Appendix I – Test Load Conceptual Designs (EIR-3019494)

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	Engineering Information Record

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Project No.:	00225.03.0050	**Project Name:**	DOE Atlas Railcar	

Title: Atlas Railcar Test Load Design Information

This EIR provides design information necessary to fabricate the simulated cradle and cask loads needed for testing of the cask car as determined in the design analysis and simulations for use in the Phase 4 Single-Car Testing and Phase 5 Multi-Car Testing phases of the Department of Energy's Design and Prototype Fabrication of Railcars for Transport of High-Level Radioactive Material project.

This document is not safety related.

Contains Unverified Input / Assumptions: Yes: ☐ No: ☒

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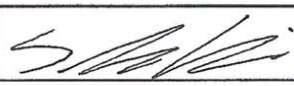
Preparer:	Slade W. Klein		6/20/17
Checker	Mark A. Denton		06/20/2017
Approver:	S. Klein for Don S. Hillstrom Per Email dated 6/9/17		6/20/17
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Revision History

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1.0 PURPOSE

This report provides design information necessary to fabricate the simulated cradle and cask loads needed for testing of the Atlas cask car as determined in the design analysis and simulations for use in the Phase 4 single-car testing and Phase 5 multi-car testing phases of the Department of Energy's (DOE) contract DE-NE0008390, *Design and Prototype Fabrication of Railcars for Transport of High-Level Radioactive Material (HLRM)* [3.1] to the Association of American Railroads (AAR) standard S-2043, *Performance Specification for Trains Used to Carry HLRM* [3.2]. This document provides a discussion of a conceptual design of the test loads, test load cradles, and its end stops.

1.1 Related Documents

The design basis requirements document for this project is provided in EIR-3014611 [3.3].

Additional information on each test load associated project phase – Phase 4 single-car testing and Phase 5 multi-car testing – is available in EIR-3018318 [3.4] *High Level Radioactive material (HLRM) Prototype Railcars Phase 4, Phase 5 and Production Estimates and Schedules.*

The conceptual ballast load design is presented in DWG-3018955 [3.5] and CALC-3018954 [3.6].

1.2 Dynamic Modeling Plan

The "notice to proceed with fabrication" of a railcar design will be granted by the AAR Equipment Engineering Committee (EEC). Transportation Technology Center, Inc (TTCI) is subcontracted to provide dynamic modeling of the Atlas railcar design.

Initial dynamic modeling scoping was performed by TTCI to determine the requirements of the analysis necessary to meet the requirements of S-2043 for the 17 different cask/cradles combinations. Originally, it had been proposed to use a minimum load cask a nominal load case and maximum load case as bounding conditions. However, based on the initial runs performed by TTCI, it became apparent that bounding runs should be revised to the empty condition case, a maximum load case, and a highest cg case. It was also discovered that the empty Atlas railcar would require ballast weight to meet the requirements of S-2043.

The Atlas project team documented our dynamic modeling plan and submitted it to the AAR EEC for review and approval [3.7]. The Atlas team proposed that the EEC agree that the Atlas cask railcar and its cradle-to railcar interface attachment system be approved and tested to AAR S-2043, and that the successful results of the proposed dynamic modeling test plan including the conceptual cradle designs will provide analytical evidence of the entire securement system for approval under AAR S-2043, paragraph 5.4.7 titled "Securement System Test", approval under AAR S-2043 as a whole, and approval under AAR Rule 88.

2.0 ATLAS RAILCAR TEST LOAD

A test load to simulate cask/cradle payloads will be required for single-car and multi-car testing of the Atlas cask railcar. As a required contract deliverable, AFS will provide the DOE with design information necessary for fabrication of the test loads.

Currently, test load configurations are adopted to simulate bounding condition loads, for all 17 different cask/cradle combinations including the HI-STAR 190 XL cask. Test loads were selected based on the guidance of the dynamic modeling plan as described in Section 1.2. Basic information concerning the selected test loads, test load configurations and conceptual designs of the test loads, cradles and end stops were developed by AFS in order to provide design information necessary for future fabrication.

