes preparing for future large-scale transport of spent nuclear fuel (SNF) and high-level radioactive waste (HLW) since transport will be a necessary component of an integrated waste management system. DOE continues to plan and develop options for the design of an integrated nuclear waste management disposition system. A significant destination-independent component of this integrated system is a rail transport capability for SNF and HLW. This paper provides an overview of the current DOE-NE effort related to designing and fabricating prototype railcars.

INTRODUCTION

The Blue Ribbon Commission on America's Nuclear Future made a series of recommendations to the Secretary of Energy in 2012 regarding the management and eventual disposal of SNF and HLW. [1] One recommendation was to make "prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available." In response to these recommendations, DOE-NE established the Nuclear Fuels Storage and Transportation Planning Project (NFST). The mission of NFST is to lay the groundwork for implementing interim storage, including associated transportation activities.

Moving commercial SNF from its current locations at reactor sites will require both a receiving site(s) and a safe and secure transportation capability. The U.S. currently has a very limited capability to move large rail-size casks of SNF. Improved rail transportation capability will be needed to move the SNF, no matter where the final destination is located.

The Association of American Railroads (AAR) has published a technical standard developed specifically for railcars used to transport High-Level Radioactive Material (HLRM): *Performance Specification for Trains Used to Carry High-Level Radioactive Material, Standard S-2043*. [2] AAR defines the term HLRM to include SNF and HLW. DOE is developing prototype railcars that satisfy Standard S-2043.

HLRM from commercial nuclear power plants will need to be shipped in transport casks certified in accordance with 10 CFR Part 71 by the Nuclear Regulatory Commission (NRC). The NRC has certified transport cask designs supplied by various manufacturers. These rail transportation casks will weigh between approximately 82 and 156 tons when loaded; additionally, each cask, if transported by rail, would need to be attached to the railcar by a cradle (often called a "skid") that is expected to weigh between 10 and 20 tons. No existing railcars have been approved as AAR Standard S-2043 compliant for shipping these NRC-certified casks. Therefore, transport of HLRM over the railroad infrastructure in the U.S. in railcars that meet Standard S-2043 will require new railcars to be designed, tested, and approved by the AAR for use.

An effort to design and develop prototypes, conduct necessary testing and secure approval of Standard S-2043 compliant railcars is estimated to take approximately seven years to complete. Approval by the AAR will require extensive full-scale testing of the individual railcars and the complete rail consist.

DOE-NE is currently designing and developing prototype cask and buffer railcars. The end result of this effort will be cask and buffer railcar designs and fabricated prototypes ready for testing. Future activities are envisioned to perform the required testing and obtain approval of the cask and buffer railcars from the AAR.

In the longer-term, DOE, or a future waste management and disposal organization (MDO), will have several options to choose from for establishing and maintaining the necessary railcar fleet for SNF shipments in future years, e.g., purchase railcars, lease railcars, or contract for complete transportation services. While a complete transportation system cannot be fully developed until a destination site is known, long lead-time activities necessary for transportation system development such as design and prototype fabrication of railcars can be addressed now. DOE's NFST is proactively laying the groundwork so that a transportation system capability will be available to ensure safe, secure, and efficient movement of SNF from commercial nuclear power reactor sites in a timely manner when a receiving site becomes operational.

RAILCAR DESIGN ACQUISITION

The DOE awarded a firm-fixed-price (FFP) contract on August 21, 2015 for the design, associated analysis, and prototype fabrication of cask and buffer railcars to transport HLRM. This was the culmination of 18 months (March 2014 to August 2015) of concerted effort to prepare the solicitation, review and evaluate the proposals, and make the contract award to AREVA Federal Services (AFS).

The new cask railcars have been named *ATLAS*. The ATLAS Railcar Design Project logo is shown in Fig. 1.

Fig. 1. Logo for ATLAS Railcar Design Project.

DOE initiated the 18-month procurement effort by conducting various activities including market research and a combined sources sought notice and request for information. The information obtained from these activities was reviewed and any resulting changes were implemented into the requirements documents. For example, DOE’s original statement of work (SOW) required the railcar design to fit into AAR clearance plate B, but based on feedback received from industry, DOE changed the requirement to AAR clearance plate C which increases the maximum length of the railcar between truck centers from 41’3” to 46’3”. These plate designations refer to the AAR’s standard railcar clearance diagrams that define the maximum height, width, and length for railway vehicles and their loads to ensure safe passage over bridges, through tunnels, around curves, and past other structures alongside the railroad tracks.

After release of the RFI (April 2014) and before release of the RFP (December 2014), DOE also decided to limit the SOW to design and fabrication of prototype cask and buffer railcars, so the current contract does not include testing of the railcars or approval by the AAR. Therefore, a follow-on contract will be required to perform this latter technical scope.

The RFP was posted to the FedConnect and FedBizOps web portal on December 8, 2014, as solicitation number DE-SOL-0006863 for the design, associated analysis, and prototype fabrication of railcars. Two amendments of the solicitation were later posted, both of which extended the proposal due dates. The NFST’s cask railcar system requirements document [3] was incorporated into the SOW and identifies applicable standards for the cask cars. A preproposal teleconference was conducted on December 22, 2014, that provided an overview of the RFP, a description of the SOW, instructions on responding to the RFP, and answers to questions received by DOE. DOE received the proposals on February 23, 2015 and immediately began the proposal review and evaluation process.

