

HVE CASE STUDY – EXAMPLE REPORT

February 16, 1992

Anchorage Borough District Attorney's Office
State of Alaska
1031 West Fourth Avenue
Anchorage, Alaska 99501

Attn: Ms. Dianne Warwick

Re: Your Ref - State v. John David
D/A - 11-4-91

Subject: Crash Reconstruction - Preliminary Report

Dear Ms. Warwick:

At your request, Engineering Dynamics Corporation reconstructed a crash that occurred in Anchorage, Alaska. It was reported that on Monday, November 4, 1991, at approximately 4:16 PM, during clear, dry weather conditions, a 1975 Peterbilt truck tractor (bobtail; no trailer), driven by Mr. John David, was southbound on Arctic Boulevard when a 1982 Volkswagen Vanagon, driven by Ms. Alice Walker, entered Arctic Boulevard from a parking lot at a convenience store on the west side of Arctic Boulevard and attempted to cross the southbound lanes and proceed northbound. The vehicles collided, resulting in the death of Ms. Walker.

The purpose of the reconstruction was to determine the cause(s) of the crash. Of particular interest were the speed of the David Peterbilt prior to the crash and the location of the Peterbilt when the Volkswagen pulled out into traffic.

SUMMARY OF CONCLUSIONS

1. The primary cause of the accident was Ms. Walker's decision to enter Arctic Boulevard with insufficient distance between her vehicle and the oncoming Peterbilt.
2. The speed of the Peterbilt driven by Mr David may have been a contributing factor.
3. Mr. David's perception/reaction time was well within the normal range; driver inattention by Mr. David was not a factor.

PROCEDURE

1. The accident site was inspected on January 5, 1992. The site was measured and photographed. The locations of reference points (poles, pavement striping and pavement edges) were documented. Potential restrictions to visibility were identified. A 3-dimensional model of the crash site was prepared for purposes of analysis.
2. The vehicles were inspected on January 4, 1992. Each vehicle was measured and photographed. Damage profiles were developed from vehicle measurements. The condition of major vehicle systems, including steering, brakes and tires, was documented. Vehicle 3-dimensional data sets were prepared for each vehicle for purposes of analysis.
3. The police accident report and photographs were reviewed for pertinent information, including measurements of reference points and skidmarks. Witness statements were also reviewed.
4. HVE reconstruction and simulation analysis was performed to estimate the speed of the vehicles at the time of the crash. The pre-braking speed of the Peterbilt was also estimated and driver steering and braking inputs were estimated using HVE simulation to determine how the Peterbilt's driver responded to the Vanagon as it entered traffic.
5. A time-distance study was performed by analyzing the HVE simulation results to determine the location of each vehicle when Mr. David perceived a need to react (i.e., when he saw the Vanagon entering traffic and recognized that a threatening situation existed).
6. HVE visualizations were performed by attaching the virtual camera to each vehicle as the simulations were replayed in real time to visualize the crash sequence as seen by each driver, as well as to determine if limited visibility was a factor.
7. Avoidability analysis was performed and the resulting simulations were videotaped.
8. The above inspection, review, analyses and visualizations were used to determine the cause(s) of the accident.

FINDINGS

1. Inspection at the crash site revealed Arctic Boulevard was a 4-lane, undivided road, with two lanes northbound and two lanes southbound. Lane widths were 12 feet. The road was straight and level and had a 6-inch crown in the vicinity of the crash. The traveled lanes were bordered on each side by 6-foot wide sidewalks with 6-inch curbs. The surface of the traveled lanes was moderately-worn asphalt. See Figures 1 and 2.

The Party World convenience store was located on the west side of Arctic Boulevard approximately 150 feet south of Chugach Way. The store had a 60x120 foot level asphalt parking lot with two sloped (8 percent) entrance ramps.

The speed limit for traffic on Arctic Boulevard was 35 mph. A traffic signal was located at Chugach Way. There was no traffic control for vehicles entering Arctic Boulevard from the convenience store.

2. The light green, 1975 Peterbilt model 352-M cab-over-engine tractor, VIN 67046, was inspected at General Service Corporation in Anchorage. The vehicle was still drivable. The vehicle had a tag axle which was raised at the time of the crash. See Figures 3 through 6.

Inspection of the tires revealed the front Goodyear rib-style tires had an average tread depth of 16/32 inches. The tread depth of the rear lug-style retreaded tires ranged from 11/32 to 20/32 inches. Inflation pressures were not measured but were adequate.

