TECHNICAL RECONSTRUCTION ATTACHMENT

ATTACHMENT 1: SCENE DIAGRAM AND DATA ANALYSIS

Houston, TX

HWY15FH010

(6 pages)

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

TECHNICAL RECONSTRUCTION ATTACHMENT

A. TECHNICAL RECONSTRUCTION STAFF

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B. INTRODUCTION

The NTSB Office of Highway Safety initiated a field investigation of a crash that occurred September 15, 2015 in Houston, Texas involving a school bus that fell from a highway overpass after having been struck by another vehicle. The collision was investigated by the Houston Police Department (HPD).

As reported by the HPD, the school bus was traveling eastbound on South Loop E Freeway (I-610) in the right center lane of the four-lane limited access highway. As the school bus approached the overpass above Telephone Road, a 2004 Buick LeSabre passenger vehicle traveling in the left center departed its lane of travel to the right and collided with the bus. The bus then moved to the right, traversed the right travel lane and shoulder and impacted the concrete parapet wall on the bridge above Telephone Road. The bus then surmounted the parapet wall and breached the rail on top of the wall.[1] The bus fell from the bridge and came to rest on its left side facing westward on the east side of Telephone Road.

As part of the NTSB investigation, responding investigators acquired information and data from local parties including the HPD and Texas Department of Transportation. Relevant information and data were provided for technical reconstruction review.

C. SITE DIAGRAM

During their investigation, HPD documented the highway area with a Leica 3D scanner and provided the point cloud data to NTSB investigators. The area documented included the breached section of the bridge rail, the position of rest for the bus and portions of both roadways adjacent those features. Using a combination of the scan data, scene photographs and highway build plans, a post-collision diagram was created. The approximate area of impact was derived from video images recorded from a system on board the school bus. The completed diagram is depicted in figure 1.

[1] The rail was described as a Type C-4 that ran parallel to the top of the parapet wall.

