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DURABILITY TESTING OF THE HIGH-CAPACITY GA-4/GA-9 TRAILER

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ABSTRACT

General Atomics (GA) is under contract to the US Department of Energy (DOE), Idaho Field Office, to develop two legal-weight truck from-reactor spent-fuel shipping casks with trailers. GA is developing these high-capacity transport systems to support the Office of Civilian Radioactive Waste Management's (OCRWM) mission to transport spent fuel from reactors to a permanent disposal site. GA's goal is to maximize the number of fuel assemblies that the transport system can safely carry. The GA-4 Cask is being designed to transport four pressurized-water-reactor (PWR) spent-fuel assemblies, and the GA-9 Cask is being designed to transport nine boiling-water-reactor (BWR) spent-fuel assemblies. The use of these high-capacity transport systems will have a large benefit to public safety since the number of legal-weight truck shipments will be reduced by at least a factor of four over existing spent-fuel shipping cask systems.

Achieving these capacities requires that the weight of each component of the transport system, i.e., cask, trailer and tractor, be minimized. The weight of the trailer is of particular importance. With a high load-to-weight ratio, the durability and reliability of the trailer become significant factors in the success of the transport system. In order to verify that the trailer design will meet the durability and performance requirements to safely transport spent-fuel, GA has planned an extensive testing program. The testing program includes non-destructive examination (NDE) of the trailer welds, operational testing, a static load test, an over-the-road performance test, and a test to verify the durability of the trailer up to its 1,000,000-mile design life. Since a prototype cask will not be available for the testing, GA designed and built a dummy payload that simulates the correct weight distribution and approximates the dynamic response of the prototype cask.

TRAILER DESCRIPTION

The trailer is a single-drop design (Fig. 1) nearly 43 ft (13.1 m) long. GA has allotted 9,000 lb (4,080 kg) for the trailer. The total weight of the transport system must be less than the federal gross vehicle weight limit of 80,000 lb (36,300 kg). For the other components, GA has allotted 16,000 lb (7260 kg) for the tractor, 54,000 lb (24,500 kg) for the packaging (cask and spent fuel), and 1000 lb (454 kg) for margin in case one of the components exceeds its target weight.

The cask and trailer system will have a center of gravity approximately 75 in. (191 cm) above grade. This center of gravity is significantly lower than the 85.75 in. (218 cm) maximum center of gravity specified by Draft ANSI N14.30 (Ref. 1); the standard which the trailer is designed to meet.

The trailer's primary structural members are two custom shaped T-1 steel I-beams that run the length of the trailer. The cross members between the two main I-beams are a combination of I-beams and C-sections. The trailer has decking in the middle of the trailer to provide work space for operational personnel. The tiedown system consists of four hinged-pillow block assemblies that are located directly above the main trailer I-beams and are attached to these beams by a system of lateral, vertical, and longitudinal supports .

The trailer has standard equipment such as an air-ride suspension system with automatic leveling capabilities, "S" cam brakes, aluminum fenders and wheels, low profile tires and 16 in.-travel landing gear. The trailer also has a high-strength fabric personnel barrier which is attached to a retractable aluminum frame. The design is described in detail in Ref. 2.

TRAILER STATIC LOAD AND ROAD TEST

After the trailer is fabricated, the manufacturer will perform NDE on all welds and operational tests on the brakes, electrical system and air suspension system. After the operational tests, per draft ANSI N14.30, a static load test will be performed. The dummy payload and extra weight will be installed on the trailer with a maximum weight of twice the normal payload. After two hours, the load will be removed and the trailer structure reinspected. After the static load test, a road test with the dummy payload in place will be performed. The loaded trailer will be tested at normal highway speeds for a minimum of ten miles (including on and off ramps or comparable turns, ascents and descents). The test will also include at least ten normal starts and stops, and five ninety-degree turns. After the road test, the payload will be removed and the trailer structure reinspected.

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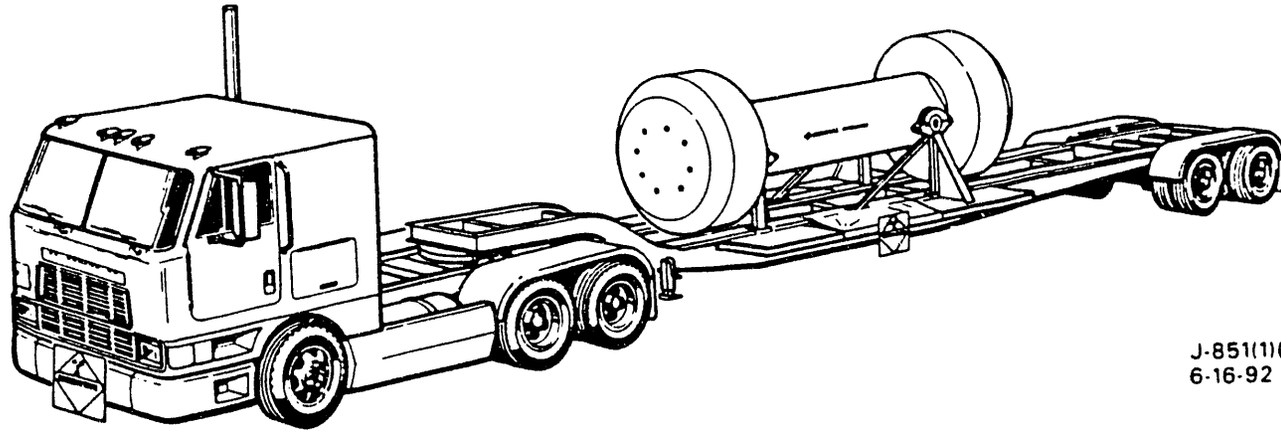

