CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE MOTORCOACH FIRE INVESTIGATION

SCI CASE NO.: CA10030

VEHICLE: 1998 PREVOST MODEL H3-45 MOTORCOACH

LOCATION: NEW YORK

INCIDENT DATE: JULY 2010

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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BACKGROUND

This on-site investigation focused on the origin and severity of a fire that initiated in the rear axle area of a 1998 Prevost Model HS-45 motorcoach (**Figure 1**). The vehicle was in-transit, occupied by the 53-year-old male driver and 51 passengers, comprised of young adults. The motorcoach was traveling southbound at highway speeds on an interstate roadway when the driver noticed smoke emanating from the right rear of the motorcoach. The driver brought the vehicle to a controlled stop on the right shoulder and attempted to suppress the fire with the onboard fire extinguisher; however, the fire became too intense and ultimately consumed the entire motorcoach. All passengers were safely evacuated from the motorcoach without injury.

Figure 1: Left front oblique view of the 1998 Prevost motorcoach.

Notification of this incident was obtained from the investigating police agency by the Calspan Special Crash Investigations (SCI) team on July 6, 2010. The SCI team forwarded the notification to the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA) on the same day. The SCI team established telephone contact with the motorcoach company and gained cooperation to conduct the on-site inspection of the motorcoach at a local tow yard. The on-site investigation was conducted on July 9, 2010, and involved a detailed inspection of the motorcoach with the primary emphasis placed on the point of origin. Additionally, the incident site was inspected and interviews were conducted with the president and the safety director of the motorcoach company. A fire expert conducted a review of the images and SCI documentation for this investigation to determine fire origin and cause. The opinion relating to these issues is included as *Attachment A* of this report.

SUMMARY

Incident Site

The motorcoach fire occurred on a two-lane physically divided interstate highway with a posted speed of 105 km/h (65 mph). The physical division consisted of a depressed grass median with a W-beam median barrier. The southbound travel lanes were straight with a positive grade of 2 percent. The travel lanes were surfaced with asphalt and were supported by a narrow inboard shoulder and a 3 m (10 ft) outboard shoulder. The inboard shoulder contained a continuous rumble strip and was separated from the inboard travel lane by a single

Figure 2: North-facing view of incident scene.

solid yellow line. The outboard shoulder was delineated from the outboard travel lane by a solid white fog line and continuous rumble strip. To the west of the roadway, outboard of the shoulder, was a narrow grassy slope with a negative grade that transitioned into a ditch bordered by a line of mixed vegetation and deciduous trees. The daytime weather conditions were clear with a temperature of 30 Celsius (86 Fahrenheit) degrees, 37 percent relative humidity, and west-southwest winds of 10 km/h (6 mph). **Figure 2** depicts a look back view from the final rest position of the motorcoach. A schematic of the incident site is attached as **Figure 16**.

Vehicle Data

1998 Prevost Model H3-45

The motorcoach involved in this incident was a 1998 Prevost Model H3-45, with a 56-passenger capacity (exclusive of the driver). The motorcoach was identified by the following Vehicle Identification Number (VIN): 2PCH33494W1 (production number deleted). The motorcoach was similar to the exemplar shown in **Figure 3**. The actual mileage was unknown. The motorcoach was stopped for a roadside inspection in November 2009. This inspection involved a Level 3, driver only inspection. The annual safety inspection was conducted in January 2010 at the motorcoach terminal. A single violation was detected that involved an air leak in the left front brake system

Figure 3: Right front oblique view of an exemplar motorcoach.

Driveline

The motorcoach was configured with a rear-mounted diesel engine linked to an automatic transmission. The engine was a Detroit Diesel Series 60, inline 6-cylinder diesel of unknown displacement, which was equipped with a left side-mounted turbocharger. The transmission type was an Allison automatic transmission. Engine cooling was achieved by a left rear corner mounted radiator. The exhaust system included a single muffler and tailpipe located on the left rear undercarriage. The service brakes were air-activated disc on the steer and tag axles with drum brakes on the drive axle.

