3D LASER SCANNING GROUP CHAIRMAN FACTUAL REPORT

Valhalla, New York

DCA15MR006
(14 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF RESEARCH AND ENGINEERING
WASHINGTON, D.C. 20594

3D LASER SCANNING FACTUAL REPORT

A. CRASH INFORMATION

Location:	Commerce Street Grade Crossing on the Metro-North Harlem Line, Valhalla, Westchester County, New York
Vehicle #1:	2011 Mercedes ML350
Vehicle #2:	Metro-North passenger train 659
Operator #2:	Metro-North Railroad
Date:	February 3, 2015
Time:	Approximately 06:26 p.m. EST
NTSB #:	**DCA15MR006**

B. CRASH SUMMARY

For a summary of the crash, please refer to the *Crash Summary Report* in the docket for this investigation.

C. 3D LASER SCANNING GROUP

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A. 3D LASER SCANNING

A three-dimensional (3D) laser scanner was used to record the 3D data of crash-related objects including the grade crossing, the lead rail car, the Mercedes SUV, and also an exemplar rail car. The scanner cannot capture objects that are out of its line of sight. As a result, special targets were used to link together multiple scans from various vantage points.

In this accident, the lead rail car, the grade crossing, the Mercedes SUV, and an exemplar rail car were examined and scanned using both a FARO Focus 3D X120 and a

FARO Focus 3D X330 laser scanner.[1,2] The scanners were used in unison to increase efficiency. Both the interior and exterior of the lead rail car and the exemplar rail car were scanned. Generally, the exterior of the Mercedes SUV was scanned but much of the interior was also visible. The grade crossing was scanned along with the north-bound track to the point where the 3rd rail switched from the east to the west side of the track, which was approximately 275 feet from the center of the grade crossing. Approximately, 370 feet of track was scanned.

The scanning activity was conducted post-recovery and may not represent the condition of the vehicles immediately after the accident. A total of 85 individual scans were performed during this investigation. Measurements were taken from the point cloud data, which is a product of the 3D laser scanner.[3]

1. Lead Rail Car - 4333

The exterior of the lead rail car was documented with a total of 21 exterior scans and 5 interior scans. Two of the 21 exterior scans were performed to document the underside of the rail car in key areas. Images from the point cloud created by the scanner documenting the lead rail car exterior are shown in Figure 1 and Figure 2. The interior of the car from the developed point cloud data is shown in Figure 3.

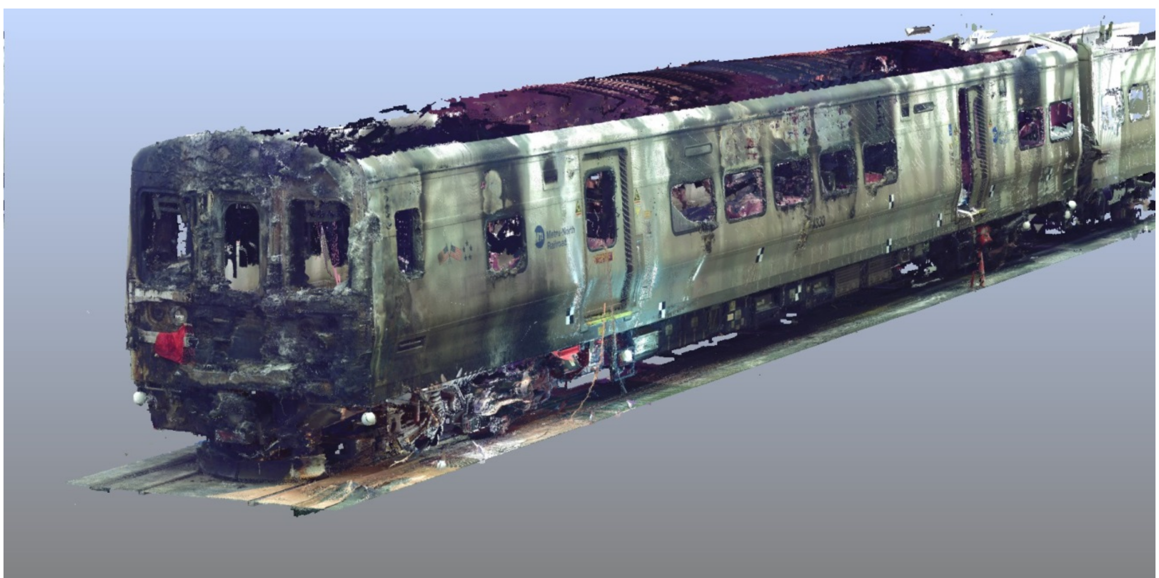

Figure 1: An image from the 3D laser scanner point cloud showing left side of the lead rail car - 4333.

