SURVIVAL FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

Baltimore, MD

HWY17MH007

(23 pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C.

SURVIVAL FACTORS GROUP CHAIRMAN'S FACTUAL REPORT

A. CRASH INFORMATION

Location:	Eastbound Frederick Avenue between South Monastery Avenue and South Morley Street, Baltimore, Baltimore County, Maryland
Vehicle #1:	2015 IC 64-Passenger School Bus
Operator #1:	AAAfordable Transportation, LLC
Vehicle #2:	2012 Ford Mustang
Operator #2:	Private Operator
Vehicle #3:	2005 New Flyer Transit Bus
Operator #3:	Maryland Transit Administration
Date:	Tuesday, November 1, 2016
Time:	Approximately 6:30 a.m. eastern standard time
NTSB #:	**HWY17MH007**

B. SURVIVAL FACTORS GROUP

Ronald A. Kaminski, Survival Factors Investigator, Group Chairman
NTSB Office of Highway Safety
490 L'Enfant Plaza East, S.W., Washington, DC 20594

C. CRASH SUMMARY

For a summary of the crash, refer to the *Crash Summary Report,* which can be found in the docket for this investigation.

D. DETAILS OF THE SURVIVAL FACTORS INVESTIGATION

The Survival Factors investigation concentrated on interior and exterior inspections of the 2015 IC school bus and 2005 New Flyer transit bus, review of the emergency response, injury documentation, and interviewing of first responders and transit bus passengers. For uniform description, "left" will refer to the driver's side, and "right" will refer to the boarding door side of both buses.

1. 2015 IC School Bus

The school bus was occupied by only the driver and a school aide, at the time of the crash. The inspection of the school bus was conducted on Saturday November 5, 2016 at Maryland Transit Administration's Bush Division facility at 1515 Washington Blvd. Baltimore, Maryland.

1.1. 2015 IC School Bus Exterior Deformation

The school bus sustained two impacts. The first impact was to the front of the bus colliding with rear of the 2012 Mustang. The second impact was to the front left bumper corner when it collided with the transit bus causing damage to the front end with the damage extending down the left side.

The deformation to the bus's front end from impacting the Mustang could not be determined due to the severity of the school bus's impact with the transit bus. The estimated maximum crush was approximately 91 inches to the front bumper and 125 inches to the apex of the driver's side front windshield header and left A-pillar. The direct damage extended to the roof, which was also buckled aft. The overall impact resulted in the left frame rail being shifted to the right approximately 27 inches as measured at the upper front shock absorber mount, with an upward deflection. See **Figure 1** below[1]

Figure 1. Exterior view of deformation to front end and left side of the crash involved school bus.

The impact resulted in buckling to the loading door/right A-pillar. The loading door side roof was buckled and extended to the mid-point of the bus. The left A-pillar was torn away. The

[1] Refer to Survival Factors Photo 1. Exterior view of deformation to front end and left side of IC school bus.

rear bumper was slightly separated from the chassis due to the frame deformation. The loading stairwell was also deformed with the stair steps shifted upwards and back.

The left exterior rearview mirror was broken off. The pop-out stop sign on the left exterior adjacent to the driver's seat was also torn off. Both windshield panes of the bus were broken out.

The bus was equipped with eleven windows on each side plus the driver's slider window. Windows are referred to starting from 1 at the front. There were three emergency exit windows on both sides, windows 3, 6, and 9. The side window openings except the emergency exit windows measured 24 inches wide and 28 inches in height. The emergency exit windows measured 24 inches wide by 26 inches in height. The bi-fold loading doors each had upper and lower windows and only the forward bi-fold door windows were cracked. The bi-fold loading doors were forced open by first responders and was not operational. The driver's slider window and the first two side windows on the left were broken out. The first two windows behind the loading door were also cracked. The rear emergency exit door was operational.

1.2. 2015 IC School Bus Interior Inspection

The interior damage was concentrated primarily to the driver's seating area and the first row behind the driver. The roof, sidewall and dash were crushed aft and laterally to the right side. As previously mentioned, the front-loading door stairwell was deformed.

Figure 2. Interior view of intrusion to driver seating in the school bus.

As shown in **Figure 2**, the driver seat was significantly displaced aft and laterally towards the center of the bus due to intrusion from the transit bus.[2] First responders cut the driver's seatback

[2] Refer to Survival Factors Photos 2-6. Interior views of IC school bus and driver's seat belt.

off to remove the entrapped driver. Inspection of the driver's lap and shoulder belt showed evidence it stretched and separated during the crash and had been cut by first responders.[3] All instrument panel gauges were displaced and broken out. The driver's steering wheel was cut off from the column during the extrication process.

The 64-person capacity school bus had 11 rows of seats on each side and was not equipped with seat belts. The first 10 rows were 3-person seats with the last row on each side being a 2-person seat. There were padded modesty panels behind the driver's seat and at the loading stairwell. Emergency responders cut out both modesty panels (at loading door and behind the bus driver's seat), the two rows of seats behind the driver, and the second seat row on the passenger side to extricate the bus driver. The cut seats and right-side modesty panel were found in the debris pile and using the extrication marks left on the seat frames, investigators determined where each piece was originally positioned and then examined them. Examination of the cut-out seats and modesty panels revealed visible deformation to only the backside of the first-row seatback indicating that the school bus aide was seated in the second row behind the driver, towards the aisle. The remaining cut-out modesty panel, seatback and seat pan frames exhibited no other damage. Examination of the remaining passenger seats revealed that numerous seat pans had been flipped forward in rows 5-8 on the driver's side and row 11 on the passenger's side. According to the Baltimore Police Detective in charge of the investigation, numerous seat pans were flipped up to search for any possible child occupants.

The school bus was equipped with two Specialty Manufacturing roof hatches located at row #3 and row #9. The forward roof hatch was not damaged but was found partially opened at the time of inspection and could not be easily closed due to buckling of the roof. The rear hatch remained closed and operational. A 5 pound Amerex fire extinguisher Model B402 was found in the debris pile at the inspection site. The tag attached to the extinguisher (serial number CB969711) indicated that it expired July 2017.

