Accident Investigation -
What You Can Do to Help Determine
What Happened?

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A little bit about me

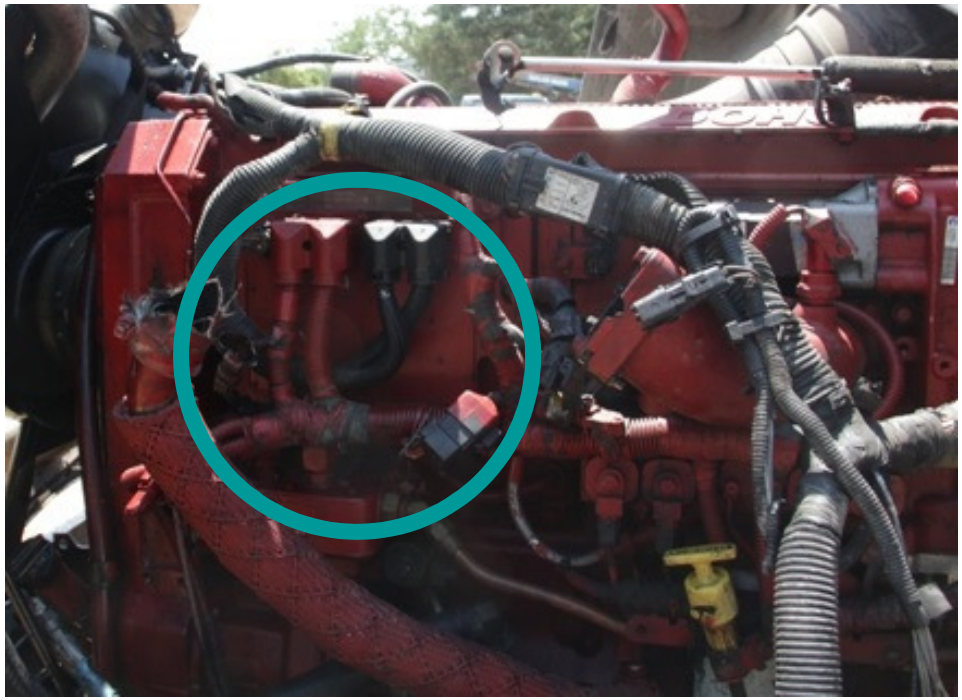
- Allen Powers (allen@3axisllc.com)
  - Born in Ohio, lived in Alabama, Tennessee,Georgia,Mississippi
  - BSME, Master's in Mechanical Engineering from University of Alabama in 1982 / 1985
  - Taught mechanical engineering at The University of Alabama
  - NASA, Aerospace first 10 years
  - Accident reconstruction since 1983

A little bit about 3Axis Engineering

- 3Axis Engineering started in 2012
  - Was Doughty & Powers Engineering for 15+ years
- We provide professional, data-driven, mechanical engineering solutions to motor vehicle accident reconstruction
  - i.e., determine what happened, and (to a limited degree), what could have happened
- "Who caused the accident?" and "Whose fault?" are not engineering questions

Brief Overview of Presentation

- Photography
  - Scene/vehicles
- Event Data Recorders
  - Passenger/Commercial Vehicles
- Scan Technology



Accident scenes begin to change before the dust settles

An initial responder is often faced with the decision whether to include someone like me – or not.

Accident Photography

Photos serve two important functions

1. Provide a permanent, accurate, and unbiased record of something specifically observed at accident scene
2. Capture evidence (mark on road or damage to a vehicle) that may later reveal significant details that were not observed or measured at the time the photo was made

from *The Traffic-Accident Investigation Manual*, J Stannard Baker and Lynn B. Fricke, Northwestern University Traffic Institute, 9th Ed., 1986.

Photographs – “Dos”

- What to do
  - Know how to use camera / cell phone
    - automatic settings work well for most shots
    - use best quality - most pixel settings.
  - Start before data (tire marks, off road marks)
  - Start wide, end narrow
    - details need context
  - Include permanent landmarks if possible
    - utility poles, road signs, manhole covers, striping, reflectors, etc.

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Digital Photogrammetry

Photo taken at accident scene by Trooper:

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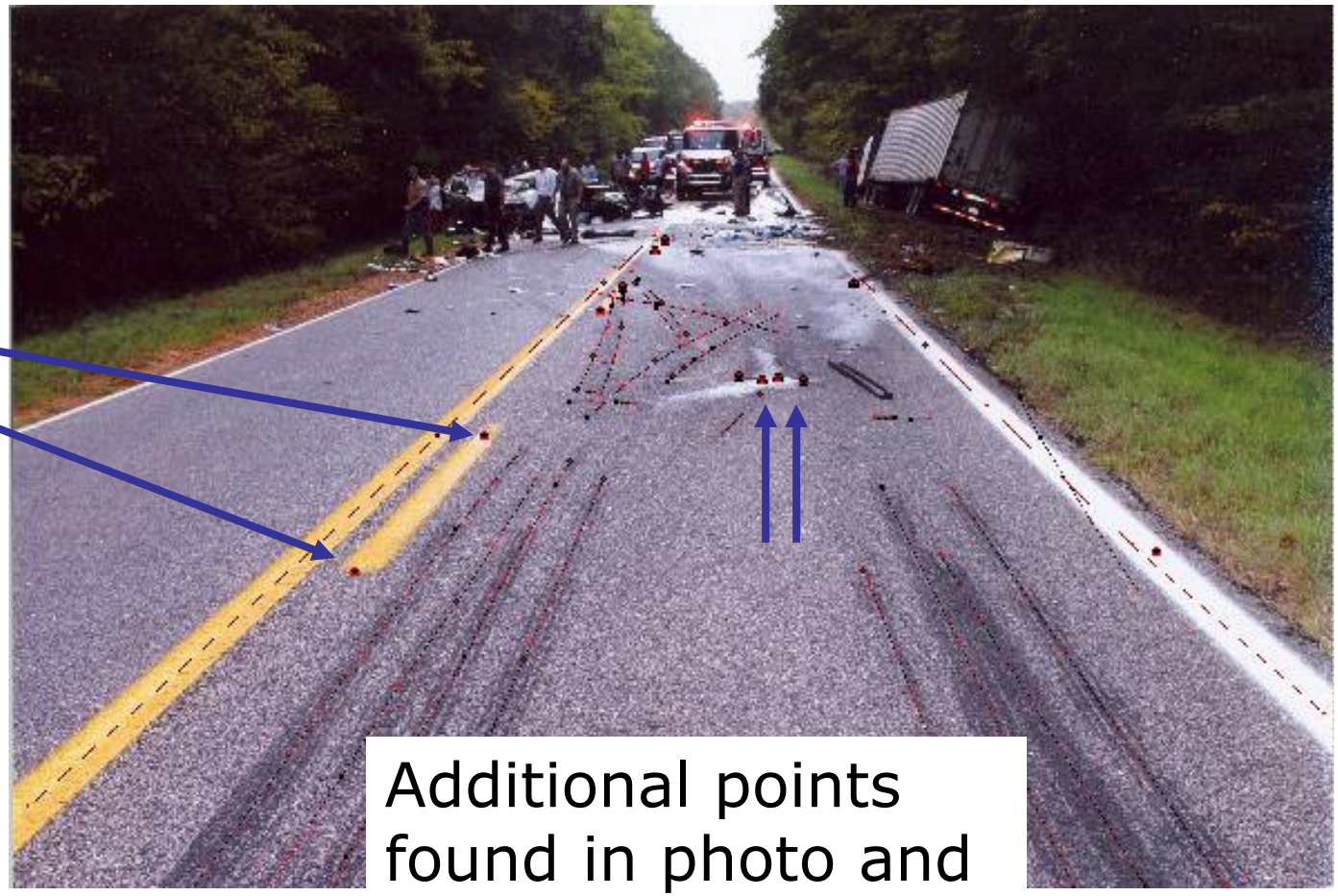
Digital Photogrammetry

