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Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE MOTORCOACH FIRE INVESTIGATION

SCI CASE NO.: CA09038

VEHICLE: 1999 MCI MODEL 102-EL3 56-PASSENGER MOTORCOACH

LOCATION: TEXAS

INCIDENT DATE: MAY 2009

Contract No. DTNH22-07-C-00043

Prepared for:

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Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety system.

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16. Abstract This on-site investigation focused on the origin and severity of a fire that involved an in-transit motorcoach that was traveling at highway speed. The motorcoach was a 1999 MCI 102-EL3, with a 56-passenger capacity. The motorcoach was occupied by a 60-year-old male driver and 53 passengers, comprised of 38 students between the ages of 10 to 11 years of age and 15 adult chaperones. The adults were seated throughout the passenger compartment of the motorcoach. The driver detected smoke in his rear view mirror emanating from the right rear area of the motorcoach while traveling at highway speed on a divided roadway. He brought the vehicle to a controlled stop on the right shoulder of the roadway. The driver ordered the immediate evacuation of the passengers, and they safely exited without injury. The driver retrieved the onboard fire extinguisher in an attempt to suppress the fire prior to the arrival of the local fire department. The firefighters used water to extinguish the fire that was confined to the rear area of the motorcoach. Minimal heat and smoke-related damage occurred to the interior of the motorcoach. The motorcoach was towed from the incident site and was deemed a total loss by the insurance company.			
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BACKGROUND

This on-site investigation focused on the origin and severity of a fire that involved an in-transit motorcoach that was traveling at highway speed. The motorcoach was a 1999 MCI 102-EL3, with a 56-passenger capacity **(Figure 1)**. The motorcoach was occupied by a 60-year-old male driver and 53 passengers, comprised of 38 students between the ages of 10 to 11 years of age and 15 adult chaperones. The adults were seated throughout the passenger compartment of the motorcoach. The driver detected smoke in his rear view mirror emanating from the right rear area of the motorcoach while traveling at highway speed on a divided roadway. He brought the vehicle to a controlled stop on the right shoulder of the roadway. The driver ordered the immediate evacuation of the passengers, and they safely exited without injury. The driver retrieved the onboard fire extinguisher in an attempt to suppress the fire prior to the arrival of the local fire department. The firefighters used water to extinguish the fire that was confined to the rear area of the motorcoach. Minimal heat and smoke-related damage occurred to the interior of the motorcoach. The motorcoach was towed from the incident site and was deemed a total loss by the insurance company.

Figure 1. Back right view of the 1999 MCI 102-EL3 motorcoach.

This fire incident was identified through an Internet news search on June 5, 2009 by the Calspan Special Crash Investigations (SCI) team during a search of potential cases of interest to the National Highway Traffic Safety Administration (NHTSA). The notification was forwarded to NHTSA's Crash Investigation Division (CID) and was assigned for SCI follow-up on the same day. The SCI team established contact with the owner of the motorcoach company and his insurance representative on Monday, June 8, 2009. Following numerous telephone calls to both representatives, they consented on June 11, 2009 to an on-site inspection of the motorcoach. The insurance company representative requested the presence of a consulting engineer during the SCI inspection. The SCI inspection of the motorcoach was conducted on July 1, 2009. The on-site investigation involved a thorough visual inspection and documentation of the motorcoach, supported by digital images, and an inspection of the incident site to determine the origin of the fire. A fire expert conducted a review of the digital images and the SCI documentation for this case. His opinion relating to the fire origin and cause is included as *Attachment A* of this report.

SUMMARY

Incident Site

This motorcoach fire occurred on the northbound lanes of a four-lane divided state route during daylight hours. According to local weather reports, at the time if this fire incident, the conditions were clear and dry with a temperature of 22 degrees C (72 degrees F), 78 percent humidity and calm wind. The roadway was surfaced with asphalt and consisted of two-lanes in the north and southbound travel directions. The road surface was coarse, comprised of large aggregate for resurfacing. A depressed grass median divided the travel lanes. On the approach to the incident site, the state route consisted of gradual left and right curves with straight sections over varying terrain consisting of shallow grades. In the immediate area of the vehicle's final rest position, the northbound lanes curved to the left and were bordered by a 3 m (10 ft) wide asphalt surfaced east shoulder with a negative sloped roadside that transitioned to a small pond that was located approximately 20 m (66') outboard of the shoulder. A dirt road intersected the northbound lanes immediately north of the incident site. The grade was estimated at 1.5 percent, positive to the north. The posted speed limit was 113 km/h 70 mph. A schematic of the incident site is included as **Figure 18**.