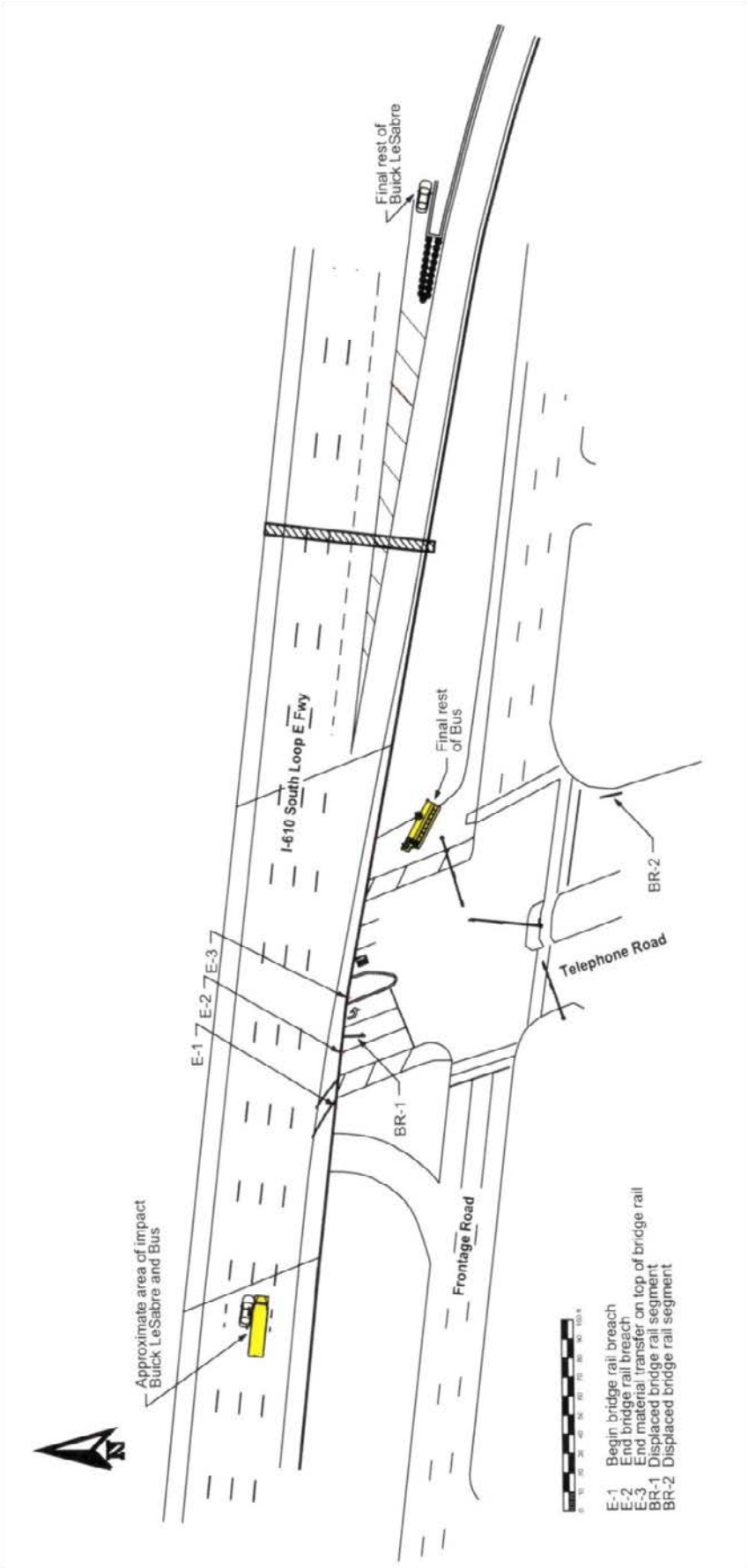

Figure 1: Scene diagram depicting the positions of rest for both vehicles and the approximate area of impact.

Figure 2 is an enlarged portion of the diagram depicting the area where the bus breached the bridge rail relative to its position of final rest. The position of the bus as it impacted the bridge was based on the documentation of roadway evidence (tire friction marks).