Several areas around the bus driver's seating area showed evidence of occupant contact (biological evidence). The steering wheel was deformed and as previously mentioned was cut off during the extrication process.

1.3. IC School Bus Seating and Passenger Egress

At the time of the crash the school bus was occupied by only the driver and a bus aide. [4] Although the bus aide stated she was seated behind the driver in the first row, contact evidence found to the back of the seatback of the first row on the driver's side indicate that the bus aide was seated in the second row behind the driver in the aisle seat position.

According to the interview NTSB investigators had with the school bus aide, she exited out the rear emergency door on her own after the crash.[5]

[3] A Baltimore City Fire Department Lieutenant stated in a follow-up call that a firefighter used a dull seat belt cutter to cut the seat belt causing it to shred.
[4] Refer to section 4.3 Injury Summary for injury information of bus driver and school aide.
[5] Refer to Human Performance Group Chairman's Attachment 5. Interview with bus aide

2. 2012 Ford Mustang

The Mustang was occupied by the driver. Inspection of the 2012 Ford Mustang was conducted on Friday November 4, 2016 at the City of Baltimore's vehicle pound at 6700 Pulaski Highway, Rosedale, Maryland.

2.1. 2012 Ford Mustang Exterior Inspection

The 2-door passenger vehicle sustained three impacts during the crash sequence. The passenger vehicle's initial impact involved the school bus striking the rear. The second impact was with the curb resulting in damage to the left front wheel assembly. The third impact was to the front bumper and edge of the hood from impacting the brick wall and fence.

The impact was concentrated to the vehicle's rear on the driver's side (see **Figure 3a and 3b** below). The direct damage from the rear impact was 38 inches wide with the maximum crush of approximately 55 inches above bumper and approximately 28 inches at bumper level.[6] The rear impact resulted in the driver's door being jammed closed. The right passenger door was operational.

Figures 3a and 3b. Overhead view of deformation to back end of Mustang and left rear angle view of deformation.

The direct damage width to the front bumper was approximately 35 inches. The maximum crush could not be determined due to the facia on the bumper corner leaving a void exposing the front left tire. The entire plastic grille was broken out. The left front wheel assembly sustained damage from the curb impact.

The rearview window was completely broken out as was the left rear side window. The entire rear end of the vehicle sustained deformation. The windshield was cracked and the crack

[6] Refer to Survival Factors Photo 7-9. Frontal, overhead, and rear views of deformation to 2012 Ford Mustang

radiated across the entire surface. The driver's window was rolled down and was still intact. Both passenger side windows remained intact.

2.2. 2012 Ford Mustang Interior Inspection

Damage to the interior was primarily to the back-seat area. The rear impact from the school bus resulted in severe intrusion into the driver's seatback.[7]

The passenger vehicle was equipped with a lap and shoulder belt in all 4 seat positions. The front seatbelts were equipped with a pretensioner and load limiter. Inspection of the driver's seatbelt revealed that the pretensioner fired for the driver and the seatbelt was locked in the extended position. Inspection of the driver's seatbelt revealed stretching and heat abrasion on the webbing in the area of the D-ring. The driver and front right passenger seat positions were also equipped with frontal and side airbags. The driver airbag and front right passenger airbag did not deploy. The side airbags were in the seatback on the outboard side of the front seats. The driver's side air bag deployed from the outboard side of the driver's seat.[8] There was a 3-4-inch diameter area of possible driver contact on the inboard side of the air bag.

2.3. Vehicle Electronic Data

The 2012 Ford Mustang's Airbag Control Module (ACM) was powered on and downloaded by the Baltimore Police Department through the On-Board Diagnostic II (OBD II) port using the Bosch Crash Data Retrieval (CDR) software. The module was capable of recording multiple events which included: pre-crash, 1st prior event, and "most recent event". Event data was recorded for the pre-crash, 1st prior event and "most recent event." Both events indicate identical ignition cycles at the event.

The system status at the "most recent event" reported that no diagnostic trouble codes (DTC) were present and the dashboard airbag warning lamp was "off". The event was listed as "complete". The ACM reported a maximum longitudinal change in velocity of + 28.01 mph at 300 ms post-Algorithm Enable (AE). The recorded maximum lateral change in velocity was -3.2 mph at 146ms post-AE.

Pre-crash data was recorded for a period of 5 seconds before AE and reported in 0.05 second intervals. The data indicated that the vehicle was traveling at about a speed of 16.4 mph when it was struck by the transit bus.

There was a deployment command by the ACM for the driver side airbag. The seat belt buckle switch status for the driver's seat indicated "buckled".

[7] Refer to Survival Factors Photo 10. Interior view of intrusion to back seat of Ford Mustang
[8] Refer to Survival Factors Photo 11. View of driver's seatback side air bag in Ford Mustang

3. 2005 New Flyer Transit Bus

The inspection of the 2005 New Flyer Transit Bus was conducted on Saturday November 5, 2016 at Maryland Transit Administration's Bush Division facility at 1515 Washington Blvd, Baltimore, Maryland.

3.1. 2005 New Flyer Transit Bus Exterior Inspection

The transit bus sustained extensive damage as a result of the impact with the school bus. The impact damage started at the front left bumper corner and extended vertically to the windshield header. The damage extended down the left side tearing away the sheet metal and all seven transit bus windows including the driver's slider window creating an approximate 32-foot-long by 6-foot tall opening.[9] (See **Figure 4** below) At the end of the left side damage, just past the rear wheels, there was an approximate 12-foot section of thin metal sidewall structure from the transit bus that was found folded up, accordion style.[10]

Figure 4. Exterior view of extent of deformation to front left bumper corner and down left side of New Flyer transit bus.

