SCALE EFFECTS IN LNG HAZARD ANALYSIS AND TESTING

MASTER

Progress Report

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James A. Fay

Department of Mechanical Engineering
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, MA 02139

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ABSTRACT

Research progress consisted principally of a study of the effect of LNG spill size on the physical parameters used in hazard analysis and the completion of measurements of radiant heating rates from the burning of pure fuel vapor samples. The theoretical study examined the dependence upon spill volume of twenty one significant physical quantities as determined by existing models of LNG spill effects. This dependence was given as a power of the spill volume. The radiation measurements determined the dependence of several radiant heat pulse characteristics on fuel sample size and were compared with several simple models. These studies are being continued.

PROGRESS REPORT

A principal effort during the first nine months has been a review of existing models used for predicting the safety hazards which might result from accidental spills of LNG on land and water and the determination of how the principal physical effects (which those models describe) would depend upon spill size. Among the effects considered were spill duration, evaporation time, critical wind speed for plume formation, characteristic wind speed below which gravity mixing dominates, far field concentration, pool fire duration, radiant heat loss from pool fire, fireball burnup time, flame height, and radiant heat pulse, vapor cloud burnup time, and detonation overpressure. The dependence of these quantities on spill volume was expressible as a power of the spill volume, assuming that the physical properties of the atmosphere (such as meteorological parameters), water and land were fixed.

Thus, while models of different levels of sophistication might lead to different numerical values for the physical quantities of interest, the dependence upon spill volume (considered as an independent variable) is generally the same for different variations of each model.

The results of this phase of the research are contained in a report, "A preliminary analysis of the effect of spill size on the level of hazard from LNG spills on land and water," by James A. Fay, which will be included as a part of the appendix to the report, Integrated LNG Safety and Environmental Control Program Plan, to be published by the Division of Environmental Control Technology of ERDA.

During this same period a series of measurements of radiant heat emissions from the unsteady, diffusive burning of pure vapor samples of methane, ethane and propane were concluded. These measurements included the determination of the amount and time of peak intensity and the duration of radiant heat pulse. For each fuel, the variation of these quantities with sample volume was determined and compared with two models of radiant emissions from flames, the black body model and the transparent flame model. For all fuels, the measured variation of total heat emission with sample size was in disagreement with both models, showing a stronger dependence on sample size than either model can account for. However, the measurements did indicate that the heat lost by radiant emission was in the range of 10% - 20% of the fuel heating value, and thus somewhat lower than what has generally been observed in buoyant flames formed above a pure fuel jet or liquid pool.

This research is reported in an Sc.D. Thesis, "Combustion of Unconfined Vapor Clouds", by David H. Lewis, Jr., submitted to M.I.T. in September 1977. In addition, earlier work on the fluid mechanical aspects of this type of combustion is reported in an article, "Unsteady burning of unconfined vapor clouds", by James A. Fay and David H. Lewis, Jr., Sixteenth Symposium (International) on Combustion, 1397-1405, The Combustion Institute, Pittsburgh, 1976.

In addition, data on flame radiation from fires was reviewed and correlated, and visits were made to experimental facilities at Sandia Laboratories in Albuquerque and the U. S. Naval Weapons Center at China Lake.

The above research activities were in general accordance with the contract work statement. During this period, the principal investigator has devoted approximately fifty percent of his time to the contract research. For the remaining period, about twenty five percent of the time of the principal investigator will be required. Much of this will be spent on further analysis of scale effects on radiant heat emission.