Responding Report

Re:	Dewar v. Finnigan
Incident Date:	November 27, 2016
ICBC Claim:	AR11340-6
Your File:	1127574

Prepared for:

Ms. Barbara Devlin
Alexander Holburn Beaudin + Lang LLP
2700 – 700 West Georgia Street
Vancouver, BC
V7Y 1B8

Principal Author:

Kurt W. Ising, MASc, PEng
Principal, Senior Engineer

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1.0 QUALIFICATIONS

I, Kurt Ising, PEng, am responsible for the content of this report. I have a Master of Applied Science in Aerospace Science and Engineering (1994, University of Toronto) and a Bachelor of Science in Mechanical Engineering (1991, University of Manitoba). I have been a registered Professional Engineer in British Columbia since January 1999 and a registered Professional Engineer in Alberta since October 2003.

I have been working at MEA Forensic Engineers & Scientists Ltd. since 1995 and have primarily been involved in technical investigations of motor vehicle accidents. I have been qualified as an expert in the field of accident reconstruction and/or human factors in the Provincial and Supreme Courts of British Columbia, the Court of Queen's Bench of Alberta, the Supreme Court of Yukon, the Superior Court of Los Angeles County and the Circuit Court of the State of Oregon. My curriculum vitae is attached in Appendix A.

2.0 CERTIFICATION

I am aware that my duty as an expert witness is to assist the court and not to act as an advocate for any party. This report has been prepared in conformity with that duty. If called on to give oral or additional written testimony, I will give that testimony in conformity with that duty.

Ms. Janice Lee, PEng, assisted with the analysis, fieldwork and preparation of this report under my direct supervision. The opinions expressed in this report are mine.

3.0 INSTRUCTIONS

I was asked to review the materials listed in Appendix B and technically assess a report dated July 28, 2020 by Dr. Amrit S. Toor of Intech Engineering Ltd. My letter of instruction is attached in Appendix C.

4.0 BACKGROUND

It is my understanding that the incident took place at around 7:36 pm on November 27, 2016 in the 2100 block of Wall Street, Vancouver, BC. Ms. Lindsay Finnigan was driving a 2009 Mazda 3 south on Wall Street when she struck Mr. Garth Dewar, who had just left his residence at Hampton Court (2121 Wall Street) and was crossing the street.

4.1 Incident Scene

Dr. Toor did not inspect the incident scene. His description and diagram of the scene are based on scene photographs taken by the police and aerial imagery from the City of Vancouver and Google Street View imagery.

Ms. Lee attended the incident scene on June 30, 2020 and took measurements, photographs, and a total station survey. I also reviewed the provided police photographs and historical imagery from Google Street View and VanMap (2020).

In the 2100 block, Wall Street was a residential road that ran generally north-south (Figure 1). There was a traffic circle at the Eton Street intersection. South of the traffic circle, Wall Street was about 11.6 meters wide, with curbside parking permitted along both sides of the road. Southbound traffic faced a downhill grade of about 1.6%.

Hampton Court (2121 Wall Street) was an apartment complex on the west side of Wall Street. There was a paved walkway from the entrance to the curb (Figure 2). There were

trees and utility poles along the west side of Wall Street and a single street lamp on the east side of Wall Street, slightly north of the Hampton Court entrance. The speed limit was 30 km/h.