[1] The FARO Focus X120 laser scanner has an advertised scan range of 100 meters.
[2] The FARO Focus X330 laser scanner has an advertised scan range of 330 meters.
[3] FARO quotes a systematic measurement error (one sigma) of ±2 mm (±0.079 in) at ranges of 10 m (33 feet) and 25 m (82 feet). FARO quotes a random error (one sigma) of less than ±2.2 mm (±0.087 inches) in a fest-fit plane at ranges of 10 m (33 feet) and 25 m (82 feet), with a target reflectivity of either 10 % or 90 %. Additional uncertainty in dimensional data may result from the manual choice of points to represent a specific object from the entire 3D point cloud.

Figure 2: An image from the 3D laser scanner point cloud showing the right side of the lead rail car - 4333.

Figure 3: An image from the 3D laser scanner point cloud showing the interior of the lead rail car - 4333.

2. Grade Crossing

The accident grade crossing was documented with a total of 16 scans. Seven of the 16 scans were performed to document the approach to the crossing and the crossing itself. The additional 9 scans were performed to document the north-bound track 2 just past the point where the 3rd rail switched from the east side to the west side of the track. Views from the scanner of the approach to the crossing are shown in Figure 4 and Figure 5.[4] Images from the scanner showing the northbound track are shown in Figure 6 and Figure 7. The distance from the center of the grade crossing to the start of the 3rd rail on the east side of the track past the crossing (44.3 feet) and the distance from the center of the crossing to the start of the 3rd rail on the west side of the crossing (274.5 feet) are shown in Figure 8.

According to witnesses, the SUV was initially positioned between the grade crossing gate arm and the tracks.[5] Based on these witness reports, this initial position of the SUV relative to the eventual position of an exemplar train was reconstructed in the computer for visualization purposes (see Figure 9). This visualization, based on the scan data and a model of an exemplar SUV, assumes a best-case scenario with the SUV as far aft from the crossing based on the position of the crossing arm and as close to the centerline of the roadway as possible. This position, Figure 9, places the SUV in a position where it is fouling the tracks the least, while still assuming that the SUV is in position to travel across the tracks into the appropriate lane on the opposite side.

Eyewitness reports indicate that the driver then moved the SUV forward onto the crossing immediately prior to the train's arrival at the grade crossing. A position of the train and SUV immediately prior to impact, consistent with the damage to the SUV, is shown in Figure 10.

Metro-North Railroad also surveyed the grade crossing, the tracks, and the final rest position of the train and the SUV. Images of the survey alone and the survey overlaid on the laser scan data are shown in Figure 11 and Figure 12.

[4] The images from the scanner are shown in a planar view, which results in a curvature due to the 360 degree scan laid onto a two-dimensional image.
[5] See the Human Performance Group Chairman's Factual Report.

Figure 4: An image from the 3D laser scanner showing the grade crossing approach from the west side, in the direction traveled by the Mercedes SUV driver.

Figure 5: An image from the 3D laser scanner showing the grade crossing approach from the east side.

Figure 6: An image from the scanner looking north-bound from the grade crossing on track 2.

Figure 7: An image from the scanner, looking north-bound, showing the nose piece of the 3rd rail and the 3rd rail switching from the east side to the west side on track 2. (Note that the 3rd rail has been repaired on track 2.)