Tires / Wheels

The motorcoach was configured with three axles consisting of the front steer axle, dual-wheel drive axle, and the rear tag axle. The SCI team was unable to locate an intact, readable manufacturer's placard that identified the recommended cold tire cold pressure and the Gross Axle Weight Ratings. Therefore, the aforementioned data is unknown. The vehicle manufacturer recommended tire size was 315/80R22.5. The Gross Vehicle Weight Rating (GVWR) was obtained from a Department of Motor Vehicles database and was listed at 23,614 kg (52,060 lb). The involved motorcoach was equipped with OEM-style 9.00x22.50 aluminum wheels at all three axle positions. At the time of SCI inspection, only the steer axle tires remained intact. Both were Goodyear G409MBA tires, size 315/80R22.5. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Damage
Left Steer	Flat	9 mm (11/32”)	None
Right Steer	Flat	Unknown	None
Left Drive - Outboard	Unknown	Unknown	Unknown, tire missing from wheel
Left Drive - Inboard	Flat	3 mm (4/32”)	Small patch of tread in contact with roadway during fire remained intact; sidewall burned full-thickness, half-circumference, on both sides
Right Drive - Outboard	Flat	Unknown	Near complete incineration of tread and sidewall; steel structure of outer bead remains with rubber from 5-7 o’clock positions
Right Drive - Inboard	Flat	Unknown	Near complete incineration of tread and sidewall; steel structure remains
Left Tag	Flat	Unknown	Sidewall burned full-thickness, full-circumference on both sides
Right Tag	Flat	Unknown	All rubber fully consumed by fire; steel structure of sidewall and bead remain

Exterior

The motorcoach was a monocoque body/frame design. The front, side, and rear body panels were of fiberglass composite, with trim and fascia consisting of plastic, aluminum, and rubber components. The frame that encompassed the passenger compartment was constructed of square stock tubing with gusset plate reinforcement. The roof structure was of similar square stock aligned in a grid pattern. Two emergency exits were incorporated into the roof structure, located at the centerline between the C and D-pillars and G and H-pillars.

The side body panels incorporated three wide storage compartments within the wheelbase. There were also several equipment and mechanical maintenance access doors positioned on both sides of the motorcoach. The fourth compartment on the left and right sides of the vehicle housed the Heating, Ventilation, and Air Conditioning (HVAC) components for the passenger compartment. There was also one fuel filler cap located in the upper rear aspect of each of the two HVAC compartments. A large door spanned the rear of the motorcoach and provided access to the engine compartment. Additionally, the battery compartment was located on the right side, aft of the rear axles.

Interior

The interior of the motorcoach was configured for the driver and 56 passengers. The driver’s seat and the forward controls were conventionally mounted to the left side of the unit and left of the center aisle, directly opposite of the loading door and entrance staircase. The driver’s fully adjustable seat was equipped with a 3-point lap and shoulder belt system. Typical vehicle controls and gauges were mounted within the vinyl and polymer instrument panel, similar to the exemplar interior depicted in **Figure 4**.

Passenger seating consisted of 14 rows of four seats, laterally offset in groups of two on either side of the center aisle as seen in the exemplar interior shown in **Figure 5**. All seats were of tubular steel construction with foam padding, and covered with a synthetic blend fabric. Each seat was also equipped with a reclining seatback, adjustable head restraint, and a metal footrest.

Figure 4: Driver's area in an exemplar Prevost motorcoach.

Figure 5: Interior of the passenger compartment of an exemplar Prevost motorcoach.

The back row consisted of two seats on the left side of the motorcoach, adjacent to which was a small lavatory. The lavatory was constructed of plywood walls incorporated into the right rear corner of the motorcoach. These walls and the ceiling of the motorcoach were covered in a synthetic carpet material similar to the fabric covering the seats.

Aircraft-style overhead storage compartments extended the length of the passenger area on both sides of the motorcoach. These compartments had top-hinged rigid fiberglass doors and were designed to facilitate the storage of carry-on luggage and personal belongings. On the underside of these compartments and directly above the passenger seats were courtesy reading spotlights, accompanied by several staggered video screens used for passenger entertainment.

Incident

Pre-Incident

The motorcoach was southbound on the outboard travel lane of the interstate highway, followed by a second motorcoach from the same company. Each was transporting approximately half of a group of 102 combined passengers consisting of young adults. Both motorcoaches had been in-transit for approximately 90 minutes at continuous highway speeds. The driver of the involved motorcoach heard a loud noise that he associated with a blow-out of a tire. He slowed the vehicle and steered onto the right shoulder.