Reference points measured and then located in photo:

Camera position and orientation determined.



Additional points found in photo and position determined by software.

Photographs – “Don’ts”

- What not to do
  - Stand in one place and shoot essentially the same photo 5 times
  - Take photos documenting damage to your vehicle only
  - Set camera on lowest resolution to get more photos on the memory card
  - Print photos (or save to PDF), then delete the original digital files
  - Take photos like a news reporter

Keys to Good Scene Photographs

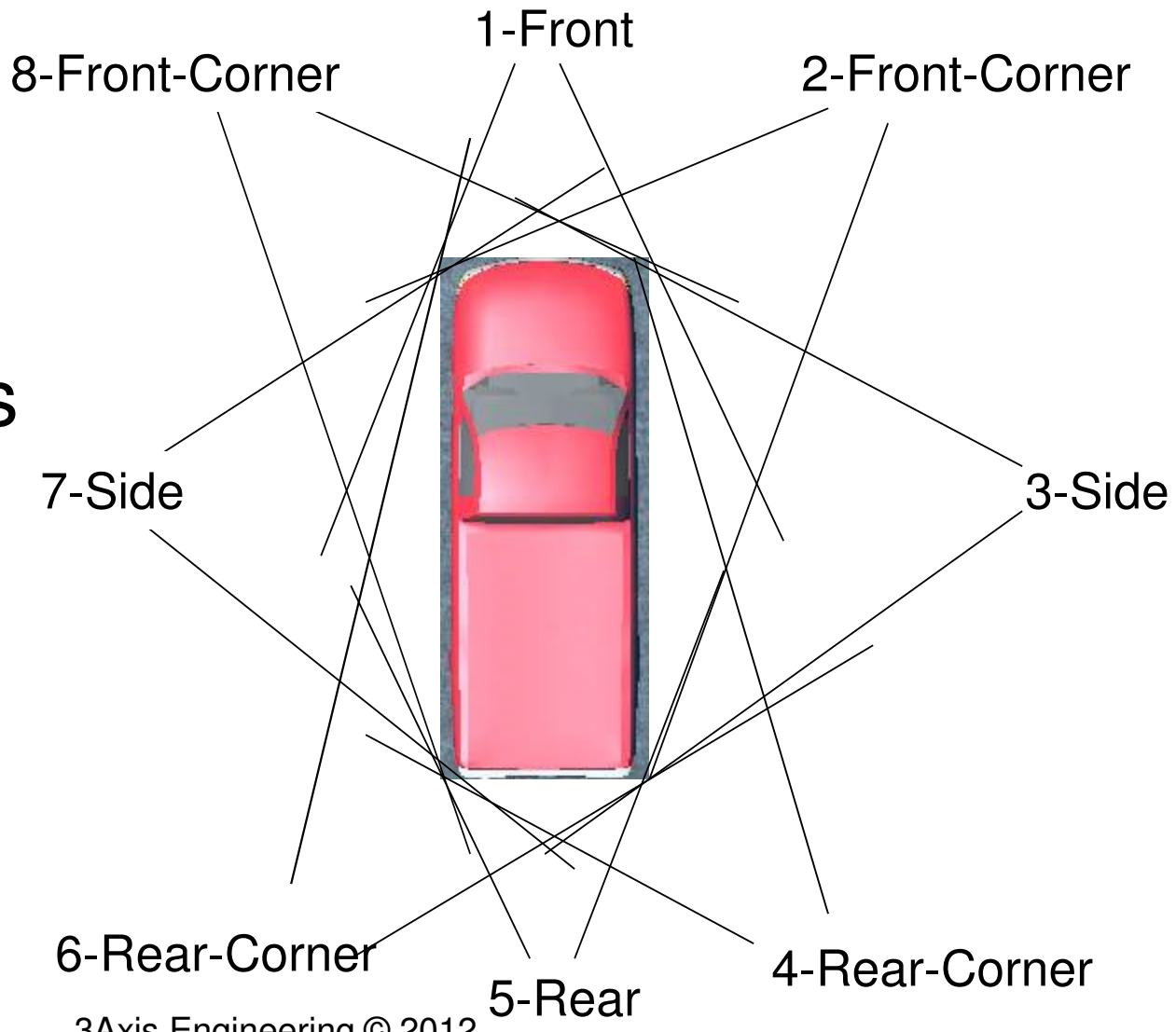
- Make photographs soon of things that will change
  - Vehicle rest positions
  - Tire marks may disappear quickly with traffic
  - Debris will be swept up and moved or discarded

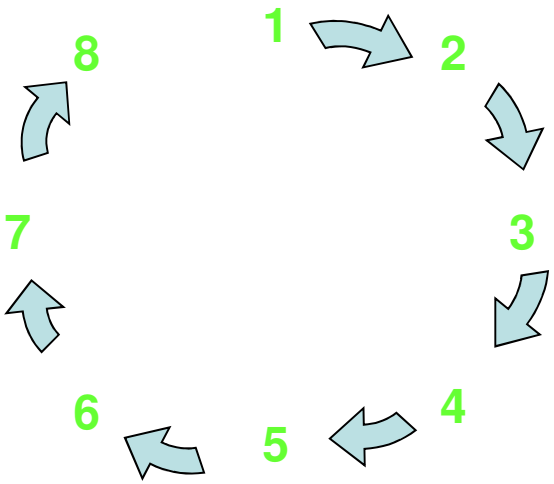
from *The Traffic-Accident Investigation Manual*, J Stannard Baker and Lynn B. Fricke, Northwestern University Traffic Institute, 9th Ed., 1986.