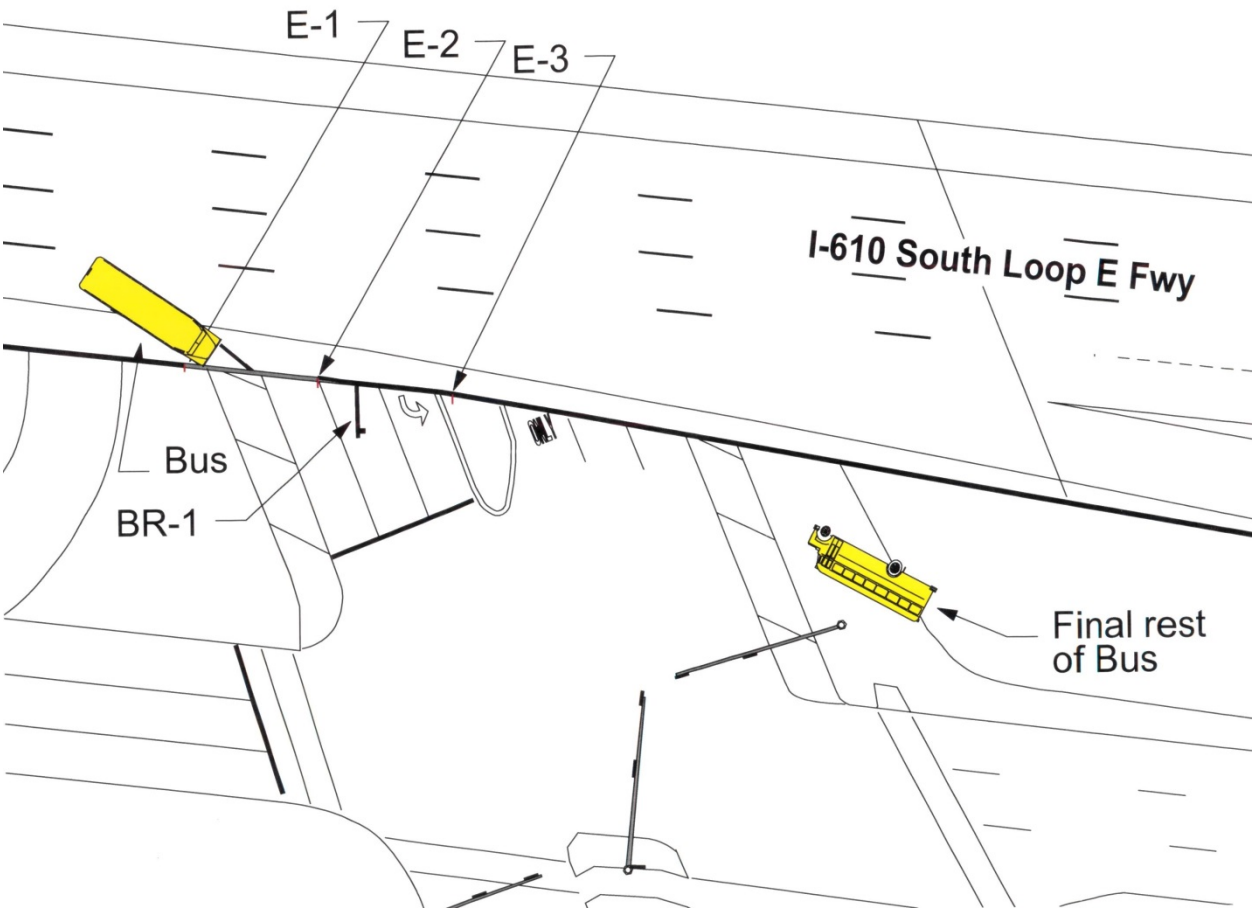

Figure 2: Enlarged portion of diagram depicting the section of bridge rail that was breached and the position of final rest for the bus.

D. SCENE DATA ANALYSIS

Examination of the scan data and scene photographs enabled NTSB staff to identify certain dimensional and distance information pertinent to the crash. Based on the 3D scan along the outer surface of the bridge, the top of the bridge rail was elevated about 1.5 feet above the 1.5 foot parapet wall, or about 3 feet above the roadway surface on the bridge as measured from the bottom surface of the drain openings in the wall. While the vertical height of the wall and rail as measured in the scan corroborated the highway build plans, these measurements did not capture the change in roadway height due an overlay of the bridge deck. Beginning approximately 79 feet from the west end of the bridge, approximately 30.8 feet of rail was missing. Two segments of the displaced rail were observed in the roadway below. One segment, which was captured in the scan data, was located in the left southbound lane of Telephone Road just below the bridge.

The second segment was observed in scene photographs to be in the right northbound lane of Telephone Road just south of the Frontage Road intersection.

Photographs depicted evidence of black material transfer on the parapet wall beginning about 1.5 feet past the western end of the rail breach. Material transfer (interspersed with gouging to the concrete) continued toward the eastern end of the rail breach. Additional black material transfer then continued an additional 29 feet along the top of the intact rail east of the breach. Where the intact rail resumed at the eastern end of the breach, the first seven feet of rail was observed to be angled (bent) downward toward the top of the wall.

Scene photographs depicted the presence of tire friction marks on the right shoulder and atop the right edge line at an angular heading toward the breach in the rail. The dimension of the marks could not be discerned on the scan and the overall length of those marks was not depicted in the photographs.

The vertical height from the top of the parapet wall to the roadway below the bridge (Telephone Road) measured 20.9 feet. The vertical height from the top of the bridge rail to the same roadway surface measured 22.4 feet. The position of rest for the bus was approximately 96 feet east-southeast of the east end of the rail breach.

Figure 3 is a screen capture of the scan point cloud depicting the bridge segment that included the rail area breached by the bus. Dimensions depicted in the image include the opening created by the missing bridge rail, the length of material transfer evidence along the parapet wall and intact rail and the vertical height of the parapet wall relative to the roadway beneath the bridge and the bridge rail relative to the wall.