Vehicle Data

Exterior

The involved motorcoach was a 1999 Motor Coach Industries (MCI) Model 102-EL3. The vehicle was manufactured in June 1999 and was identified by Vehicle Identification Number (VIN): 1M8TRMPA2XP (production number deleted). The motorcoach was configured for a 56-passenger capacity (exclusive of the driver) with underbody luggage compartments. The hubometer mounted to the right drive axle recorded 780,845 km (485,208 miles). The instrument panel mounted odometer was digital and the battery power to the vehicle had been turned to the off-position at the master cut-off switch in the battery compartment, located forward of the right rear axles. The instrument panel odometer reading at the time of the incident is unknown.

The motorcoach was a monocoque design with three axles supporting the vehicle. The axles consisted of the front steer axle, a dual-wheel drive axle, and a rear tag axle. The front, side and rear body panels were constructed of fiberglass with a painted outer aluminum surface. These panels were attached to a truss frame with rigid fiberglass insulation positioned within the framework between the inner and outer body panels. **Figure 2** is an overall view of the motorcoach.

Figure 2. Front left view of the motorcoach.

The front bumper system was comprised of a steel reinforcement beam that was concealed by a composite fascia. The bumper was hinged and opened in a downward direction to provide access to the spare tire that was mounted horizontally behind the front bumper and under the front floor of the motorcoach.

The side body panels concealed a large under-floor compartment for the stowage of luggage within the wheelbase with three top-hinged access doors on each side of the motorcoach. The rear of the motorcoach consisted of a single top-hinged engine compartment door that was framed with square stock aluminum with a fiberglass cover that was bonded to the frame. This door was located below the beltline of the motorcoach. A fixed fiberglass panel concealed the top back aspect of the motorcoach. Two side-mounted doors provided access to the engine compartment. These doors were forward-hinged and were constructed of an aluminum frame with fiberglass and sheet metal surfaced outer panels. The air conditioning condenser and the radiator were located at the left rear area of the motorcoach below the level of the beltline.

Driveline / Service Brakes / Fluids

The motorcoach was powered by a rear-mounted Detroit Diesel Series 60 inline six-cylinder engine with a displacement of 12.7-liters. Power was transferred to the drive axle through an Allison B500 automatic transmission. The engine was equipped with a turbocharger that was mounted on the left (driver's) side of the motorcoach. The primary 24-volt alternator was located at the right side of the engine with a secondary 12-volt alternator located on the left side of the engine. Both units were powered by a V-belt from the power take-off (PTO) of the engine. The starter was located on the lower right aspect of the engine. A dual-stage fuel filter was mounted to a bracket secured to the frame on the right side of the engine. The dual cartridge filters were contained within composite or fiberglass-type canisters. The air conditioning compressor was located in the lower right corner of the engine compartment and was driven by a V-belt off the engine's PTO. Located to the left of the engine compartment was a drive shaft and differential unit that transferred power to the cooling fans for the left side-mounted air conditioning condenser and radiator. An air box assembly was located above the engine compartment. **Figure 3** is an overall view of the engine compartment.

Figure 3. Engine compartment of the MCI motorcoach.

The oil capacity of the engine (with filters) was listed in the service manual at 36 liters (38 quarts). Cooling of the engine was achieved by a left side-mounted copper core radiator adjacent to the air conditioner condenser. The exhaust system utilized a single muffler that was mounted horizontally on the left undercarriage of the motorcoach.

The service brakes on the MCI motorcoach were air-activated drum brakes at the three axle positions. The instrument panel-mounted air pressure gauge showed a positive reading at the time of the SCI inspection. Both the primary needle and the green needle for the rear brakes displayed 448 kPa (65 PSI) of pressure on the gauge. The brake linings and chambers were not inspected during this investigation.