If you had started with this one you couldn't show that there was no other data.

Photographing Vehicles

- Start with the “basic 8”
- Front, side, and rear shots should be perpendicular to vehicle if possible





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Photographing Vehicles

- Details of damage
  - Use same “start wide, end narrow” approach
- Items of typical interest
  - Imprints of one vehicle on another
  - Tire or other abrasion marks
  - Damage to head-, tail- or marker-lights
  - Damage to wheels or tires
    - Document if tires “pinned” against vehicle in collision

Things we can do

- Specialized photographs
  - Elevated cameras
- Read (Download) EDRs
  - Passenger Vehicles
  - Commercial Vehicles
- Scan Scenes and Vehicles

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Miller v. EARY

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Overhead view from elevated camera

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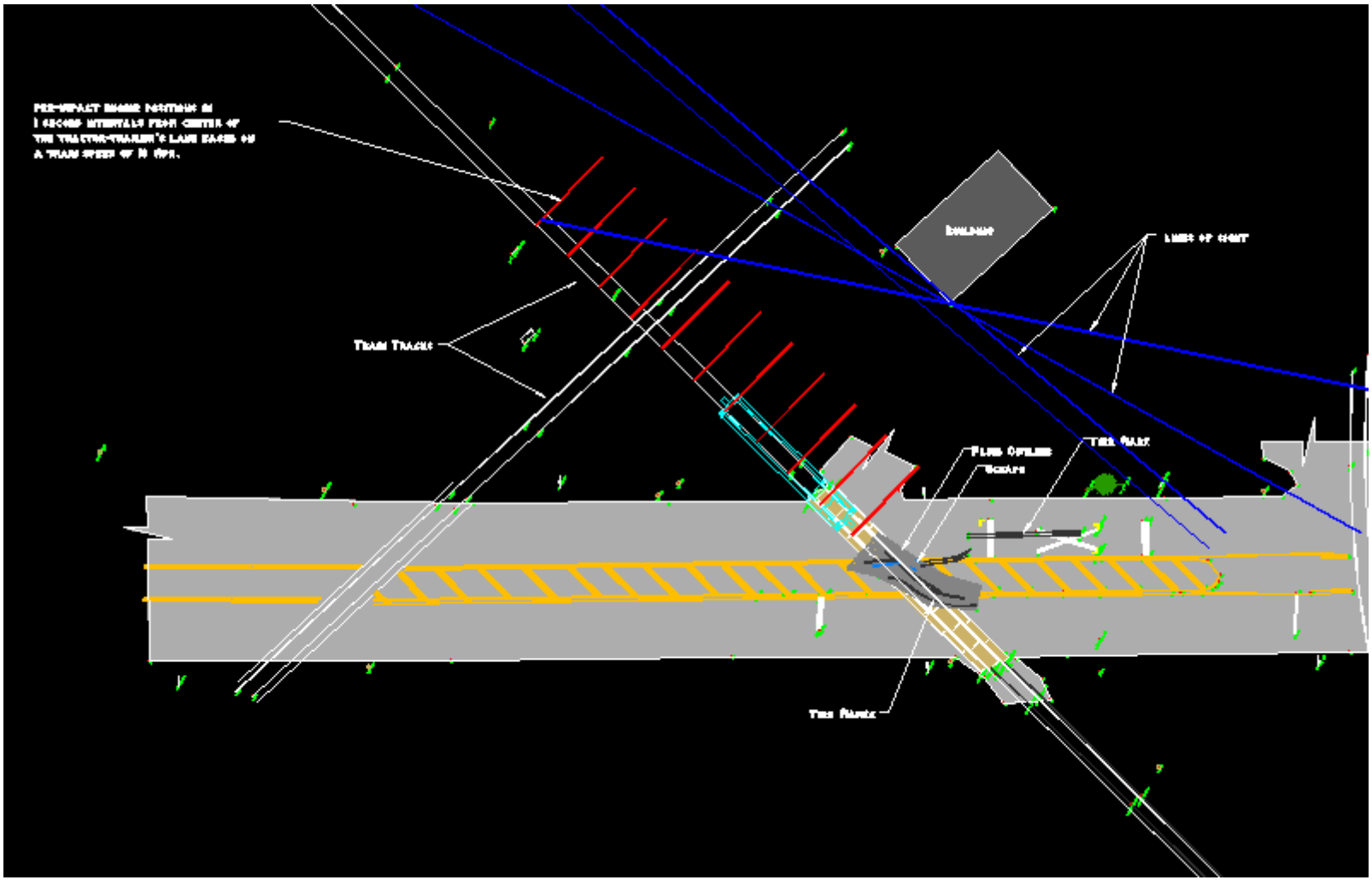
Note tire marks only on one side.



T/T hits engine. Scale drawing of evidence, able to show T/T had ample time to perceive/react and stop.

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Alabama Gulf Coat Rail
Photographs showing damage to an engine and rail car

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Photograph showing paint at old clear position

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Damaged/Repaired Engine
PhotoModeler dots placed for photographs

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3D Model Created from PhotoModeler Data