3.2. 2005 New Flyer Transit Bus Interior Inspection

The transit bus interior damage mirrored the extensive exterior damage. The intruding front end of the school bus tore away all 18 seats (seats 1-18) and the majority of vertical and overhead

[9] Refer to Survival Factors Photos 12-15. Exterior views of deformation to left side of New Flyer transit bus.
[10] Refer to Survival Factors Photo 15. Close-up view looking rear to front at left side New Flyer transit bus sheet metal buckled up accordion style.

yellow handrails down the entire left side. All the seats on the right side (seats 24-39) remained attached to floor and sidewall as did the last row of (seats 19-23) across the back of the bus. Seat numbers are shown on the seating chart **Figure 6.**

The manufacturer's build sheet indicated that the driver's seat was manufactured by Recaro North America Inc. and the model was the Ergo AM80 with pneumatic suspension. The driver's seating area sustained intrusion resulting in the driver's seat pan being shifted aft and inboard approximately 11 inches. The driver's seatback was partially detached, being connected on the inboard side by electrical conduit. The driver's seat was equipped with a lap and shoulder belt that first responders cut in order to extricate the driver. Examination of the driver's seat belt showed signs of heavy heat abrasions and cupping, indicating loading from the driver's usage. The belt latch remained buckled. The driver's steering wheel was deformed.[11] The passenger seats were not equipped with seat belts.

Immediately aft of the driver's seat on top of the wheel well box was a large 3-foot square by 5-foot tall radio box which was completely sheared away from its mounting. The wheel well box adjacent to the front-loading stair was intact and inside was a 5 pound Amerex fire extinguisher and a Safe-Lite emergency kit containing reflective triangles and flares.

The interior seating configuration was transit style with five inward facing seat rows (three on left side two on right side) and eleven forward facing rows (five on left side and six on the right side). The very last row of the bus extended from side to side with five forward facing seats. Refer to **Figure 6**. MTA Bus Seating Chart for layout configuration.

The manufacturer's build sheet indicated that all the passenger seats, including the fold-up wheelchair seats, were manufactured by American Seating Company with the model being the Otaco 6468. According to the on-line brochure, the seats were constructed using a pre-formed molded fiberglass shell and high-strength thermoplastic back with a high-strength, fatigue resistant, welded steel frame.[12] None of the passengers seats were equipped with seatbelts.

The seat attachment points for the entire left side were all torn away from their mountings. The seatbelts for the left side wheelchair securement that were located on the floor below the flip-up seats 1-5 remained primarily intact and were not in use at the time of the crash. The securement belts/hooks located on the left sidewall and near the left sidewall were torn away.

All the seats down the right side remained in place but sustained some damage as a result of the intrusion and flying debris. Intruding debris from the left side impact was displaced into the aisle and partially into the passenger seats on the right side.[13] The intruding debris restricted access and the examination of seats 32-33 to 36-37. However, all the right-side seats remained intact even though some sustained dents and deep scratches from the intruding and flying debris. The overhead handrails on the right side were displaced from seat 30-31 to 38-39. See **Figure 5** on next page.

[11] Refer to Survival Factors Photos 16-19. Interior views of driver seating area, seat belt and steering wheel of the New Flyer transit bus.
[12] http://www.americanseating.com/transportation/products/transportation-6468
[13] Refer to Survival Factors Photo 20-21. Interior views looking from rear to front in the crash involved transit bus and front to rear in an exemplar transit bus.

Figure 5. Interior view looking from rear to front showing extent of intrusion into occupant compartment in the crash involved transit bus.

The right side of the transit bus had 5 windows plus the front entry door and rear side exit door, which were all still intact. The clear plastic cover on the emergency box near the upper left corner of the side exit door was broken out.[14] Windows 2-3 on the passenger side were emergency exit windows that measured 38 inches in height and 49 inches in width. At the time of the inspection, both emergency exit windows were open/ajar and still operational. The emergency exit windows were all marked and had an instruction sticker in red print stating "Pull red handle down and hold while pushing window out at bottom" next to the red handle on the aft vertical surface. There were two Transpec roof hatches, one at the very front near the driver's seating area and the other in the very back just forward of the back row. At the time of the inspection, the rear hatch was closed and operational while the forward hatch was partially open.

The sheet metal covering the left rear tandem wheels under seats 17-18 was torn open exposing the undercarriage and wheels.

Evidence of occupant contact and biological fluids were found on the floor, the seats, and numerous displaced vertical and overhead yellow handrails. The backside of the seatback in seat 28 located in the aisle seat on the right side, 2 rows behind the side entry door, had an indentation in the fiberglass shell in a location consistent with a knee impact. In seats 24-25 there was blood evidence on the leading edge of the seat pan. There was blood evidence on the lower portion of the forward modesty panel wall at the side exit door. There were areas of dried biological fluids near the front in the aisle aft of the loading door and another towards the center of the bus forward of the side exit door.

[14] The emergency box on the side wall located at the upper left corner of the rear side doors stores the pull handle that when pulled releases the air pressure on the doors allowing them to be pushed open.

3.3. New Flyer Transit Bus Seating Chart

The transit bus was occupied by the driver and thirteen passengers at the time of the crash. Based on interviews with five passengers (in seats 37, 31, 25, 14, and 10) interior video, autopsy reports, and police post-crash photographs, a seating chart (**Figure 6**) was established.[15, 16]

