National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

RRD24FR003

VIDEO STUDY

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A. ACCIDENT

Location: New York, New York
Date: November 29, 2023
Time: 12:13 a.m.
Train: New York City Transit passenger train No. 2317-D

B. SUMMARY

B.1. The accident

On November 29, 2023, about 12:13 a.m., northbound New York City Transit (NYCT) passenger train No. 2317-D struck and fatally injured an NYCT employee working as a flagger on a cleaning crew on track B2 of the D line near the 34th Street-Herald Square Station in Manhattan, New York. As the train entered the cleaning crew's work zone, it experienced an uncommanded brakes-in-emergency (BIE) application. When the operator exited the train to see what caused the BIE application, they saw that the employee was under the train and unresponsive. The employee was transported to a nearby hospital for treatment and pronounced dead. No other injuries were reported. The accident took place in an underground tunnel, visibility conditions were dark, and weather was not a factor.

B.2. Objective and scope of the Video Study

The main objective of this Video Study was estimating the speed of the train as it was braking based on a video recorded by a camera installed near the location of the accident. A secondary objective was documenting the phone calls between a supervisor, the flagger and a track employee that occurred before and after the time analyzed in the video.

C. DETAILS OF THE INVESTIGATION

C.1. Estimation of the speed of the train

Three videos recorded by cameras located near the site of the accident were available. The three videos had duration of 3 hours, resolution of 956x716, and average frame rate of 30 fps (frames per second). One of the videos included visual information that could be used for estimating the speed of the train, as described next.

The moving train appeared in the video at time 12:11:57 AM based on the time stamp in the video. The video time stamps had resolution of one second. The train motion stopped at time 12:12:18 AM. Estimating the location of the train became possible at time 12:12:02 AM. Figure 1 shows a frame of the video at time 12:12:02 AM.

Figure 2 shows a schematic drawing of a Model R68 subway car. Speed estimation was based on the time it took the train to pass a distance between adjacent car doors. The figure shows that the distance from the first door to the second door and the distance from the third door to the fourth door were 18.1875 feet. Based on the spacing of the truck centers in the figure, the distance from the second door to the third door was 17.625 feet.

Since each car had four doors, three speed estimates were possible for each moving car. The entire lengths of only two cars were seen moving in the video. The motion of the train stopped before it became possible to estimate the time to pass the distance from the second door to the third door of the third car. Consequently, seven speed estimates were possible, three based on each of the first two cars and one based on the third car.

Figure 3 shows the video frame at the time when the leading edge of the second door of the first car touched the left edge of the video frame. Figure 4 shows the video frame at the time when the leading edge of the third door of the first car touched the left edge of the video frame. Since the door-to-door distance was known, the distance traveled by the train between these video frames was known.

The video had average frame rate of 30 fps. However, since each frame was shown twice, the effective average frame rate was only 15 frames per second, resulting in average time resolution of 1/15=0.07 seconds. Furthermore, the stated frame rate of 30 fps was an average rate. The video file included the times when frames were to be displayed as the video was playing. When these actual times were analyzed, it was detected that the frame-to-frame times of every three adjacent frames were 0.03 seconds, 0.03 seconds and 0.04 seconds. The resulting average frame-to-frame spacing was (0.03+0.03+0.04)/3=0.0333 seconds. This average frame spacing results in average frame rate of 1/0.0333=30 fps.

It is likely that the camera acquired video frames at the typical frame rate of 30 fps that corresponds to constant frame spacing of 0.0333 seconds. However, then the multi-camera security system saved the frames at the non-uniform rate corresponding to frame spacings of 0.03 seconds, 0.03 seconds and 0.04 seconds.

Since speed was estimated over time periods that were at least 1.26 seconds long (38 or more video frames), not having exact 2:1 ratio between the number of 0.03-seconds frame spacings and the number of 0.04-seconds frame spacings would not have resulted in significant door-to-door timing errors if a uniform frame rate of 30 fps was assumed. However, since the frame spacings embedded in the video file were known, they were used in the analysis.

The seven measured door-to-door times were 1.53 seconds, 1.67 seconds, 1.53 seconds, 1.26 seconds, 1.27 seconds, 1.33 seconds and 1.47 seconds. The seven door-to-door distances traveled during these seven times were 18.1875 feet, 17.625 feet, 18.1875 feet, 18.1875 feet, 17.625 feet, 18.1875 feet and 18.1875 feet. Figure 5 shows the seven estimated train speeds, computed by dividing traveled distances by the times to travel them, in units of miles per hour. The figure shows a speed estimate at the time of the video frame corresponding to the end of a measurement door-to-door distance. For example, the speed estimated based on the frames shown in Figure 3 and in Figure 4 is placed at 12:12:06.47, the time corresponding to the video frame in Figure 4.

