

INTEGRATED APPROACH TO TRAILER DESIGN FOR SPENT FUEL CASKS

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ABSTRACT

General Atomics (GA) is developing the GA-4 and GA-9 spent fuel transportation systems for the U. S. Department of Energy's Office of Civilian Radioactive Waste Management (DOE-OCRWM). The scope of our contract includes spent fuel casks, legal weight trailers, and ancillary equipment.

Recent structural failures of spent fuel trailers have focused attention on trailer design. As a major element of spent fuel transportation systems, the concerns address the adequacy of trailer performance requirements, structural design and analysis, and in-service inspection and maintenance procedures.

In response to these concerns, GA has applied an integrated approach to the design of the GA-4 and GA-9 transportation systems. The objectives are to design reliable, high-integrity trailers and to demonstrate their performance by test. Once the design is complete, a prototype trailer will be fabricated and a performance test program conducted in accordance with a comprehensive test program. GA's trailer test program will include both design and operations elements, and will be used to optimize the operations and maintenance plan. The results of this program will provide positive public and regulatory perception of trailer durability and will support the development of industry standards for both legal weight and overweight trailers for spent fuel applications.

INTRODUCTION

The Nuclear Waste Policy Act (NWPA) of 1982 mandates that DOE establish an integrated waste management system for permanent disposal of spent nuclear fuel, commercial and defense high-level wastes, and any other waste form declared by the U.S. Nuclear Regulatory Commission (NRC) to require permanent isolation. The mission goals of DOE's Office of Civilian Radioactive Waste Management (OCRWM) require that the system be designed for maximum capacity at minimum cost within existing regulations. To support this objective, OCRWM has awarded GA a contract to develop the GA-4 and GA-9 legal weight truck (LWT) transportation systems (Fig. 1) to transport pressurized-water-reactor (PWR) and boiling-water-reactor (BWR) spent fuels. The scope of GA's contract includes development of the casks, trailers, and ancillary equipment.

TRAILER DESIGN OBJECTIVES

An evaluation of incidents involving shipment of spent fuels indicates a history of structural failures in trailers. These failures have raised concerns regarding the adequacy of trailer design standards for spent fuel shipments. Because the shipping casks are specifically designed to withstand accidents without loss of containment, no trailer failure has ever resulted in a radiological leak. However, the potential risk of an accident, and public perception of nuclear transportation, motivate the designer to ensure that spent fuel trailers do not fail.

A recent trailer roll-over in California, caused by a structural failure in the gooseneck, renewed concerns and focused attention on trailer design. Although the cask was empty during the accident and was not damaged, the incident raised questions about the structural adequacy of trailers designed for spent fuel shipments. The items of interest were the trailer performance requirements, the extent of structural design and analysis, the adequacy of

in-service inspection and maintenance procedures, and the accuracy of predictions of trailer design life.

To answer these questions, GA has applied an integrated systems approach to the design of the GA-4 and GA-9 trailers. Figure 2 shows the elements of our trailer development program. The ultimate goal of the program is to design safe, rugged, and reliable trailers and to demonstrate trailer performance with verification testing. The results of this program will provide positive public and regulatory perception of trailer durability, and will support the development of industry standards for both legal weight and overweight trailers.

The objectives of GA's integrated trailer design effort are to:

- Maintain a pro-active, integrated systems approach to design of the GA-4 and GA-9 transportation systems,
- Provide safe, reliable, high-efficiency, engineered trailers designed with input from trailer manufacturers and industry standards groups,
- Enhance system reliability and public confidence via trailer performance testing, and
- Continue contributions to development of industry standards for development of legal weight trailer specifications.

PERFORMANCE CRITERIA

As shown in Fig. 2, we began our trailer development program by preparing the performance criteria for the transporter system. This document establishes the design envelope and requirements for interface with the cask and tractor. It also defines other requirements for suitability with the OCRWM mission such as safety, safeguard, decontamination, and operations considerations. Structural performance is outlined to assure trailer ruggedness. We will

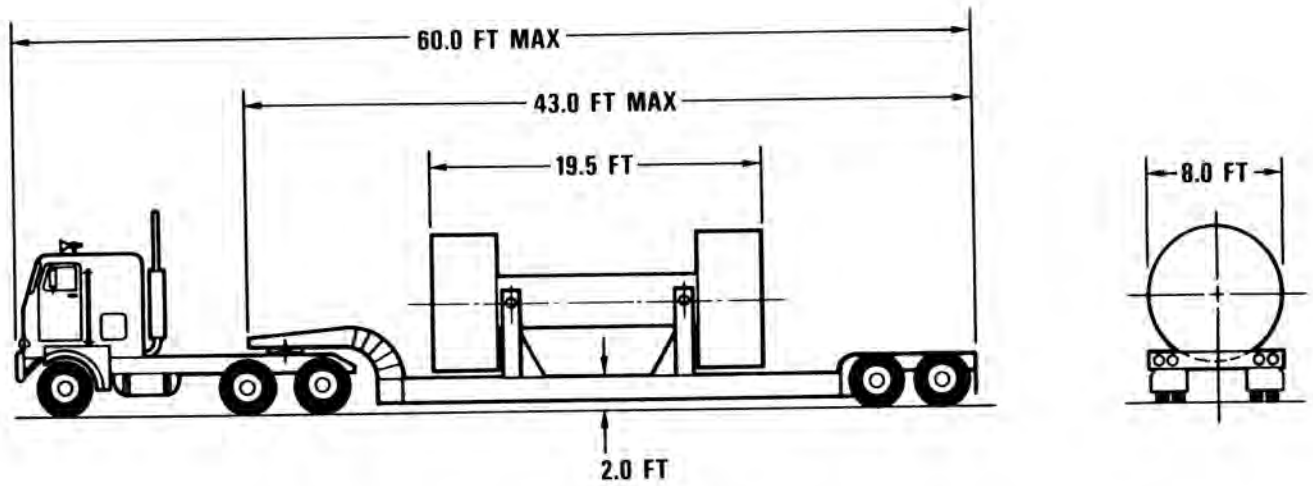


Fig. 1. The GA-4 and GA-9 Transportation Systems are Designed for High Safety, Reliability and Capacity.