Tires/Wheels

The motorcoach was equipped with OEM-style aluminum wheels at the three axle positions and with radial tires, size 315/80R22.5. The front steer axle tires, the drive axle tires, and the left tag axle tire were Sumitomo ST178 LP tires. The right tag axle tire was a BF Goodrich LRL tire. The only visible DOT Tire Identification Number (TIN) was on the right outboard drive axle tire and was as follows: U24D 8XHW 3407. The vehicle placard identified the recommended tire size of 315/80R22.5 on 9.00x22.5 rims. The recommended cold tire pressures for the three axles were as follows:

Steer Axle (First) – 827 kPa (120 PSI)
Drive Axle (Second) – 621 kPa (90 PSI)
Tag Axle (Third) – 827 kPa (120 PSI)

The specific tire data documented at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	862 kPa (125 PSI)	12 mm (15/32”)	None
Right Front	707 kPa (102.5 PSI)	12 mm (15/32”)	None
Left Drive Inboard	Unknown, remained inflated	6 mm (8/32”)	None
Left Drive Outboard	Unknown, remained inflated	6 mm (7/32”)	Tread slightly burned at top aspect
Right Drive Inboard	Unknown, remained inflated	6 mm (7/32”)	None
Right Drive Outboard	Unknown, remained inflated	5 mm (6/32”)	None
Left Tag	810 kPa (117.5 PSI)	6 mm (7/32”)	Upper third of sidewall superficially burned extending onto tread
Right Tag	869 kPa (126 PSI)	13 mm (16/32”)	Upper 2/3rds of sidewall superficially burned

The total Gross Vehicle Weight Rating for this motorcoach was 22,635 kg (49,900 lb). The Gross Axle Weight Ratings were as follows:

Steer axle – 7,258 kg (16,000 lb)
Drive Axle – 10,432 kg (23,000 lb)
Tag Axle – 7,258 kg (16,000 lb)

Interior

The interior of the motorcoach was configured for the driver and 56-passengers. Passenger loading of the motorcoach was achieved through a single door located at the right front corner area. The door was hinged at the forward aspect and was pneumatically controlled during normal operation. The seating area of the motorcoach was positioned high in relation to the chassis. Access to the passenger compartment was provided by a staircase consisting of six steps.

The driver's seat and the forward controls were conventionally-mounted on the left side of the motorcoach and left of the center aisle, adjacent to the loading door and the curved staircase. The driver's seat was mounted on a pneumatic base and was a high-back seat with an integral head restraint. A 3-point lap and shoulder belt system was available to the driver. The driver stated that he was restrained by the safety belt system. **Figure 4** is a forward view of the interior of the motorcoach.

Figure 4. Forward view of the interior of the motorcoach.

Figure 5. Rearward view of the interior of the motorcoach.

The passenger area of the motorcoach was configured with 15 rows of seats on the left side of the center aisle and 13 rows on the right. Each row consisted of two seats with reclining seatbacks. The seatbacks were equipped with integrated head restraints. The rows were offset laterally left to right. An onboard restroom was incorporated into the right rear corner of the passenger compartment and was constructed of a molded fiberglass shell. The ceiling of the motorcoach was finished with a fabric headliner with two roof-mounted emergency exits. **Figure 5** is a rearward view of the interior of the motorcoach.

The seats were constructed of tubular steel frames with foam padding on the cushions and seatbacks. A synthetic blend fabric covered all surfaces of the seats and the integrated head restraints. Each seat was equipped with a rigid plastic armrest mounted to the outboard aspect of the seat.

Overhead storage compartments were located on both sides of the motorcoach and consisted of an aircraft-type overhead storage system with hinged rigid plastic doors that opened upward. These compartments facilitated the storage of carry-on items by the passengers. Reading lights were configured into the bottom of the overhead compartments. An onboard entertainment system that consisted of a Compact Disc

player and a Video Cassette Player/Recorder was located in the forward left overhead storage compartment, immediately behind the driver. Six fixed CRT monitors were mounted to the underside of the overhead compartments at the front, mid, and rear third areas of the passenger compartment.

Fuel System

The motorcoach was configured with a fuel tank that was mounted laterally to the undercarriage of the vehicle forward of the drive axle. Filler tubes concealed by doors were located on each side of the motorcoach forward of the referenced axle. Both filler caps were in-place, secure and undamaged at the time of the SCI inspection. The fuel tanks had a rated capacity of 689 liters (182 gallons). The motorcoach operated on Low-Sulfur Diesel (LSD) fuel.

Motorcoach Service History

The owner of the motorcoach did not provide the service history for this SCI investigation.

Driver/Passenger Data

The driver of the motorcoach was a 60-year-old male. He wore prescription eyeglasses and stated that he was restrained by the manual safety belt system.