Following the evaluation process, AFS was selected and the contract was awarded for design and prototype fabrication on August 21, 2015. The resulting contract includes a 12-month schedule reduction (compared to AFS's original proposal) and a single, negotiated FFP contract for all three project phases. Both cost and schedule were reduced in the final FFP contract along with reduced project risk to DOE.

ATLAS RAILCAR DESIGN PROJECT

The ATLAS Railcar Design Project has three phases that are being performed under a single multi-year FFP contract. Phase 1 is Mobilization and Conceptual Design, Phase 2 is Preliminary Design, and Phase 3 is Prototype Fabrication and Delivery. A brief summary of the major activities in each of the three project phases is provided in this section. Testing on the prototypes needed to secure railcar design approval will be a follow-on phase to be conducted directly after the first three phases. The summary-level project schedule is shown in Fig. 2. The effort to design and develop the ATLAS cask car and buffer car prototypes, perform the testing, and obtain approval from AAR is estimated to take seven years, from 2015 to 2022.

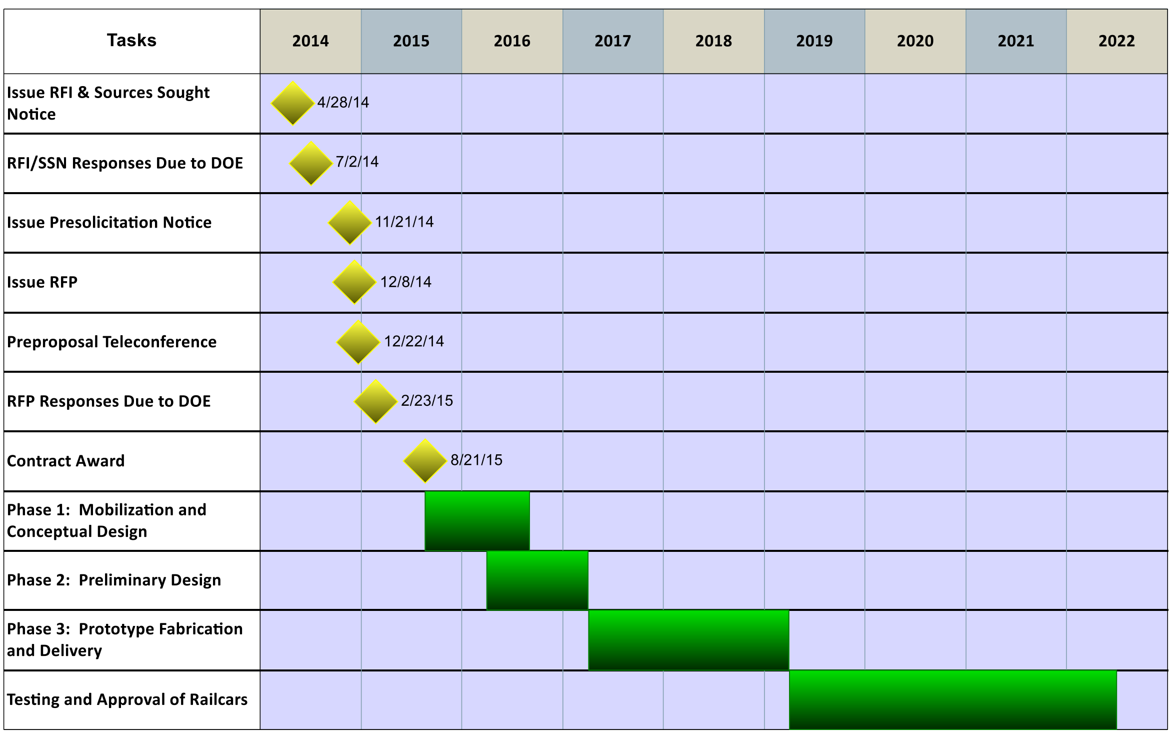

Fig. 2. Schedule for ATLAS Railcar Design Project

The schedule does not include any hold points between the phases, so the contractor does not need approval from DOE to start work on any of the phases. The scheduled completion dates for Phases 1, 2, and 3 are August 2016, March 2017, and March 2019, respectively. Note that Phase 2 is scheduled to start in April 2016, which is four months before Phase 1 is scheduled to be finished.

