8-Axle Railcar Prototype Design

Spent Fuel and Waste Disposition

Prepared for
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Office of Integrated Waste Management

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SUMMARY

The purpose of this document is to summarize FY20 work related to the design of an 8-axle railcar for the transportation of spent nuclear fuel.

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The authors would also like to thank the following:

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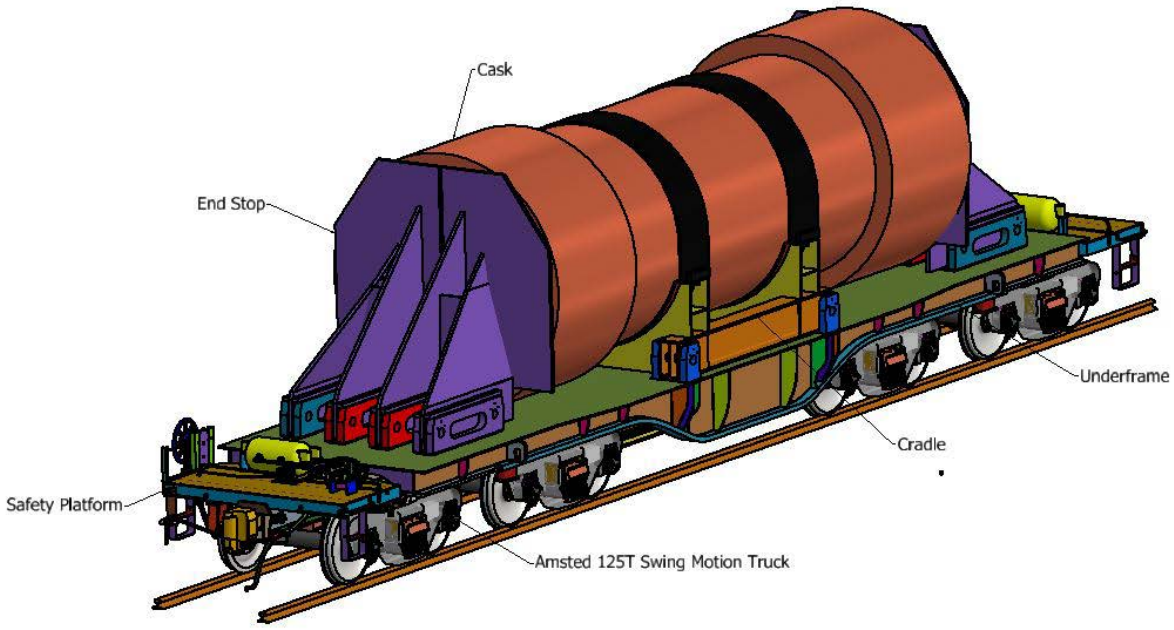
FY20 8-Axle Railcar Prototype Design



1 BACKGROUND

Large-scale transportation of commercial spent nuclear fuel (SNF) and High-Level Waste (HLW) is an important technical challenge that is DOE's responsibility to resolve. It is anticipated the majority of commercial SNF and HLW will be transported by rail in transport casks certified in accordance with 10 CFR Part 71, issued by the Nuclear Regulatory Commission (NRC). The NRC has issued Certificates of Compliance (CoCs) to transport cask designs supplied by various manufacturers. There are several models of these transportation casks that could be used to transport SNF and HLW, and these casks can weigh up to approximately 240 tons when loaded, including the shipping cask, cradle, impact limiters, and end stops. The DOE has developed a mounting system for accommodating 17 such cask designs as part of a parallel design effort for a 12-axle railcar design, called Atlas.

PNNL is supporting an effort for the design of an 8-axle SNF Railcar that incorporates an identical mounting layout to the Atlas railcar and is intended to carry all 17 cask designs. The proposed design uses a heavy duty, flat deck railcar, supported on two span bolsters, which are further supported on four commercially available, 2-axle freight trucks (known as Swing Motion® trucks) from Amsted Rail, rated for an axle load of 78,750 lb. (125-ton trucks). The current design is anticipated to meet DOE's requirements for this project, including:

- A flat-deck railcar design capable of transporting any of the 17 casks identified using one of 4 cradle designs
- Adoption of the cradle system and mounting arrangements designed by the current Atlas project to ensure design compatibility
- Ability to meet all performance requirements outlined by the Association of American Railroads (AAR) in S-2043 for such cars, including:
  o Clearances and dimensions, including Plate E and curving

o Structural performance
o Track worthiness performance, and
o Brake system performance

Further, the 8-Axle design is anticipated to offer several operational advantages to the DOE, including a lower weight, a shorter car, and a lower deck height (resulting in a lower loaded center of gravity), not to mention both lower initial and maintenance costs. The geometry of the car layout in terms of truck spacing, span bolster spacing, etc. should also offer other advantages including better curve negotiability and ability to handle tighter curves, as may be seen at industrial sites.