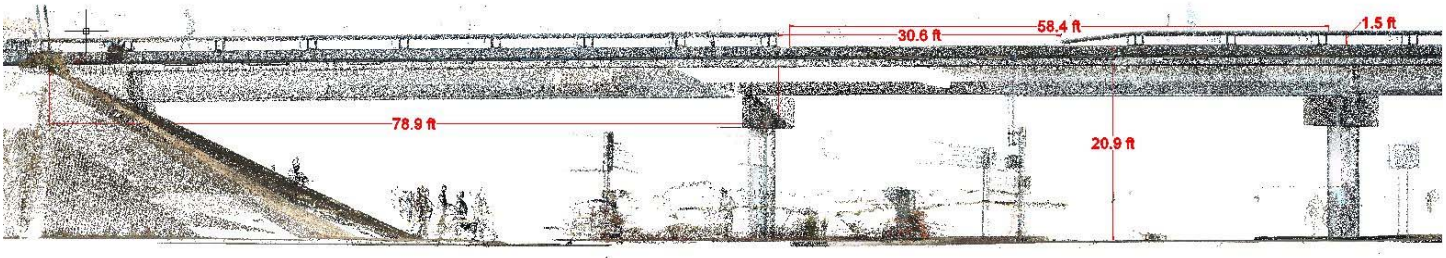

Figure 3: Image of scan point cloud depicting area of bridge rail breached by the bus.

E. OTHER DATA ANALYSIS

1. Buick Crash Data

During their investigation of the collision, HPD completed a data download of the airbag control module (ACM) in the Buick. Many ACMs record event or crash data when an acceleration over time threshold indicative of an impact is detected. Crash data includes reporting on acceleration (crash pulse), a calculated change in velocity, and system status parameters including, but not limited to deployment timing, multiple event occurrences, and the

presence of diagnostic trouble codes (DTC). Some systems record pre-crash data that may include parameters such as vehicle speed, engine speed, and brake switch circuit status.

The module in this vehicle (type SDM-GT) was capable of storing both deployment and non-deployment events related to the supplemental restraint system. Non-deployment events, of which this module will only store one, can be overwritten by more severe events or events that result in a deployment command. Data retrieved from the Buick included a single event that was classified as a non-deployment. The report indicated that the recording was complete, but not locked and no multiple events were detected. A total of four (4) ignition cycles had been recorded between the event and the data download. The intervening ignition cycle count is consistent for a vehicle that likely remained operable after a crash. The ignition cycle count in combination with other system status parameters indicates that the crash and pre-crash data acquired from the download resulted from the impact with the school bus.

The event recorded a maximum negative longitudinal change in velocity of 3.65 mph at 102.5ms after module wake-up. Photographs of the vehicle depicted damage to the right side of the vehicle that was characteristic of a sideswipe impact. Paint damage, minor body panel indentations and material transfer evidence ran the length of the vehicle between the front and rear axles. The most significant damage appeared to be a sidewall puncture of the front tire with adjacent rim damage and the rearward displacement of the leading edge of the front passenger door.

Pre-crash data were reported for a period of five seconds before module wake-up (impact), in one second intervals. That data indicated a near constant speed of 70 mph with some slowing to 68 mph about one second before impact.[2] The engine speed was steady with only a slight decrease from 1792 RPM to 1728 RPM at the last data sample (-1 second). Percent throttle is constant at 10% during the five seconds reported. This module also recorded the brake switch circuit state for a period of eight (8) seconds before impact.[3] The circuit state was reported as "off" indicating that the brakes were not applied before the impact.

2. Bus Speed Calculations

The vertical fall height and longitudinal distance traveled by the bus provided sufficient information to calculate the forward speed of the bus after it breached the bridge rail and began to fall. Using this data the speed was calculated at 39–40 mph. This estimate did not account for any speed loss due impact with the parapet wall or bridge rail.

END OF REPORT

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[2] Pre-crash data parameters are recorded asynchronously with final data point sampled at a time no greater than one second before module wake-up (impact).
[3] Brake switch circuit state is reported as "on" or "off" indicating whether the switch was engaged or not. An "on" status would indicate that the brake pedal was depressed sufficiently to energize the brake lamp circuit and light the brake lamps. Pedal application pressure is not measured.