The engine was started and the brake system compressor charged the brake system to 105 psi. A 65 psi brake treadle valve application resulted in a maximum brake pushrod stroke between 1.5 and 2.0 inches. Brake lining thickness was adequate and brake drums were in good condition. The front axle was unbraked. The power steering system and all linkages were intact.

Inspection of the Peterbilt revealed it had sustained minor frontal impact damage. A clear tiremark was visible on the left end of the bumper, consistent with impacting the Volkswagen's left front tire (see Figure 5).

The orange and white, 1982 Volkswagen Vanagon, VIN WV2YG0257CH034065, was inspected at Benson's Body Shop. The vehicle was not drivable. See Figures 7 through 10.

Inspection of the tires revealed all four were Dunlop Max Trak-Grip tires. The tires were of the M+S (Mud and Snow) tread designation and the treads were studded. The front tires had an average tread depth of 13/32 inches; the tread depth of the rear tires was between 5/32 and 8/32 inches. The inflation pressures for the left front and left rear tires were 27 and 22 psi, respectively. Both right-side tires were deboned and uninflated.

Visual inspection of the steering system revealed all linkages were intact. The steering was locked by impact damage. Inspection of the brake systems revealed no obvious defects. The pedal was firm.

The vehicle had sustained major collision damage on the left (driver's) side. Damage profile measurements revealed the penetration was 20+ inches deep. The characteristic of bumper over-ride was observed in the damage profile, consistent with the height of the Peterbilt's bumper. The driver's seat had become dislodged from its tracks due to collision-related damage.

3. The State of Alaska Uniform Police report, Police Case No. 91-162042, prepared by Trooper Tamonian, revealed the Peterbilt vehicle caused 80 feet of pre-impact skidmarks and 84 feet of post-impact skidmarks en route to its rest position. Their location was documented relative to a reference point at the northeast corner of the intersection at Arctic Boulevard and Chugach Way. Severe tire scrubbing resulted from the post-impact sliding of the Vanagon en route to its rest position. The vehicles came to rest in the inside southbound lane; the Peterbilt was straddling the centerline. Traffic was moderate at the time of the accident. A drawing of the crash sequence is shown in Figure 11.

Crash site photographs showed the intersection as it existed at the time of the crash. The road surface was dry. Significant tiremarks were visible in the traveled lanes. Photographs taken at the scene also showed the vehicles at their rest positions. The vehicle positions at impact were easily identified from visible tire marks. See Figures 12 through 15.

Photographs of the Volkswagen Vanagon revealed severe collision damage on the left side (see Figure 15). Damage to the Peterbilt was minor.

Photogrammetry was used to confirm the length of the skidmarks, as well as to determine their locations more precisely for purposes of analysis. See Figure 16.

Ms. Walker sustained major injuries to her chest and head. She died in the hospital approximately 4 hours later.

4. HVE/EDCRASH analysis revealed the speed of the David Peterbilt was 33 to 41 mph at impact; the speed of the Walker Volkswagen was between 4 and 11 mph. It should be noted that the speed of the Vanagon could not be estimated precisely due to the weight disparity between vehicles. HVE/EDSMAC4 simulation analysis confirmed the above range of impact speeds.

HVE/EDVDS simulation analysis revealed the pre-braking speed of the Peterbilt was 41 to 46 mph when the brakes were applied. Matching the simulated and actual vehicle pre-impact paths revealed that steering preceded braking by about 1/2 second. Thus, based on the braking time and distance, the driver began his steering reaction to the Volkswagen Vanagon about 1.6 seconds before impact.

HVE/EDVDS simulation also revealed that maximum braking deceleration of the Peterbilt was limited to about 0.25 G because its front axle was unbraked. If front brakes were installed and working, the Peterbilt's deceleration rate would have been approximately 0.45 G. It must be noted, however, that front brakes were not a legal requirement for this vehicle or other on-highway trucks of that vintage.

5. The time required for the Volkswagen to pull into traffic was dependent on its impact speed, its speed when it left the driveway, and its rate of acceleration. A series of possible scenarios revealed a range of 1.1 to 4.0 seconds.

Based on the above information, the driver of the Peterbilt reacted 1.2 to 2.4 seconds after the Vanagon began entering the roadway.

Based on the above information, the Vanagon entered Arctic Boulevard when the Peterbilt was approximately 190 feet away.