The seven estimated speeds shown in Figure 5 are in the range between 7.2 mph and 9.8 mph. The average of the seven estimated speeds is 8.6 mph. The figure shows a period of about four seconds when the train was accelerating. The acceleration during this period was small, less than 0.03 g. Possible reasons for this acceleration include heating of brakes, change in slope of the track, and change in aerodynamic drag on the train.

Speed can also be estimated based on the time it took a subway car to travel the distance from the first door to the fourth door, which is 54 feet according to Figure 2. The estimated speed of the first car is 7.78 mph, and the estimated speed of the second car is 9.51 mph. This increasing speed is in agreement with the more detailed speed estimates shown in Figure 5.

C.2. Documentation of phone call times

Phone carrier records were used to document the timing of phone calls involving a supervisor, the flagger and a track worker that occurred shortly before and shortly after the time period during which the train speed was estimated. Figure 6 is a graphical representation of the phone calls. The dotted green lines represent the time period during which the train speed was estimated.

D. CONCLUSIONS

The speed of a braking subway train involved in an accident was estimated over 11.67 seconds based on a video. The estimated speed varied between 7.2 mph and 9.8 mph.

FIGURES

Figure 1. Video frame at time 12:12:02.00 AM

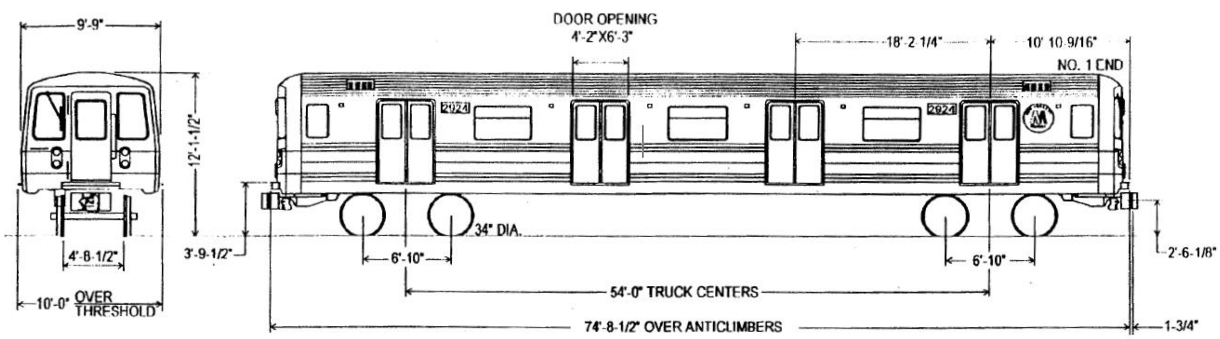

Figure 2. R68 subway car

Figure 3. Video frame at time 12:12:04.80 AM (first car, second door)

Figure 4. Video frame at time 12:12:06.47 AM (first car, third door)

