C6 Determining Inter-Event Independence for a Heavy Truck Multiple Impact Collision

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By describing these efforts and methodology, the attendees will be exposed to the inductive use of EDR data to derive parameters useful in heavy truck accident analysis. These methods include the use of inter-event boundary conditions to evaluate the potential independence, or non-inde- pendence, of the multiple collision events in the subject accident.

This presentation will impact the forensic community and/or humanity by helping the attendee to learn how to apply heavy truck black box data, and derived reconstruction data points, to create practical analysis case modes, with common-sense meaning, that can have large legal and financial consequences. This will allow the attendees to extend their existing forensic skills, abilities and professionalism by applying them to an area scientific investigation where pre-2000 skills may be less complete.

SYNOPSIS: This analysis concerned a 1999 Kenworth W900 Tractor Trailer traveling on a highway, which impacted six slower moving or stopped units in five impact events before coming to rest. The issue con- stituting our principal assignment was a determination of the potential independence, or non-independence, of the five identifiable collision events in the subject accident. In other words, a major litigation issue was

whether this accident constituted one amalgamated event or constituted five separate events.

This required an examination of the facts of the subject accident, the vehicle EDR data and reconstruction results. The result of the analysis was a set of sub-incident scenarios, which showed that, as long as the tractor trailer driver stayed on the road, there was no scientific way for the four separate impacts subsequent to impact #1 to be considered as independent or physically sole and separate. The analysis results were presented as four sets of sub-incident analysis charts.

The analysis results were derived from secondary and tertiary data parameters based on the primary EDR data, as well as from the Newtonian laws of physics and motion.

LEARNING OBJECTIVES: By describing these efforts and method- ology, the attendee will be exposed to the inductive use of EDR data to derive parameters useful in heavy truck accident analysis. These methods include the use of inter-event boundary conditions to evaluate the potential independence, or non-independence, of the multiple collision events in the subject accident.

THEORY OF THE ANALYSIS: There were six steps required to accomplish this analysis. Elements of the analysis include:

1. Derived Parameters Based on the EDR Data

The first part of the analysis was to determine the subject tractor EDR acceleration record (the first derivative of the EDR velocity record) at and about the projected time of the collision sequence record to determine if there was a clear indication of vehicle impact. This can be determined by seeing if the indicated longitudinal deceleration (- SAE J1733 'X' axis acceleration) exceeded the known maximum braking ability of the subject tractor-trailer combination. Figure 1.1 shows the source EDR data for the -10sec to +14sec period. Figure 1.2, the derived data (acceleration), shows that, in this case, there was no indication of vehicle impact from the derived acceleration record. Figure 1.2 also shows that the hard brake record is trig- gered at approximately -0.30 G to -0.33 G (or above -9 mph) , which is defined as 0.0 sec in the EDR hard brake record.

Time	Vehicle Speed (mph)	Engine Speed (rpm)	Brake	Clutch	Engine Load (%)	Throttle (%)	Cruise	Diagnostic Code
-0:10	76.0	1629	No	No	57.50	100.00	No	No
-0:09	76.0	1637	No	No	53.50	100.00	No	No
-0:08	76.0	1626	No	No	62.00	100.00	No	No
-0:07	73.5	1585	Yes	No	89.00	100.00	No	No
-0:06	67.5	1332	No	No	0.00	0.00	No	No
-0:05	66.0	858	No	No	0.00	0.00	No	No
-0:04	51.0	598	No	No	19.00	0.00	No	No
-0:03	58.0	597	No	No	19.00	0.00	No	No
-0:02	56.5	598	No	No	20.00	0.00	No	No
-0:01	52.0	599	Yes	Yes	21.50	0.00	No	No
0:00	43.0	597	Yes	Yes	22.50	0.00	No	No
+0:01	36.0	599	Yes	Yes	21.00	0.00	No	No
+0:02	31.0	600	Yes	Yes	20.00	0.00	No	No
+0:03	28.0	599	Yes	Yes	20.50	0.00	No	No
+0:04	25.5	599	Yes	Yes	24.50	0.00	No	No
+0:05	22.5	599	Yes	Yes	28.00	0.00	No	No
+0:06	19.0	599	No	Yes	27.00	0.00	No	No
+0:07	17.0	599	No	Yes	27.50	0.00	No	No
+0:08	16.0	601	No	Yes	26.00	0.00	No	No
+0:09	11.5	599	No	Yes	27.00	0.00	No	No
+0:10	9.5	600	No	Yes	25.50	0.00	No	No
+0:11	6.0	600	No	Yes	25.50	0.00	No	No
+0:12	2.0	600	No	Yes	25.00	0.00	No	No
+0:13	0.0	600	No	Yes	24.00	0.00	No	No
+0:14	0.0	604	No	Yes	19.00	0.00	No	No