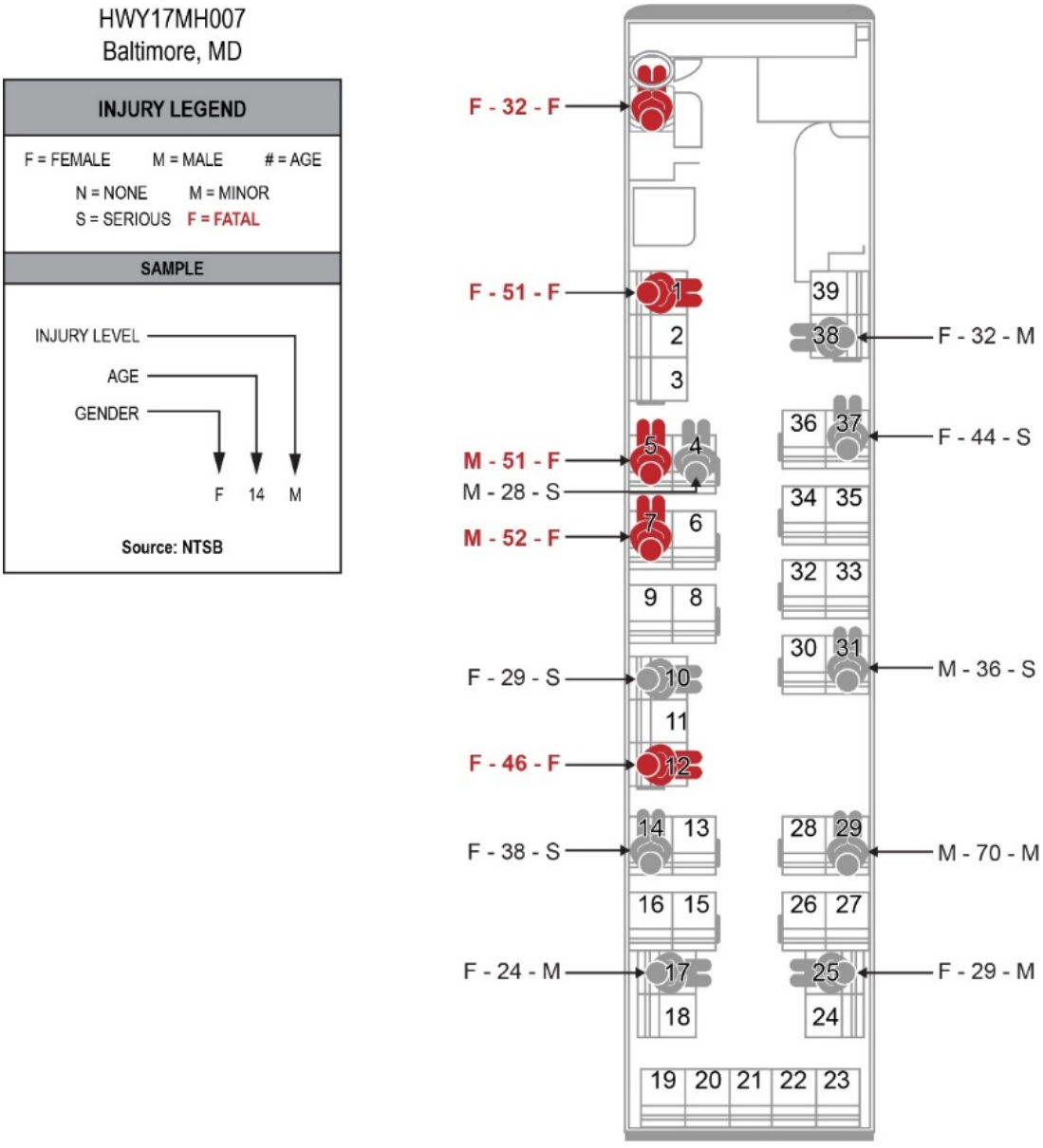

Figure 6. MTA Bus Seating Chart

[15] Refer to Survival Factors Attachment 1. Passenger Interviews
[16] See the Onboard Video Summary Report in the docket for this investigation.

3.4. New Flyer Transit Bus Passenger Egress

Based on interviews with five passengers, after the crash two passengers exited the bus through the side rear door, one passenger stated that they went out the right side emergency exit window, another passenger stated she was helped out through the left side opening, and the fifth passenger was carried out on a stretcher.[17] Seven of the remaining eight passengers were carried out on backboards by first responders. The last passenger egressed out of the bus on his own but his exit path is unknown.

3.5. Exemplar New Flyer Transit Bus

An examination of an exemplar transit bus documenting the original seating configuration and positions of the radio box, stationary seats, fold-up seats, and locations of the wheelchair securement seatbelts was performed.[18]

The driver's seating area was closed off on the entry door area by a thick clear Plexiglas shield that locked from the inside. A portion of the plexiglass shield is shown to the far-right side of the **Figure 7**, where is it seen attached to the radio box behind the driver's seating area. The driver seat was air cushioned and equipped with a lap and shoulder belt. All 39 seats in the transit bus were constructed of the same molded fiberglass shell and high-strength thermoplastic back as on the accident bus.

