Special Crash Investigations Program: Investigation of a Fatal Crash Involving a Vehicle with Level 2 Automation

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NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

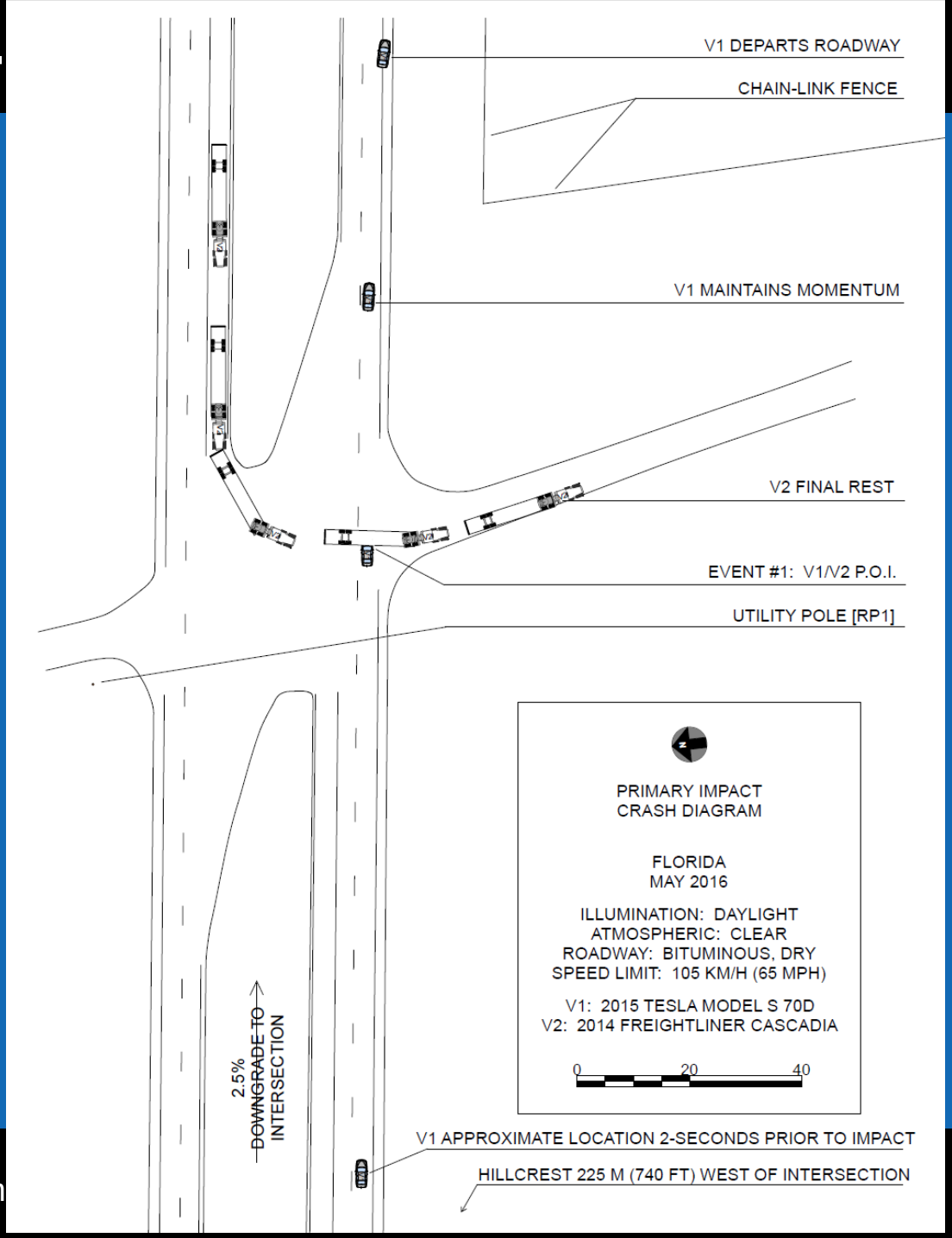
Case Overview

Facts

- Crash in May 2016 in Florida
  - 2015 Tesla Model S 70-D
  - 2014 Freightliner Cascadia tractor\power unit
    - 2003 Utility Trailer unit

Case Overview

Overview of Crash Scene



Case Vehicle

- 2015 Tesla Model S 70-D
- Manufactured June 2015
- Purchased new by the owner August 2015
  - October 2015 received software upgrade enabling "Autosteer"
  - At time of crash – using the most recent vehicle firmware, version 7.1 (2.17.37) – Received telemetically April 2016