2.1 Atlas Railcar Test Load Conditions

To align with the dynamic modeling plan (Section 1.2) and based on preliminary dynamic modeling results and previous experience with the M-290 railcar, three test load configurations will be required. These conditions are adopted to simulate the two minimum load conditions, the maximum load condition and the highest cg condition. By coincidence, the maximum load and highest cg condition represent the same load case, which is the loaded HI-STAR 190 XL cask. The final required test loads and conditions will not be fully defined until the Atlas Railcar S-2043 Phase 4 single-car testing's actual test plan is developed by TTCI. The test load conditions are shown in Table 2-1.

Table 2-1: Test Load Conditions

Minimum Condition 1	Minimum Condition 2[1]	Maximum Condition[2]
Atlas Railcar + Ballast Load	Atlas Railcar + Lightest Cask Weight / Conceptual Cradle	Atlas Railcar + Maximum Cask Weight / Conceptual Cradle (Also Maximum cg case)
(Estimated weight – to be confirmed by final dynamic modeling)	(Empty MP197 cask and conceptual cradle)	(Loaded HI-STAR 190 XL Cask and conceptual cradle)
Test Load = 200,000 lb.	**Test Load = 202,710 lb.**	**Test Load = 474,405 lb.**
	(176,710 + 26,000)	(420,769 + 53,636)
	Taken from Table 4-3 and Table 4-4 of [3.8]	Taken from Table 4-3 and Table 4-4 of [3.8]

Notes:

1) Based on the TTCI test plan, a second minimum load case may be required.
2) The dynamic modeling plan requires a maximum weight condition and a maximum cg condition. For this project the HI-STAR 190 XL cask and conceptual cradle is both the maximum weight and maximum height cg case.

2.2 Atlas Railcar Test Load Descriptions

2.2.1 Minimum Condition 1

The minimum test load condition is the "empty condition" defined here as the Atlas railcar loaded with the ballast load. The ballast load design is described in DWG-3018955 [3.5] and CALC-3018954 [3.6].

2.2.2 Minimum Condition 2

Based on the Atlas Railcar S-2043 Phase 4 single-car testing's actual test plan, a second minimum load case may be required. The lightest cask and conceptual cradle load may need to be tested separately from the "empty condition". The empty MP197 cask and conceptual cradle is the lightest combined load and was used as a basis for the minimum condition 2 test load (See Table 4-3 and Table 4-4 of [3.8]). The MP197 conceptual cradle is constructed from two main I-beams, which sandwich saddle cross members and a central shear key. There are four pin locations in the main I-beams for attachment of the cradle to the railcar. The conceptual cradle is 178 inches long and 116 inches wide. The minimum condition 2 test load is fabricated out of 4-inch-thick circular plates welded together circumferentially using skip welds. The test load is 208 inches long and has a maximum diameter of 91.5 inches. See Figure 2-1 and Figure 2-2 below for more dimensions. The test load and cradle are

constructed from carbon steel. The critical characteristics of the minimum condition 2 test cradle and load are shown in Table 2-2. The minimum condition 2 test load was designed to match weight, mass moments of inertia and cg with the empty MP197 cask and conceptual cradle.

Table 2-2: Characteristics of Minimum Condition 2 Test Load

Test Load	Required Weight, lb.	Conceptual Test Load Design Weight, lb.
Conceptual Cradle	26,000	26,000
Minimum Condition 2	176,710	186,000
Total	202,710	212,000

A sketch of the minimum condition 2 conceptual cradle is shown in Figure 2-1and the test load is shown in Figure 2-2. The test load is restrained to the railcar with the shear key in the longitudinal direction and with the saddle assembly and tie-down restrain band in the lateral and vertical directions. The minimum condition 2 test load is shown on the railcar in Figure 2-3.