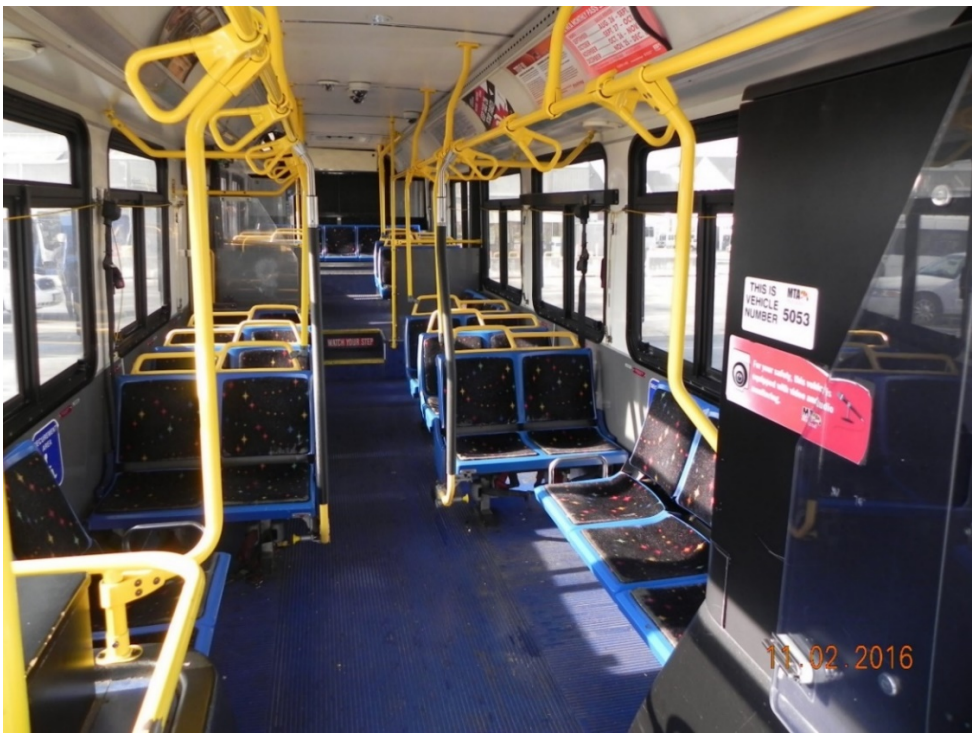

Figure 7. Interior view of exemplar New Flyer transit bus looking from front to rear. **Note:** Seat configuration.

[17] Refer to Survival Factors Attachment 1. Passenger Interviews
[18] Refer to seating chart schematic on previous page for configuration.

The exemplar New Flyer transit bus windows and seating layout was identical as the accident vehicle with the exception of the wheelchair securement seatbelts that were manufactured by Indiana Mills Manufacturing Inc. (IMMI) instead of American Seating Company. These securement belts were located under the flip-up seats in seats 1-5 (3-person flip up seat and a two-person flip-up seat) on the left side and seats 36-39 (both two-person flip-up seats) on the right side.

3.6. Transit Buses

Under the Federal Motor Vehicle Safety Regulations (FMVSRs) Title 49 Code of Federal Regulations, Part §390.3(f)(2), the transit bus is exempt and not required to meet standards addressing occupant protection (FMVSS 201 Occupant Protection in interior Impact and FMVSS 202 Head Restraints), or crash protection for the occupant compartment (FMVSS 208 Occupant Crash protection- Driver only).

A research study published in February 2012 that was conducted by the National Institute for Aviation Research (NAIR) and sponsored by the U.S. Department of Transportation, evaluated the crashworthiness of mass transit buses.[19] For better understanding of how injuries and damage result from bus crashes, this research used computational and virtual reality methods to model crash effects on buses and their occupants and full-size sled tests with "crash dummies" of varying sizes to verify the simulation results.

The NAIR research study had three main objectives;
(1) define the structural response of mass transit buses
(2) describe the occupant kinematics and injury mechanisms in the interiors of mass transit buses, and
(3) think of interior design ideas and crashworthiness design measures for mass transit buses.

The research found that the main mechanism of injury to passengers were passenger-to-passenger interaction and passenger-to-seat-structure impacts. The research recommended design strategies to help reduce passenger injuries and fatalities during side, frontal, and rear-impact collisions of transit buses. The study also made recommendations for filtering the current accident database for transit buses and mixing mathematical modeling into future research and accreditation measures.

4. Emergency Response

The Baltimore County dispatchers were notified of the crash through the 911 system at 6:28 a.m. At 6:32 a.m. the Baltimore City Fire Department (BCFD) dispatched Truck 8 with the initial Incident Commander (IC), Rescue Squad 20, and Medic 15. Truck 8 and the IC arrived on scene at 6:35 a.m. followed by Squad 20 at 6:38 a.m. and the first arriving BCFD Medic 15 at 6:41 a.m.[20] The Baltimore Police Department (BPD) was dispatched at 6:33 a.m. and their first unit

[19] https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0021.pdf
[20] Refer to Survival Factors Attachment 2. Baltimore City Fire Department Incident Report

arrived at 6:34 a.m.[21] The Maryland Transit Administration Police was notified of the crash at 6:35 a.m. and responded with their first unit arrived at 6:46 a.m.

When the first BCFD lieutenant arrived on scene from the west at 6:35 a.m. he stopped near the Mustang behind a squad car with flashing lights and initially didn't see the entangled buses further east down the street. As he walked around the squad lights he saw the buses and immediately went back in his truck and drove closer to the final rest area of the buses. As he pulled up, he saw people lying on the grassy parkway and immediately requested that dispatch send out a couple more medic units. As the highest-ranking officer on scene, the lieutenant assumed Incident Command (IC). After completing his scene evaluation and seeing people underneath the debris in the MTA bus, at 6:40 a.m., the acting IC declared the crash a Mass Casualty Incident (MCI) and requested three additional medic units and a rescue group. A triage area was set-up on the grassy parkway adjacent to the final resting area south of the transit bus.

The IC instructed the crew from Truck 8 and other firefighters to start extrication of the viable and deceased passengers stuck under the debris in the transit bus. He then radioed Rescue 26, who were in route, and instructed them to start extrication of the school bus driver upon their arrival. First responders initially found the school bus driver viable but he expired early in the extrication process. The transit bus driver was found entrapped in her seating area and pronounced deceased early in the event.

When the BCFD Battalion Chief arrived on scene at 6:44 a.m., he assumed command from the lieutenant and proceeded to set up a command post, that included the EMS chief, the EMS branch director. He assigned a lieutenant as triage and transportation officer. He requested another EMS officer to take over triage while the initial one, handled transport. At 6:54 a.m., the IC requested two more Medic units.

The BCFD sent Engine Units 53 and 42, Squad 40, Trucks 10 and 8, and Rescue 1 and Rescue 26 (both extrication units).[22] The BCFD sent six ambulances (3 Advanced Life Support and 3 Basic Life Support) and transported eight patients with varying degrees of injuries, to local hospitals.[23] The Baltimore County EMS sent ALS units Medic 4 and Medic 13 and transported two seriously injured patients.[24] One transit bus passenger was not transported from the scene but went later to a hospital for treatment.