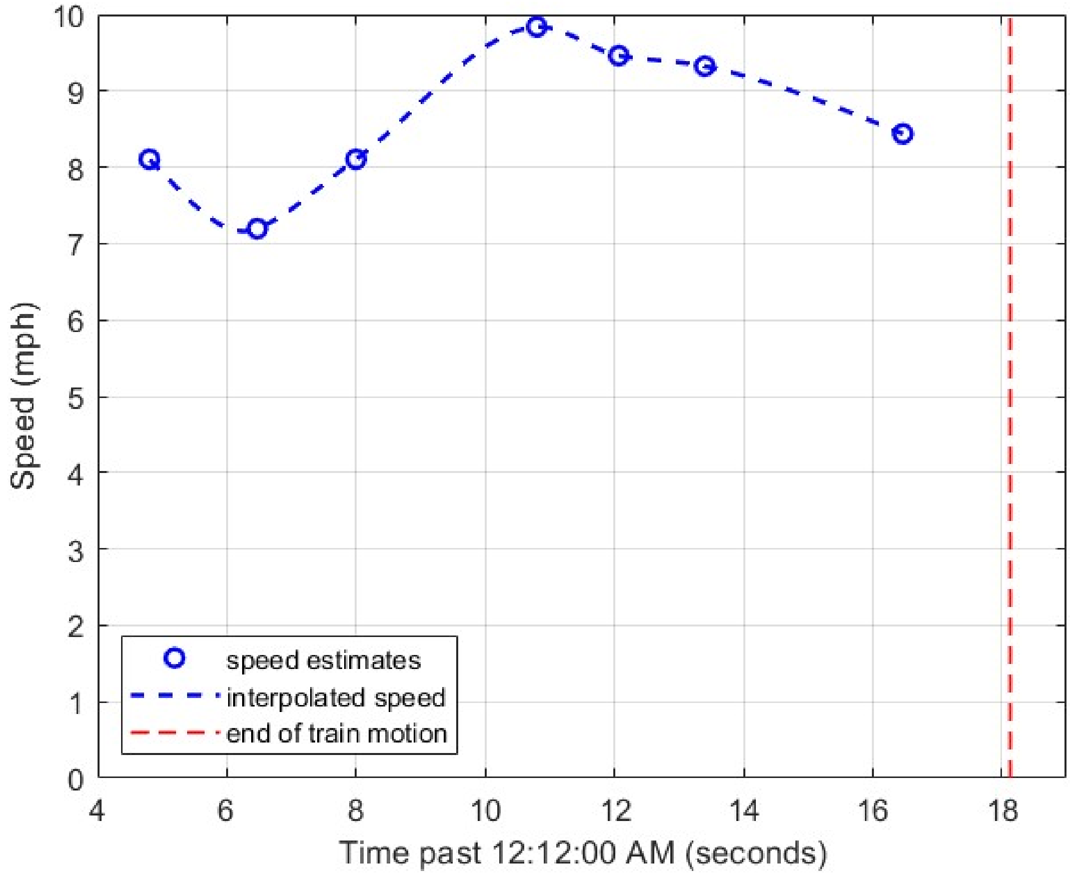

Figure 5. Estimated train speed

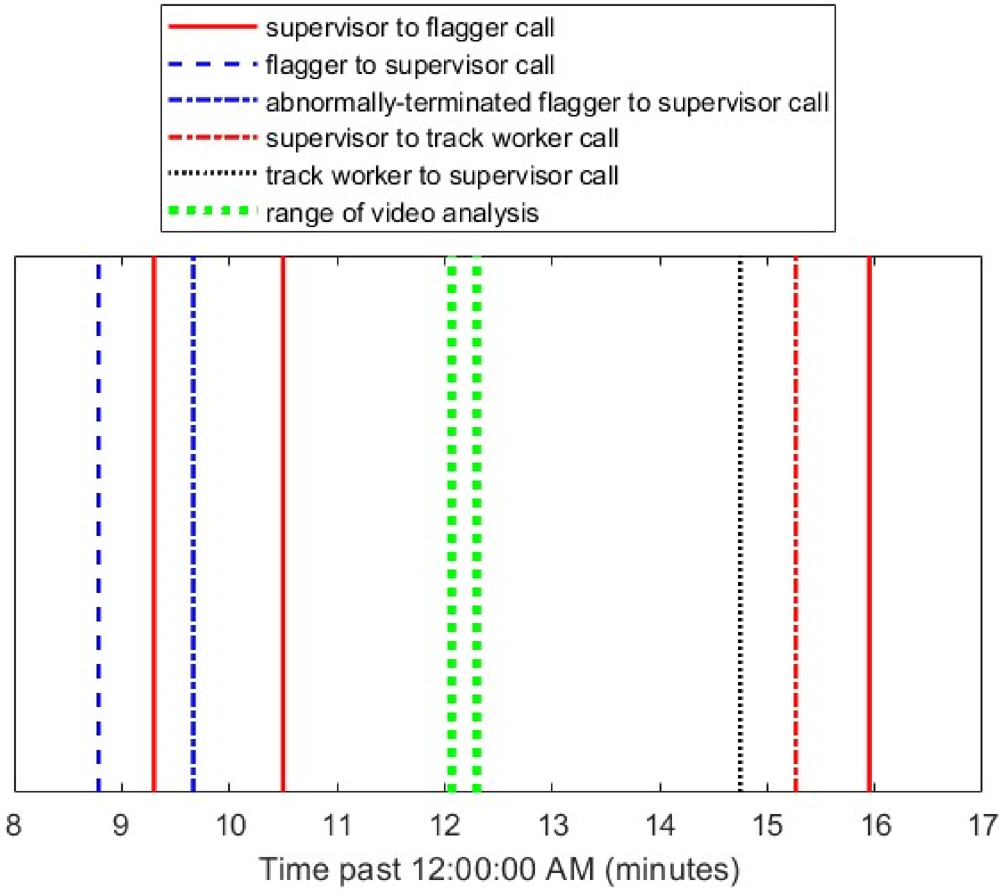

Figure 6. Graphical representation of phone call times