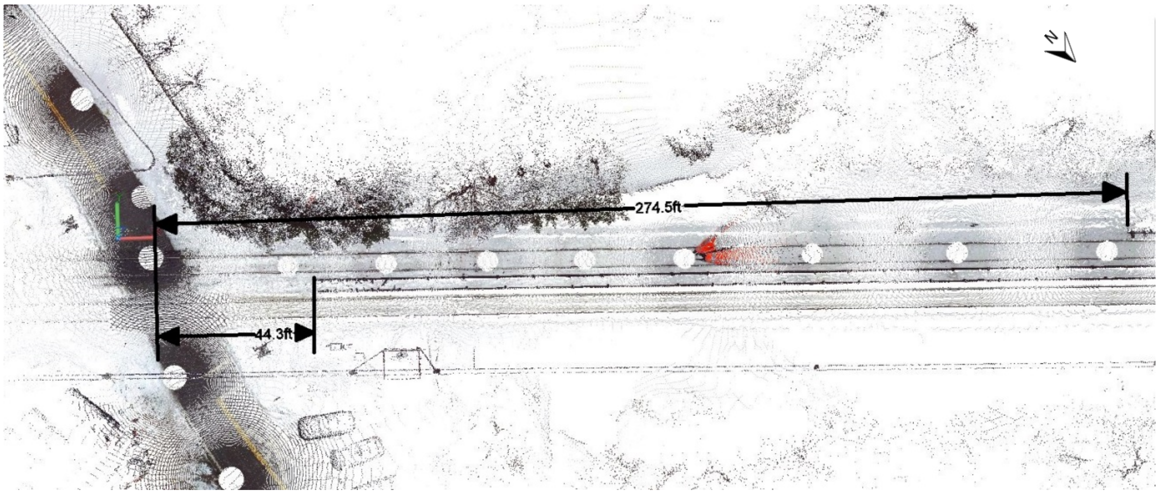

Figure 8: The locations of the start of the third rail measured from the center of the grade crossing. The third rail switched from the east side to the west side of the crossing.

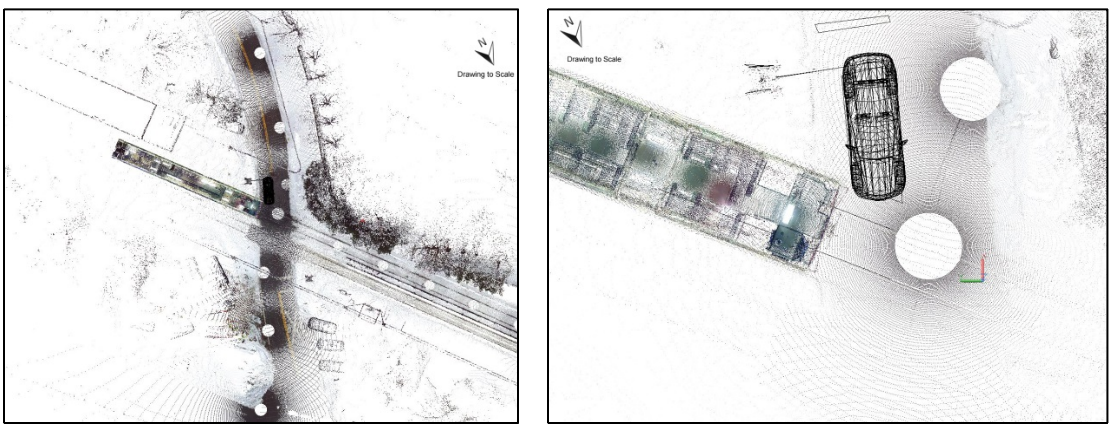

Figure 9: Images of the estimated positon of the SUV relative to the approaching train, assuming the least amount of fouling, prior to the SUV moving forward onto track 2. On the left, the image shows the surrounding roadway and tracks. On the right, the image shows a close-up view. Images are to scale.