6. After setting up and executing the above simulations, a virtual camera was positioned near the driver's head within each vehicle and the simulations were replayed in real time. The resulting visualizations were videotaped (see videotaped runs 3 and 4). These simulations revealed how the other vehicle appeared as viewed from each driver's position before and during the crash sequence. See Figures 17 and 18.
7. Because the Peterbilt's estimated speed (41 to 46 mph) was in excess of the posted speed (35 mph), additional simulation analysis was performed to determine the avoidability of the crash had the Peterbilt been travelling at the posted speed when the crash sequence began. These additional HVE simulations revealed the available time before impact increased slightly (approximately 1.1 seconds). Under some scenarios, impact still occurred but was minor (i.e., the Peterbilt just clipped the rear of the Vanagon) and the impact speed was reduced to about 22 to 25 mph. Under some scenarios, collision was avoided. Under some scenarios the collision was moderate, but still included the driver's compartment. Several of these simulations were videotaped (see video runs 5 through 8).

CONCLUSIONS

1. Based on the distance available between the oncoming Peterbilt and the Vanagon, the primary cause of the crash was Ms. Walker's driver error. Regardless of the chosen scenario, the Peterbilt was too close when Ms. Walker entered Arctic Boulevard. This conclusion was substantiated by the real-time visualizations of the oncoming Peterbilt as viewed from Ms. Walker's driver-side window.
2. The Peterbilt driven by Mr. David was exceeding the speed limit by approximately 10 mph when the crash sequence began. Had his vehicle been traveling at the posted speed, some scenarios revealed the crash severity would have been reduced or avoided completely. Thus, excessive speed may have been a contributing factor.
3. Based on the simulation analyses, the Peterbilt's impact speed would have been reduced by about 10 mph if front brakes had been installed. Thus the lack of front brakes was a factor that increased the crash severity; however, the crash would still have occurred.
4. Based on every scenario studied, there was no reason to conclude that driver inattention by Mr. David was a factor in the crash.
5. No obstructions to visibility existed at the time of the crash.

DISCUSSION

1. It is possible that glare from the sun was a possible contributing factor. However, two reasons suggest glare was not a factor: (1) The HVE environment, which positions the sun according to local time, date, latitude and longitude, revealed the Vanagon would only have been in the glare of the sun after it reached the center of the road, and not while it was in the driveway on the west side of the road; and (2) Mr. David reacted to the Vanagon well within a normal range of perception/reaction times.

Respectfully submitted,

ENGINEERING DYNAMICS CORPORATION

Terry D. Day, P.E.
Principal Investigator



Figure 1 - Accident site as inspected on January 4, 1992, 60 days following the crash. This view is looking southbound, the direction traveled by Mr. David.



Figure 2 - Accident site as inspected on January 4, 1992, looking northbound.



Figure 3 - Frontal view of 1975 Peterbilt tractor as inspected on January 5, 1992. Note the black, circular impression towards the left end of the bumper. This impression was caused by the Volkswagen's left front tire.



Figure 4 - Oblique view of 1975 Peterbilt tractor. Note the minor frontal damage.



Figure 5 - Left frontal view of Peterbilt tractor shows damage to bumper and left front corner.



Figure 6 - Close-up view of right end of the Peterbilt bumper showing paint transfers from the Volkswagen Vanagon. The condition of the left front tire is also visible; the condition of this tire was typical of other tires on the vehicle.



Figure 7 - Frontal view of 1982 Volkswagen Vanagon as inspected on January 5, 1992. Note severe impact damage on the left side.