The motorcoach was occupied by 38 child passengers in the 10 to 11 year age group and 15 adult chaperones. The chaperones were seated throughout the interior of the motorcoach. All of the passengers safely exited the motorcoach following the directive of the driver. There were no injuries associated with this fire incident.

Incident

Pre-Incident

The motorcoach was transporting the tour group from an overnight field trip to their home destination. The motorcoach departed the hotel and traveled northbound on the four-lane divided highway. The driver travelled approximately 75 minutes en route to his final destination at the time of the fire. During this daylight northbound travel, the driver was required to slow and accelerate through speed limit transitions in township areas with speed limits ranging from 72-113 km/h (45-70 mph). The terrain was relatively level with gradual changes in elevation. The road surface was a combination of asphalt and concrete. Long segments of the asphalt road surface were resurfaced with a base-coat of asphalt that contained a coarse aggregate. The SCI investigator observed this condition during the on-site investigation as the road surface produced subtle vibration and significant tire noise of the rental car. In the immediate area of this fire incident, the speed limit was 113 km/h (70 mph) with a positive grade of approximately 1.5 percent.

Incident

While ascending the grade and negotiating the shallow left curve, the driver observed smoke through the right outside mirror emanating from the rear of the motorcoach. He slowed the vehicle and brought the motorcoach to a controlled stop on the east (right)

shoulder of the roadway. The shoulder sloped downward to the east, away from the travel lane and the roadside contained a negative grade that transitioned to the pond.

The driver initiated the safety procedures and ordered the immediate evacuation of all passengers from the motorcoach. The passengers exited the vehicle through the right front door and proceeded north of the motorcoach to level ground away from the vehicle and traffic. A cellular call was placed to the emergency response system to report the fire and request firefighting assistance. The driver used the onboard fire extinguisher in an attempt to suppress or contain the fire at the rear of the motorcoach. A fuel line began to leak and a stream of burning diesel fuel ran down the roadside slope toward the pond. Local fire department personnel responded to the scene and used water to extinguish the fire. Absorbent barriers were placed around the fuel leak to contain the diesel fuel from leaking into the pond.

Post -Incident

Following the suppression of the fire, the motorocach was towed from the scene. Another motorcoach was driven to the scene to transport the passengers to their final destination. The involved motorcoach was inspected by the insurance company and the vehicle was considered a total loss. The motorcoach was transferred to a regional insurance vehicle salvage facility for auction. The SCI inspection of the motorcoach occurred at this location.

Fire Damage

The motorcoach sustained fire-related damage that was confined to the rear exterior and engine compartment areas of the vehicle. The passenger compartment sustained fire and heat related damage to the fiberglass restroom unit, the rear ceiling, and the overhead storage compartments over the left rear rows of seat. Smoke traveled along the ceiling and vented at all seams and openings in the fabric covered ceiling and overhead compartments; staining the sides of the ceiling, the emergency roof exits (closed), and the overhead storage compartment doors. A detailed discussion of the motorcoach damage is as follows.

Exterior - Front

The frontal area of the motorcoach was not damaged by this fire. The bumper fascia was intact, clean and free of damage. The spare tire access door remained closed and operational. The headlamps and turn signal lenses were intact and clear. The windshields were intact and free of smoke staining. The upper inboard corner of the right windshield was cracked. These cracks were located in the upper third of the laminated glazing and extended from the centerline of the vehicle to the midline of the glazing. It was doubtful that these cracks were related to this fire incident. The windshield wipers were in the stowed position against the center gasket of the windshields. The Plexiglas-type sunscreen panel above the windshields was intact.

Left Side

The fire damage to the left side of the motorcoach was confined to the rear area, aft and inclusive of the rear axles **(Figure 6)**. The fiberglass skirt panel over the rear tires (drive

and tag axles) was burned at the rear aspect and was removed post-incident. Smoke staining on the white outer body panels began at the centerline of the drive axle area and extended upward and rearward. The same body panel directly over the tag axle tire displayed three levels of fire related damage, starting with the burning of the paint on the aluminum outer surface, extending to the disintegration of the aluminum outer surface, to the full-thickness burning of the fiberglass backer panel. The rigid insulation located between the inner and outer body panels did not burn. The burning of the fiberglass panel and the aluminum outer panel extended rearward to the aft edge of the rear wheelbase opening and vertically to the level of the beltline. This fire/burn pattern extended from under the rear tag axle area.

Figure 6. Front and left side views of the motorcoach.