Incident

As the driver brought the motorcoach to a controlled stop, he noted smoke emanating from the right rear area of the vehicle. The driver placed the transmission in park, set the parking brake, and turned-off the ignition. He exited the vehicle and proceeded to the right rear area to investigate the source of the smoke. As he approached the right rear axle area, he identified a visible fire. The second motorcoach came to a controlled stop approximately 0.4 km (0.25 mi) behind (north) the involved motorcoach. Both drivers evacuated the occupants of the involved

motorcoach without incident and attempted to suppress the fire by utilizing the onboard ABC fire extinguishers of both motorcoaches. The fire was too intense for their available fire suppression equipment and they were forced to retreat to a safe location.

Post-Incident

A cellular call was placed to the local emergency response system to report the fire event. Local police, fire, and Emergency Medical Services (EMS) personnel responded to the reported location. The volunteer fire department arrived on-scene within 15 minutes of the call. The fire progressed from its origin in the right rear axle area and spread in all directions to involve the entire rear axle area, the lower storage and component compartments aft of the rear axles, the engine compartment, and the entire passenger compartment. The firefighters used a combination of fire retardant foam and water to extinguish the fire. EMS personnel were present as a precautionary measure, though none of the occupants was injured as a result of the incident. The involved motorcoach was removed from scene by a local recovery service and transported on a flatbed trailer to a local tow yard where it was held for SCI inspection.

Vehicle Damage

Exterior – Front

The front of the motorcoach sustained minor damage **(Figure 6)**. All components below the level of the beltline, including the bumper, bumper fascia, headlight and turn signal assemblies, and body paneling were intact and undamaged. The windshield was divided into four quadrants. All four windshield glazing panels had been removed during firefighting activities in an effort to ventilate the interior of the motorcoach and aid in the extinguishment of the fire. Glass and laminate lined the intact gaskets along all four frame edges. There were four wiper blade assemblies for the upper and lower windshields. Both lower wipers were undamaged and remained in the stowed positions. The upper wipers were coated in soot and partially melted from the radiant heat. The left half of the windshield header was soot stained and charred, while the right aspect was intact and undamaged.

Figure 6: Minor frontal damage to motorcoach.

Left Side

Damage to the left side of the motorcoach was extensive and extended full-height from the D-pillar rearward. The left side damage is depicted in **Figure 7**. All of the left side glazing was out of the vehicle. The perimeter of the three glazing panels between the A- and B-pillars remained intact within the gaskets on all frame edges. The lower aspect of the glazing panel between the B- and C- pillars was in

Figure 7: Left side damage to the motorcoach.

place. The four aforementioned glazing panels were penetrated and removed by the firefighters to ventilate the interior of the motorcoach and aid in the extinguishment of the fire. There were no remnants of the seven remaining glazing panels from the C-pillar rearward to the J-pillar. The majority of the aluminum framework of these glazing panels was consumed by the fire. There were no remnants of glass, trim or gaskets.

The painted body panels displayed evidence of heat and fire exposure immediately aft of the steer axle at frame level and between the C- and D-pillars at the beltline. Body panels forward of this area remained intact and undamaged. The aft edge of the steer axle wheel well was blackened and blistered at frame level. Similar heat and fire damage extended from the lower forward corner to the upper rear corner of the forward storage compartment, while extending forward across the body paneling toward the beltline between the C- and D-pillars.

All remaining storage compartment doors and body paneling progressing rearward displayed moderate to severe fire damage. Paint was burned from the exterior surfaces, and the fiberglass panels were melted and charred. The middle storage compartment doors were cut diagonally post-incident by firefighters in order to gain access to the intra-wheelbase storage area. The door to the HVAC compartment was burned full-thickness, and the exterior fiberglass surface was broken away at its upper aspect. The fuel filler cap in the upper rear corner of the HVAC compartment was intact. The door to the storage compartment forward of the rear axles was burned full-thickness, and the upper two-thirds of the fiberglass outer surface had melted and was broken away.

Fiberglass, plastic, and aluminum components of the body paneling, fascia, and splashguard surrounding the rear axles were fully consumed by the fire. All body paneling above the rear axles was burned full-thickness, with the frame of the motorcoach exposed. Oxidation on the frame evidenced the high heat of the fire in this area. As depicted in **Figure 8**, there were no remnants of the outboard drive axle tire. The corresponding alloy wheel was slightly melted on its outer bead from the 9-6 o'clock positions, with blackening and smoke damage around surrounding the lugs. The inboard drive axle tire was burned full-thickness on 180 degrees of its sidewall, with exposure of the steel cord. A small area of tire tread that had remained in contact with the road surface during the fire was intact and undamaged. This area was rotated 180 degrees from its original 6 o'clock position at the time of SCI inspection, and was attributed to towing and recovery efforts. The tag axle tire was burned to full-thickness on the full circumference of its sidewalls on both sides, with exposure of the steel cord. Combustible rubber and polymer components of the air ride suspension and shock absorbers were consumed by the fire.