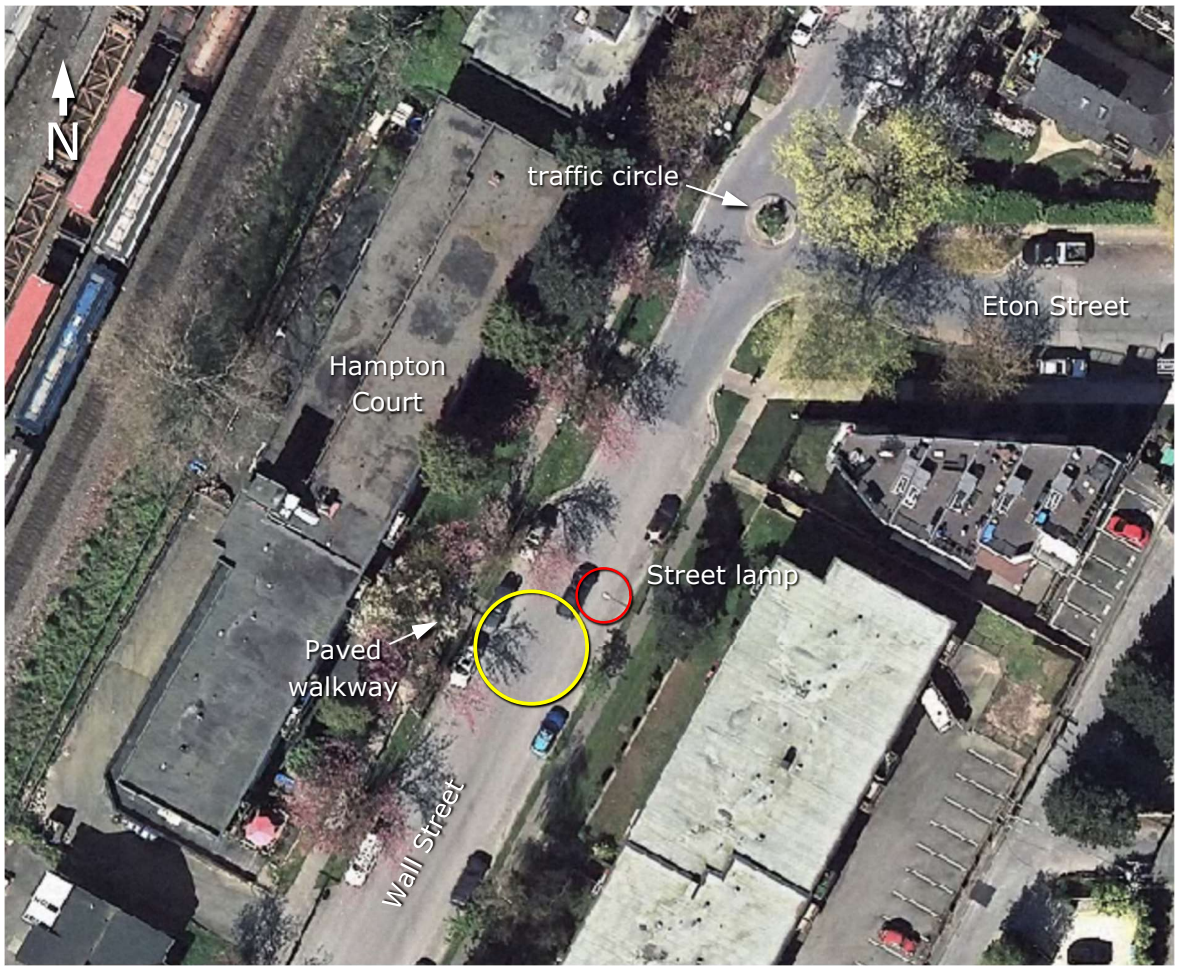

Figure 1: Aerial photograph of the incident scene in 2016 (VanMap, 2020). The area of impact is circled in yellow. The nearest street lamp is circled in red.

Figure 2: Photographs taken at Ms. Lee's scene examination. Views shown facing the Hampton Court entrance (top) and facing south from near the traffic circle (bottom).

The provided police photographs show the Mazda at rest facing south, south of the Hampton Court entrance (Figure 3). The Mazda appeared to be generally aligned with the road and within the northbound half of the road. Its front wheels were generally straight. Southeast of the Mazda and behind a parked Pontiac was a pool of blood, which I understand was where Mr. Dewar came to rest (Figure 4). A plastic fragment of the Mazda's left rear-view mirror lay next to the Pontiac's driver side door (Figure 5). There were several cars parked along the west curbside of Wall Street, near the Hampton Court

entrance, as well as along the east curbside. At the time that the police photographs were taken, the roads were wet, with shallow puddles.