Figure 2-1: Minimum Condition 2 Test Load Cradle

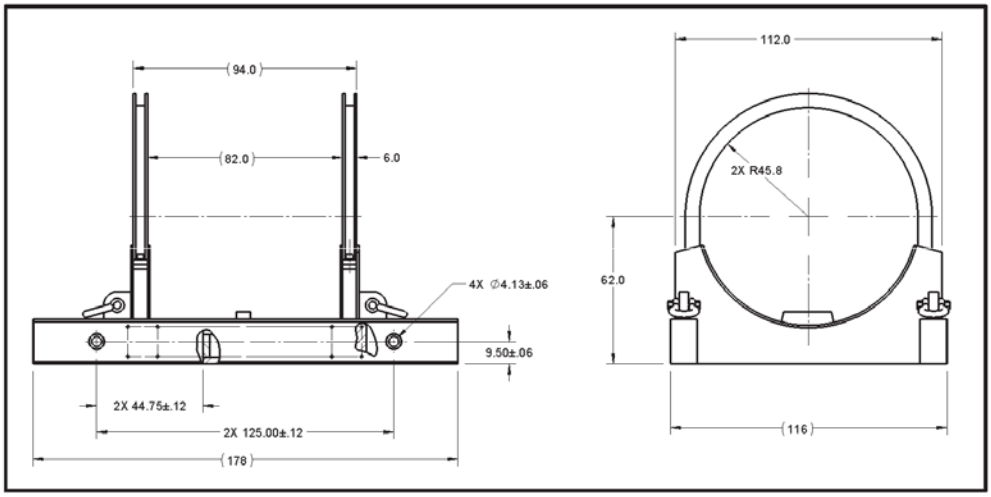

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Figure 2-2: Minimum Condition 2 Test Load

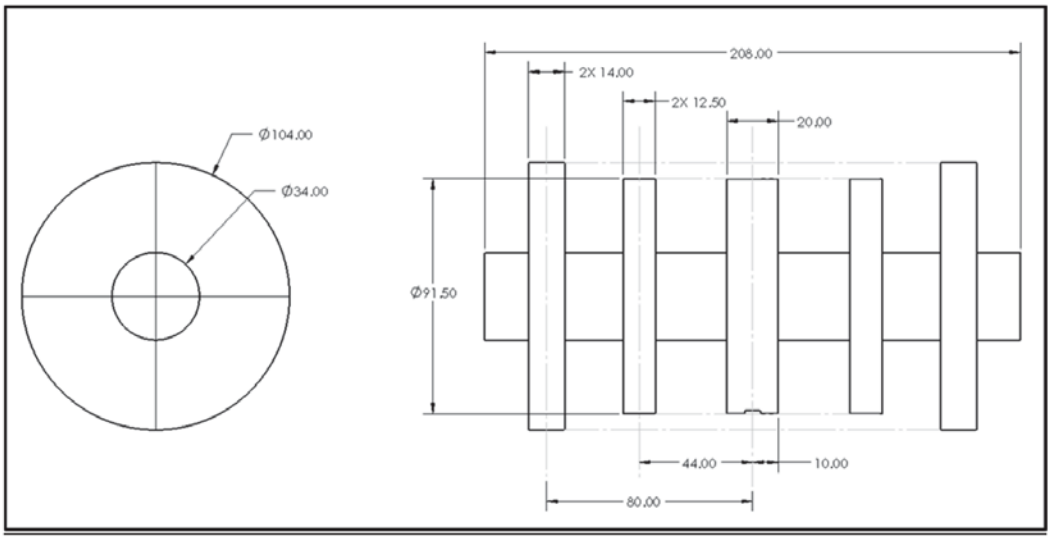
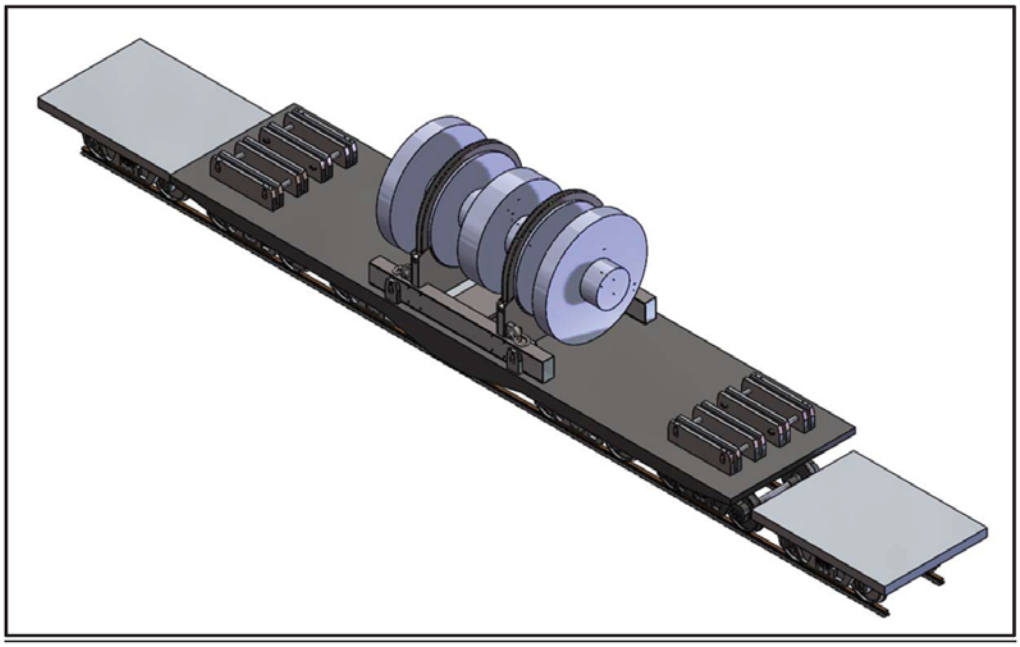