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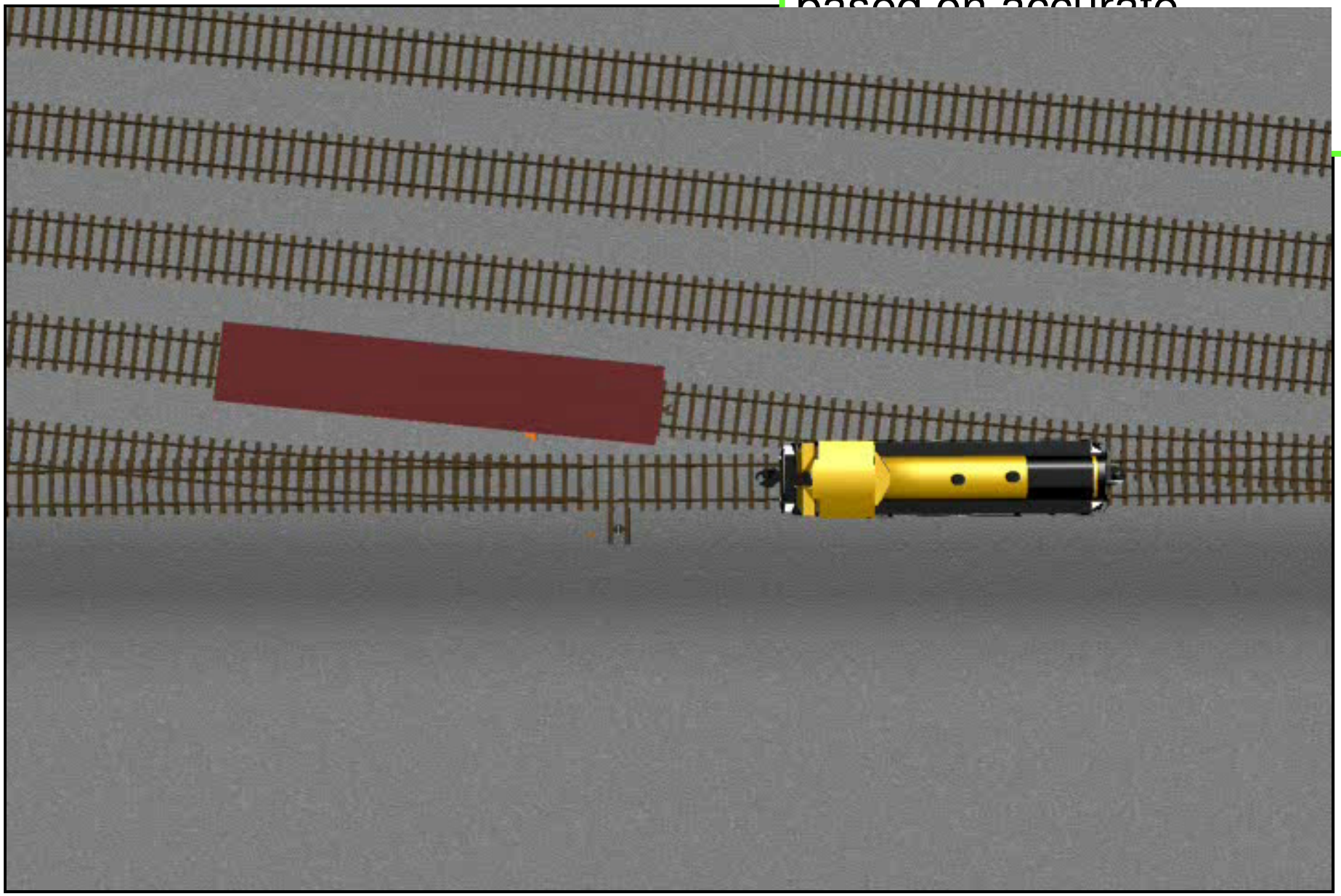
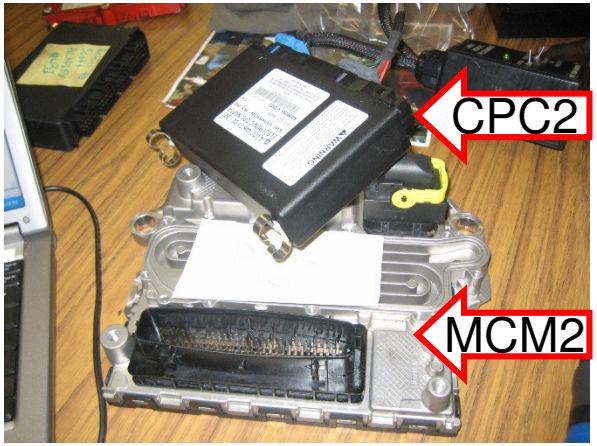
Video showing interaction based on accurate



EDR - Event Data Recorder

- "Black boxes" that store accident data on many passenger and commercial vehicles best referred to as EDRs
- Typical questions:
  - What gets stored?
  - What vehicles have EDRs?
  - Can the data disappear or get erased?
- Answer: It depends!



Passenger Vehicle EDR

- Passenger vehicle event data found in the airbag control module (ACM), or powertrain control module (PCM) for some 2004-2011 Fords
  - GM (from 1994)
  - Ford (from 2001)
  - Chrysler (from 2005)
  - Toyota (from 2002)
  - Honda (from 2012)
  - Mazda (from 2011)
  - Nissan* (from 2012)
  - most others (from 2014)
- Available data depends on manufacturer, model, year, etc.

*Nissan can download data from some 2007-2012 vehicles

Passenger Vehicle EDR

- Recording triggered by collision
  - Many store vehicle speed, braking, and other information for 2 seconds to 6 minutes pre-crash, typically 2 to 5 seconds.
- Deployment of airbags (or seatbelt tensioners)
  - Data usually locked and won't get overwritten
- Non-Deployments
  - Accident data may exist
    - not usually locked
    - may get overwritten if vehicle put back into service

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Very detailed ACM data from a 2014 Ford

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Brake Powertrain Torque Request	Driver Gear Selection
- 5.0	73 [118]	21.6	Off	1,968	non-engaged	No	Drive
- 4.5	74 [119]	21.1	Off	1,972	non-engaged	No	Drive
- 4.0	74 [119]	21.1	Off	1,974	non-engaged	No	Drive
- 3.5	74 [119]	21.1	Off	1,986	non-engaged	No	Drive
- 3.0	74 [119]	21.6	Off	1,984	non-engaged	No	Drive
- 2.5	74 [119]	22.4	Off	1,982	non-engaged	No	Drive
- 2.0	74 [119]	22.4	Off	1,990	non-engaged	No	Drive
- 1.5	74 [119]	21.4	Off	1,972	non-engaged	No	Drive
- 1.0	73 [117]	0.0	Off	2,020	non-engaged	No	Drive
- 0.5	71 [114]	0.0	Off	1,934	non-engaged	No	Drive
0.0	68 [110]	0.0	Off	1,824	non-engaged	No	Drive

Pre-Crash Data -5 to 0 sec [10 samples/sec] (First Record)