Figure 3: Police photographs showing the Mazda at rest, with views facing south on Wall Street (top) and west from the east curbside (bottom).

Figure 4: Police photographs showing the Mazda from a northbound-facing view (top) and a closeup of a pool of blood behind a parked Pontiac, southeast of the Mazda (bottom). The top photograph was brightened to show other scene features.

Figure 5: Police photograph showing debris from the Mazda next to the parked Pontiac.

I used the total station measurements and scene photographs to determine the Mazda's rest position and the layout of scene evidence shown in the police photographs (Figure 6).

Figure 6: Estimated rest position of the Mazda and scene evidence, including the approximate positions of nearby parked cars along Wall Street, shown overlaid on a 2016 aerial of the incident area and a drawing based on the total station survey.

4.2 Mazda 3

The Mazda 3 was not available for examination but I did review photographs and a repair estimate by ICBC. It was identified as a blue 2009 Mazda 3 GT four-door hatchback with Vehicle Identification Number: JM1BK343691231789 and BC license: 703 WNW. The repair estimate indicated that it was equipped with anti-lock brakes.

The ICBC repair estimate specified replacement of the front grille, license plate frame, hood assembly, windshield and left rear-view mirror and repairs to the front bumper cover. The repair estimate also noted that the damage to the left rear door area was unrelated to this incident.

The front center of the hood was flattened and the grille was fractured directly in front of this hood damage (Figure 7). The hood appeared to be misaligned with the front headlights. The lower part of the windshield was fractured just left of the vehicle's centerline. The front license plate bracket was fractured on the right side and the license plate was bent in.

The left rear-view mirror's plastic housing was fractured, with pieces missing (Figure 8).