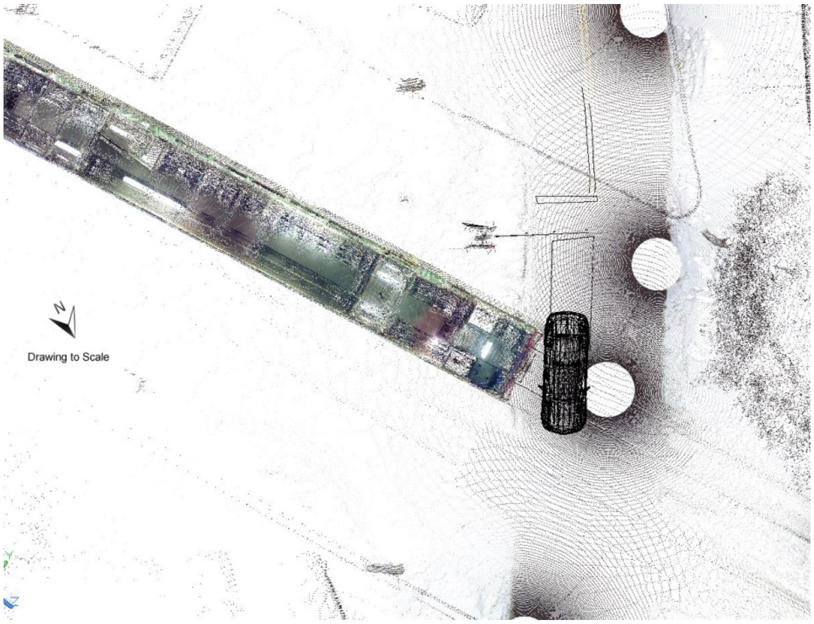

Figure 10: A position of the train and a model of the SUV immediately prior to impact, consistent with the damage to the SUV. Images are to scale.

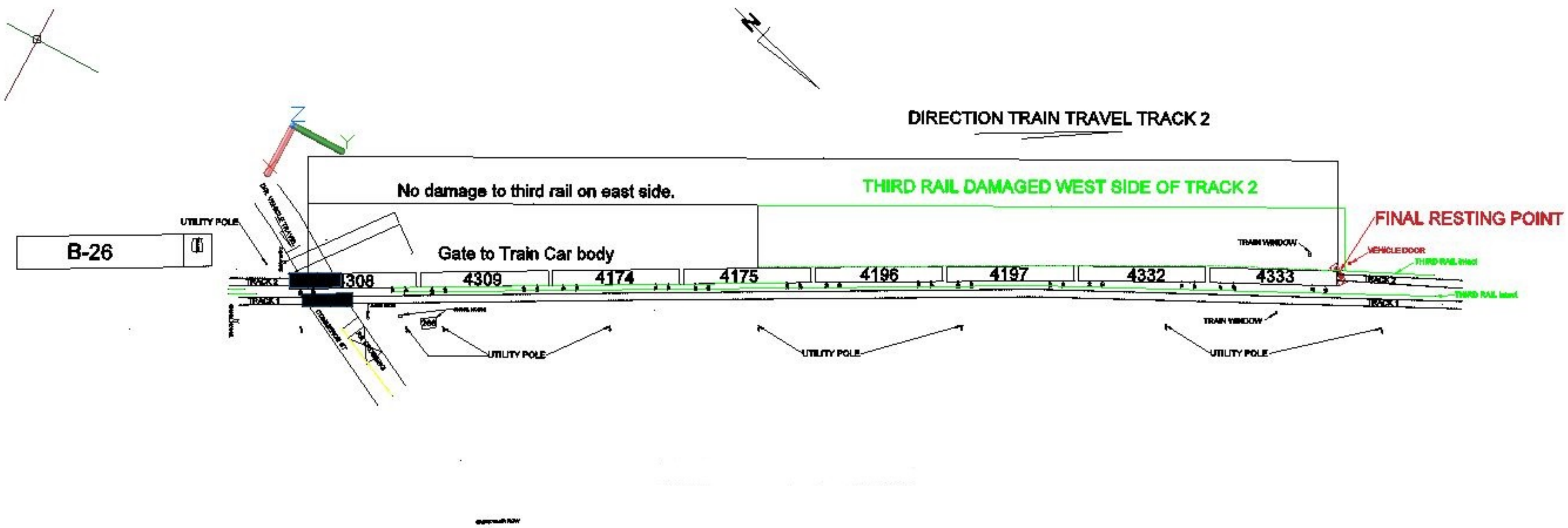

Figure 11: The Metro-North survey data showing the grade crossing, the tracks, and the final rest positon of the train.