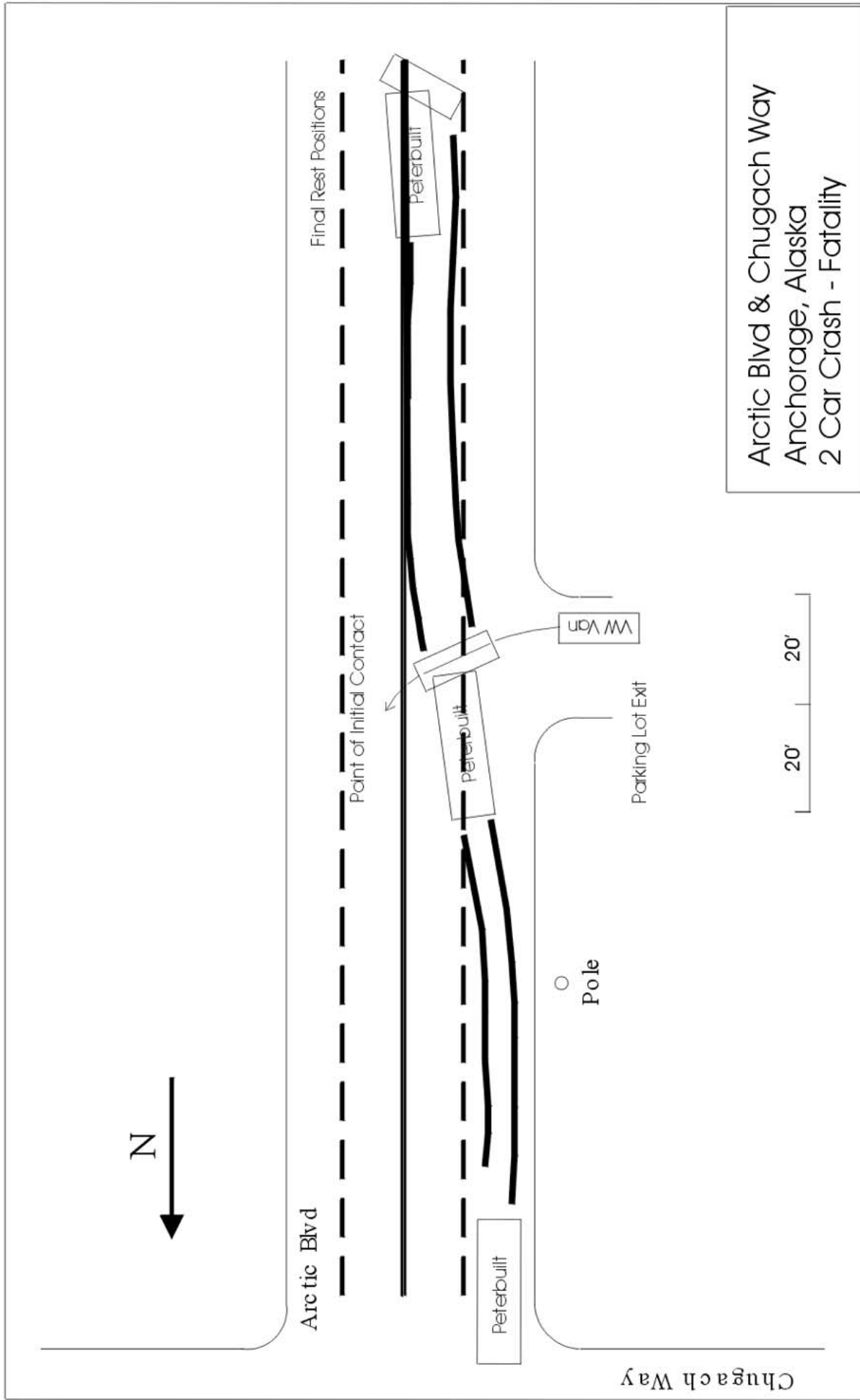
Figure 8 - Oblique view of 1982 Volkswagen Vanagon. Note that both right-side tires are debeaded and not inflated. The right front wheel rim shows evidence of lateral skidding that led to the debeading.



Figure 9 - View of severe impact damage on the left side of the Vanagon. Tape measure and damage outline drawn on the concrete floor are also visible.



Figure 10 - View of Vanagon interior showing the driver's seat dislodged from its tracks.



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Figure 11 - Schematic of crash sequence showing the Truck southbound on Arctic Blvd as the Van pulled out of the parking lot. The vehicles collided and skidded southerly to their rest positions.



Figure 12 - Crash site photograph of the southbound lanes of Arctic Boulevard. The view is looking south. Note the skidmarks and the vehicles, still in their rest positions. Note also the sign for the Party World convenience store on the west side of the road. Note the north driveway exit from Party World used by the Vanagon as its driver attempted to cross the southbound lanes of Arctic and proceed northbound.



Figure 13 - Closer view of vehicle at the crash site. Note the character of the tire marks. The heavily striated marks were caused by the Vanagon's tires as it was pushed laterally. These marks identify the location of the Vanagon at impact.



Figure 14 - Close-up view of the Peterbilt at rest. The left front tire is steered to the right, and caused a sweeping scuffmark visible in the photo. This information indicates the driver was attempting to steer back into the southbound lanes after impact.