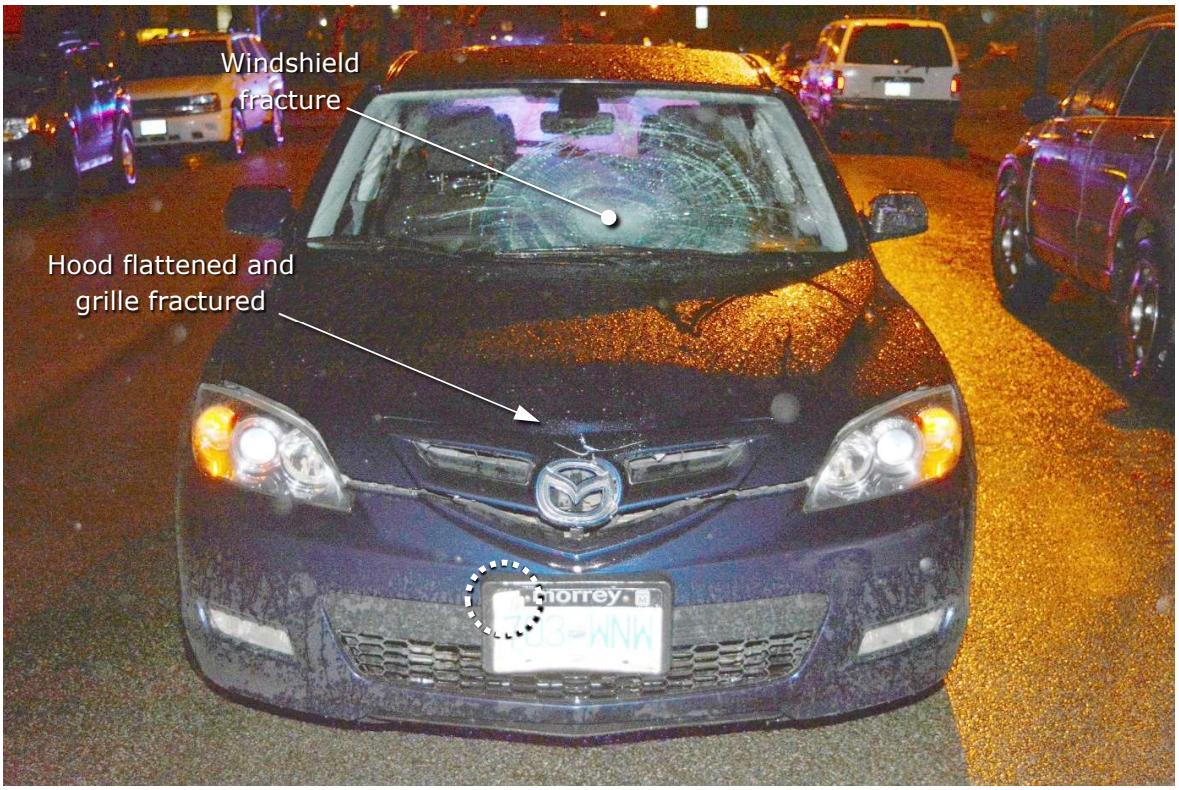

Figure 7: Mazda 3 damage. The front license plate bracket was fractured where circled. This image was brightened for clarity.

Figure 8: View from the left front.

4.3 Mr. Dewar's Injuries

The provided police file stated that Mr. Dewar had sustained a left fibula fracture, a large laceration to the left side of his forehead and multiple abrasions and cuts to the face and arms. It is my understanding that at the time of the incident, Mr. Dewar weighed between 280 and 290 lbs (127 and 132 kg) and was 5'10" tall (178 cm).

5.0 Review of Dr. Toor's Report

I was asked to review and comment on the Motor Vehicle / Pedestrian Collision Analysis report dated July 28, 2020 by Dr. Amrit S. Toor, PEng of Intech Engineering Ltd. I will comment on sections of Dr. Toor's report using his own headings.

5.1 "4.0 Facts and Assumptions"

I accept the assumptions made by Dr. Toor; however, I would caution on assumption (4a) of Dr. Toor's report, stating "*The Finnigan Mazda was southbound on Wall Street, travelling near the middle of the road*." This assumption is later used to make additional implications about Ms. Finnigan's pre-impact actions in Dr. Toor's report. This will be discussed in further detail below.

5.2 "5.3 Review of the Provided Police Data"

Dr. Toor assessed the Mazda's rest position as being, "… *in a predominantly southbound direction, but angled slightly to the south-east, and biased toward the northbound side of the road*." I agree that the Mazda was within the northbound half of the road with a southbound heading; however, I believe the Mazda's right side was about aligned with the road's centerline and therefore about 0.5 meters west of the position shown in Figure 6 of Dr. Toor's report. I would also emphasize that if the Mazda was angled slightly southeast, it was very minor. The police photographs show that the Mazda was in general alignment with the road and that its front wheels were not notably steered to the left (or right).

5.3 "6.3 Impact Speed of the Finnigan Mazda"

Dr. Toor states that he calculated the Mazda's speed using three independent methods. I find that the impact speed ranges presented in his first two methods are wider than he has presented. I also find that the impact speed calculated in his third method could be lower than he has considered.

Dr. Toor first assessed the type of engagement Mr. Dewar had with the front center of the Mazda, based on Mr. Dewar's height. He then considered Mr. Dewar to have travelled between 14 and 16 meters from impact to rest, assuming that Mr. Dewar had been crossing the road from the apartment walkway either directly across or at a slight angle to the south, where his vehicle was parked.

In Dr. Toor's first method (Section 6.3.1 of his report), he referenced a table that gave general damage descriptions for different impact speed ranges (Toor et al, 2002).

I reviewed staged collisions by Crash Test Service (1998, 2004, 2015), in which the front of small passenger vehicles, with similar front profiles as the Mazda, struck the side of stationary pedestrian dummies in a similar orientation to the impact with Mr. Dewar. At impact speeds of as low as 30 km/h, the striking cars sustained similar damage to the Mazda; that is, front bumper cover damage, flattening of the hood, and a windshield fracture (Figure 9). In these tests, the adult pedestrian dummies had heights between 1.72 and 1.81 meters and were struck by cars with front bumper heights between 0.54 and 0.58 meters. The dummies' corresponding center of mass heights were between 0.96 and 1.01 meters, based on using the same center of mass reference that Dr. Toor used in his report. Similar to Dr. Toor's calculation of Mr. Dewar's center of mass being about 0.44 meters above the front bumper of the Mazda, the dummies in these staged collisions had a center of mass that was above the striking car's front bumper by between 0.40 and 0.46 meters. Therefore, based on the Mazda damage alone, a lower impact speed of about 30 km/h was possible.