Autopilot

- Autopilot was made incrementally available to this vehicle through software upgrades
  - *Autopilot allows Model S to steer within a lane, change lanes with the simple tap of a turn signal, and manage speed by using active, traffic-aware cruise control. Digital control of motors, brakes, and steering helps avoid collisions from the front and sides, as well as preventing the car from wandering off the road*
- Designed for limited access highways with prominent lane markings
- Technology was not intended to replace human driver

Other Vehicle

- 2014 Freightliner Cascadia tractor
- 2003 UTI dual axle refrigerated 53’ box trailer
- Trailer had a GVWR of 65,000 lbs
  - Loaded with 16 pallets of produce that weighed approximately 20,000 lbs

Case Overview

Precrash

- Case vehicle 40-y/o driver
- Traveling east in right lane
- Data from Tesla indicated:
  - Vehicle had been operating this trip for ~41 mins
    - ~37 mins were in Autopilot
    - Autopilot system activated 3 times during this driving cycle
    - Last activation 6.2 mins (~6.7 miles) prior to crash
    - Operated in restricted mode for ~1 mile until town limits
  - Approximately 5 mins prior to crash driver set cruise to 65 mph
    - Adjusted this upward 3 times over 3 mins
    - Last recorded action by driver was speed increase to 74 mph
      - ~112 sec prior to crash

Precrash (cont.)

- Alerts to driver during this ~41 mins driving cycle:
  - Hands on steering wheel visual alerts: 7
  - Hands on steering wheel chime alerts: 6
  - Hands on steering wheel enhanced chime alerts: 0
  - Hands on steering wheel slowing alert: 0

- For the ~41 mins cycle prior to the crash the Tesla was in Autopilot mode for 92% of the time