Figure 15 - Close-up of the vehicles at rest showing the severe penetration of the front of the Peterbilt tractor into the left side of the Vanagon. Note also the striated tire mark leading to the left rear tire of the Vanagon, and the thin tire mark leading to the debaded right front tire of the Vanagon.

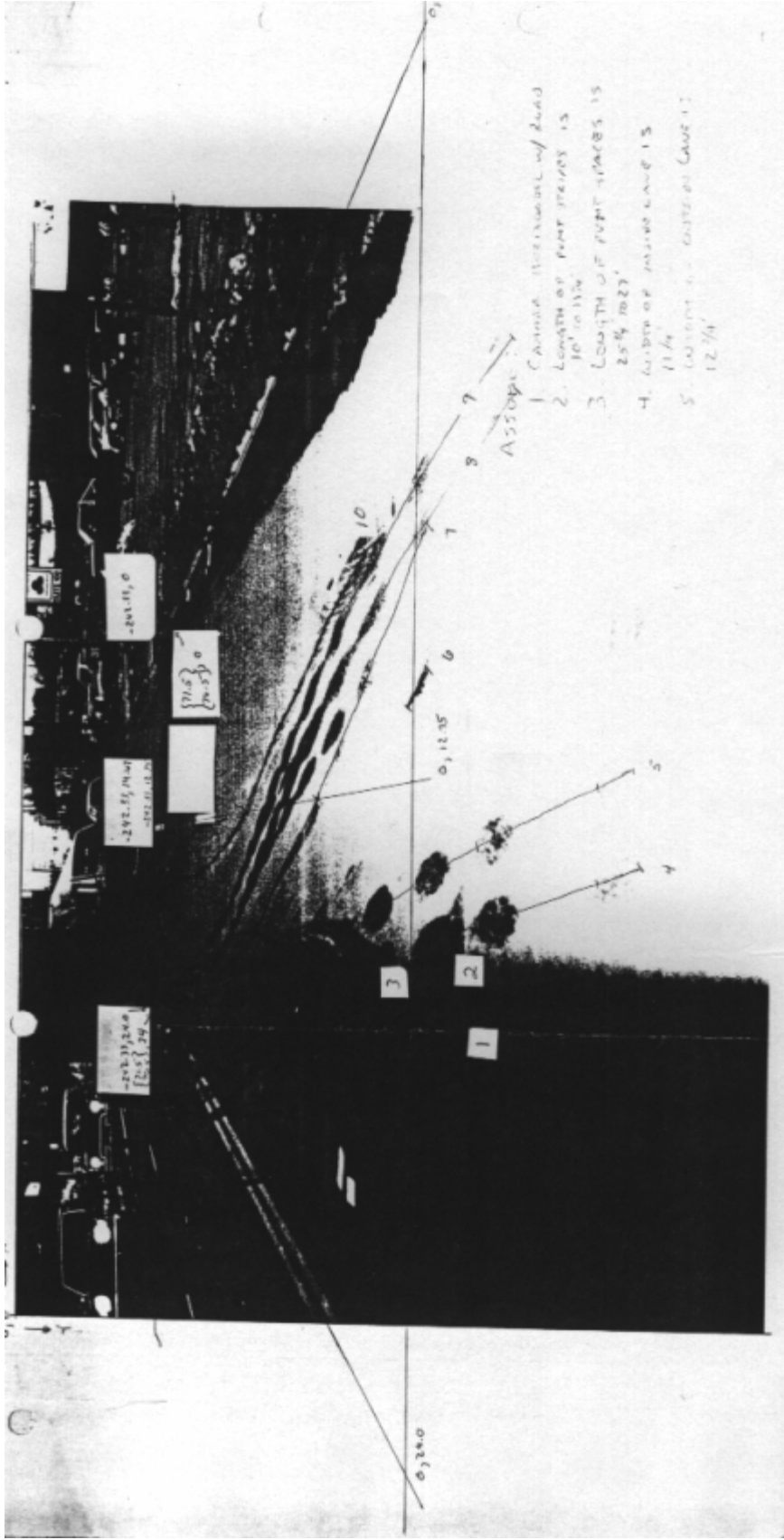


Figure 16 - Photogrammetry was used to confirm the locations and dimensions of the post-impact tire marks for both vehicles. The photogrammetry also helped to confirm which vehicle caused which marks, as well as the intermediate orientations of the vehicles as they skidded and rotated between impact and rest.