Elements of the design such as the lower deck height, lower sprung mass, and better curve negotiation, also offer some dynamic performance benefits, including higher stability and more controlled vertical load variations. The predicted performance of the system is presently based on reasoned assumptions about several parameters, including the stiffnesses, damping constants, and inertias of several elements and components. The actual values of these assumed parameters will be confirmed as the car goes through prototyping and testing. At that point, the simplicity of the 8-Axle car's layout will allow more opportunities for finetuning and enhancement of the final design, if necessary.

Following the design goals and requirements laid out by the U.S. Department of Energy (DOE), Sharma & Associates, Inc. (SA) initially developed three concepts for an 8-axle railcar capable of transporting SNF and HLW casks and recommended one for further development. The recommended concept uses a heavy duty, flat deck railcar, supported on two span bolsters, which are further supported on four (4) commercially available, 2-axle freight trucks – (known as Swing Motion® trucks from Amsted Rail. Subsequently, SA advanced the railcar design from a conceptual design to a prototype design, through a refinement process, wherein modeling, analysis and optimization techniques were used to improve upon the conceptual design.

Also, working with Amsted Rail, SA evaluated the dynamic performance of the railcar and truck combination under the full set of track worthiness criteria in S-2043. The results of the dynamic simulations suggest that the design largely meets the dynamic performance requirements of S-2043, with a few minor exceptions. Further review shows that the performance, even for the conditions with minor exceptions, is largely in line with the performance expected for the 12-axle car design that the DOE is currently testing.

This fiscal year a preliminary design submittal was presented for review by the Equipment Engineering Committee (EEC) of the Association of American Railroads (AAR) and describes the design, engineering, and analysis of an 8-axle, heavy duty, flat-car, intended for transporting Spent Nuclear Fuel (SNF) and High-Level radioactive Waste (HLW) casks. Overall, the design team believes that the 8-Axle design meets the design goals, and offers a platform for further enhancements, if needed, based on the results of the prototype testing.

2 PROJECT EXECUTION

PNNL has managed the 8-axle railcar design effort for DOE. The contract for the design was competitively bid and PNNL participated in the process. The company awarded the design contract (Sharma and Associates), the current contract phase, will also be part of the railcar fabrication and testing as the designer. The role of PNNL and its team included:

- Contracting support

- Quality Assurance support
- Technical expertise via PNNL staff and subcontractors.
- Assistance with writing the RFP for the design contract
- Selecting and subcontracting with railroad experts to build a highly qualified team of reviewers.
- Evaluation of bids received
- Managing the design effort in a 3-phase approach.
- Reviewing the design work in the first two phases.
- Assisting in the selection of the design to be put forward in the EEC submittal.
- Reviewing the PDS submittal, including detailed technical review by PNNL and PNNL contractors.
- Assisting with the selection of the EEC independent reviewers
- Supporting the end of phase 3 of the initial design effort where the goals is gaining EEC approval to advance to prototype approval, fabrication, and testing.

This effort is a strategic part of PNNL's nuclear sector support of DOE-NE's mission of solving the nation's issues related to spent fuel transportation and disposal.

The 8-axle railcar project prototype design has been completed and the design has been submitted to the American Association of Railroads (AAR) Equipment Engineering Committee (EEC) for approval to proceed with prototype fabrication. Design approval and authorization to construct a prototype railcar are anticipated in early FY21.

3 NEXT STEPS

The Preliminary Design Submittal was provided to the AAR EEC in July of 2020. Two independent reviewers were identified by the review team and approved by the AAR EEC. One for structural analysis and one for dynamic analysis.

Since the preliminary design has been submitted for review (July 2020) to the AAR EEC the next steps for the 8-axle railcar design and testing are:

- Approval of the prototype design for fabrication
- Final design and fabrication of the prototype railcar
- New contract involving an extensive testing campaign at Transportation Technology Center Incorporated (TTCI) a wholly owned subsidiary of the Association of American Railroads.