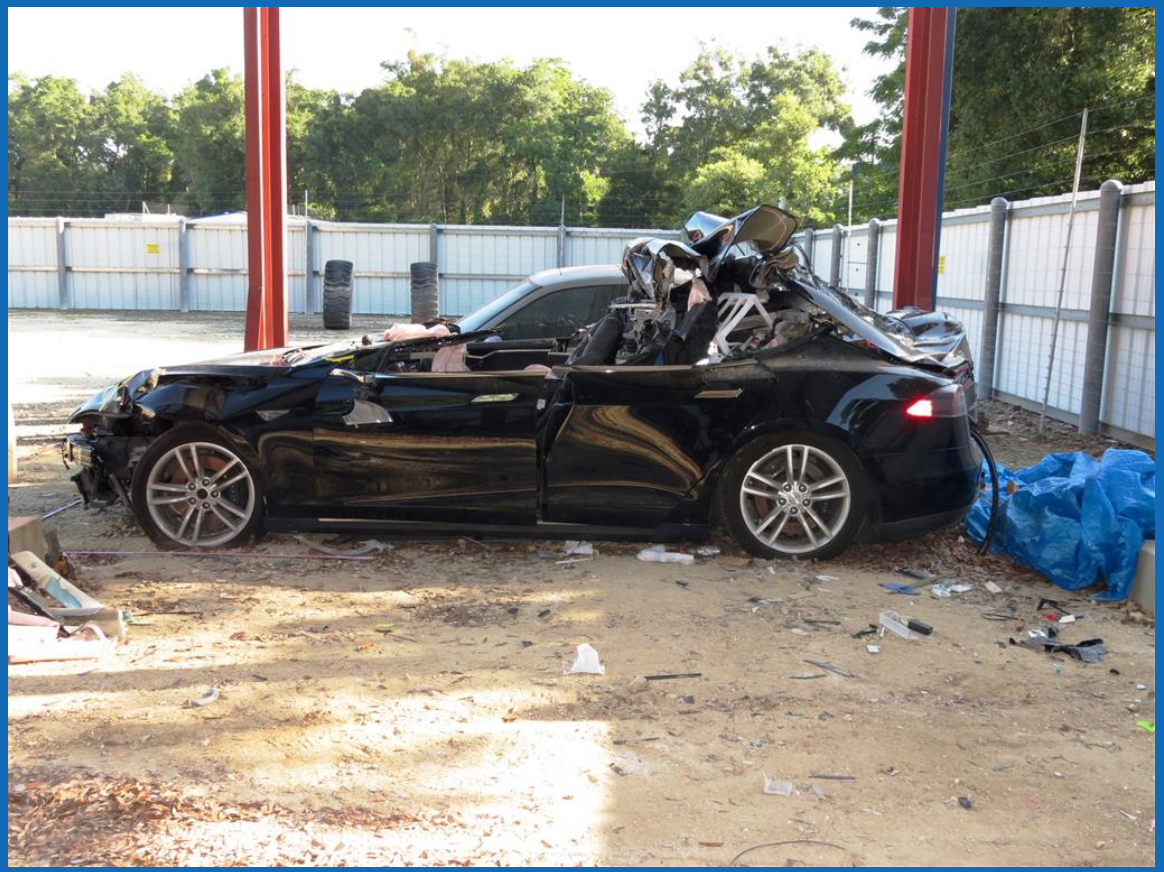
Case Overview

Precrash

- Other vehicle (Freightliner) operated by 62-y/o driver
- Freightliner initiated left turn across the path of the Tesla
- Impact was in right lane, traveled approximately 72 ft through the turn
- Did not make statement to police
- Initially indicated to SCI:
  - "Did not see" the Tesla
- During 2nd interview indicated:
  - Came to a full stop prior to left turn
  - No vehicles were within his sight, began left turn
  - During acceleration he noticed Tesla crested transition to 2.5% downgrade
  - Thought he had enough time to complete turn

Crash

- Tesla under-rode trailer at the mid point area
- Sheared the greenhouse and roof structure from Tesla
- Driver's head contacted numerous intruding components
  - sustained fatal injuries



Crash

- Right side of trailer impacted
- Damage evident across underside of trailer

Crash

- Tesla continued ESE path off road and contacted
  - Chain link Fence 2x
  - Wooden utility pole
    - Then rotated CCW to final rest

Crash

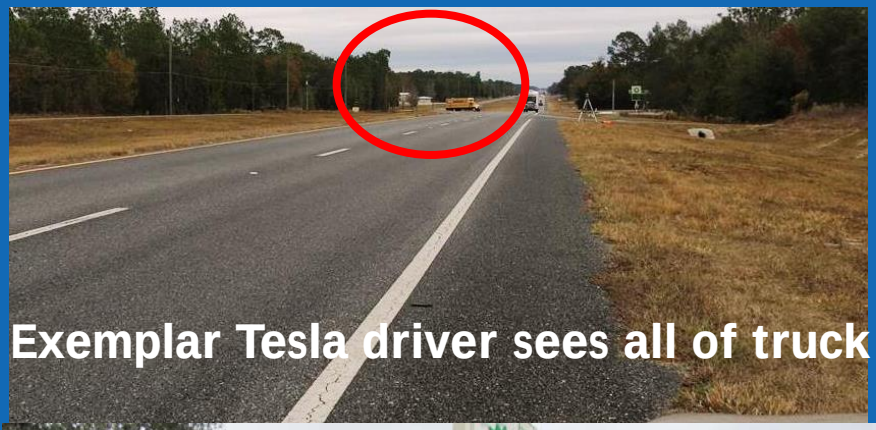
- Trajectory ~886.5 ft from impact with tractor-trailer to final rest of Tesla

Tesla Equipment

- EDR data imaging was not supported by a commercially available tool
- On-board performance recorded data was provided by Tesla:
  - Vehicle speed
  - Accelerator pedal position
  - Brake status / steering wheel angle
  - Cruise control state
  - Lead vehicle presence and distance
  - Front and rear motor torque
  - Odometer
- ~Six minute interval prior to crash:
  - Traffic Aware Cruise Control engaged
  - “Autopilot” was active