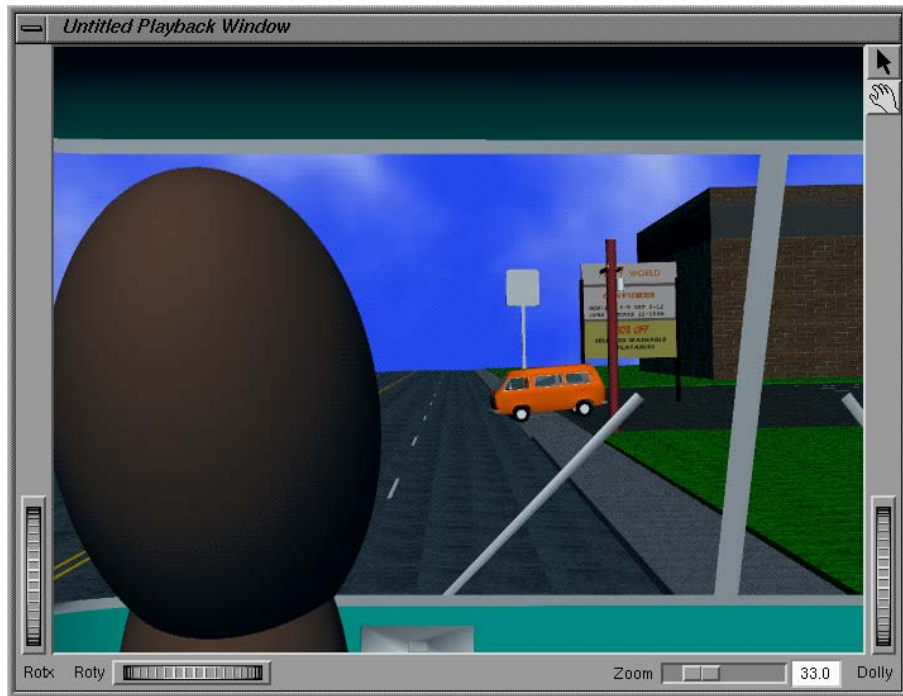


Figure 17 – Simulated view from driver’s position of Peterbilt truck prior to crash.

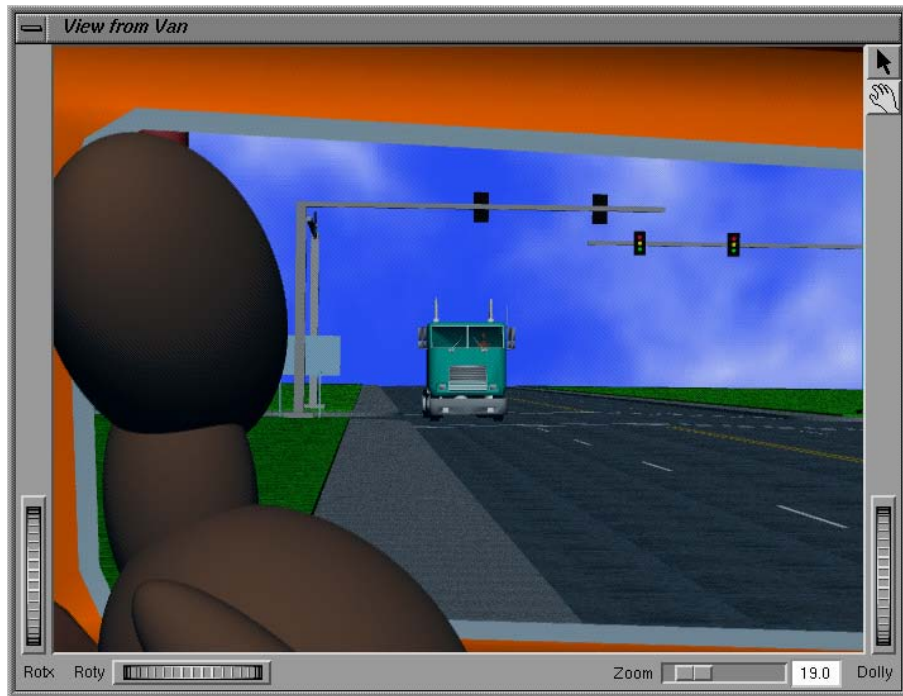


Figure 18 – Simulated view from driver’s position of VW Vanagon prior to crash.