A review of the ten Transport records for the injured occupants of all three vehicles showed that after the IC declared the MCI at 6:40 a.m. and then requested two more Medic/Ambulance units at 6:54 a.m. the total of Medic units that responded was eight. Two Medic units arrived on scene 31 and 36 minutes after the initial dispatch but only 7 and 12 minutes after being dispatched at 6:54 a.m. Although Medic 15 went out on the initial call and arrived at 6:35 a.m. they remained on scene and conducted triage while the later arriving Medic units transported patient to hospitals.

[21] Refer to Survival Factors Attachment 3. Baltimore Police Department CAD logs
[22] Refer to Survival Factors Attachment 4. Baltimore Fire Department Response Synopsis
[23] ALS refers to Advanced Life Saving and BLS means Basic Life Saving
[24] Refer to Injury Summary on Page 19 of this Report

The IC stated that later in the incident the Chief ordered him to send everybody through critical incident stress management. At that point, the IC transferred command over to another Battalion Chief who then oversaw the removal of the deceased from the buses.

According to a Detective with the Maryland Transit Administration Police, once on scene they assisted the Baltimore City Police in not only securing the scene but also dispatched the appropriate people out to the bus in order to retrieve and download the video footage captured by the video system on the MTA bus. Additionally, the MTA police coordinated moving both buses a secure location at the MTA facility.

Traffic on both roadways was closed immediately following the crash and was redirected. The roadways were re-opened at 5:37 pm. Ambulance egress from the scene was set-up for ambulances to depart the scene from the eastside on Frederick Avenue.

Eight local emergency service agencies responded to the scene of the crash. The responding agencies were:

Baltimore Police Department	Baltimore City Fire Department
Baltimore County Ambulance	Maryland Transit Administration Police
Maryland Transportation Authority Police	Baltimore County Medical Examiner
Maryland Department of Environment	Maryland Transit Administration

Baltimore fire department incident reports are included in this factual report.

4.1. Baltimore Fire Department Mass Casualty Incident

The Baltimore City Fire Department has a Method of Operation (MOP) 807-1 for handling Mass Casualties Incidents (MCI).[25] The BCFD categorizes any incident involving more than 10 patients requiring treatment and transport to be classified via radio as a "Mass Casualty Incident." Mass casualty incidents are further classified as "Level 1," "Level 2," or "Level 3" based on the number of patients.

According to the MOP 807-1 this crash was categorized as a Level 1 Response that required the following response;

- 11-25 patients
- 1 Medic Unit
- 1 EMS District Officer
- 1 Suppression Company
- Box Alarm (including 1 Medic Unit)
- One Additional EMS District Officer (for a total of 2)
- Four Additional Medic Units (for a total of 6)
- Rescue 1
- BC EMS
- Medical Director

[25] Refer to Survival Factors Attachment 5. Baltimore City Fire Department Mass Casualty Plan

The MOP instructs the first arriving unit that an incident where a large number of people appear to be sick or injured will make a rapid, approximate assessment of the number and severity of patients using the five (5) S's of initial scene management during a mass casualty incident (MCI). They are:

- Safety Assessment
  - Assess the scene for safety
- Size-up
  - Type and cause of incident
  - Approximate # of victims
  - Severity of injuries (ambulatory vs. non-ambulatory)
  - Area involved (perimeter control and access issues)
  - Pertinent demographics
- Send Information
  - Establish command
  - Size up communications
  - Official declaration of MCI (Level 1, 2, and 3)
  - Request notification of EMRC/FRED alert
  - Request additional resources
- Set-up
  - Establish staging
  - Identify best ingress and egress
  - Establish work areas for triage, transport, and morgue
- START (Simple Start and Rapid Triage)

4.2. Maryland Transit Administration

The Maryland Transit Administration is a division of the Maryland Department of Transportation (MDOT). As part of their outreach program, the MTA recently developed a training program titled "*First Responder Training: Local Bus*" that has seven Modules with embedded video. The purpose of this training program was designed to train their personnel and first responders from surrounding jurisdictions to handle incidents within the MTA Local Bus Transportation system.[26]

One of the training modules is titled: "*Incident Safety, Command and Management*" explains the concepts of incident safety, incident command, and the National Incident Management System (NIMS), including the divisions of labor and responsibilities of the different responding groups, and the importance of operating under a clearly understood unity of command. The introduction states that the goal of the module is to familiarize personnel and first responders with safety and incident command protocols, depending on the size and scope of the event.

4.3. Hospital and Medical Examiner Information

Eight transit bus passengers and the school bus aide were transported by ground ambulances to five area hospitals with varying degrees of injuries. The ninth surviving transit

[26] The staff of the Maryland Transit Administration's Office of Training and Development, Bus Operations, Office of Safety, Quality Assurance & Risk Management; and the Baltimore City Fire Department created the MTA training program.

passenger went to the hospital on his own. The four fatalities were transported to the Baltimore County Morgue where autopsies were later completed.

The treating facilities are as follows:

University of Maryland Medical Center	Johns Hopkins Hospital
St. Agnes Hospital	Sinai Hospital
University of Maryland- R. Crowley Adams Shock Trauma Center	Baltimore Office of Chief Medical Examiner

4.4. Injury Summary

Based on the BPD Traffic Collision report, this crash resulted in six fatalities, the driver of the IC school bus, the transit bus driver, and 4 passengers in the transit bus. Medical records revealed that five transit bus passengers sustained serious injuries, four passengers in the transit bus, the Mustang driver, and the school bus aide sustained minor injuries.

The transit bus driver and four transit passengers that sustained fatal injuries were all seated on the left side of the transit bus, in the area of impact. Refer to **Figure 6**. MTA Bus Seating Chart for the exact seat positions of the deceased.

The occupant injuries are summarized in **Table 1**.