Times (sec)	Steering Wheel Angle (degrees)	Stability Control Lateral Acceleration (g)	Stability Control Longitudinal Acceleration (g)	Stability Control Yaw Rate (deg/sec)	Stability Control Roll Rate (deg/sec)
- 5.0	1.1	0.03	0.0	0.0	0.0
- 4.9	1.5	0.007	0.003	0.0	0.12
- 4.8	1.8	0.036	0.013	0.0	0.0
- 4.7	1.3	0.006	0.008	-0.12	0.37
- 4.6	1.3	0.012	0.0	0.12	0.37
- 4.5	1.5	0.014	0.013	0.37	0.12
- 4.4	1.3	0.011	0.003	0.5	0.5
- 4.3	1.5	0.028	-0.002	0.37	0.5

Commercial Vehicle EDR

- Commercial vehicle event data typically stored in the diesel's engine / electronic control module (ECM)
  - Detroit Diesel
  - Cummins
  - International
  - Caterpillar

  } Can be downloaded by 3Axis

  - Volvo / Mack → only 3 vendors in North America
  - Paccar → use local dealer
- Available data depends on engine manufacturer, model, year, etc. – often a minute or so pre-crash

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Commercial Vehicle EDR

- Recording triggered by deceleration ("hard" braking / "quick" stop, etc.)
  - vehicle slows by 7 to 10 mph in one second
  - record often starts well before a collision
- "Last stop" recorded by some Detroit Diesel, Mack, Volvo and International engines
- Data volatility
  - Commercial vehicle EDR data is not locked
  - Can be overwritten if the vehicle is driven after accident

Peoplenet Onboard Event Recording

Trigger

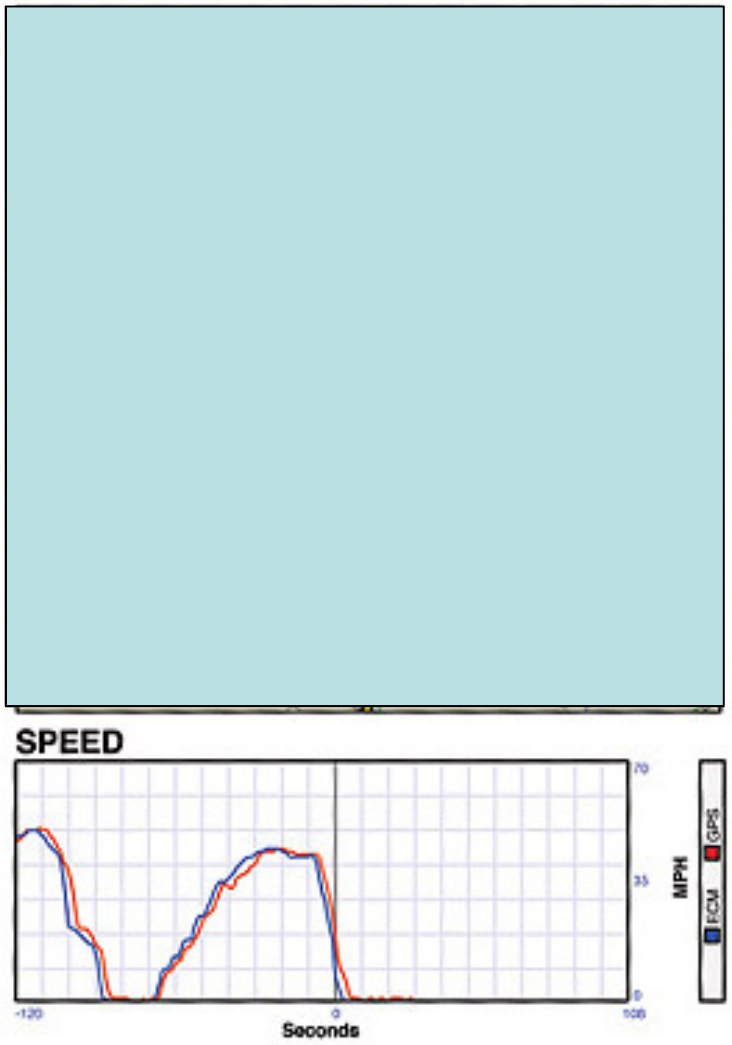
Some systems also trigger on stability-control input (i.e. swerve)

ONBOARD EVENT RECORDING DETAIL

Carrier:
Date / Time:
Event Trigger: Sudden deceleration
Vehicle:
VIN:
OBC DSN:
Odometer:
Pre Seconds: 120
Post Seconds: 30

TIME	GPS SPD	ECM SPD	HDG	RPM	CC
10:38:29	47.0	48.0	358.0	1730.00	Off
10:38:30	47.0	48.5	358.0	1747.25	Off
10:38:31	48.0	49.0	358.0	1757.50	Off
10:38:32	49.0	49.0	358.0	1766.00	Off
10:38:33	50.0	49.5	358.0	1775.00	Off
10:38:34	50.0	50.0	358.0	1784.50	Off
10:38:35	50.0	50.0	358.0	1792.75	Off
10:38:36	50.0	50.0	358.0	1793.00	Off
10:38:37	50.0	50.0	358.0	1797.25	Off
10:38:38	51.0	49.5	358.0	1768.75	Off
10:38:39	50.0	48.5	358.0	1733.25	Off
10:38:40	50.0	47.5	358.0	1695.25	Off
10:38:41	50.0	46.5	358.0	1674.00	Off
10:38:42	49.0	45.5	358.0	1516.75	Off
10:38:43	48.0	45.0	358.0	1095.00	Off
10:38:44	46.0	44.0	358.0	750.50	Off
10:38:45	45.0	43.0	358.0	599.25	Off
10:38:46	44.0	40.5	360.0	599.00	Off
10:38:47	41.0	36.0	358.0	599.75	Off
10:38:48	40.0	28.5	358.0	598.75	Off
10:38:49	38.0	22.0	358.0	598.25	Off
10:38:50	35.0	21.5	0.0	600.25	Off
10:38:51	30.0	21.0	0.0	599.00	Off
10:38:52	24.0	20.5	0.0	598.00	Off
10:38:53	21.0	19.5	0.0	599.25	Off
10:38:54	21.0	19.0	360.0	599.25	Off
10:38:55	21.0	18.5	358.0	598.50	Off
10:38:56	21.0	17.5	358.0	599.75	Off
10:38:57	20.0	17.0	358.0	599.25	Off
10:38:58	19.0	16.5	358.0	600.25	Off
10:38:59	17.0	14.5	358.0	600.25	Off
10:39:00	16.0	11.0	356.0	600.25	Off
10:39:01	15.0	4.0	356.0	600.25	Off
10:39:02	11.0	0.0	356.0	600.75	Off
10:39:03	6.0	1.5	358.0	600.25	Off
10:39:04	3.0	0.0	10.0	600.25	Off
10:39:05	1.0	0.0	10.0	598.75	Off
10:39:06	1.0	0.0	332.0	599.25	Off
10:39:07	1.0	0.0	324.0	599.00	Off
10:39:08	1.0	0.0	336.0	600.25	Off
10:39:09	1.0	0.0	360.0	600.50	Off
10:39:10	1.0	0.0	58.0	600.00	Off