Figure 2-3: Minimum Condition 2 Test Load on Atlas Railcar



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2.2.3 Maximum Condition

The maximum test condition is simulated by the Atlas railcar loaded with the maximum condition test load. The loaded HI-STAR 190 XL cask and conceptual cradle and end stop design was used as a basis for the maximum condition test load. The HI-STAR 190 XL conceptual cradle is constructed from two main I-beams, which sandwich saddle cross members. There are four pin locations in the main I-beams for attachment of the cradle to the railcar. The maximum condition test load is fabricated out of 4-inch-thick circular plates welded together circumferentially using skip welds. The test load is 237 inches long with a maximum outer diameter of 106.5 inches and a center beam diameter of 74 inches. See Figure 2-4 and Figure 2-5 below for more dimensions. The test load and test load cradle are constructed from carbon steel. The critical characteristics of the maximum condition test load are shown in the Table 2-3. The maximum condition test load was designed to match weight, mass moments of inertia and cg with the loaded HI-STAR 190 XL cask and conceptual cradle.

Table 2-3: Characteristics of Maximum Condition Test Load

Test Load	Required Weight, lb.	Conceptual Test Load Design Weight, lb.
Conceptual Cradle	53,636	53,636
Maximum Condition	420,769	420,865
Total	474,405	474,501

A sketch of the maximum condition test load is shown in Figure 2-4 and Figure 2-5. The test load is restrained to the railcar with the saddle assembly and tie-down band in the lateral and vertical directions. Shoring is used between the test load and the cradle end stop to secure the load in the longitudinal direction. The maximum condition test load is shown on the railcar in Figure 2-6.