Figure 8: Left rear axle area of the motorcoach.

The body paneling aft of the rear axle areas was burned full-thickness. Fiberglass was melted and broken away in most areas. The radiator compartment door was fully consumed, and the body paneling at the upper rear corner was burned through to expose the frame.

Rear

Fire damage to the rear plane of the motorcoach was extensive, as all combustible exterior surfaces were burned. The majority of the polymer bumper fascia and internal support structure were consumed by the fire, with only a small melted portion remaining in the left corner as seen in **Figure 9**. The taillight assemblies were fully consumed. Fiberglass and aluminum components of the engine compartment door and upper paneling were also fully consumed, causing exposure of underlying frame rails and vehicle components.

Right Side

The right side of the motorcoach was burned in a fashion similar to that of the left side, as seen in **Figure 10**. Evidence of heat and fire damage was present from the rear corner forward to the approximate midpoint of the motorcoach at the level of the beltline and frame. The engine and battery storage compartment access doors aft of the rear axles were nearly entirely consumed by the fire, with only small sections of melted fiberglass strands remaining at the mounting brackets on the hinges. The batteries and associated components originally located within the compartment immediately aft of the tag axle had been consumed by the fire and were reduced to a cluster of oxidized wire and non-combustible components. Fiberglass and aluminum body paneling above the engine compartment access door at the rear corner were completely consumed, which had created full-exposure of the underlying frame and remnants of vehicle components.

Figure 9: Fire damage to the rear of the motorcoach.

Figure 10: Right side damage to the motorcoach.

The fiberglass, plastic, and aluminum components of the body paneling, fascia, and splashguard surrounding the rear axle wheel well were completely consumed by the fire. The rubber of the tag axle tire was consumed. The steel cord from the sidewall and bead was the only remnants of the tire. The tag axle alloy wheel was melted clockwise from the 3-11 o'clock positions, with a hardened pool of melted aluminum at the 6 o'clock position. The rubber sidewalls of both drive axle tires were completely consumed by the fire, which resulted in the separation of the melted tread and collapse of their steel cord structures. The outer alloy wheel was intact with evidence of high heat from the 7-12 o'clock positions. Damage to the right rear axle area is depicted in **Figure 11**. Fire involvement of the tires had incinerated the polymer splash shield within the wheel well and consumed all other combustible materials in close proximity to the flames. Air ride suspension assemblies were reduced to only heat-oxidized metal components. Fire involvement surrounding the vertical frame-mounted shock absorbers had consumed the rubber and polymer components in a manner such that the integrity of their compression chambers was compromised, leading to the subsequent collapse of the right rear suspension.

Figure 11: Fire damage to the right rear axle area of the motorcoach.

Aluminum and fiberglass body paneling above the rear axles were burned full-thickness, with exposure of the underlying frame in the area of the H-pillar. The surrounding body paneling between the I and F-pillars displayed heat and fire damage consisting of burned paint, blistering, and isolated heat-induced buckling. The storage compartment access door immediately forward of the drive axle remained operational and was partially ajar. This was attributed to post-incident salvage activities. Its exterior shell was blackened from heat and fire damage, with the majority of the paint blistered and burned.

There was minor damage to the HVAC compartment door forward of the F-pillar consisting of smoke discoloration from thermal ventilation of the fire through the vertical air induction slats. The fuel filler cap located in the upper rear corner of the HVAC compartment remained intact, though no manufacturer's fuel system specification placard was present. Remaining body panels and storage compartment doors below the beltline from the F-pillar forward to the passenger access door remained operational, intact, and undamaged.

The passenger access door at the front corner was a remote automated pneumatic door. The upper and lower glazing panels were intact and undamaged, indicating that the door remained open during the incident. The forward six glazing panels between the A and G-pillars were shattered, with their perimeters still intact and seated within the gaskets on all frame edges. The aforementioned glazing panels were shattered by firefighters in an effort to ventilate the interior of the motorcoach and aid in the extinguishment of the fire. There were no remnants of the four remaining glazing panels rearward to the J-pillar, and the majority of their glass, molding, gaskets, and aluminum framework was melted, or completely consumed by the fire.