TIME	GPS SPD	ECM SPD	HDG	RPM	CC
10:39:55	38.0	41.5	358.0	1687.75	Off
10:39:56	38.0	42.0	358.0	1504.00	Off
10:39:57	39.0	42.5	360.0	1517.50	Off
10:39:58	40.0	42.5	0.0	1533.75	Off
10:39:59	42.0	43.0	358.0	1552.00	Off
10:40:00	42.0	44.0	358.0	1569.75	Off
10:40:01	43.0	44.0	358.0	1577.25	Off
10:40:02	44.0	44.0	360.0	1582.75	Off
10:40:03	44.0	44.5	358.0	1590.75	Off
10:40:04	44.0	44.5	358.0	1599.25	Off
10:40:05	44.0	44.5	358.0	1602.75	Off
10:40:06	44.0	44.5	0.0	1604.50	Off
10:40:07	45.0	44.5	0.0	1605.00	Off
10:40:08	45.0	44.5	0.0	1605.00	Off
10:40:09	45.0	44.0	0.0	1582.50	Off
10:40:10	45.0	44.0	0.0	1574.25	Off
10:40:11	44.0	43.0	0.0	1542.00	Off
10:40:12	44.0	42.5	2.0	1532.25	Off
10:40:13	44.0	42.5	2.0	1524.75	Off
10:40:14	43.0	42.5	4.0	1515.75	Off
10:40:15	43.0	42.0	2.0	1509.75	Off
10:40:16	43.0	42.0	2.0	1504.25	Off
10:40:17	43.0	42.5	2.0	1515.00	Off
10:40:18	43.0	42.5	2.0	1524.50	Off
10:40:19	43.0	42.5	2.0	1531.25	Off
10:40:20	43.0	43.0	2.0	1531.00	Off
10:40:21	43.0	42.0	2.0	1549.25	Off
10:40:22	43.0	41.0	2.0	1143.00	Off
10:40:23	42.0	37.0	2.0	782.50	Off
10:40:24	39.0	32.5	2.0	601.75	Off
10:40:25	36.0	30.0	2.0	602.00	Off
10:40:26	33.0	26.0	4.0	600.75	Off
10:40:27	30.5	22.5	4.0	600.00	Off
10:40:28	26.0	18.0	6.0	601.00	Off
10:40:29	19.0	7.5	4.0	599.75	Off
10:40:30	13.0	5.0	2.0	600.25	Off
10:40:31	10.0	2.5	6.0	599.75	Off
10:40:32	8.0	0.0	6.0	600.00	Off
10:40:33	6.0	0.0	12.0	600.50	Off
10:40:34	3.0	0.0	24.0	601.25	Off
10:40:35	1.0	0.0	16.0	599.50	Off
10:40:36	1.0	0.0	242.0	599.00	Off