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FIGURE 1
GA-4/GA-9 HIGH-CAPACITY TRANSPORTATION SYSTEM

TRAILER DURABILITY TEST PLAN

In order to verify the durability of the high-capacity trailer design, GA initiated a program to perform an accelerated durability test. The program evaluated two approaches to durability testing: (1) test the trailer frame on a "shake table" that uses hydraulic actuators to simulate the over-the-road response and (2) test the complete trailer on a test track that simulates the over-the-road response. The test track approach was chosen to give the OCRWM program the opportunity to incorporate a tractor that meets the system weight and other specification requirements into the durability test program. This will ensure that the total system response is as accurate as possible. AlliedSignal Automotive Proving Grounds (AAPG) was chosen to perform the testing.

The test will be performed in three phases: (1) development of an over-the-road response profile that will form the basis for setting up the test track, (2) an accelerated 240,000-mile durability test using the Phase I over-the-road response profiles, and (3) an accelerated 760,000-mile durability test.

Phase I - Response Profile

The testing vendor will develop a road-response profile for the tractor-trailer combination. The trailer will be equipped with strain gages and accelerometers. Strain gages will be located at the areas of high stress. Accelerometers will be placed at the kingpin, at the center of gravity of the dummy payload and on the tiedown supports. The trailer with the dummy payload will be driven over state roads, interstate roads, railroad crossings, and bridges to develop "real-world" response profile data. GA will choose the real-world routing based on information from existing studies. The average distance between the utility and repository of 1780 miles was taken from Ref. 3. The mix of road conditions is based on the Near-Site Transportation Infrastructure Project (Ref. 4): 75% smooth concrete interstate; 17% rough concrete interstate; 6% smooth asphalt primary road; and 2% rough asphalt primary road, bridge approaches, and railroad crossings.

The response profile accelerometer data will be recorded, and a "rainflow" analysis performed to determine the number and g levels of events (shocks) per mile. Rainflow analysis is an industry-accepted approach used in vehicle testing. Then the trailer will be driven over the durability events on the test track (impact bumps, cobblestones, etc.) at different vehicle speeds and the accelerations measured. The test track results will be compared to the real-world results. The test track events and speeds will be chosen to closely match inputs resulting from the real-world response profile data with a factor of safety applied. A final analysis will establish the durability course and the rate that the durability test can be accelerated (in the range of 20:1 to 40:1).

Phase II - 240,000 Mile Durability Test

The trailer will be driven over the chosen durability course continually on a shift basis. AAPG will maintain a log of all events that occur on each shift for both the tractor and trailer. The tractor and trailer will be serviced periodically to maintain the system in a safe operating condition. Frequent visual checks will be made by the driver. Periodic formal visual and liquid penetrant or magnetic particle examinations of the trailer structural welds will be made by qualified inspectors. If weld cracks or other anomalies are observed, an evaluation will be made to determine the cause. The solution may be to repair the weld or to make structural changes to strengthen the trailer before proceeding with the test.

Phase III - 760,000 Mile Durability Test

After completion of the 240,000-mile durability test, the results will be evaluated and a decision will be made whether to perform the remaining accelerated 760,000-mile durability testing for the 1,000,000-mile trailer design life.

SUMMARY

The goal of durability testing is to obtain valuable information on the response of the trailer to real-world conditions and utilize the results to optimize the design while meeting the design goals of the GA-4 and GA-9

transportation system. The real-world conditions will be simulated based on analyses of the types of roads the trailer will be driven over. Testing will be conducted at a test track with a tractor pulling the trailer. A tractor that meets the transportation system requirements is being procured by TRW Environmental Systems Services to be used in the test program. The durability testing program will ensure that the final design of the high-capacity GA-4/GA-9 trailer meets the design requirements of the OCRWM program to provide safe and reliable service in the transport of spent fuel.

REFERENCES

1. "American National Standard for the Design, Fabrication and Maintenance of Semi-Trailers Employed in the Highway Transport of Weight-Concentrated Radioactive Loads," Draft ANSI N14.30, July 1990.

2. N. D. Rickard, J. A. Kissinger, C. Taylor, and A. Zimmer, "High-Capacity, High-Strength Trailer Designs for the GA-4/GA-9 Casks." Proceedings of the Second Annual International High-Level Radioactive Waste Management Conference. Las Vegas, NV, April 28-May 3, 1991.

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4. J. M. Viebrock and N. Mote, "Near-Site Transportation Infrastructure Project Final Report," DOE/CH-10441-1, February 1992.

DISCLAIMER

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