

## **Motor Vehicle Fire Research Institute Awarded Contracts**

**Title:** Comprehensive Analyses of Data from Studies Sponsored by GM, MVFRI, and NHTSA

**Contractor:** FM Global Research

**Duration:** June 1, 2003 – April 30, 2004

**Purpose:**

Automobiles contain large amounts of flammable synthetic polymer parts and components and carry flammable fluids in the engine compartment and in the fuel tank. In crashes, polymers and fluids ignite and burn and release heat, smoke and toxic compounds that present danger to the passengers. This problem was investigated in a five-year study funded by General Motors because of the settlement between GM and DOT for the owners of C/K vehicles. The study was performed by GM, National Institute of Standards and Technology (NIST), SwRI and FM Global Research (FMGR) and consisted of the following projects:

- Project B.3: Fire Initiation and Propagation Tests
- Project B.4: Evaluation of Potential Fire Intervention Materials and Technologies
- Project B.10: Study of Flammability of Materials
- Project B.14: Demonstration of Enhanced Fire Safety Technology
- Project B.15: Theoretical and Experimental Study of Thermal Barriers Separating Automobile Engine and Passenger Compartments

Recently, additional projects have been funded by MVFRI and NHTSA to investigate fuel tanks exposed to heat, and the toxicity and flammability of automotive materials

Since valuable data are now available to provide pertinent information to enhance survivability in vehicle crash fires, this project will serve as a comprehensive analysis of the pertinent data from GM, NHTSA and MVFRI funded studies. Results from the GM, NHTSA and MVFRI funded studies will be summarized and remaining issues as well as successes and failures of the studies will be identified. The proposed study consists of the assessment of fire protection in an occupant compartment of a vehicle based on fire and flammability correlations and simple engineering tools for ignition, and flame spread behaviors, and for the survivability of occupants. The following tasks will be performed:

- **Task 1 – Fire and Flammability Issues for Automotive Materials**

The objective of this task is to summarize the work done under the GM funded study complemented by the MVFRI and NHTSA funded studies with emphasis on the fire and flammability behaviors of automotive materials to derive information on fire hardening of materials based on correlations. Data from the mini-scale, small-scale, intermediate-scale and large-scale tests will be analyzed in a comprehensive fashion to describe the melting, ignition, pyrolysis, combustion and fire propagation behaviors and release rates of heat, smoke, and toxic compounds. These analyses will be complementary to the analyses in Tasks 2 and 3 consistent with the overall goal of the proposed study. This task is expected to provide the following information:

- References and listing of most of the data and video recording from the GM study with brief summary for their utilization in various tasks of this proposed study
- Summary as well as success and failures of the GM funded study – fire, flammability and fire suppression issues
- Underhood fires – identification of better materials of reduced flammability
- Automotive materials – identification of cost effective improved materials than used in the GM study based on the surveys to 300 manufacturers, extensive fire and flammability research data at FM Global and NIST and data available in the open literature
- Correlations for material properties and fire behavior – establishment of the correlations using data from Projects B.3, B.4 and B.10
- Regulatory test(s) for the Flammability of automotive materials – identification of the conditions to which materials are expected to be exposed in vehicle crash fires and their simulation in the proposed regulatory test(s)

- **Task 2 – Ignition and Flame Spread Issues for Automotive Materials**

The objective of this task is to summarize the work done under the GM study with emphasis on ignition and flame spread behaviors and to assess the effectiveness of fire hardening of materials to enhance resistance to ignition and flame spread based on simple engineering tools. Data from the intermediate-scale and large-scale tests especially the time history of ignition and flame spread recorded by video cameras and IR thermography will be analyzed in a comprehensive fashion. These analyses will be complementary to the analyses in Tasks 1 and 3 consistent with the overall goal of the proposed study. The task is expected to provide the following:

- Summary as well as success and failures of the GM funded study – ignition, flame spread and fire suppression issues
- Underhood fires – ignition and flame spread behaviors of materials identified as improved materials in Task 1
- Automotive materials – ignition and flame spread behaviors of materials identified as cost effective improved materials in Task 1
- Correlations for material properties and fire behavior – utilization and refinements of the correlations established in Task 1 and establishment of additional correlations for the assessment of ignition and flame spread behaviors
- Regulatory test(s) for the Flammability of automotive materials – ignition and flame spread behaviors of materials under conditions expected in vehicle crash fires and their simulation in the proposed regulatory test(s)

- **Task 3 – Survivability Issues**

The objective of this task is to summarize the work done under the GM study with emphasis on the survivability and to assess the effectiveness of fire hardening of materials to enhance survivability based on simple engineering tools. Data analyses will be performed in a comprehensive fashion to describe creation of untenable conditions in vehicle-crash fire tests. Data from the small-scale and large-scale vehicle burn tests will be used in the analyses. Toxicity analyses performed in the

GM study using FAA Combined Hazards Survival Model and Purser's hazard model will be included in the comprehensive analyses. The task is expected to provide the following:

- Summary as well as success and failures of the GM funded study – survivability issues
- Strong and weak points of existing engineering tools to assess survivability – identification of degree of accuracy needed to make judgmental decisions about improving fire protection via fire hardened materials and/or fire suppression in an occupant compartment and utilizing of the engineering tool for survivability in the proposed study
- Underhood fires – effect on the survivability by using materials identified as improved materials in Task 1 and with higher ignition and flame spread resistance from Task 2
- Automotive materials – effect on survivability by using materials identified as cost effective improved materials in Task 1 with higher ignition and flame spread resistance identified in Task 2
- Correlations for material properties and fire behavior – utilization and refinements of the correlations established in Tasks 1 and 2 and establishment of additional correlations for the survivability assessment
- Regulatory test(s) for the Flammability of automotive materials – needs for inclusion of survivability assessment