Roof

The fire expanded in all directions away from its origin due to the fuel availability created by the involvement of the tires and other vehicle components and progressed to the interior of the passenger compartment before extending vertically to the roof. The aluminum, fiberglass, and polymer components of the roof were completely consumed from the D-pillar to the rear of the motorcoach. Only the exposed frame grid-work of the roof structure remained, which was oxidized, buckled, and distorted by the high heat of the fire. The emergency roof exits originally located between the C to D-pillars and the G to H-pillars were completely consumed by the fire.

Interior

The interior of the motorcoach sustained extensive damage as the fire spread into the passenger compartment above the rear axles. A large amount of debris, which had fallen from the ceiling or displaced by firefighters, littered the soot and smoke covered stainless steel forward entrance staircase to the motorcoach. The entire instrument panel and driver's compartment was melted, distorted, and discolored by direct heat and fire involvement. Wiring harnesses of the gauge cluster were exposed by the consumption of the polymer paneling above the instrument panel. The vinyl coating of the steering wheel was completely melted from the wheel, with a small disfigured portion remaining at the center of the hub. Only the oxidized metal frames of the seats remained, as all of the fabric and cushions of all seats, including the passenger seats and driver's seat, were completely consumed. The onboard restroom was also consumed by the fire. A view of the rear of the passenger compartment is provided in **Figure 12**.

The aircraft-style overhead storage compartments with top-hinged doors were completely consumed by the fire aft of the C-pillar. The structure of the forward-most overhead compartment remained on either side of the passenger seating area, still mounted to the small section of the remaining roof panels **(Figure 13)**.

Figure 12: Rear of the interior of the motorcoach.

Figure 13: Forward area of the interior of the motorcoach.

SCI Fire Source

The fire appeared to have originated in the right rear axle area of the motorcoach based on driver statements, the science of fire behavior, and the SCI investigative findings. During the inspection of the motorcoach, the SCI team ruled out the engine compartment as a potential location of origin due to a lack of evidence of mechanical malfunction, electrical short-circuit, flammable liquid residue, or high heat damage typically associated with vehicle fire origin. Other areas of the vehicle were ruled out for the same reason.

Physical evidence at the scene consisted of a long dragging tire mark on the right shoulder of the roadway that extended from the outboard travel lane and ended at the burn pattern. This tire mark is documented in **Figure 14**, which depicts the look-back view of the motorcoach's trajectory. Based on its location with respect to the trajectory and position of the motorcoach, the tire mark was associated to an outboard tire on a right rear axle.

Figure 14: Tire mark visible in look-back of motorcoach's approach.

Figure 15: Location of fire origin at right tag axle.

Fire pattern analysis and knowledge of the tendency of fire to progress vertically and horizontally toward sources of fuel, heat, and oxygen were used in identifying the origin of the fire. Based on the overall burn pattern of the fire's progression, the SCI team focused on the right rear area of the motorcoach as the source of the fire's evolution. The SCI team noted evidence of high heat and extensive fire-related damage concentrated within the right rear axle area.

The SCI team recognized the degree of incineration of the tag axle tire, corresponding alloy wheel, and proximal vehicular components relative to the remaining axle positions on the motorcoach. As the fire's fuel sources in this area were exhausted, the fire proliferated vertically and horizontally through the undercarriage towards supplemental fuel sources within the engine compartment, left axle area, and ultimately the passenger compartment. Accordingly, the SCI team identified the right rear tag axle as the location of the fire's origin **(Figure 15)**. The specific cause of the fire could not be determined as the wheel ends were not disassembled; therefore brake and wheel bearing issues could not be ruled out as the source of the dragging tire.