Visibility Study

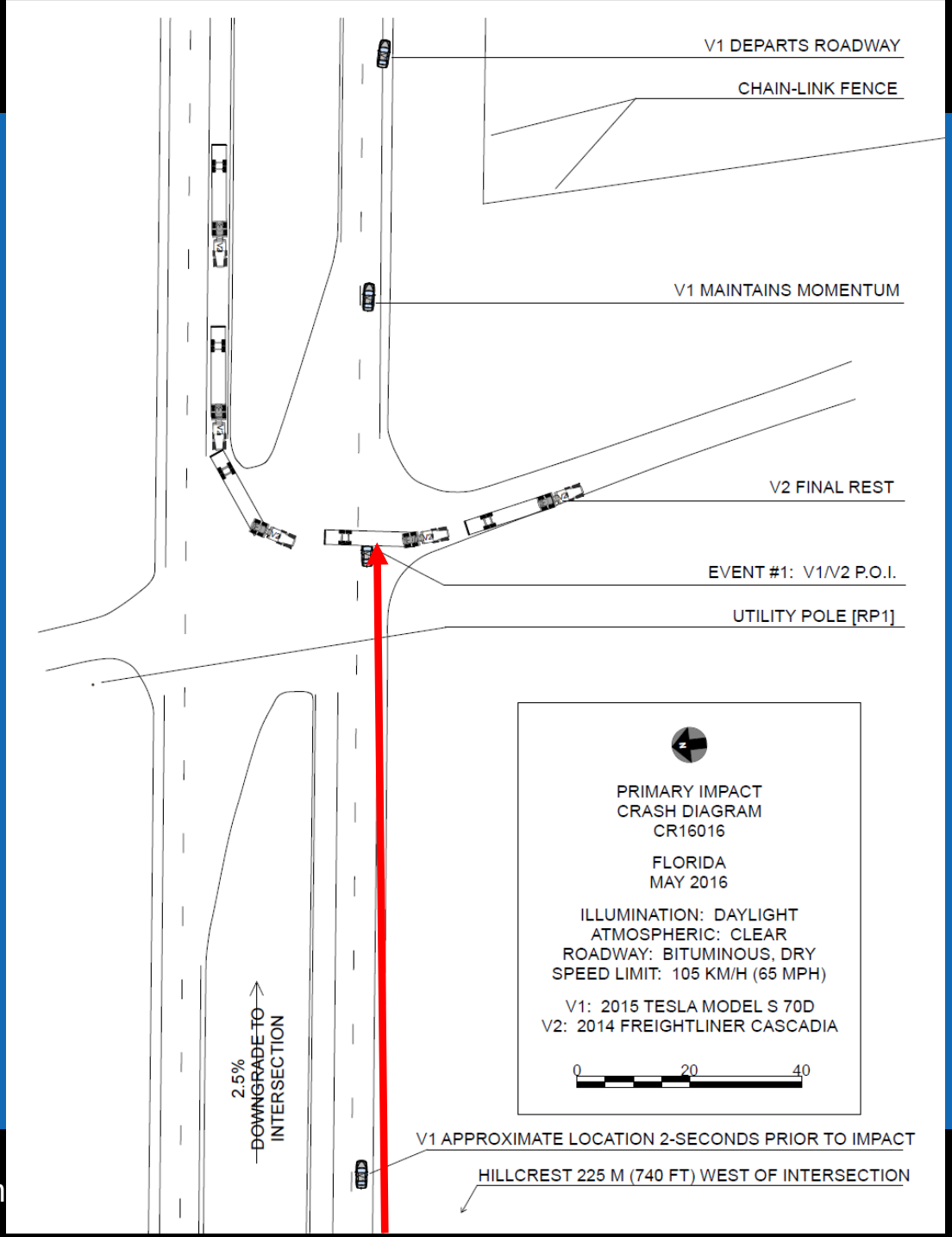
- Exemplar vehicles (approximating eye height) were used to establish line of sight
- Line of sight measurements were taken with the Freightliner at "reported" stopped position and as moving through turn
- Exemplar driver (Tesla) begins to see top of truck at 1,417 ft
- Exemplar driver sees all of truck at 961 ft
- 2 ft traffic cone placed on eastbound lane near POI
  - Visible to exemplar driver at ~1,073 ft



Exemplar Tesla driver sees all of truck

Exemplar truck with targets affixed

- From the hillcrest to west side of intersection was 740 ft
- At speed limit (65 mph) it would be ~7.7 sec to intersection
- Tesla was traveling at ~74 mph would cover this distance in ~6.8 sec



Tesla Equipment

- Additional equipment present:
  - Laptop computer
  - Monitor
  - Cell phone
- Aftermarket Computer Mounting system
  - Attached to right front seat
    - All attachments loose so pre-crash position was undermined

Conclusions

1. The Tesla Autopilot system was engaged and the driver used the TACC and Autosteer features
2. Multiple sources of possible distractions were present inside the Tesla
3. Visibility for both vehicles was clear and unobstructed
   a. The Tesla driver had ~7+ sec to initiate an avoidance action
4. There were no indications the Tesla driver provided any steering or braking inputs to avoid the crash
5. The Tesla's multiple advanced driver assistance systems were functional at the time of the crash
6. 2015 Tesla Model S Owner's Manual states it is the driver's responsibility to *"stay alert, drive safely and be in control of the vehicle at all times."* In addition, *"…be prepared to take corrective action at all times."*

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Questions?