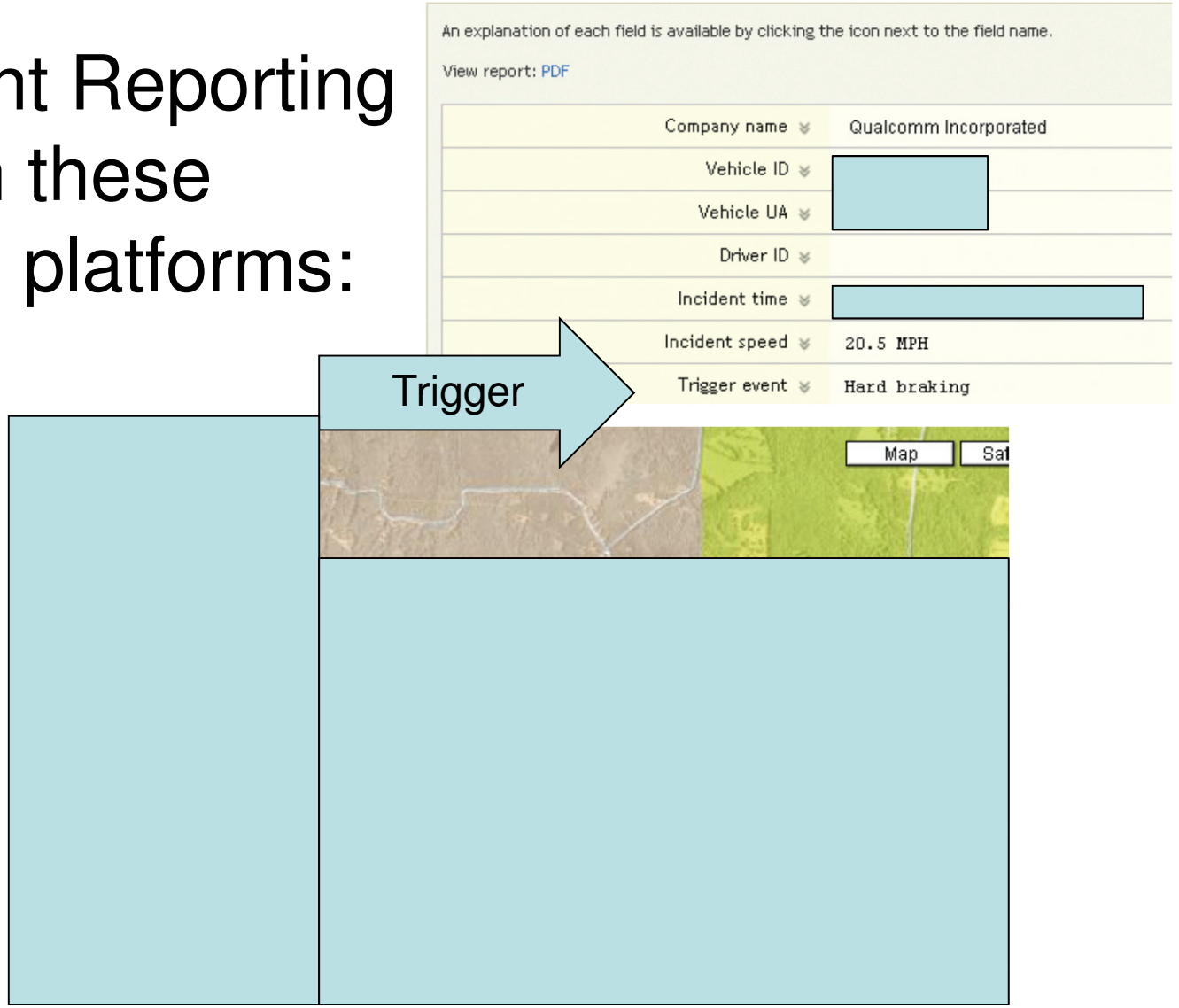


http://www.peoplenetonline.com/onboard-event-recording

QualCOMM

Critical Event Reporting <u>available</u> on these QualCOMM platforms:

- MCP50
- MCP100
- MCP110
- MCP200



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Bankston v. Walter Coke


HLMX 43034

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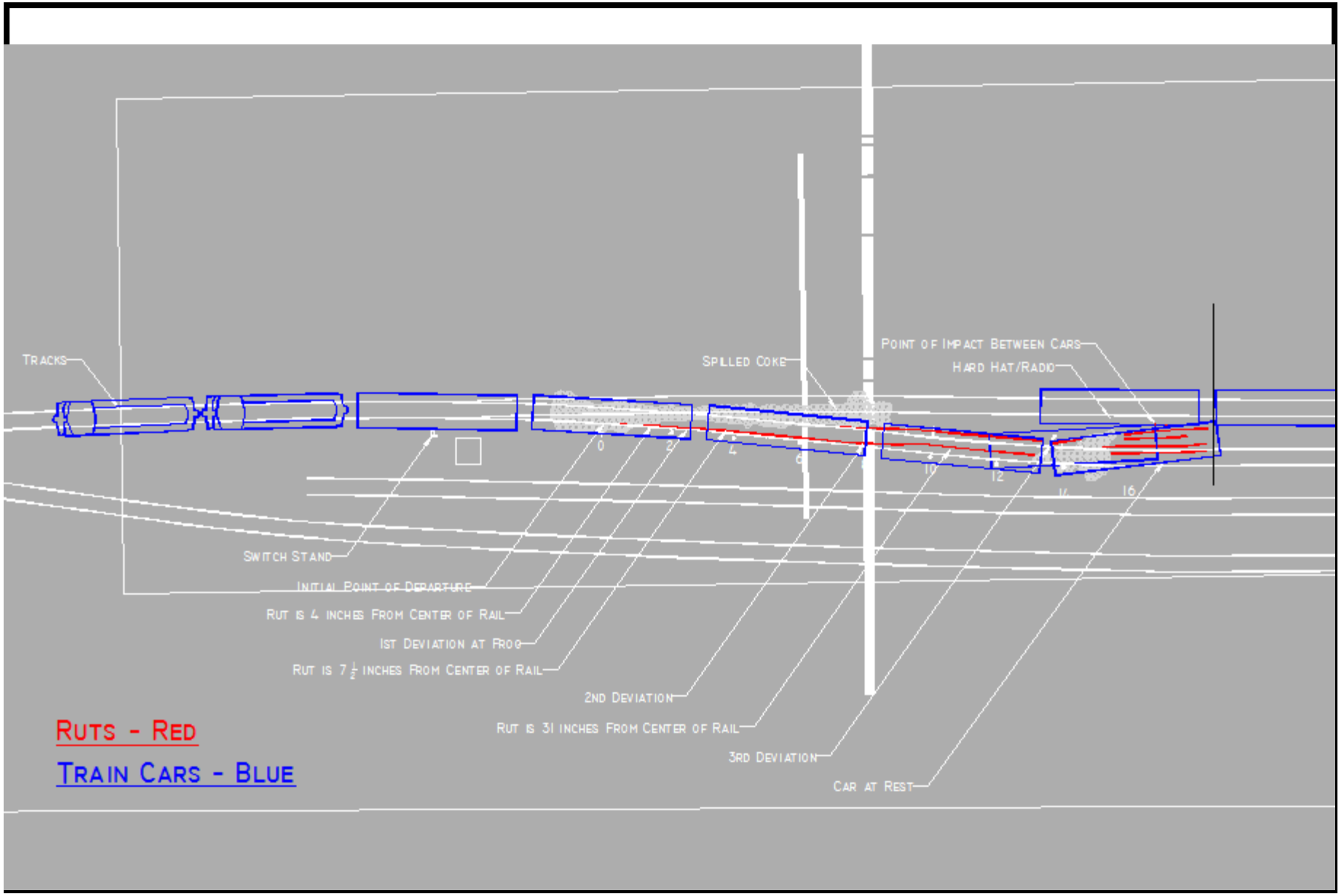