Figure 7. Left rear fire damage.

The fire extended vertically above the axles and involved the side window glazing **(Figure 7)**. There were seven glazing panels within the passenger area of the motorcoach. The rear two-thirds of the sixth panel from the front of the motorcoach was smoke and soot stained. The lower rear third of this glazing panel was heat cracked with an area of the outer layer of the laminated glazing burned away. The plastic laminate and the inner glazing panel remained intact. The seventh glazing panel located aft of the rear axles was burned more extensively than the sixth panel. The lower half of this panel was melted and out of place. The remaining upper section was heat cracked and in place.

The left tag axle tire exhibited a burn pattern to the outer sidewall that involved the upper third of the tire, extending from the 10-2 o'clock sector of the sidewall. (It should be noted that the tire appears to have been rotated during the towing of the vehicle.) The corresponding area of the tire tread also exhibited heat and fire related damage as the tread was reduced in depth with melting of the sipes. The tread area of the outer left drive axle tire was melted to a lesser degree than the tag axle tire.

The louvered door panel that covered the radiator and the air conditioning condenser remained closed and intact. Fire damage was limited to the upper forward aspect of the fiberglass door. This area was burned with smoke damage noted to the upper three louvers.

The left side air suspension bladders that were mounted inboard of the tires and above the rear axles were damaged by the fire. The forward bladder was deflated and intact with

minimal heat damage noted to the inboard aft area of the bladder. The rear 50 percent of the mid bladder was burned and deflated, but intact. The rear bladder was completely burned and melted. The rubber splash shield that was positioned between the left drive and tag axles was intact and undamaged. The left rear shock absorber and sway bar link bushings were surface burned, but intact.

Back

The back of the motorcoach sustained extensive fire-related damage **(Figure 8)**. The composite rear bumper fascia was completely consumed by the fire. The underlying sheet metal panel exhibited two areas of high heat oxidation. The lower mid point and the right edge of this component was clean with minimal surface rust present.

Figure 8. Fire damage to the back of the motorcoach.

The engine compartment was concealed by a single top-hinged door that was framed with aluminum and covered with a fiberglass outer skin. The outer panel was bonded to the frame. This panel was completely consumed by the fire and the lower right corner area of the frame was melted **(Figure 9)**. This area of the door frame exhibited evidence of high heat as the aluminum appeared clean. The remainder of the frame was blackened by the lower temperatures of the fire. The bonding material was present on the top aspect of the door frame. This area was not exposed to the high heat that the lower area of the door experienced.

The square stock framework at the back aspect of the motorcoach was exposed by consumption of the engine compartment door. The left upright located outboard of the engine compartment door was blacked by the fire. The same component on the right side of the engine compartment exhibited a high heat pattern **(Figure 9).** The steel of the right side component was clean and free of soot-like material.

Figure 9. High heat oxidation to the right frame member and engine compartment door.

The tail lamp assemblies were located outboard of the engine compartment door. The left tail lamp lens was melted with the perimeter of the lens remaining in place. The right lens experienced high heat that melted the plastic material onto the bottom of the tail lamp frame.

The gel coat of the fiberglass panels located above the engine compartment was burned. The fiberglass matting was intact as was with the overall structure of the panels. The right side area of these panels was burned full-thickness, exposing the inner fiberglass

insulation. The marker lights mounted at the top aspect of the rear panel were burned. The lenses and lamp assemblies were completely consumed.

Right Side

The fire damage to the right side of the motorcoach began at the drive axle location and extended rearward to the back corner **(Figure 10)**. The body panel over the rear axles was burned at the rear aspect and was removed from the vehicle prior to the SCI inspection. The rigid insulation panels within the trussed frame remained intact. The most rearward panels were charred at the aft and upper aspects. Located immediately below these panels was a side mounted access door to the engine compartment. This forward hinged door was constructed of an extruded aluminum frame with a fiberglass panel that formed the cover of this door. This panel was completely consumed by the fire. The aluminum latch pocket that was mounted to the upper third on the trailing side of the door frame was 50 percent consumed by the fire. Firefighting personnel used a pry bar to open this door. The lower aft aspect of the frame was deformed forward by this activity. The top mid aspect of the door frame exhibited an area of high heat oxidation. This area appeared clean as the remaining area of the door was smoke and soot stained. This high heat oxidation continued vertically onto the vehicle frame immediately above this access door **(Figure 11)**.