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Figure 2-4: Maximum Condition Test Load Cradle

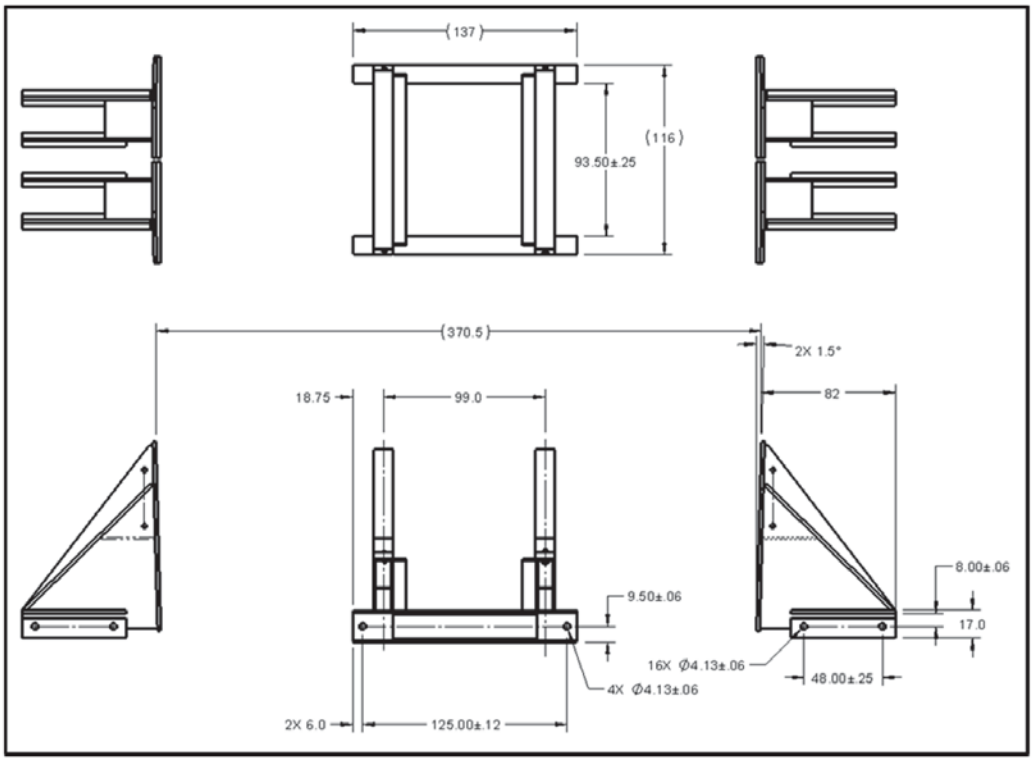

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Figure 2-5: Maximum Condition Test Load

