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

TECHNICAL RECONSTRUCTION GROUP CHAIRMAN'S FACTUAL REPORT

A. CRASH INFORMATION

Location:	300 block of Talley Road, Chattanooga, Hamilton County, Tennessee
Vehicle #1:	2008 Thomas Built School Bus
Operator #1:	Durham School Services LP of Warrenville, IL
Date:	November 21, 2016
Time:	Approximately 03:20 p.m. Eastern Standard Time (EST)
NTSB #:	**HWY17MH009**

B. TECHNICAL RECONSTRUCTION GROUP

Robert Squire, 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* in the docket for this investigation.

D. DETAILS OF THE TECHNICAL RECONSTRUCTION GROUP INVESTIGATION

The Technical Reconstruction Group provided investigative support through the examination of collision scene and involved vehicle documentation as provided by other NTSB investigative groups. Factual data was also acquired through the review of documentation provided by the Chattanooga Police Department (CPD) and the City of Chattanooga Department of Transportation.

Primary documentation included scene photographs and three-dimensional laser scans provided by CPD investigators and road survey data provided by the city Department of

Transportation.[1] Factual reports prepared by other NTSB investigative groups should be consulted for additional information.

1. Collision Site Location and Documentation

The crash involved a 2008 Thomas Built, 84-passenger school bus that overturned and collided with a tree after becoming errant and departing the roadway. Documentation indicated that the bus had been traveling southbound on Talley Road when it became errant while negotiating a curve near the intersection with Sunset Avenue. Documented roadway evidence was consistent with the bus driver having oversteered the vehicle while traveling through the curve. After exiting the curve, the vehicle partially departed the pavement onto the right roadside before returning to, and then crossing the roadway. The bus collided with a wooden utility pole, completely departed the pavement, overturned and collided with a tree.

Talley Road through the area of the collision, is a two-lane, north-south roadway that traverses a residential district. The highway extends for a total distance of about 1.7 miles and exhibits changes in vertical and horizontal alignment at numerous locations, including the crash location. Separation of the opposing travel lanes was delineated by double-yellow line pavement striping. Through the area of the collision no shoulders or edge lines are present, and the speed limit is posted at 30 miles per hour.

The vehicle's position of final rest was located approximately 284 feet south of the Sunset Avenue intersection.[2] Sunset Avenue intersects Talley Road from both the east and west at near right angles with cross traffic controlled by posted stop signs. Through the intersection, Talley Road exhibits a curvature that extends about 181 feet through a radius of approximately 352 feet. Tangent segments extend north and south of the curve for distances of approximately 500 and 880 feet respectively. Because of the curve Talley Road transitions from a heading of 170°/350° (SSE/NNW) on the northern tangent to 200°/020° (SSW/NNE) on the northern tangent - a change of about 30° (29.5° as indicated by survey data). As indicated by the survey data, the beginning and end of the curve (point of curve and point of tangent) were located about 146 feet north and 35 feet south of the Sunset Avenue intersection respectively.[3]

In addition to the curve, this portion of highway also exhibits a change in vertical alignment. North of the curve, the southbound direction exhibits a descending grade of about 4.9% over a distance of approximately 440 feet.[4] The descending grade levels about 83 feet into the curve or 63 feet north of the Sunset Avenue intersection. The highway remains relatively level for a distance of about 120 feet at which point an ascending grade begins. The grade ascends at an average of about 4.3% over (southbound direction) 150 feet.[5] The grade crests about 207 feet

[1] The length of Talley Road covered by the 3D scan extended north and south of Sunset Avenue for approximate distances of 324 and 380 feet respectively. The City Department of Transportation provided survey data covering a distance of 1,432 feet between Rogers Road and Midwoode Drive.
[2] Distance based on a direct linear measurement within the 3D site scan from the vehicle position of rest to the approximate center of the intersection. Dimensional measurements are based on 3D scan data provided by the Chattanooga Police Department and survey data provided by the City of Chattanooga Department of Transportation and are generally rounded to whole numbers.
[3] Surveyed to intersection midpoint.
[4] Elevation change of about 20.89 feet.
[5] The initial portion of the grade exhibits a maximum grade of 6.9%.

south of the Sunset Avenue intersection or 82 feet north of where the bus came to rest. As the highway continues south from the grade crest it appears relatively level (ascending about one foot over the remaining 312 feet of the survey).