Figure 10. Fire damage to the right rear side area of the motorcoach.

Figure 11. High heat oxidation to the area above the right side engine compartment door.

The right side of the motorcoach was configured with seven glazing panels within the passenger compartment. The first four glazing panels were free of damage and smoke staining. The inside surface of the fifth glazing panel was covered with a light smoke stain. The sixth panel was heavily blackened by smoke and heat with the aft 40 percent of the gazing melted by the fire. The remaining glazing immediately forward of the holed area was fractured by heat. The seventh panel was completely consumed by the fire. The aft vertical frame and the rearward aspect of the top frame member for this window exhibited evidence of high heat oxidation. The framework in these noted areas was clean as the remainder of the frame and adjacent areas were blacked by smoke. The frame oxidation was above and slightly rearward of the previously mentioned oxidation to the side access door frame. The restroom glazing panel at the back corner of the motorcoach was completely consumed by the fire. An opaque interior panel over this window was melted by the heat.

The skirt panel that was mounted over the axles and tires was burned at the aft aspect and the remaining panel was removed from the vehicle. The splash shield positioned between the rear axles was intact with superficial burn/heat damage to the upper aft aspect of the rubber shield. The air suspension bladders were involved to the same level as the left side units. The forward bladder was intact and undamaged. The mid air bladder was in place with the aft aspect of the bladder burned full-thickness. Extensive fire damage was noted to the rear bladder. Melted rubber and cord was present at the upper area as the lower aspect was completely burned. The rubber shock mount and sway bar bushings were charred and intact.

The right side drive axle tires were intact, inflated and undamaged. The outboard sidewall of the right tag axle tire was superficially burned. The burned area involved an approximately 60 percent of the sidewall. The tire was rotated 180 degrees from its position during the fire as a result of the tow process. The aluminum wheel was blackened by smoke, but was not damaged. The tag axle tire maintained air pressure.

Engine Compartment

The engine compartment was visible through the rear door area and the right side area due to the complete burn of the fiberglass door panels. At the time of the SCI inspection, the compartment remained intact and undisturbed since the fire. **Figure 12** is an overall view of the engine compartment.

The left side of engine compartment contained the mechanical drive system for the AC condenser and radiator fan assembly. The V-belt that powered this unit was burned, but intact and in place around the pulleys. The assembly was blackened and exhibited smoke and heat damage. Located above this unit were the engine's turbocharger and the associated plumbing. The turbocharger and all connecting components were intact. Rubber connectors were burned; however, all components remained in position. The 12-volt alternator was mounted to the left of the engine block. This unit was intact with no evidence of high heat. The V-belt that powered this alternator was consumed by the fire. **Figure 13** is a view of the left side of the engine compartment.

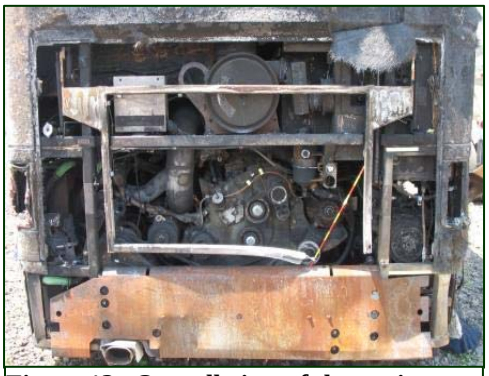

Figure 12. Overall view of the engine compartment.

Figure 13. Left side of the engine compartment.

The engine block was blackened by the fire. The paint remained on the left side and mid area of the block **(Figure 14)**. The 24-volt alternator was mounted to the right of the engine. This unit was blackened by the fire, but otherwise intact. The bottom aft aspect of the mounting bracket exhibited an area of high heat oxidation. A heavy gauge cable was routed across the engine to the alternators. This cable was braided copper wire with a plastic insulation and was secured to the block by two clips. The insulation was completely burned from the cable. The left clip remained intact with no evidence of damage. The cable arced due to electrical flow at the center mounted clip. The bottom of the clip that was in contact with the cable was melted and the copper cable was burned and melted from this arcing **(Figure 14)**.

Figure 14. Engine and arced cable.

Figure 15. Right side of the engine compartment.

A canister blower/venting unit was mounted above the engine on the vehicle's centerline. High temperature silicone rubber connectors were burned through at the mid points but remained intact under the stainless steel band clamps.

