Auto Fire Research including Suppression

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MVFRI

Outline

- Part 1 – MVFRI Fire Research
  - Contractor reports
  - Recommendations to NHTSA
- Part 2 – Fire Suppression

Background

- GM funded ca $10 M in fire research – 1995 to 2005
  - Part of settlement with DOT
- GM funded MVFRI ca $4.1 M for crash-induced fire research – 2001- 2009
- Principles were: Dr. Kennerly Digges and Dr. R. Rhoads Stephenson
- About $14 M worth of recent research on which to base fire safety improvements
- All GM and MVFRI reports available on website:
  - www.mvfri.org

Summary of MVFRI Research (Contractor Reports)

- All on Website – Organized by
  - Resources – 6 reports
  - Data Analysis – 7 reports
  - Testing and Experimental Studies – 9 reports
  - Future Technologies – H2 and high voltage – 5 reports

NHTSA Recommendations

Potential Rulemaking Changes

- FMVSS 301- Fuel System Integrity
  - Extend leakage requirements to all flammable fluids
  - Add door opening requirement after crashes
  - Lower flammable fluid leakage allowance
- FMVSS 302 - Flammability
  - Regulate flammability of underhood liners
  - Regulate flammability of other underhood materials
  - Improve 302 test procedure
- FMVSS 303 – NG fuel system integrity
  - Update crash speed and barrier to match 301

Potential Rulemaking Changes (Cont.)

- FMVSS 304 – NG tank standard
  - Replace tank-level bonfire test with vehicle-level test
  - Add localized fire test for tanks
  - Standardize bonfire test conditions – fuel; heat release rate
  - Test bare tank without PRD to get burst time
- FMVSS 305 – Battery Safety
  - Upgrade rear crash speed and barrier to match 301
  - Add requirement of “no fire” after the crash tests
- Future Hydrogen standards
  - Do vehicle-level burn test
  - Mark vehicle with blue diamond similar to natural gas

New Car Assessment Program (NCAP)

- Add ratings for fire safety and egress
- For liquid fuels - add burn test after 301 frontal crash
- For CNG vehicles – add engine compartment burn test
- For H2 vehicles – add passenger compartment burn test

State Programs

- Work with states to ensure that high pressure tanks (CNG or H2) are periodically inspected and taken out of service at the end of their useful life
  - Consider use of annual registration system
  - Get legal authority to remove tank from service without owner's permission

National Center for Statistics and Analysis

- Reduce under-reporting of fires
- Improve data on entrapment and rescue times
- Evaluate effectiveness of upgraded 301 standard
- Obtain better data on ignition sources
  - electrical, hot surface ignition, or mechanical sparks
- Get distributions of emergency response times
- Add field to uniquely identify the primary fuel for the vehicle
- Determine frequency of underbody pool fires

Research and Development (conventionally fueled vehicles)

- Determine relative frequency of electrical, hot surface ignition, or mechanical sparks as the ignition source
- Study benefits of battery disconnect devices
- Slow progression of fire from engine compartment to the passenger compartment
- Develop flammable fluid containment requirements
- Develop tests of underhood fire suppression systems
- Develop non-flammable or less flammable underhood fluids
- Investigate aging effects on plastic fuel tanks

Research and Development (H2 and NG fueled vehicles)

- Develop vehicle-level burn test
- Develop a localized fire test for tanks
- Develop new generation of PRDs – line sensitive
- Develop oven-based PRD activation test
- Validate the new PRD creep test
- Continue numerical modeling of the response of tanks to fire

NHTSA Recommendations

- Full text with details and rationale is available at:
  - www.mvfri.org
  - www.regulations.gov
    - NHTSA Docket NHTSA-1998-3585-0611

Part 2 – Fire Suppression

- Under-Hood Foam Fire Suppression System; University of Maryland
- Vehicle Fire Suppression Research Needs; Anthony Hamins; National Institute of Standards and Technology (NIST)

University of Maryland

- Developed a N_2 foam generation system
  - 220 to one foam expansion ratio
- Conducted 5 tests on automobiles
- Capable of extinguishing standard fire
- Foam remains in engine compartment – stable
- System needs to be packaged for compact installation
- Sensing needs to be added
- Can probably be scaled for truck or bus applications
- See SAE paper 2005-01-1789