Figure 9: Staged collisions resulting in similar vehicle damage as Ms. Finnigan's Mazda, at impact speeds of 30 km/h by the Ford Mondeo (top row) and Opel sedan (middle row) and 34 km/h by the Opel Astra (bottom row). Impact orientation is shown on the left and post impact damage on the right. Pre-existing damage is shown by black hatch marks.

In Dr. Toor's second method (Section 6.3.2 of his report), he referenced another research paper that he published in 2003, in which the empirical model from his 2002 study was re-modelled with the addition of more real-world crash tests. Dr. Toor calculated a midrange impact speed of between 44 and 48 km/h for the Mazda; however, if the 5th and 95th percentile equations presented in this study were considered, the calculated impact speed was between 35 and 57 km/h.

In Dr. Toor's third method (Section 6.3.3 of his report), he considers Ms. Finnigan to have applied hard braking, at a rate of 0.63 g, across a distance of 11 to 12 meters, resulting in an impact speed of 42 to 44 km/h. Due to the wet roads and the Mazda's anti-lock brakes, I would not expect to see tire marks left by the Mazda at the scene. Therefore, the lack of tire marks cannot confirm when or how hard Ms. Finnigan applied the brakes to rest. It is possible that Ms. Finnigan braked hard from impact to rest, as Dr. Toor has assumed, although his calculations then imply that Ms. Finnigan saw Mr. Dewar prior to impact and first applied the brakes at least 0.3 seconds before impact. This is because, at the onset of braking, time and distance are needed for the vehicle's brake pressure to reach maximum capacity (Goudie et al, 2000). That is, in order to reach the braking level assumed by Dr. Toor at impact, Ms. Finnigan had to have started braking before impact.

Alternatively, the lack of tire mark evidence does not preclude the possibility that Ms. Finnigan had braked some time after striking Mr. Dewar. For example, if Ms. Finnigan had been initially travelling at 35 km/h when her Mazda struck Mr. Dewar and applied hard braking 0.3 seconds after impact, then, including brake lag effects, she would have travelled about 12 meters from impact to rest. If the brakes had been applied later, then the Mazda's impact speed was lower and vice versa. If the distance travelled was 11 meters rather than 12 meters, then either a lower impact speed or a shorter reaction time was possible, with all other things being equal. For reference, 11 meters corresponds to Mr. Dewar having walked at a southeasterly angle towards his car in Dr. Toor's report.

Dr. Toor summarized his analysis by concluding that the Mazda's speed was probably about 46 km/h. As discussed above, the speed ranges presented in each of his methods are too narrow. Based on the literature, staged collisions, and calculations discussed above, I find that it was possible for the Mazda to have been travelling at as low a speed as 35 km/h at impact.

5.4 "6.4 Pre-Impact Speed and Positions of the Finnigan Mazda and Pedestrian Dewar"

Dr. Toor compared the Mazda's rest position with assumption (4a) of his report, which assumes that the Mazda was initially centered on the road, to conclude that the Mazda had likely swerved to the left before impact. Dr. Toor then made the additional assumption that Ms. Finnigan started braking at the same time that she steered. I would emphasize that the Mazda's pre-impact motions are based on assumptions and not on physical evidence. As discussed in Section 5.2, the Mazda's rest position was generally aligned with the road and its front wheels were not noticeably steered to the left (or right). Based on the scene evidence, there are no physical constraints preventing Ms. Finnigan from steering the Mazda after impact, if at all. Similarly, and as described in Section 5.3, Ms. Finnigan could also have started braking after impact.