The air compressor was mounted to the lower right corner area of the engine compartment. This unit was intact with no evidence of high heat. All of the electrical wire insulation for the harness on the top of the compressor was burned. The V-belt that powered this unit was burned. **Figure 15** is a view of the right side of the engine compartment.

The fuel filter assembly, starter, and associated wiring harness were located on the right side of the engine compartment and were accessed through the side panel located at the aft rear aspect of the motorcoach **(Figure 16)**. The starter was mounted longitudinally with the starter solenoid located on top of the component. Two heavy gauge electrical cables were routed to the solenoid from the rear aspect of the engine compartment. A third cable grounded the starter to the engine block.

It was noted that an accumulation of oil and grease was present in this area of the engine compartment. The area immediately surrounding the starter cables and the solenoid exhibited evidence of high heat. The oil and grease accumulation surrounding those components was burned away. Larger diameter copper tubing located directly above the starter was burned clean.

The fuel filter consisted of two cartridge-type filters that were contained within composite or fiberglass canisters. This filter assembly was secured to a heavy-gauge mounting bracket located above the starter. The upper filter cartridge was burned and in place, with its outer canister completely consumed by the fire. The lower filter and canister were completely burned. The braided fuel line remained intact. The fuel filter bracket, the aft area of the starter and solenoid, starter cables and terminal connectors were burned clean, evidence of high heat. The insulation was burned from all the cabling.

The upper power cable attached to the starter solenoid was routed horizontally through a clamp bracket, then dropped vertically and routed in a gradual 90 degree bend. This cable was routed adjacent to the fuel filter bracket located immediately above the starter. Inspection of the cable and bracket revealed evidence of arcing **(Figure 17)**. This arcing resulted in a partial melting of the cable and the semi-circular erosion/burning of the heavy gauge steel bracket. The close proximity of the cable to the bracket suggests the possibility that the insulation of the cable was abraded over time due to vibration. The exposed energized cable contacted the bracket resulting in the arcing. This arcing was a possible source of the engine compartment fire.

Figure 16. Fuel filter, starter, and starter cables viewed through right side access door.

Figure 17. Arced starter cable against bracket.

Undercarriage

The undercarriage of the motorcoach was not inspected due to the limited ground clearance. The muffler and tailpipe were visible at the lower back left corner of the chassis. The inside surface of the tailpipe was clean and free of carbon.

Roof

The exterior roof of the motorcoach was intact. Minimal fire damage occurred at the back area and was limited to smoke staining and burning of the painted surface. There was no burn though of the roof.

SCI Fire Source

The arcing of the battery cable against the fuel filter bracket was determined to be the primary cause of the fire as the origin was located directly above the starter location. This area displayed the high heat commonly associated with origin.