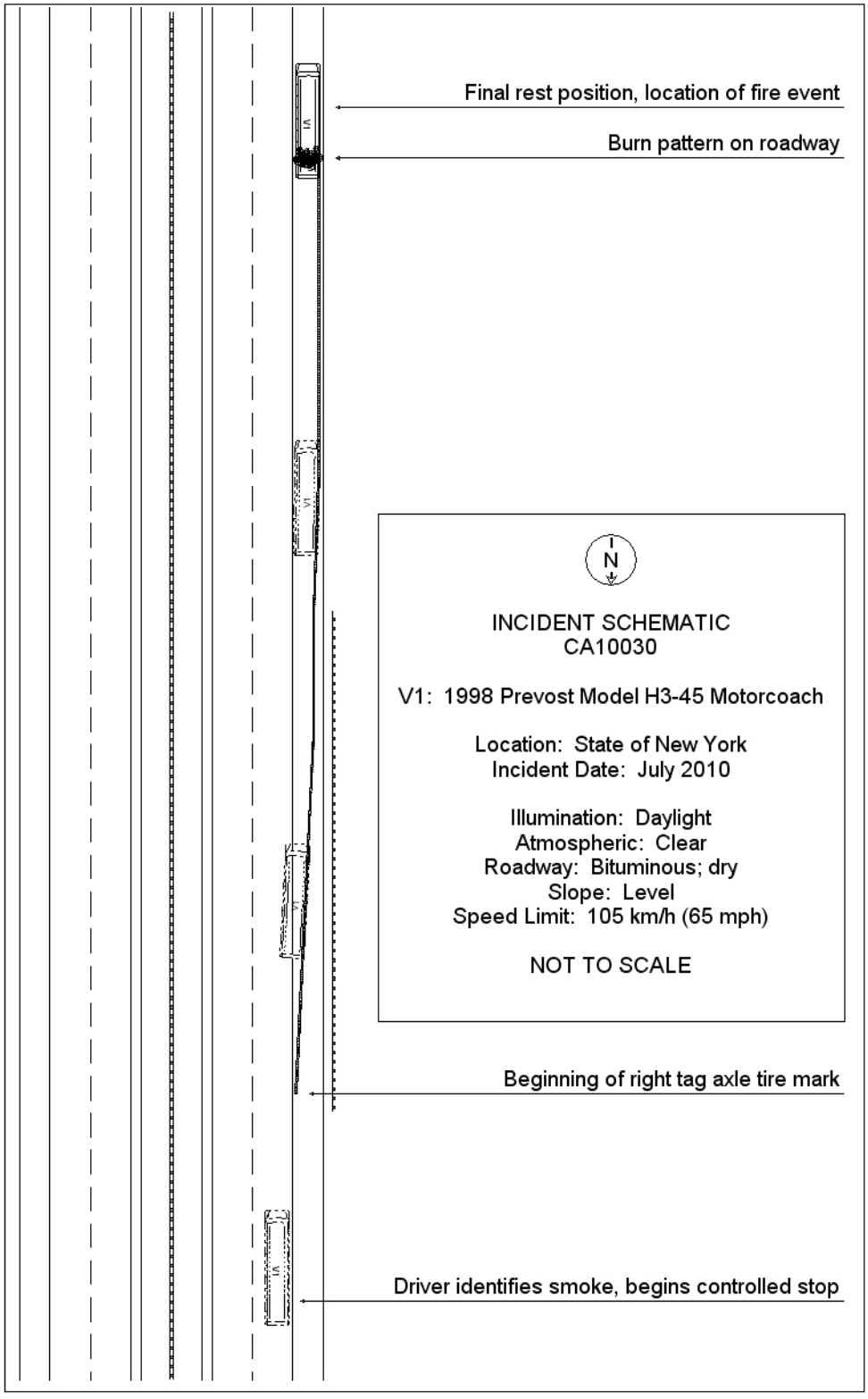

Figure 16: Incident schematic.

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 the photographs and documentations 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.

SCI Case Number CA10030

Determination of Origin: The driver of this motor coach reported hearing a tire blowout followed by noticing smoke emanating from the right rear of the coach. Once he was pulled over he exited the coach and determined he had a right rear tire fire. Extended response time by the local volunteer fire department allowed for considerable involvement/consumption of the coach and therefore the burn patterns and damage to the vehicle are not indicative of an area of origin. The area of origin was therefore determined as the right rear tire by the witness accounts, and verified by tire marks found at the scene that correlate well to a right rear tire.

Determination of Cause: Comparing the amount of relative damage to the two right rear wheels on this vehicle, and the damage to the structure around the rear axles, indicates that this fire is consistent with a right side tag axle tire fire. The root cause of the tire fire cannot be determined as the wheel end was not disassembled and the brakes, wheel seals, and bearings were not inspected.