Dr. Toor considered a steady walking speed of 5.8 km/h by Mr. Dewar, with a range of 5.4 to 6.1 km/h, from the curbside to impact. He notes that, because of the cars parked along the curbside, Mr. Dewar would have cleared the parked cars and travelled about 4 to

5 meters further to impact. I will use this same range of speeds and distances for Mr. Dewar in the following sections.

Dr. Toor then assumed an average approach speed of 46 km/h by the Mazda to calculate that it was about 36 meters away from impact when Mr. Dewar had just cleared the parked cars. This is the position at which Dr. Toor then assessed Ms. Finnigan's avoidance opportunity, which I will discuss in further detail below.

5.5 "6.5 The Opportunity for Ms. Finnigan to Avoid Impact"

Dr. Toor assessed Ms. Finnigan's avoidance opportunity in two different ways, each with implications that are not discussed in his report.

In his first approach, he determined that if the Mazda had been traveling at 36 km/h rather than 46 km/h, when it was 36 meters away from impact, then no reaction would have been necessary by Ms. Finnigan and Mr. Dewar would have had enough time to clear the Mazda's path. This approach invariably requires a lower alternative approach speed for any given approach speed by Ms. Finnigan, in order for Mr. Dewar to pass in front of the Mazda safely. For example, using Dr. Toor's average values, if the Mazda's approach speed was 35 km/h, then the Mazda was 27 meters away from impact when Mr. Dewar cleared the parked cars, in which case an alternative speed of 28 km/h would have been required for Mr. Dewar to clear in front of the Mazda's path.

In Dr. Toor's second approach, he calculated that for an alternative speed of 44 km/h, Ms. Finnigan could have avoided impact with Mr. Dewar by initiating her perception response time of 2.0 seconds, followed by hard braking, providing enough time for Mr. Dewar to clear the Mazda's path. This avoidance scenario implies that Ms. Finnigan saw Mr. Dewar when he stepped out from between the parked cars, 36 meters away. Considering Ms. Finnigan's seated position in the Mazda, the required sightline distance was about 38 meters at this point.

At the time of the incident, it was fully dark (MEA Forensic, 1995). The only ambient light was from a single street lamp on the opposite side of the apartment complex, which was about 11 meters away from Mr. Dewar's initial position. Therefore, when Mr. Dewar first stepped out from between the parked cars, this street lamp may not have sufficiently illuminated him. Ms. Finnigan would have had to rely substantially on the Mazda's headlights for detection.

In a study by Olson and Sivak (1983), pedestrians dressed in either white or dark clothing stood on either side of a dark, rural road. Subject drivers and passengers were instructed to identify the pedestrians with the press of a button as soon as possible. I considered the measured results of young drivers (18 to 30 years of age), the delay of the button-press and the subjects' pre-awareness of the pedestrians' presence (Roper and Howard, 1938). Based on this study and the considerations mentioned above, an average driver's detection of a white-clad pedestrian would have occurred about 45 meters away; a darkly-clad pedestrian would have been detected about 25 meters away.

It is my understanding that Mr. Dewar had been wearing a red and green jacket, blue jeans and running shoes. It is unclear what shade of red and green his jacket was, though unless it was quite light, it was likely most similar to the darkly-clad pedestrians in the Olson and Sivak (1983) study. Therefore, from a distance of 38 meters away, an average driver may not yet see Mr. Dewar in the dark. If Mr. Dewar had taken the shortest path to cross the road, then at some point he would have become more illuminated by the street lamp. If Mr. Dewar had walked at a southeasterly angle towards his car, as Dr. Toor had also

considered, then he more likely stayed out of the street lamp's range. In addition, the rain and reflection from puddles would further reduce an average driver's visibility, making it more difficult to see a darkly-clad pedestrian in the dark.