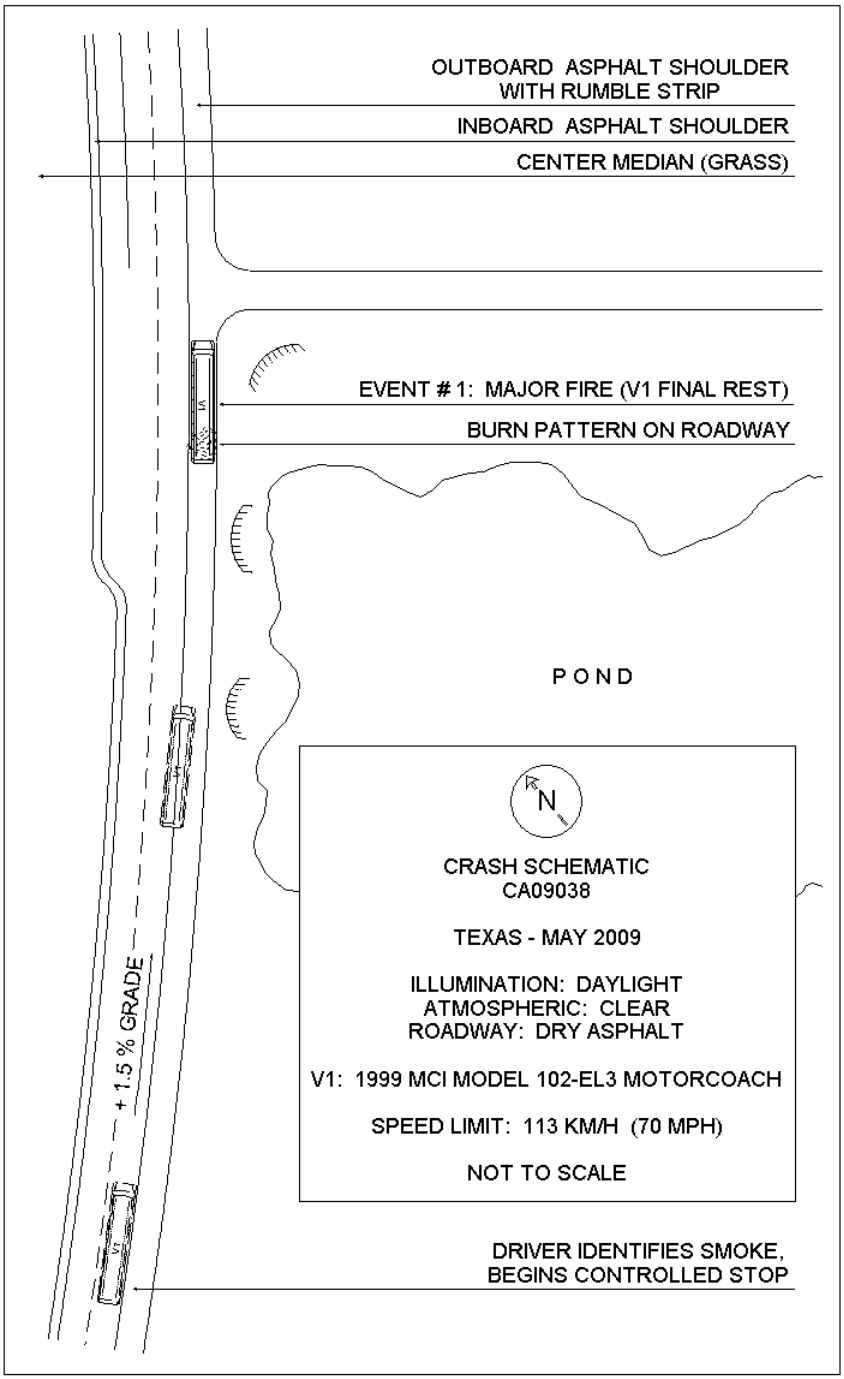

Figure 18: Incident Schematic

ATTACHMENT A:

FIRE EXPERT'S REVIEW AND OPINION REPORT

Independent review and subsequent opinion by a fire origin and cause investigator:
It should be noted that this investigator was not directly involved with the vehicle fire or scene inspections, but rather depended on a review of the photographs and documentation collected by the Calspan SCI team. Whereas this is not the optimal process when conducting an origin and cause investigation, the option of reviewing previous documentation is acceptable methodology according to NFPA 921, "Guide for Fire and Explosion Investigations" (2008 edition), and is adequate for the subject investigations given the scope and purpose of these evaluations.

For each case, photographs and documents were reviewed initially to determine an area or point of origin for the fire. Then this area was analyzed to determine a most probable cause. The area of origin was determined by an interpretation of the fire patterns left by the fire and supporting witness information. Interpreting fire patterns involves assessing the different amounts of damage to the various components involved taking into consideration the progression of the fire which is determined by the various fuel loads involved, the physical properties of the various materials, environmental effects, and the dynamics of the fire itself.

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Determination of Origin: Exterior inspection of the motorcoach clearly shows the fire damage was localized to the rear engine compartment of the vehicle. Some lesser amounts of damage extend into the rear drive and tag axle areas and rising onto the aluminum outer skin and the rear most windows. Only relatively minor damage is noted inside the vehicle caused by heat and smoke. When viewed from the back, fire damage is most prevalent on the right side of the vehicle. When the left and right rear sides are compared, damage is most extensive on the right side and extends further forward. Within the engine compartment, damage is also most prevalent on the right side. It should also be noted that the driver reported first seeing smoke in his right rear view mirror. This report correlates with the damage observed. This analysis places the area of origin within the right side of the engine compartment in the vicinity of the right side engine compartment door. Within this area, the burn patterns and heat damage appear to be centered in the area directly above the starter.

Determination of Cause: Within this area of origin, a short circuit was identified between a positive battery cable and a steel fuel filter bracket. Since battery to starter circuits are not fused, short circuits are a competent heat source and can ignite the wire insulation, resulting in a fire. This evidence is consistent with electrical arcing being the most probable cause of the fire.