Table 1. Summary of Occupant Injuries

Vehicles and Occupants (17 Total)	**Injury Information***		
	Minor	**Serious**	**Fatal**
2015 IC School Bus			
Driver (1)	0	0	1
Passenger (1)	1	0	0
2012 Ford Mustang			
Driver (1)	1	0	0
2005 New Flyer Transit Bus			
Driver (1)			1
Passenger (13)	4	5	4
TOTAL	**6**	**5**	**6**

***** Injury level as defined by Title 49 Code of Federal Regulations 830.2: Fatal - injury which results in death within 30 days of the accident; Serious - injury which requires hospitalization or results in fractures, hemorrhages, nerve, tendon, internal organ damage, or serious burns; Minor - other injury that is not a serious injury; None - used for occupants who were not injured.

Based on the autopsies performed on the school bus driver, transit bus driver, and four passengers, the Baltimore County Medical Examiner determined that the cause of death for all 6 persons was the result of multiple injuries sustained in the crash.

The 67-year-old, male, school bus driver sustained fatal injuries as a result of the crash. A summary of his injuries is as follows:

Head and Neck Injuries

- Fracture at the junction of the fifth and sixth cervical vertebrae
- Subgaleal hemorrhage to the brain

Torso Injuries

- Bilateral rib fractures with left pneumothorax
- Fracture of the 5th thoracic vertebrae
- Epidural and subdural hemorrhage around the thoracic spinal cord
- Internal organ laceration

Extremity Injuries

- Fractures of the left femur and tibia

The 33-year-old female transit bus driver sustained fatal injuries. A summary of her injuries is as follows:

Head and Neck

- Subarachnoid hemorrhage to the brain
- Disarticulated atlanto-occipital joint

Torso Injuries

- Multiple rib fractures with plural lacerations and contusions
- Two internal organs lacerated with hemothoraces and hemoperitoneum

Extremity Injuries

- Fractures to right and left tibia, left fibula, left humerus, and left femur

The 51-year-old, female, transit passenger who was seated in seat #1 behind the driver, facing inward sustained fatal injuries. A summary of her injuries is as follows:

Head and Neck

- Fracture to the base of the skull
- Subarachnoid and subgaleal hemorrhage over the base of the brain
- Contusions to several areas of the brain

Torso Injuries

- Multiple bilateral rib fractures
- Left lung contusion and pneumothorax
- Laceration to the lungs and two other internal organs
- Fracture and dislocation at the junction of T1-2 vertebrae with injury to upper thoracic spinal cord

Extremity Injuries

- Fractures to the left femur, left humerus, and open fracture to right wrist

The 51-year-old, male, transit passenger who was seated in seat #5, on driver's side, facing forward, sustained fatal injuries. A summary of his injuries is as follows:

Head and Neck
- Cervical vertebrae fracture's

Torso Injuries
- Multiple bilateral rib and sternum fracture's
- Lacerations to the heart and one other internal organ, with right hemothorax
- Fractured left pelvis

Extremity Injuries
- Fractures of right lower arm

The 52-year-old, male, transit passenger who was seated in seat #7, on driver's side, facing forward in the window seat, sustained fatal injuries. A summary of his injuries is as follows:

Head and Neck
- Fractures to all facial bones including the mandible and maxilla in multiple places
- Subgaleal, subdural, and subarachnoid hemorrhage of the brain
- Contusions to the brain
- Fracture of cervical vertebrae at C2-3

Torso Injuries
- Multiple bilateral rib fractures
- Laceration to base of the left common carotid artery and lacerations to two internal organs
- Fracture to the right pelvis

Extremity Injuries
- Fractures to left femur, tibia, and fibula
- Fracture to right hand

The 46-year-old, female, transit passenger who was seated in seat #12 on the driver's side, facing inward, sustained fatal injuries. A summary of her injuries is as follows:

Head and Neck
- Subgaleal and subarachnoid hemorrhage
- Contusion to both frontal lobe's
- Laceration of the brainstem
- Fracture of C3 cervical vertebrae with epidural and subdural spinal cord hemorrhage

Torso Injuries
- Multiple bilateral rib fractures, anteriorly and posteriorly
- Left hemothorax, mediastinal hemorrhage, and hemoperitoneum
- Lacerations to three internal organs and to the left pulmonary artery

Extremity Injuries
- Fractures of the bilateral clavicles, right radius, and left humerus
- Dislocation of right ulna

Hospital medical records, Transport Records, and interviews with five passengers on the transit bus established the following injury information:

- **36-year-old male** sustained a 5-centimeter laceration across the top of his scalp, a spinous process fracture, glass cuts to his face, and multiple contusions. He was seated on right side of the transit bus in seat 31. BLS Medic 12 was dispatched at 6:56 a.m. and arrived on scene at 7:01 a.m., and departed to John Hopkins hospital with this patient at 7:29 a.m.
- **38-year-old female**, was 33 weeks pregnant and sustained a fractured toe (5^{th} metatarsal) on her left foot, a torn ligament on her left knee, abrasions and lacerations to her left hand, right aspect of face, left knee and ankle. She was seated on left side of the transit bus in seat 14. BLS Ambulance 23 was dispatched at 6:38 a.m. and arrived on scene at 6:46 a.m., and departed to University of Maryland hospital with patient at 7:20 a.m.
- **29-year-old female** sustained 10 fractured ribs on her left side, a comminuted fractured left scapula, a pneumothorax and hemothorax left lung, non-displaced T1 left transverse process fracture, comminuted minimally displaced L2 and L3 left transverse process fractures, and a Grade 3 spleen laceration. She was seated on left side of the transit bus in seat 10. ALS Medic 5 was dispatched at 6:38 a.m. and arrived on scene at 6:49 a.m., and departed to University of Maryland hospital with the patient at 7:15 a.m.
- **29-year-old female** sustained a pain to her neck, back, and left bicep, bruised ribs on her left side and numerous bruises and glass cuts. She was seated on the right side of the transit bus in seat 25. BLS Medic 4 was dispatched at 6:45 a.m. and arrived on scene at 6:53 a.m., and departed to St. Agnes hospital with patient at 7:15 a.m.
- **44-year-old female** sustained an L1 spinous process compression fracture w/ mild displaced fragment, bruises to her legs, and glass cuts to face. Seated on right side of the transit bus in seat 37. This patient was entrapped under debris and needed extrication. ALS Medic 13 was dispatched at 7:00 a.m., arrived on scene at 7:11 a.m. and departed to R. Adams Cowley Shock Trauma Center with patient at 7:40 a.m.