Figure 1 depicts a Google Earth image of Talley Roads through the area of the collision. Highway features as well as fixed objects struck by the bus are illustrated.

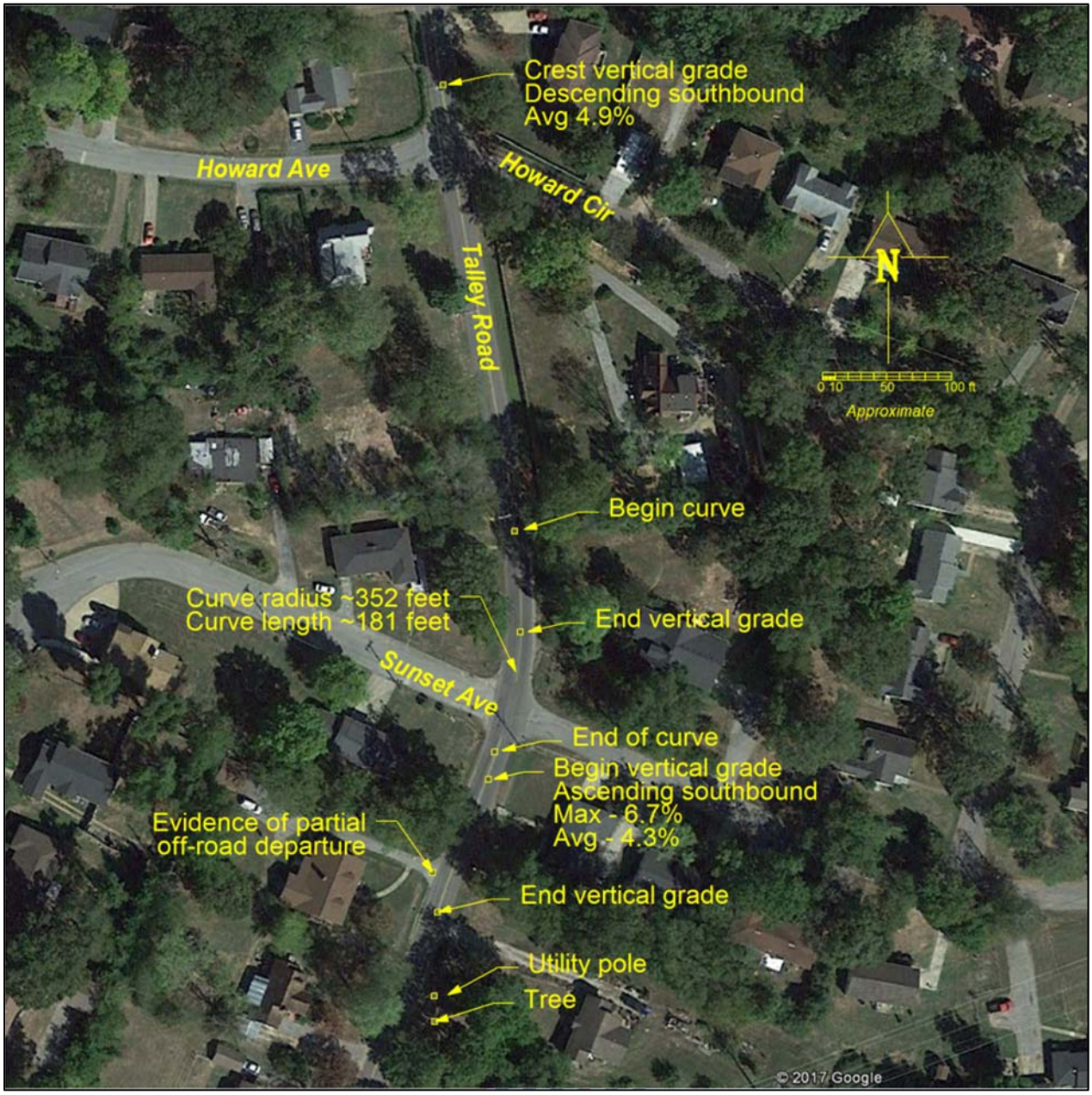

Figure 1: Google Earth image (October 2016) of Talley Road depicting relevant features. Grade dimensions are referenced along the southbound approach (bus heading) to the collision site.