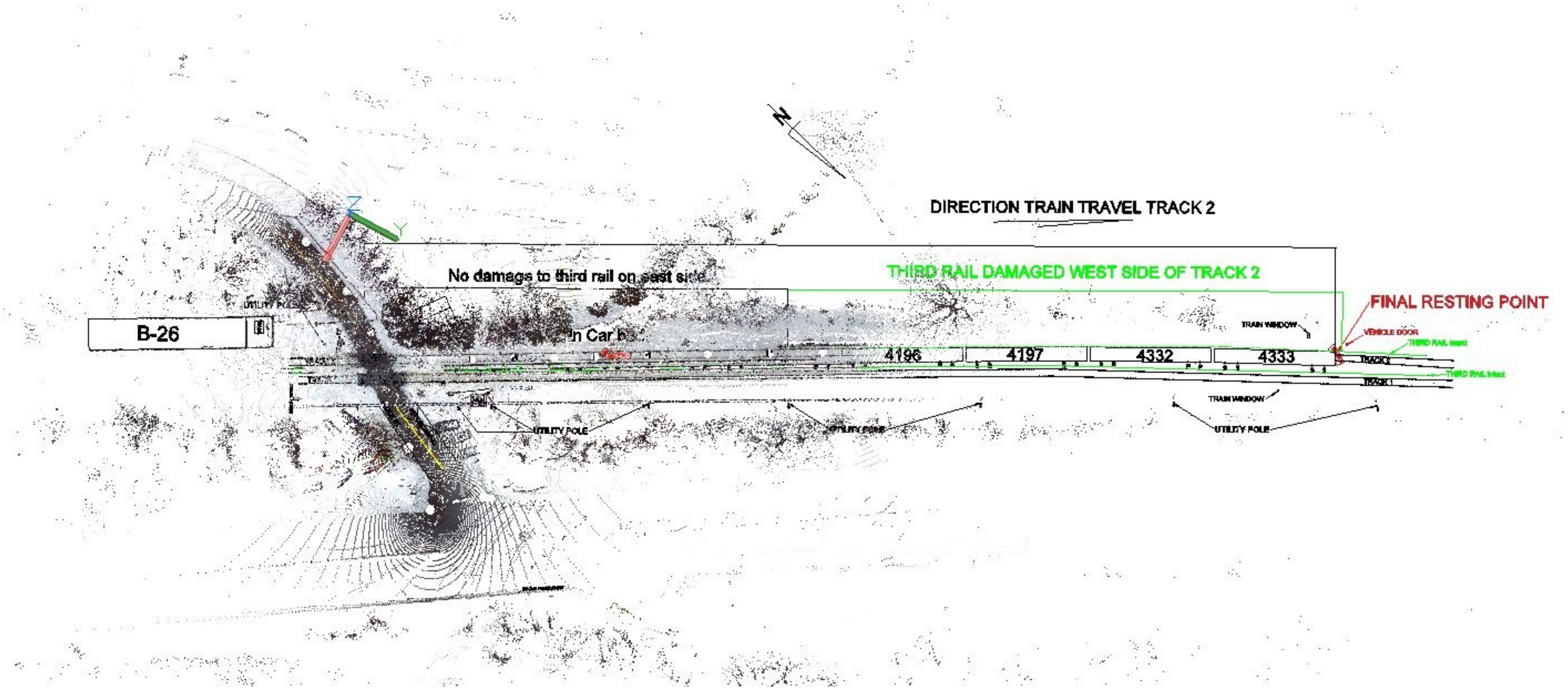

Figure 12: The Metro-North survey data overlaid on top of the laser scanning point cloud data.

3. Mercedes SUV

The exterior of the Mercedes SUV was documented with a total of 8 scans. Exterior SUV images from the point cloud created by the scanner are shown in Figure 13, Figure 14, and Figure 15.

Figure 13: An image from the 3D laser scanner point cloud showing the left side of the Mercedes SUV.

Figure 14: An image from the 3D laser scanner point cloud showing right side of the Mercedes SUV.

Figure 15: An image from the 3D laser scanner point cloud showing the back of the Mercedes SUV and a portion of the 3rd rail.

4. Exemplar Rail Car - 4021

The exemplar rail car was documented with a total of 35 scans. Fifteen of those scans were exterior scans. The additional 20 scans were performed to document the interior. Point cloud images of the rail car exterior created by the scanner are shown in Figure 16 and Figure 17. The interior of the car is shown in Figure 18.

Figure 16: An image from the 3D laser scanner point cloud showing right side of rail car 4021.

Figure 17: An image from the 3D laser scanner point cloud showing left side of rail car 4021.

Figure 18: An image from the 3D laser scanner point cloud showing the interior of rail car 4021.

END OF REPORT

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