Based on transport and hospital medical records, the following injury information was established regarding the survivors of this crash that were not interviewed:

- **28-year-old male**, was extricated from under debris and sustained facial fractures, facial laceration, laceration to back of head, bilateral shin abrasions. He was seated on left side of the transit bus in seat 4. ALS Medic 22 was dispatched at 6:38 a.m., arrived on scene at 6:44 a.m., and departed to R. Adams Cowley Shock Trauma Center with patient at 7:05 a.m.
- **32-year-old female**, sustained a laceration with swelling/bruising to face, abrasions and laceration to her left knee and swelling/bruising to her right thigh. She was seated on right side of the transit bus in seat 38. BLS Ambulance 24 was dispatched at 6:54 a.m., arrived on scene at 7:06 a.m., and departed to John Hopkins hospital with patient at 7:29 a.m.
- **23-year-old female**, complained of glass in her right eye and sustained a laceration to her left orbit, facial lacerations and abrasions, chest abrasions and bruises, lacerations, and abrasions to her left arm. She was seated on left side of the transit bus in seat 17. ALS

Medic 11 was dispatched at 6:41 a.m., arrived on scene at 6:58 a.m., and departed to Sinai Hospital with patient at 7:19 a.m.

- **70-year-old male**, according to the BCFD this passenger was not transported but later went to hospital on his own. He sustained a cervical strain and complained of pain to his left arm and a headache. He was seated on right side of the transit bus in seat 29.

- **School bus aide**: 25-year-old female, sustained a soft tissue abrasion and contusion to forehead. BLS Ambulance 23 was dispatched at 6:38 a.m., arrived on scene at 6:46 a.m., and departed to University of Maryland hospital with patient at 7:20 a.m.

- **Mustang driver**: 51-year-old male, sustained bruising to his left shoulder. BLS Medic 12 was dispatched at 6:56 a.m. arrived on scene at 7:01 a.m., and departed to John Hopkins hospital with patient at 7:29 a.m.

5. Interviews

Interviews were conducted with twelve first responders, and five transit bus passengers. The following are comments from each group.

5.1. First Responders[27]

- Initial call from dispatch went out as a car accident.
- The school bus driver initially had a pulse but before we were able to complete the extrication he expired.
- When we got to the MTA bus we could see the deceased driver and several deceased and viable patients under the debris.
- The school bus aide was already out of the bus when we arrived.

5.2. Transit Bus Passengers

- I thought the bus exploded and glass flew everywhere.
- I didn't see or hear anything prior to the crash.
- I had no indication of the accident until we hit and I was thrown to the floor.
- It was very dark and someone put their phone light on so we could find the side door.
- I was able to get up and went out the opening and was helped down by a passerby.
- Some guy broke open the box containing the emergency side door release and I ended up going out the side door behind him.

[27] Refer to Survival Factors Attachment 6. First Responder Interviews

E. DOCKET MATERIAL

The following attachments and photographs are included in the docket for this investigation.

LIST OF ATTACHMENTS

Survival Factors Attachment 1 - Passenger Interviews

Survival Factors Attachment 2 - Baltimore City Fire Department Incident Report

Survival Factors Attachment 3 - Baltimore Police Department CAD logs

Survival Factors Attachment 4 - Baltimore City Fire Department Response Synopsis

Survival Factors Attachment 5 - Baltimore Fire Department Mass Casualty Plan

Survival Factors Attachment 6 - First Responder Interviews

LIST OF PHOTOGRAPHS

Survival Factors Photo 1 - Exterior view of deformation to front end and left side of IC school bus.

Survival Factors Photo 2 - View looking from outside entry door into loading stairwell and driver seating area showing interior deformation.

Survival Factors Photo 3 - Interior view of IC school bus looking from midway back to front showing buckling to roof and displaced driver seat.

Survival Factors Photo 4 - Closer-up interior view of displaced driver's seat and area of intrusion.

Survival Factors Photo 5 - Close-up view of damaged D-ring for school bus driver's shoulder belt.

Survival Factors Photo 6 - Close-up view of separated driver seat belt shoulder webbing.

Survival Factors Photo 7 - Front left angle view of deformation to frontal plane of Ford Mustang.

Survival Factors Photo 8 - Overhead view of deformation to rear plane of Ford Mustang.

Survival Factors Photo 9 - Rear left angle view of deformation to rear plane of Ford Mustang.

Survival Factors Photo 10 - Interior view of intrusion to back seat area of Ford Mustang.

Survival Factors Photo 11 - View of driver's seatback side air bag in Ford Mustang.

Survival Factors Photo 12 - Exterior view of extent of deformation to front left bumper corner and down left side of New Flyer.

Survival Factors Photo 13 - Frontal view looking at deformation down the left side of New Flyer.

Survival Factors Photo 14 - Rear angle view of deformation to left side of New Flyer.

Survival Factors Photo 15 - Close-up view looking rear to front at left side New Flyer sheet metal buckled up accordion style.

Survival Factors Photo 16 - View from outside loading door of New Flyer looking at damaged and displaced driver seating area.

Survival Factors Photo 17 - Close up view of deformation and buckled seat belt of New Flyer driver.

Survival Factors Photo 18 - Close-up of deformed steering wheel of driver in New Flyer.

Survival Factors Photo 19 - Interior view looking from rear to front at intrusion to New Flyer.

Survival Factors Photo 20 - Interior view looking from front to rear at exemplar of New Flyer.

END OF REPORT

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