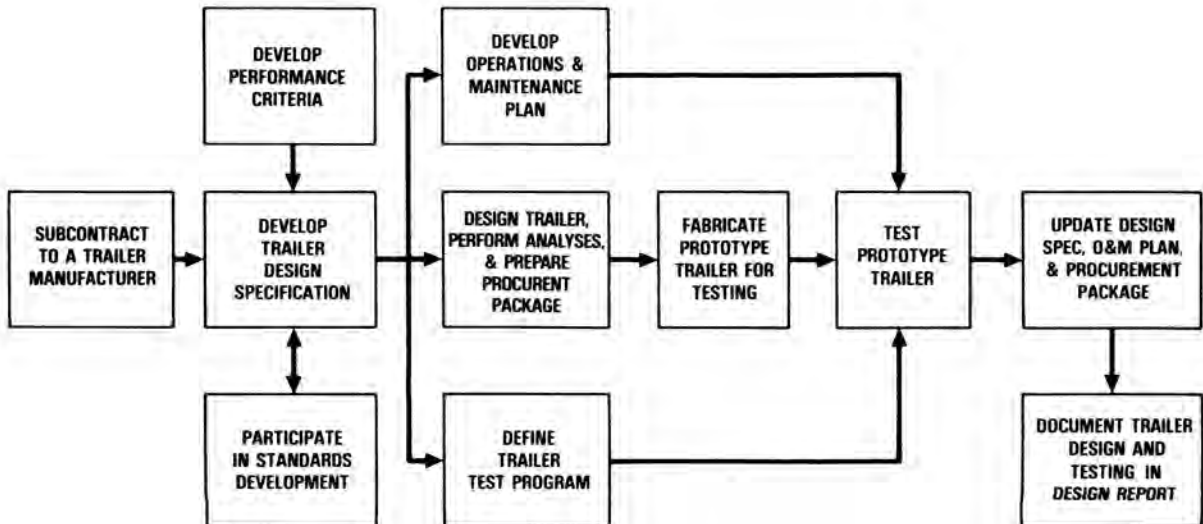


Fig. 2. GA's Program for Trailer Development Includes Input From a Trailer Manufacturer and Verification Testing of a Trailer Prototype.

use the performance criteria as the basis for the design specification, detailed design, and test plan.

TRAILER SUBCONTRACTOR

To combine GA's analytical, design, and materials technology with specialized trailer design experience, GA is subcontracting to a trailer manufacturer. Initial interest from trailer manufacturers was solicited using a Commerce Business Daily announcement, and the request for proposals will be sent out before the end of March of this year. The scope of the subcontract will include:

1. Joint preparation with GA of the trailer design specification and design analyses,
2. Preparation of the trailer design and detailed design drawings,
3. Trailer prototype fabrication, and
4. Joint development of an operations and maintenance plan.

The trailer subcontractor will also provide input for the test plan and may be involved in trailer verification testing.

DESIGN SPECIFICATION

Once the trailer subcontractor is on board, GA and the subcontractor will prepare the trailer design specification. In this document, detailed design and performance requirements will be identified including the trailer configuration, materials, and structural requirements; safety and drivability features; and in-service maintenance and inspection requirements. This document will be the basis for the detailed design which follows.

STANDARDS DEVELOPMENT

Throughout the entire trailer development program, GA will support industry standards development. Our objective will be to design a system which will be compatible with industry criteria as they evolve. Thus far we have participated in the American Association of State Highway and Transportation Officials (AASHTO) and American National Standard for Truck Transport of Weight-Concentration Radioactive Loads (ANSI N14.30) working groups. We will also interface with DOE, DOT, and the NRC as appropriate.

DESIGN AND FABRICATION

Once the design specification is complete, the trailer manufacturer will begin detailed design of the trailer,

including preparation of manufacturing drawings and supporting calculations. GA will review the design and analyses thoroughly to ensure that all the requirements of the design specification are met. We will also augment the analyses with additional analyses to verify trailer dynamic response, margins against failure, and stability.

Following detailed design, the trailer subcontractor will fabricate the trailer per the detailed design.

OPERATIONS AND MAINTENANCE PLAN

Adequate preventative maintenance and proper repair practices are essential to achieve maximum trailer safety at minimum trailer operating cost. The Operations and Maintenance Manual will define the elements of inspection, operation, scheduled preventative maintenance, and trailer repair.

The trailer manufacturer will prepare the Operations and Maintenance Manual. GA will review the document prior to release, incorporating any requirements specific to the OCRWM mission.

TEST PLAN/TESTING

GA will also prepare a trailer test plan to demonstrate trailer operational and structural performance. This test program may incorporate several elements, including:

- Static load testing to demonstrate design margin,
- Shaker table testing to simulate the dynamic input loads into the trailer,
- Real-time, over-the-road testing to simulate actual live loads and road conditions, and
- Life testing to verify design life and to evaluate operations, maintenance, and inspection plans.

For each of these options, actual cask loads will be simulated on the test trailer.

The trailer design, operations and maintenance plan, and trailer test plan come together in trailer testing. The results of the trailer test program will be used to demonstrate the performance of the trailer, improve the trailer design, and optimize the operations and maintenance manual.

ACKNOWLEDGMENTS

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