The onset of roadway evidence appeared approximately 93.5 feet south of the northern end (beginning) of the curve – slightly more than half the overall length of the curve - and about 10 feet south of the bottom of the descending grade. The roadway evidence consisted of single or closely spaced parallel curvilinear tire friction marks that tracked atop the highway centerline or were slightly offset into the northbound travel lane. Segments of the visible tire marks or paint markings applied by CPD investigators indicating the path of the tire marks were visible in the 3D scan and could be corroborated in CPD photographs.[6] The intensity of the marks darkened toward their outer edge and where two parallel marks could be discerned, they exhibited characteristics of a dual wheel configuration. From their onset, these marks covered a distance of about 140 feet. The marks terminated just inside the southbound lane about 51.5 south of the end of the curve, or 202 feet north of where the bus came to rest.

Approximately 25 feet south of the where the tire marks terminated, CPD documented tire impressions just off the pavement (about 2.4 feet) to the right of the southbound lane. The path of the tire impressions continued southward parallel to the roadway and where they crossed a paved driveway, curvilinear friction marks were visible. Although not visible in the 3D scan, CPD photographs depict divergence of those marks across the driveway surface. Approximately 64 feet from the pavement departure point a metallic mailbox (anchored in concrete) was toppled.

About 79 feet south of the pavement departure point, additional curvilinear tire friction marks appear. The path of these tire marks exhibited a south-southeasterly heading from the west side of the highway toward the east side at about a 24-degree angle relative to the southbound lane. The longest of these marks terminated just inside the northbound lane, about 25.5 feet from the utility pole that was struck by the bus.

The post-collision position of rest for the bus was against a tree located about 36 feet south and slightly west of the utility pole. At final rest the bus had overturned onto its right side, oriented such that it was facing southeastward with its roof partially collapsed by impact with a tree. The bus was located about 342 feet south from the onset of the initial tire friction marks.

Figure 2 is a scaled two-dimensional diagram depicting the post-collision position of rest for the bus and other highway features. Vehicle placement, roadway evidence and other physical features were based the 3D scan provided by CPD. Department of Transportation survey data was used to locate highway geometric features.

[6] Some portions of the roadway markings may not have been recorded by the 3D scan as certain CPD photographs depicted additional paint markings that did not appear in the scan.