5.5.1 Mr. Dewar's Avoidance Opportunity

Dr. Toor assessed Ms. Finnigan's avoidance opportunity but not Mr. Dewar's. Mr. Dewar's task of seeing the Mazda was easier because he needed to detect the Mazda's headlights against the darkness. The Mazda would therefore have been visible from the traffic circle, had Mr. Dewar looked in that direction. It is my understand that he did see the Mazda approaching before he began to cross the road. Therefore, Mr. Dewar could have made the decision to wait for the Mazda to pass before he crossed the road.

Although Mr. Dewar ultimately decided to cross the road, he still had an opportunity to reassess the situation and stop short of the Mazda. Upon identifying the Mazda as a hazard, Mr. Dewar would have required a perception / response time (PRT) before he could begin to stop himself. Olson et al (1984) studied the PRT of drivers encountering a hazard in the middle of their path, reporting an average PRT of 1.1 seconds. If Mr. Dewar had been looking at the Mazda, then I believe the distribution in Olson et al's (1984) study could be applied to his response. Mr. Dewar would have then needed time and distance to stop short of the Mazda. Wood et al (2010) measured the speed of subjects who were asked to walk at a constant speed and then stop as quickly as possible at the sound of a horn. Based on this study's measurements, I calculated that the average stopping deceleration was 0.29 g ± 0.11 g.

Therefore, based on Mr. Dewar's range of walking speeds, PRT, stopping deceleration and the extra clearance needed to stop short of the Mazda's path, his last opportunity to identify the Mazda as a hazard was when he was about 3.6 meters (3.0 to 4.7 meters with 95% confidence) and 2.2 seconds (1.9 to 2.9 seconds with 95% confidence) away from impact. For an approach speed of 46 km/h by the Mazda, the Mazda was about 29 meters away from impact at this point. For an approach speed of 35 km/h, the Mazda was about 22 meters away from impact.

6.0 CONCLUSIONS

Based on the preceding review of Dr. Toor's report, I would offer the following comments on his conclusions (1), (1a), (2a) and (2b):

(1) Dr. Toor concluded that the Mazda's impact speed was about 46 km/h. My analysis shows that the Mazda's speed could have been as low as 35 km/h, based on the scene evidence and Mazda damage.

(1a) Dr. Toor stated that it was likely that the Mazda's brakes were engaged at impact. There is no physical evidence to substantiate this statement. As mentioned in conclusion (1), it is possible for Ms. Finnigan to have struck Mr. Dewar at a lower speed than Dr. Toor has found and apply the brakes after impact to reach the same rest position.

(2a) Dr. Toor stated that at an alternative speed of 36 km/h, from the point where Mr. Dewar first stepped out from between the parked cars, no response would have been required by Ms. Finnigan and Mr. Dewar could have cleared the Mazda's path before it reached the location of impact. This avoidance approach invariably requires a lower alternative speed for any given initial speed. For example, at an

impact speed of 35 km/h, an alternative speed of 28 km/h would then have been required to prevent impact.

(2b) Dr. Toor's second method of calculating Ms. Finnigan's avoidance by reacting to Mr. Dewar when he emerged from between parked cars at an alternatively lower speed assumes that Ms. Finnigan could have seen Mr. Dewar in the darkness from 36 meters away (and more likely 38 meters away from Ms. Finnigan's seated position). I calculated that, in full darkness, an average driver could see a white-clad pedestrian from 45 meters away and a darkly-clad pedestrian from 25 meters away. Mr. Dewar's clothing description suggest that his visibility was probably closer to that of a darkly-clad pedestrian. The street lamp may have increased visibility but the rain and wet conditions would have decreased visibility.

I offer the following additional comments on Dr. Toor's report:

a. Dr. Toor assessed Ms. Finnigan's avoidance potential, but not Mr. Dewar's. Mr. Dewar could have easily seen the Mazda's headlights in the darkness had he looked in that direction. Therefore, Mr. Dewar could have avoided impact by waiting for the Mazda to pass.

b. Even after Mr. Dewar decided to cross the road, there were still opportunities for him to reassess the situation and stop short of the Mazda's path. The latest distance and time to avoid impact was about 3.6 meters and 2.2 seconds before impact, respectively.

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