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From: Bill Ruting <commandconcepts@attbi.com>
To: <ams3@nrc.gov>
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Subject: Comments on NSF Package Performance Study

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Ms. Amy M. Snyder
Spent Fuel Project Office
US NRC
Washington, DC 20555-0001

Ms. Snyder,

Attached are my comments provided for your convenience in three formats: WordPerfect (native), MS Word, and PDF. Please advise if you have any difficulties with the files.

Thank you,
William Ruting

Template = ADM-013

E-RIDS = ADM-03
Call = A. Snyder (AMS3)
A.J. Murphy - (AJM1)

COMMENTS ON THE PROPOSED SPENT FUEL TRANSPORTATION PACKAGE PERFORMANCE STUDY TEST PROTOCOLS.

William Ruting, Chief
La Grange Fire Department, La Grange, Illinois
Member - DOE TEC/WG Training Topic Group

ABSTRACT

The comments contained in this paper are limited to the fire test protocols for the spent fuel casks. These are divided into two categories: first, comments on the protocols which have been proposed and/or currently used; second, comments on potential conditions which do not appear to have been considered in the testing program.

The comments on the current test procedures are generally phrased as questions which are left unanswered by the information provided. These questions would raise concerns over the accuracy and reliability of the testing protocols and need to be either answered or addressed.

The second area of concern is based on experience and past history, plus the possibility that these casks may be shipped by rail in general commerce, the author believes it is incumbent on the NRC to evaluate these possibilities. The specific events which are of most concern would include a high-temperature flame impingement which could result from the puncture of a liquified petroleum gas (LPG) or Propane tank car, the effects of a subsequent BLEVE event, and the possibility of the cask being attacked by a highly corrosive material following a train derailment.

CURRENT PROTOCOLS

As stated in the abstract, upon review of the report, there are several statements describing either assumptions or limitations in the test which raise concerns over how these conditions alter the outcome of the test. These are as follows:

1. Section 3.4 Preliminary Analysis: it is noted that no heat load was applied to the internal surface of the cask, even though in an actual shipment the heat of decay of

the spent fuel would be significant and might dramatically alter the results due to changes in heat transfer coupled with the increase in thermal load.

2. The fuel used in the fire test protocol is described only as a "hydrocarbon"; this raises the question about the choice of fuel. While gasoline or diesel fuel may be common fuels, these materials are not shipped in any quantity by rail. On the other hand, propane and LPG are more commonly shipped by rail in containers of up to 33,600 gallons. Both of these fuels would burn with higher flame temperatures than gasoline or diesel fuel. In addition, propane with a heat of combustion (Δh_t) of 46.35 MJ/kg constitutes a much higher fuel load than kerosene (Jet fuel A) with a Δh_t of 43.3 MJ/kg.

3. On page 57, it is stated that the size of the cask *"... are not accurately portrayed"* and if the cask were correctly portrayed the *"... temperature gradients throughout the envelope would increase."* One would therefor conclude that the temperature loading on the cask would also increase significantly.

4. Section 3.4.3: If it is difficult to design a cask stand with enough strength to hold the cask in the position described, how is it then postulated that the cask would be in such a position – *"... several meters above the fuel pool ..."* – in a real-world event?

5. Section 3.5: It is stated that the fire pool tests are to be performed with the cask inside the vapor dome. This is a region where the fuel vapor is above its upper flammability limit (UFL) because sufficient air to support combustion is not introduced into this region. Therefore, the thermal stress and load on the cask will be limited to the heat introduced by the radiant flux of the surrounding flame, which is estimated to be in the range of 30 - 40% of the maximum heat output[1]. In a real event it may be more likely that the cask would be in a location near the edge of the pool and subject to direct flame impingement in addition to the radiant heating. This could increase the temperature of the cask significantly.

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1 *Fire Protection Handbook*, National Fire Protection Association, Fifteenth Edition, p 3-11..

6. Section 3.6: it seems difficult to believe that any modeling program which can perform the calculations of a seemingly complex model, and produce enough data elements to be valid would push the limits of even the most robust desktop workstation. With DOE/NRC access to high-speed computing systems, is there not a more robust modeling system available?

CONDITIONS NOT EVALUATED

Although the U. S. Nuclear Regulatory Commission (NRC) is soliciting comments only on the cask testing protocols which have already been designed or developed, these protocols fail to account for several potentially catastrophic events. In the information included below are some possible events which I believe may be far more severe that the proposed tests, yet lie within the realm of possibility.

Tank Car Issues

Improvements made since the 1970's in rail tank car safety features, including head shields and shelf couplers have vastly improved their performance in rail accidents, however, the potential for a tank car puncture from an accident is not totally remote. In reports produced by the Federal Railroad Administration[2], hazardous materials tank cars experienced punctures at impact velocities as low as 15.1 mph for impacts on the head shield, and as low as 10.5 mph for impacts without a head shield. These impacts were designed to simulate impacts of the coupler on the tank heads and not on the body of the tank. This is significant as the body of the car is made up of material that is even thinner than the head. Further, per HM-201, tank cars used in commercial service are permitted to remain in service even if the material has been corroded to a thickness below the construction design (although the amount of thinning is very limited.) It is this potential for the penetration of the tank car shell and the release of the contents which drives the scenarios set forth in the following

Scenarios

While the pool fire conditions described certainly expose the cask to significant stresses due to the thermal loading, there are some concerns which I have with this test protocol.