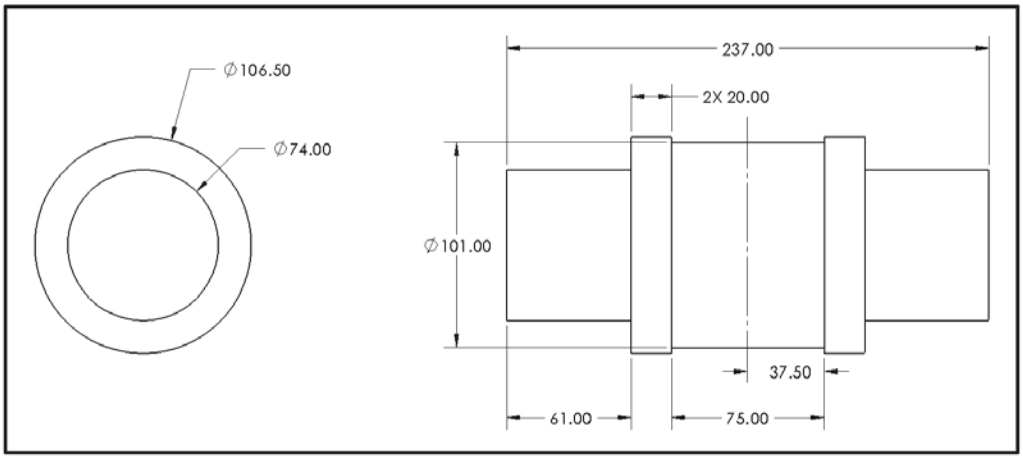
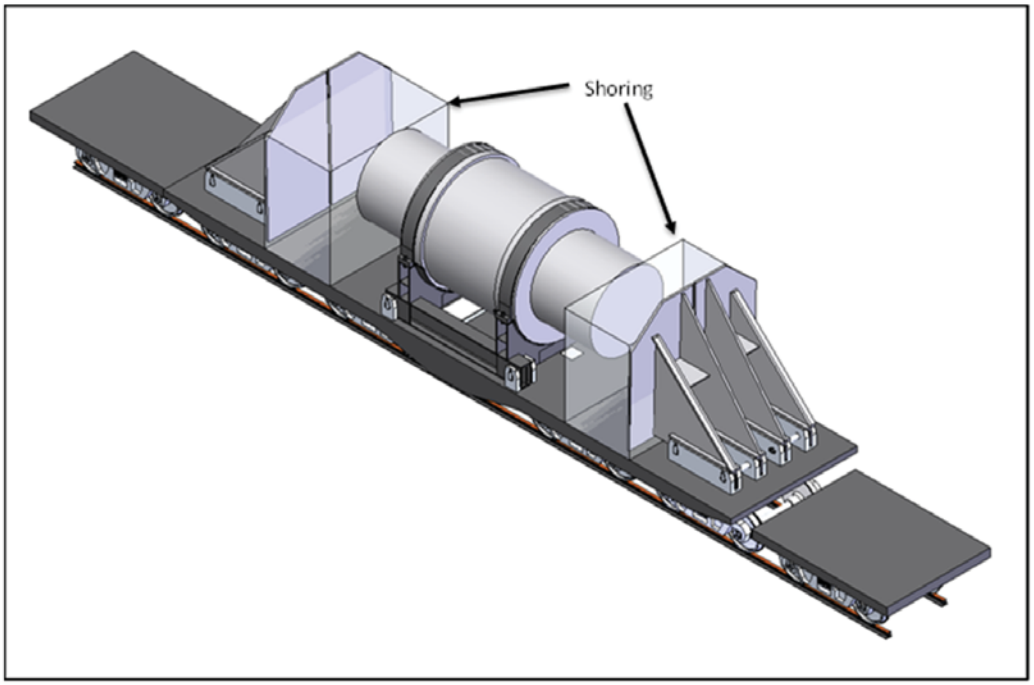


Figure 2-6: Maximum Condition Test Load on Atlas Railcar



3.0 REFERENCES

1. Department of Energy Contract DE-NE0008390, latest revision, Part I, Section C, Statement of Work.
2. Association of American Railroads, *Manual of Standards and Recommended Practices, Section C – Car Construction Fundamentals and Details,* Standard S-2043, *Performance Specification for Trains Used to Carry High-Level Radioactive Material*, 2009.
3. AREVA Federal Services Engineering Information Record, EIR-3014611, *Design Basis Requirements Document (DBRD) for the DOE Atlas Railcar*, Rev. 7.
4. AREVA Federal Services Engineering Information Record, EIR-3018318, *High Level Radioactive material (HLRM) Prototype Railcars Phase 4, Phase 5 and Production Estimates and Schedules*, Rev. 1.
5. AREVA Federal Services Drawing, DWG-3018955, *Atlas Railcar Ballast Load Assembly Conceptual Drawing*, Rev. 0.
6. AREVA Federal Services Calculation, CALC-3018954, *Atlas Railcar Conceptual Ballast Load Structural Calculation*, Rev 0.
7. AREVA Federal Services Document, AFS-IN-0031, *Atlas Project: Proposed Dynamic Modeling Plan*, February 27, 2017.
8. AREVA Federal Services, Calculation CALC-3015276, *Atlas Railcar Cradle Attachment and Combined Center of Gravity Calculation.* Rev 2.