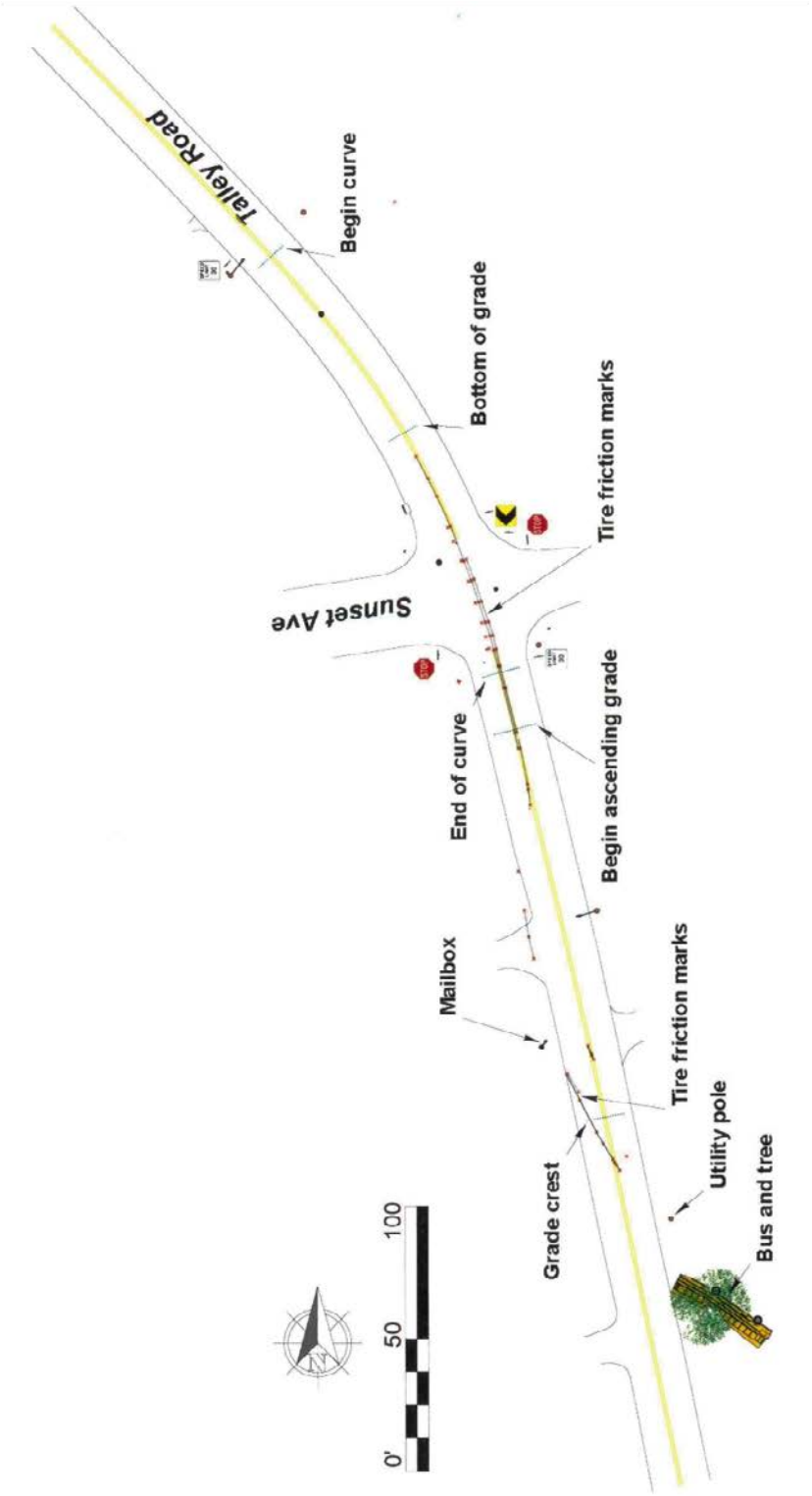

Figure 2: Scaled diagram depicting vehicle position of final rest, roadway evidence and other highway features along the vehicle pre-collision path of travel.

2. Vehicle Documentation

CBP provided NTSB investigators with 3D scans depicting the involved bus and an exemplar bus. The scan data was used to extract certain dimensional information that was then provided to other NTSB investigative groups.

Scan images depicted that the majority of damage sustained by the bus involved the collapse of the roof and its subsequent intrusion into the passenger seating area. Displacement of the roof structure was consistent with the vehicle's impact into the tree after it overturned. Some sidewall displacement consistent with the roof displacement was also observable.

Figures 3 through 8 depict 3D scan images that illustrate the damage sustained by the bus. Additional information regarding damage to the vehicle can be found in the NTSB Survival Factors Group factual report.

Figure 3: Image of 3D scan point cloud depicting the left (driver's side) of involved bus after removal from the scene. Scan data was provided by CPD.