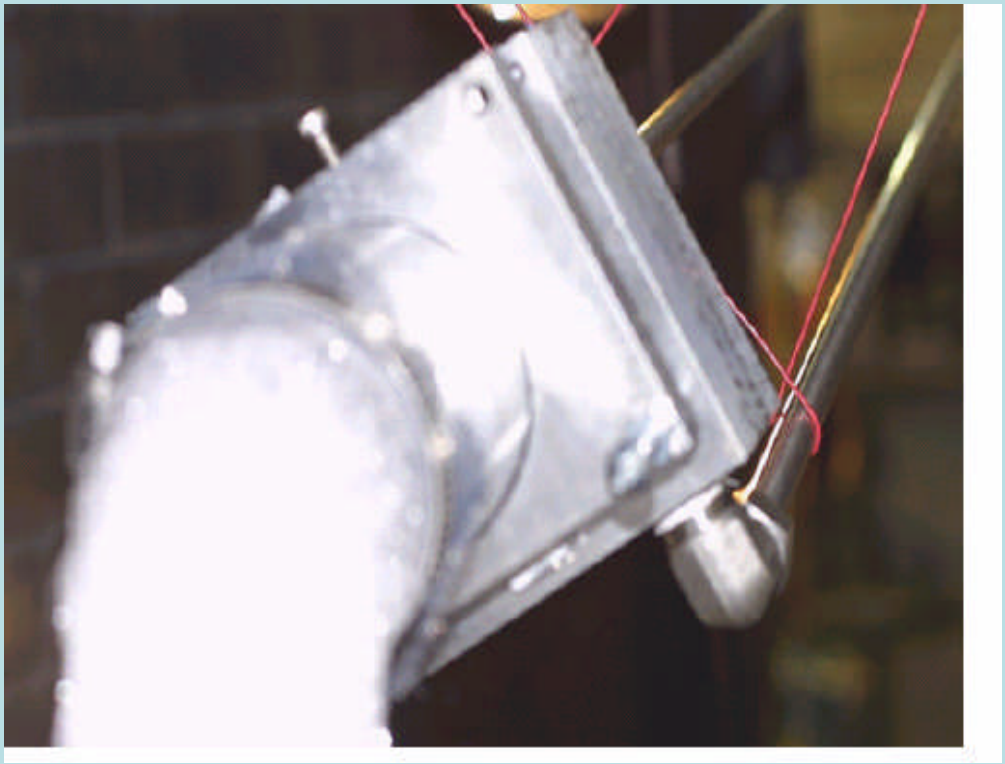
University of Maryland (Cont.) Approach

- The concept is to use Nitrogen foam to extinguish fires that are ignited at the time of the collision and to protect the engine compartment from ignition by sources, such as electrical shorts, that could cause ignition some time after the collision.

University of Maryland (Cont.)
Foam Generator

MVFRI

University of Maryland (Cont.)
Foam Characteristics



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University of Maryland (Cont.)
Foam Characteristics

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University of Maryland (Cont.)
Foam Characteristics

- Foam: ChemGuard 3% F3
  - 100% biodegradable
- The foam has an expansion ratio of 200 – 250
- For lower expansion ratios the foam will readily flow out of the engine compartment
- For higher expansion ratios the foam will evaporate too quickly when exposed to hot surfaces or flames

University of Maryland Video

- CAR # 2.avi

University of Maryland
Results

- The Nitrogen foam system extinguishes the 80 kW gasoline fire
- 470 liters of foam produced
- After 10 minutes there is only a minimal breakdown of the foam (less than 20%) within the engine compartment
- After 30 minutes there is no trace of the foam in the compartment

University of Maryland
Prototype Design

Component	Volume [L]	Weight [kg]
Solution and tank	2.1	2.5
Nitrogen and tank	2.3	2.5
Valves and regulator	0.3	1.5
Foam mixing nozzle	0.3	0.5
Totals	5	7

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Cost Justification

- Cost estimated at about $100
- Most auto fires are non-crash
- The suppression system cost may be justified by reducing property damage to the vehicle
- Possible auto insurance discount
- Occupants may then have protection in crash-induced fires

University of Maryland
Conclusions

- Feasibility for automotive applications has been demonstrated
- Sensing of fire not part of scope
- Could be scaled-up for bus or truck applications
- For further information contact;
  - Marino di Marzo, Chair
  - Fire Protection Engineering Dept.
  - University of Maryland
  - marino@umd.edu

Other Fire Suppression Papers

- SAE paper 2005-01-1791 “Development of the Ford Fire Suppression System,” Dierker et al, Ford
  - Only fully engineered suppression system for autos
  - Focused on underbody pool fires
- SAE paper 2006-01-0792 “Effective Fire Protection Systems for Vehicles,” Steven E. Hodges, Kidde Dual Spectrum

Other MVFRI Accomplishments

- All GM/DOT reports are available and organized on our website
- Organized SAE Fire Safety Committee
  - Got dozens of fire papers published at the SAE Congresses
- Several ESV papers
- Developed an interactive fire investigation course
  - Available on our website
- Provided recommendations on fire safety improvements to NHTSA

Conclusion

- There is a wealth of Auto Fire Safety information available at our website:
  - www.mvfri.org