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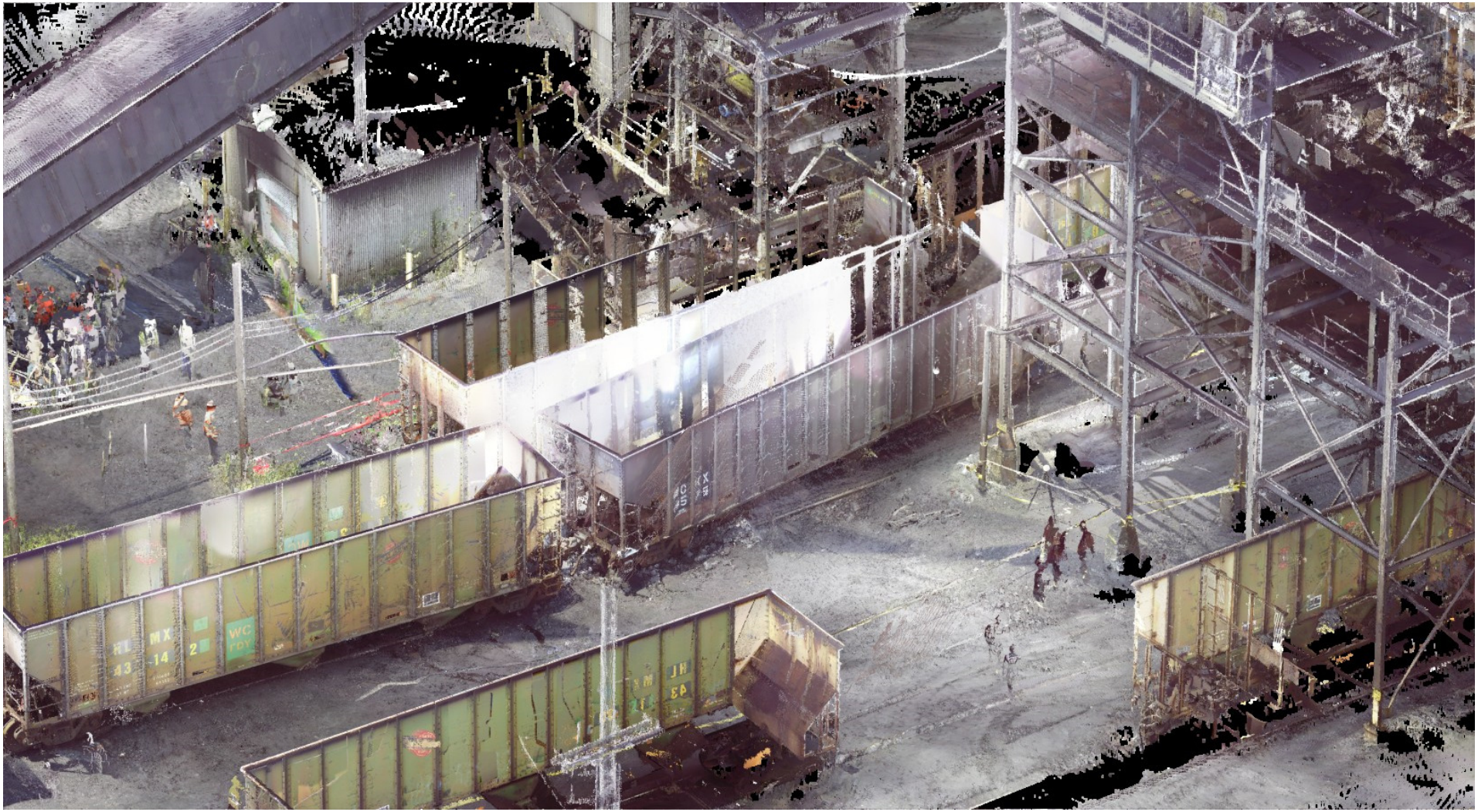
3D Scan of Accident Site (2.80 Billion Data Points)



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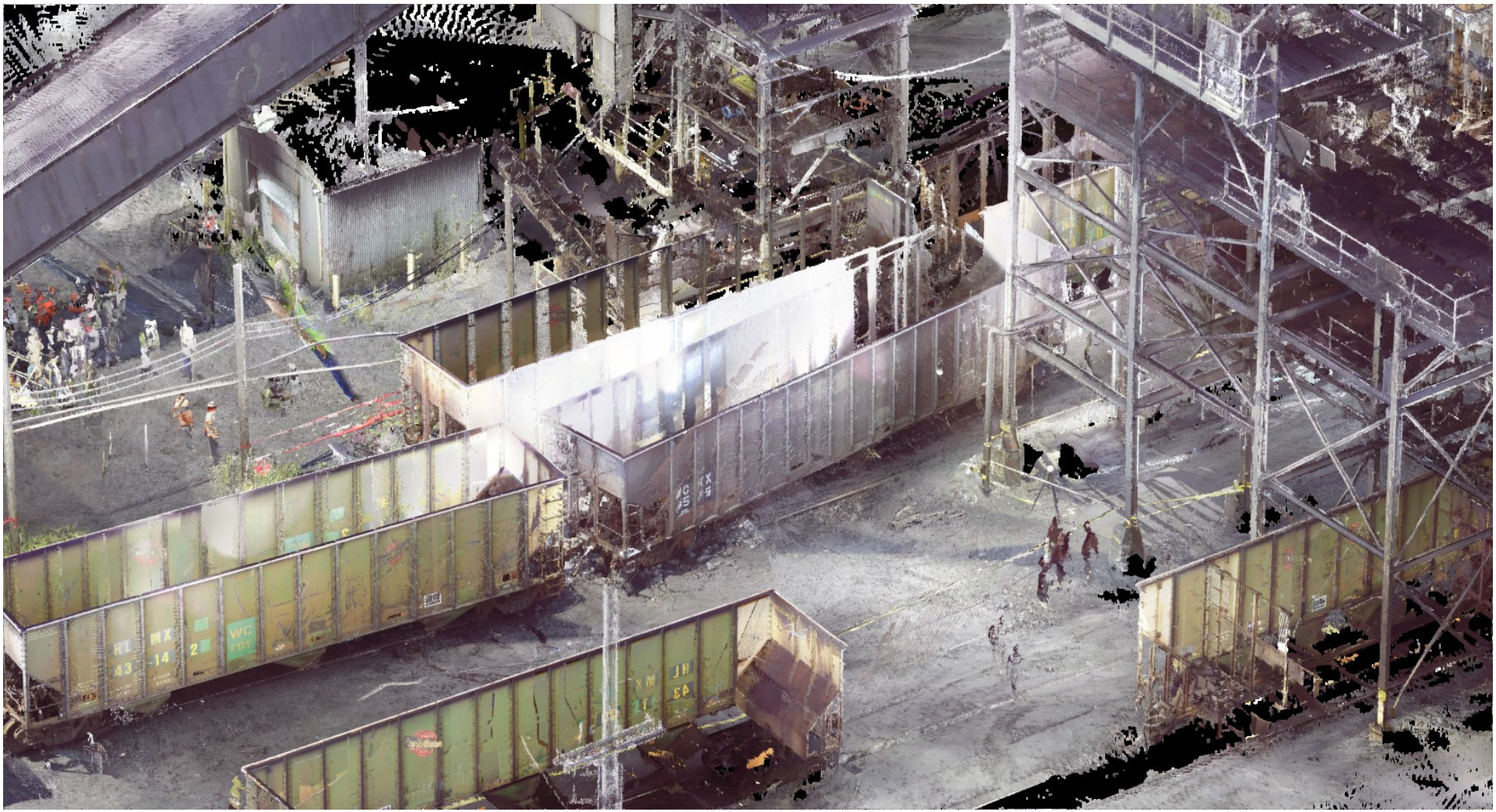
The train cars can be hidden to show the accident related data on the ground



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Fly through video of scan data at coke facility.

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Thank You!

Any Questions?