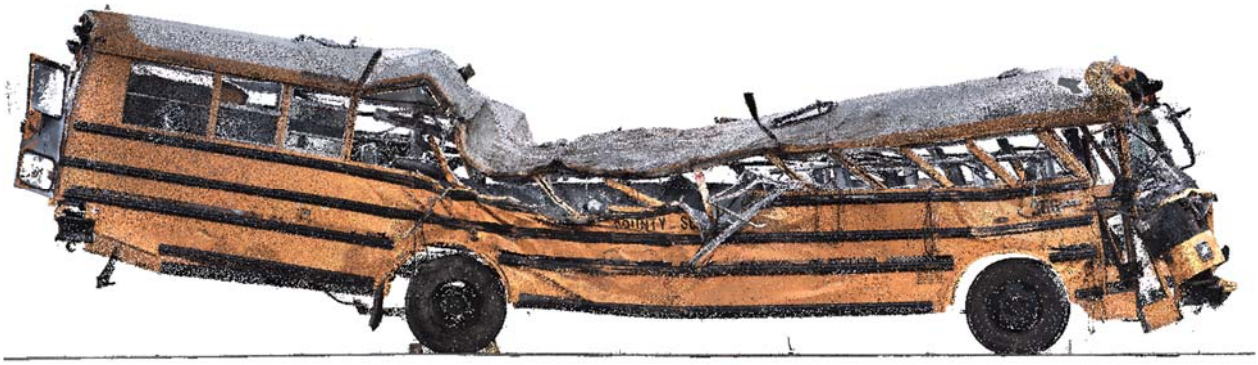

Figure 4: Image of 3D scan point cloud depicting the right (passenger's side) of involved bus after removal from the scene. Scan data was provided by CPD.

Figure 5: Image of 3D point cloud depicting an overhead view of involved bus following its removal from the scene. Scan data was provided by CPD.

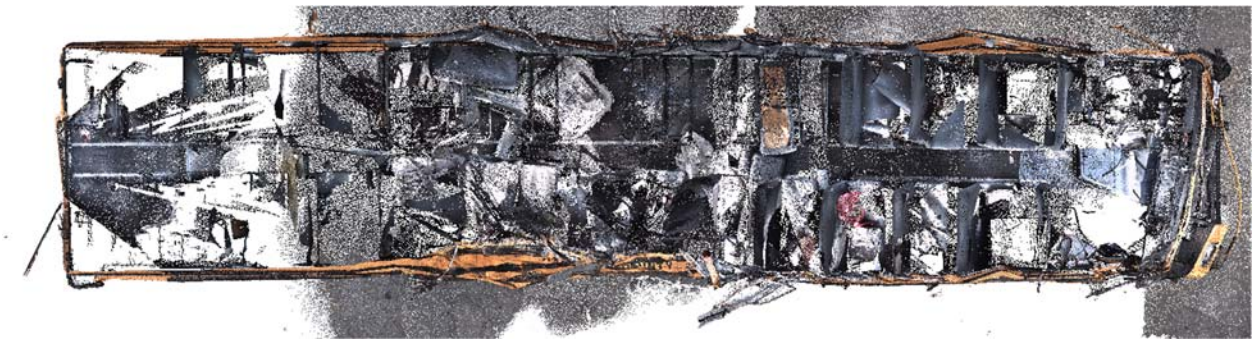

Figure 6: Image of 3D data point cloud depicting overhead view of involved with a roof sliced removed. Scan data was provided by CPD.

Figure 7: Image of 3D data point cloud depicting right (passenger) side seating about 20 inches inboard of the right sidewall. Scan data was provided by CPD.