Figure 1.1

 ** Presenting Author*

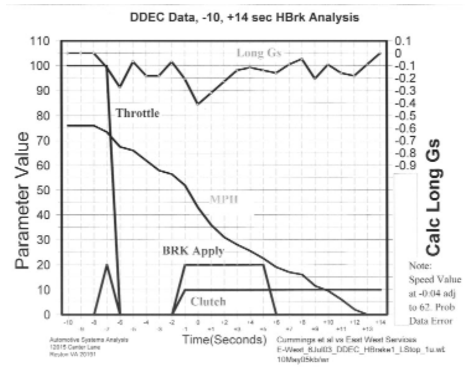

Figure 1.2

2. Positioning the Impact Sequence on a Distance Line and Time Line The second part of the analysis was to identify the impact points in distance and time, starting with impact #1. This was done by reconstruction analysis[2] which positioned each asynchronous event against the sy- chronous EDR timeline (last stop record). The reconstruction analysis input
is shown in Figure 2.1.

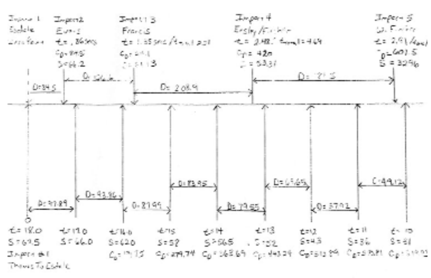

Figure 2.1

It is obvious, and a given, that impact #1 was an independent event. Thus, researchers' analysis concerned the indepen- dence, or non-independence, of the four succeeding impact events #2, #3,
#4 and #5. This was accomplished by creating five analyses per impact event:

1. Maximum velocity loss from immediate prior incident to succeeding incident, at maximum braking (worst case analysis).
2. Velocity increase from immediate prior incident to succeeding incident, at maximum acceleration (worst case analysis). An example of analyses 1 & 2 (for event #3 - event #4) is shown in Figure 2.2.

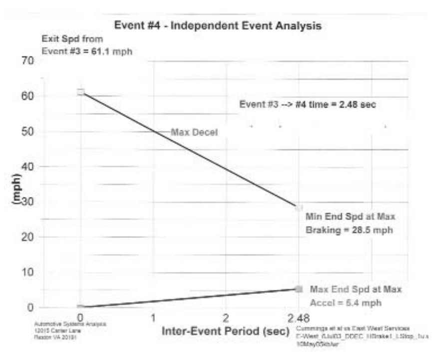

Figure 2.2

3. Distance to stop from prior incident at no braking (infinite, coast out). A reconstructed inter-event impact distance is superimposed on that distance to stop, and the calculated inter-event time is further superimposed over that data pair. From that data overlay, it can be shown that the accident could not be avoided at no braking input.

4. Distance to stop from prior incident at min statutory braking (FMCSR 393.52 Stop Table, 0.435 G). A reconstructed inter-event impact distance is superimposed on that distance to stop, and the calculated inter event time is further superimposed over that data pair. From that data overlay, it can be shown that the accident could not be avoided at minimum statutory braking.

5. Distance to stop from prior incident at max braking ability (Max Stop 0.60G). A reconstructed inter-event impact distance is superimposed on that distance to stop, and the calculated inter-event time is further superi posed over that data pair. From that data overlay, it can be shown that the accident could not be avoided at maximum capable braking.

Comparing overlay analyses for event #3 - event #4 and event #4 - event #5, one can see that there was approximately minimum FMCSR braking in the period between event #4 - event #5, whereas there was no braking in the period between event #3 - event #4.

3. Conclusion

This analysis was presented to the trial court, and the matter was resolved favorably.

References:

[1]Note that 1 G = 21.94 mph/sec. Thus, -9/21.94 mph/sec = -0.41G, more than enough to trigger a hard brake event, and well within the max braking capability of the truck (-0.60G).

[2]Reconstruction analysis, Julian R. Beaver, 9Apr04.

EDR Data Analysis, Crash Data Analysis, Braking Calculations