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2 *"Evaluation of Semi-Empirical Analyses for Railroad Tank Car Puncture Velocity, Part I: Correlations with Experimental Data"*, and *"Part II: Correlations With Engineering Analysis"* DOT/FRA/ORD-01/21.I and DOT/FRA/ORD-01/21.II (these may obtained at www.fra.dot.goc)

1. I have seen no indication of any analysis based on the possibility of a high-temperature flame-jet impingement event. This scenario, as I envision it, would occur if a cask or portion of the transport package were to strike and puncture a tank carrying propane, LPG, or other flammable gas, whether liquified or transported in a gaseous state (e.g., Hydrogen.) Should the cask penetrate the outer shell of the tank car[3], this penetration would result in the release of the gas in a jet-like flow, which, if ignited, would result in a torch-like flame. This flame could then impinge upon a limited portion of the cask, with the thermal energy concentrated on this small area. If the puncture was due to the cask, itself, it would be possible that the flame would impinge directly on the head and seal area of the cask. The flame temperature from an LPG or propane fed fire would be at the upper limits of hydrocarbon fires, estimated to be in the range of 2,100° - 2,300°C (3,800° - 4,200° F .) The duration of the event would depend entirely on physical factors including temperature, location of the puncture (above/below liquid level), and diameter of the hole. Based on my calculations using CAMEO© a 2" diameter hole in the vapor space of a DOT112 tank car carrying 33,600 gallons of propane the contents would take at least 36 minutes to be released. The combination of higher temperatures coupled with the stresses introduced by such discreet localized heating would be far different than those generated in the pool fire tests which have been conducted or modeled.

2. Similar to the conditions describer above would be a similar event where the flame impingement was on the side of the cask, rather than the end. Here too, the question is raised as to the effect of severe localized heating on both the cask and the contents. While the cask may have sufficient mass to dissipate the heat, I wonder if the rate of heat transfer away from the point of impingement will be sufficiently high so as to prevent burn-through or weakening of the cask at the point of flame contact.

3. The most egregious fire condition that might occur would be an accident involving a tank of flammable gas that subsequently resulted in a "Boiling Liquid Expanding

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3 The shell thickness of a standard DOT112J340W tank car which carries 33,600 gallons of LPG is 5/8" with 5/8" of insulation on the exterior surface.

Vapor Explosion" (BLEVE)[4]. While a BLEVE would result in a relatively transitory exposure to high temperatures, as the fuel is quickly consumed in the expanding fireball, the concern would be over the combination of the pre-heating of the cask by radiant heat from the fire prior to the BLEVE event[5], coupled with the extreme physical stresses to which it would be subjected. In the Waverly, TN, BLEVE a piece of the tank car measuring 24 feet X 12 feet was thrown 150 feet; a second piece weighing 20,000 pounds was flattened out and thrown 250 feet. It would be possible to calculate the force of the object from the available information as to the actual weight of the object and the distance it was propelled. Also unknown is to what extent the explosion shock wave and over-pressure would stress the cask, especially if it were at the epicenter of the explosion, as a BLEVE is not a "typical" vapor-air explosion.[6]

4. The last scenario which concerns me is one that would involve the puncture of a railcar transporting a highly corrosive material such as Hydrochloric Acid, Nitric Acid, Hydrofluoric Acid, an extremely caustic material such as Sodium Hydroxide, or a corrosive such as Titanium Trichloride. Depending on the location and size of the puncture, the material could leak very slowly and expose the seal area or the cask to the corrosive effects for several hours. In a serious derailment with numerous hazardous materials, it may take more than 24 hours before the leak can be stopped or controlled, or the cars relocated. There is no information which suggests that all components of the package could stand up to a prolonged exposure to a highly corrosive condition, whether vapor or liquid. In the information supplied for comment the seal material used in the HI-STAR 100 cask was not revealed, so it is not possible to consider seal resistance to the chemicals listed. It would be reasonable to assume that the sealing material was designed to resist the effects of the

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4 BLEVE's occur when the vapor space of a tank containing a liquid (usually a flammable liquid or liquified gas) is heated to its point of failure. The tank then splits in a catastrophic fashion, releasing the contents which then are ignited by the flame.

5 A BLEVE may occur at a time point ranging from 20 minutes to several hours; in a BLEVE event in Waverly, Tennessee, the explosion occurred *40 hours and 28 minutes* after the derailment.

6 Gas vapor-air explosions develop a pressure front as the rapid combustion of the gas moves out from the point of ignition. The actual pressure experienced at the epicenter of the explosion may be very low.

contents and to hold up under the high compression of the closure process, and not for external exposures. In regard to the potential for the exposure, the information reports that a 0.250" nominal gap would be present around the periphery, which would expose the seal. One additional concern is over the effects of the corrosive chemicals on the material used in the construction of the impact limiter. The report states that the impact limiter is made up of aluminum honeycomb material, which if unprotected, would be susceptible to the effects of any of a number of corrosive materials.

These scenarios which I have described are, admittedly, not highly likely, however, they are possible, and – in my opinion – deserve at least consideration, if not detailed study. Thank you for the opportunity to submit my concerns and questions to the NRC. I would be prepared to discuss these with anyone who desires to do so.

William H. Ruting, Sr.
Fire Chief
Member DOE TEC/WG Training Topics Group
4411 Joliet Avenue
Lyons, IL 60534-1535
fax/voice 708-447-4791
fireworksconsulting@attbi.com

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