The ATLAS Railcar Design Project kickoff meeting was held on September 10, 2015, in Washington, DC, at the DOE Forrestal Building. The kickoff meeting marked the beginning of the contractors' technical efforts. The primary contractor for Phases 1 through 3 is AREVA Federal Services, with six supporting subcontractors. The seven organizations and their primary roles on the ATLAS Railcar Design Project are as follows:

1. **AREVA Federal Services (AFS)**: project integrator, conceptual designs of cask cradles and attachment mechanisms.
2. **AREVA-TN (aka Transnuclear)**: cask-to-cradle-to-ATLAS railcar loading procedures, peer review.
3. **KASGRO Rail**: overview of the cradle-to-ATLAS railcar attachment mechanism design, railcar conceptual and preliminary designs, detailed railcar designs including finite-element modeling, and prototype fabrication. (Note: KASGRO Rail is a fabricator of heavy-duty railcars with an AAR-certified quality assurance program. A point of particular importance to the ATLAS Railcar Design Project is that KASGRO Rail is the fabricator of the US Navy's M-290 cask railcar, the only AAR S-2043 approved railcar to be manufactured to date.)
4. **Transportation Technology Center, Inc. (TTCI)**: dynamic modeling of railcar designs using the NUCARS computer code and AAR Standard S-2043 submittal expertise.
5. **Stoller Newport News Nuclear (SN3)**: peer review of ATLAS cradle design and loading procedures based on previous experience as cradle designer/fabricator of the US Navy's cask cradle.
6. **MHF Services, Inc.**: peer review of Phase 1 cask and cradle design data packages and AAR plate C dimensions and cask railcar clearance.
7. **Coghill Communications, Inc.**: woman-owned small business responsible for document management.

Phase 1: Mobilization and Conceptual Design

The five major activities in Phase 1 are as follows:

1. conceptual design of cradles and the cradle-to-railcar attachment system;
2. conceptual design of the ATLAS cask railcar;
3. conceptual design of the buffer railcar;
4. development of general loading procedures for each cask; and
5. functional and operational requirements of the cask and buffer railcar designs.

Phase 2: Preliminary Design

The six major activities in Phase 2 are as follows:

1. develop Phase 2 design package with procurement specifications, qualified vendor listing, design drawings/cut sheets, and fabrication inspection requirements;

2. perform design analysis, including nonstructural analysis, finite modeling for structural analysis, dynamic modeling and load simulation, and safety monitoring system design and analysis;
3. develop preliminary S-2043 design package and submit to AAR;
4. conduct periodic reviews and briefings with AAR representatives to track submission package status, and provide follow-up support to AAR as needed during the review process;
5. provide DOE with a copy of the AAR notification to "proceed with the test phase"; and
6. generate and provide a cost estimate and delivery schedule to DOE for a future production run of 120 ATLAS cask railcars and 60 buffer railcars.

Phase 3: Prototype Fabrication and Delivery

The four major activities in Phase 3 are as follows:

1. procure materials needed for prototype railcar fabrication, with KASGRO providing quality receipt inspections of all materials and AFS providing quality assurance oversight;
2. fabricate one prototype ATLAS cask railcar and two prototype buffer railcars in accordance with the AAR-approved preliminary design;
3. deliver the prototype railcars to AAR's TTCI facility in Pueblo, Colorado; and
4. deliver the final, as-built ATLAS Railcar Project documentation package to DOE.

Follow-on Phase: Prototype Testing and Design Approval

The follow-on phase will include an extensive testing program and conclude with approval from the AAR. This will require another procurement effort, followed by signing another contract. DOE intends to sign this contract before the end of Phase 3, so there should be no delay in the overall project.

FUTURE ACTIVITIES

The complete consist testing will require DOE to acquire a new escort railcar which must meet all AAR S-2043 requirements. However, DOE-NE has decided not to initiate a project to develop its own escort car at this time while it explores the possibility of using such an escort car design already being developed for the U.S. Naval Nuclear Propulsion Program. If an escort car based on this design is not available to support full consist testing (March 2019), then DOE-NE could use a surrogate escort car with the same weight and center of gravity.

DOE (or an MDO) will have several options to choose from (e.g., purchase railcars, lease railcars, or contract for complete transportation services) to establish and maintain the necessary railcar fleet for SNF and HLW shipments. A decision on the approach can be made at an appropriate time in the future. DOE does not currently plan to develop any new locomotives but envisions private railroad companies as being capable of providing locomotives compatible with the S-2043 compliant railcars.

CONCLUSIONS

This paper documents the successful results achieved by DOE in negotiating and signing a contract for the design and prototype fabrication of railcars to transport HLRM. The report describes the significant effort expended over 18 months (March 2014 to August 2015) to prepare the required acquisition documentation resulting in DOE awarding a contract on August 21, 2015, for the design and prototype fabrication of cask and buffer railcars.

While a complete transportation system cannot be fully developed until a destination site is known, long lead-time activities necessary for transportation system development such as design and prototype fabrication can be addressed now. DOE's NFST is proactively laying the groundwork so that a transportation system capability will be available to ensure safe, secure, efficient movement of SNF from commercial nuclear power reactor sites in a timely manner when a receiving site becomes available.

REFERENCES

1 *Blue Ribbon Commission on America's Nuclear Future*. Report to the Secretary of Energy, January 2012.

2 Performance Specification for Trains Used to Carry High-Level Radioactive Material. *Car Construction Fundamentals and Details, AAR Manual of Standards and Recommended Practices*, Standard S-2043 (effective 2003 revised 2008).

3 DEPARTMENT OF ENERGY. *AAR S-2043 Cask Railcar System Requirements Document*. FCRD-NFST-2014-000093 Rev. 1, December 2014.