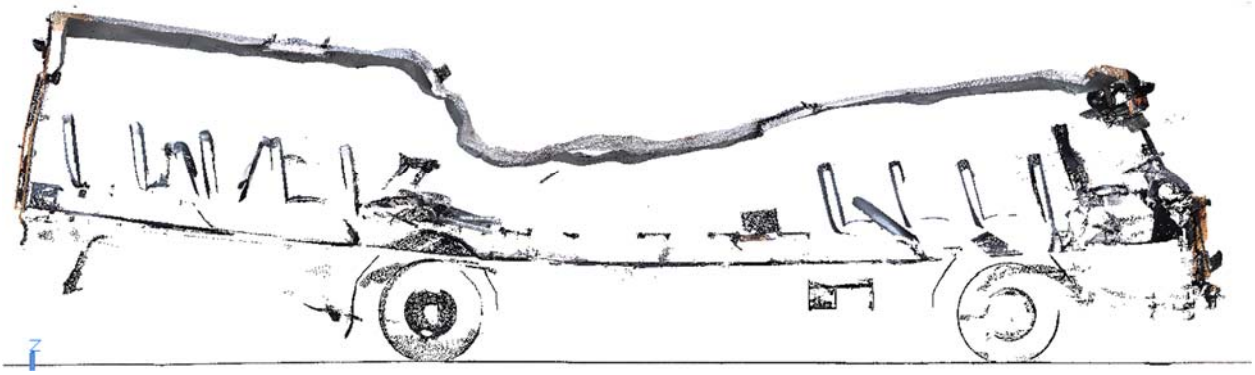

Figure 8: Image of 3D scan point cloud depicting left (driver) side seating about 20 inches inboard of the left sidewall. Note that some seating had been removed. Scan data was provided by CPD.

The front of the bus exhibited damage consistent with the utility pole impact. The impact fractured and displaced the wooden utility pole between ground level and the lower tier of telecommunications lines. The resulting vehicle damage exhibited an angular orientation of approximately 54-degrees relative to a horizontal ground surface. **Figure 9** depicts a point cloud image of the 3D scan sliced laterally behind the damaged area annotated with the angular dimension. The damage is consistent with vehicle rolling toward the right (passenger) side as the pole was struck.

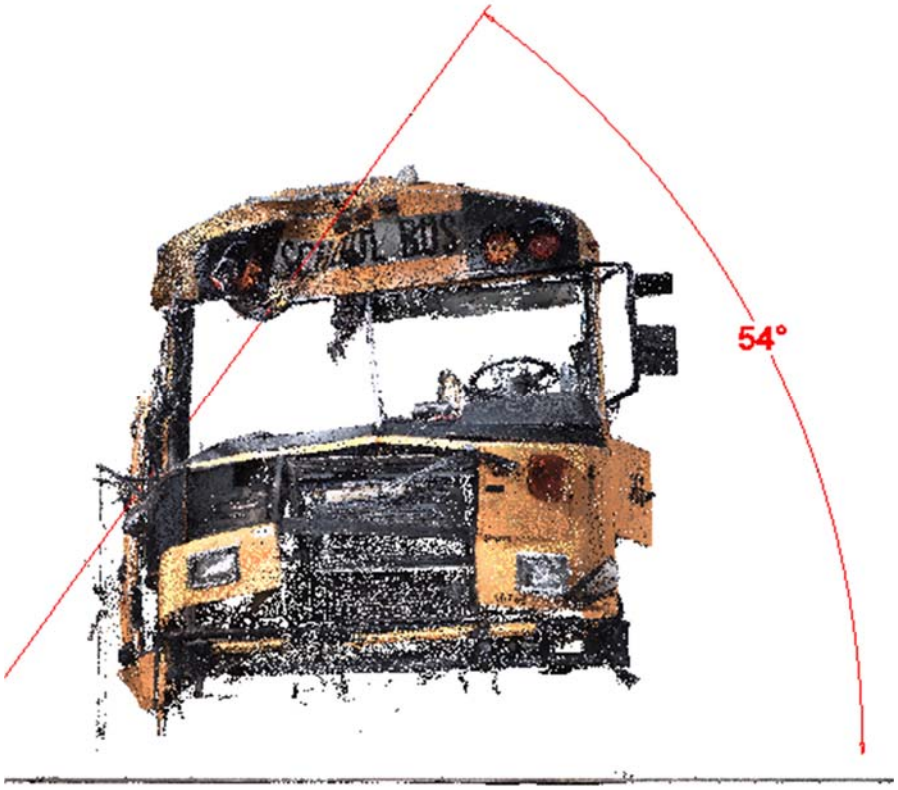

Figure 9: 3D point cloud slice image depicting impact damage to the front of the bus consistent with striking the utility pole.

E. REFERENCE MATERIAL

[1] NTSB Highway Factors Group factual report

[2] NTSB Vehicle Factors Group factual report

[3] Chattanooga Police Department 3D scans and scene documentation

F. DOCKET MATERIAL

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

LIST OF ATTACHMENTS

None

LIST OF PHOTOGRAPHS

None

END OF REPORT

Robert Squire
Highway Accident Investigator