

EDR Analyst Guide

1. Are there any EDR's available from any of the vehicles involved that are supported by CDR? (Check help file)
2. Is there more than one EDR in any of the accident vehicles? Ford PCM or GM ROS? (Check help file)
3. Are there any EDR's not covered by CDR that I can get the manufacturer to read for me or read by another tool?

How MANY different events can be identified based on physical evidence in this crash? 1 2 3 3+ (Rollover/indeterminate)

How MANY events is this EDR capable of capturing? 1 2 3 4 5 6 ?? Types??

How MANY events has this EDR Captured? 1 2 3 4 5 6 ? Types: D ND DLE Front/Rear Side Rollover

What is the RECORDING THRESHOLD? Wakeup /2G? 5mph Don't Know? RECORDING PRIORITY? Most Recent? Largest?

For **EACH** event, determine if the event is from your crash and the data is usable

1. Is it a complete and valid recording? **Yes** (it says so) **No (says not)** **Doesn't Say – check DL for other criteria**
 Any evidence of power loss at impact? YES NO INDETERMINATE BATTERY? FUSE BOX(s)? Shorts/Blown Fuses?
 If power loss, is this a 563 intent recorder with backup power supply for recording? YES NO NOT SURE
2. Key Cycles or Key On Time match? _____@event _____@imaging (for EACH event)
3. Delta V Large and/or consistent with visible crush or momentum analysis within 20%? YES NO INDETERMINATE N/A
4. Speed data consistent with reported facts, crush and postcrash travel? YES NO INDETERMINATE N/A

How much data do I have to work with?

Yes No Pre-crash speed and throttle _____ points at _____second intervals

Yes No Pre-crash braking _____ points at _____second intervals

Yes No Post crash data _____ points at _____second intervals

Yes No Any Delta V? Check off how much of that info is in the CDR report below

_____ Cumulative **Longitudinal**? (A single peak value listed in the report) at _____ ms after wakeup

_____ Cumulative **Lateral**? (A single peak value listed in the report) at _____ms after wakeup

_____ Longitudinal DV **Graph**? Duration _____ to _____ ms Zero = deploy or algorithm wakeup or other?

_____ Lateral DV **Graph**? Duration _____ to _____ ms

_____ If no Delta V, Acceleration data (Chrysler)? Duration _____ to _____ ms. Zero=deploy or wakeup?

Yes No Belt Buckled data entries in report? If present, Driver Buckled / Unbuckled? Pass. Buckled / Unbuckled?

Yes No Other things this EDR has that matter in this case?

_____ ABS on/off _____Traction Control on/off _____Stability Control on/off _____Speed Control on/off

_____ Steering Angle _____Yaw Rate _____Roll Rate/Angle _____Lat Accel from Stab.Cont? _____Long. Accel

_____ Passenger Size Empty/Child/Adult? _____ Wheel RPM? _____ Tire Pressure? _____Other?

Value	Adjustment	Adjusted
As recorded	required?	Value
In EDR	See checklist	or range?

What is most **important** in this case?

Yes No	Speed before start of event	If you have it, enter it here	_____	Yes No	_____	+/-4%
Yes No	Speed at Impact	If you have it, enter it here	_____	Yes No	_____	(see wksht)
Yes No	Post impact exit velocity	If you have it, enter here:	_____	Yes No	_____	
Yes No	Delta V	If you have it, enter it here	_____X_____Y	Yes No	_____	+/-10%
Yes No	PDOF	If you have it, enter it here	_____		_____	
Yes No	Other?_____	If you have it, enter it here	_____	Yes No	_____	

What else? Inspect the entire report – evidence of loss of control, swerve before impact?

Speed changes over time greater than allowed by laws of physics without an impact or special circumstances?

(May not be necessary if it does not matter to your main conclusions).

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Are there any **SPECIAL CIRCUMSTANCES** in this case that could affect the EDR data accuracy?

(circle Yes/No/Don't Know)

Speed Data

Vehicle Operational Conditions

- Yes No Don't Know 1. Wheels locked by braking without ABS
- Yes No Don't Know 2. Wheels slowed by heavy braking (w/ABS?) If yes, Adjustment? _____
- Yes No Don't Know 3. Wheels not in contact with ground (airborne) Over/Under report?
- Yes No Don't Know 4. Yaw - Wheels scrubbing sideways If yes, Adjustment? _____
- Yes No Don't Know 5. Ice/Snow/Hydroplaning/Burnout (wheels spinning relative to pavement)
- Yes No Don't Know 6. In reverse or otherwise going backwards (spin?)
- Yes No Don't Know 7. Data Limitations warn of special condition (i.e. GM last point recorded after AE?)

Vehicle Equipment Modifications

- Yes No Don't Know 1. Factory Tire Size? If no, Adjustment? _____
- Yes No Don't Know 2. Factory Axle Ratio? If no, Adjustment? _____
- Yes No Don't Know 3. Control module reprogrammed for tire or axle size change?
- Yes No Don't Know 4. Reprogrammed ACM? (Are Key cycles consistent, no signs of module tampering)

Delta V Data Special Circumstances/Adjustments

- Yes No Don't Know 1. Recorder only captures part of crash (slope not parallel to horizontal at end)
- Yes No Don't Know 2. Recorder captures data from BEFORE or AFTER crash (esp. 05+ Cr. Vic) Adjustment? _____
- Yes No Don't Know 3. Missed DV before wakeup? (No for continuously running algorithms) (Small)
- Yes No Don't Know 4. + offset in accelerometer (Toyota Gen 1 & 2)
- Yes No Don't Know 5. Missed Delta V due to sensor "clipping" (only concern for DV>35 mph)
- Yes No Don't Know 6. Offset collision – Need to adjust for Effective Mass Ratio?
- Yes No Don't Know 7. Need to consider GROUND FORCES during crash? (For small ΔV 's with braking)
- Yes No Don't Know 8. Need to consider UNUSUAL DELTA V CURVE SHAPE? (Multiple collisions, rotation)
- Yes No Don't Know 9. Event beyond end of graph/capture period (563 regulated)
- Yes No Don't Know 10. Small ΔV where data RESOLUTION becomes significant?
- Yes No Don't Know 11. **Restitution** adjustment needed in closing speed formula?

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Have you considered ALL the possible uses of the data?

SPEED DATA

1. Fastest speed vehicle was traveling before the loss of control or braking? +/-4%
2. Speed at Impact? Start @ wheel speed = ground speed, use Worksheet to get range
3. Braking rate at different stages – transition from accel applied to normal braking to panic braking?
4. Departure speed (post impact)?
5. Can EDR data support or discredit witness statements?
6. Multiply Speed by time to calculate DISTANCE to impact at key points? Overlay speed data onto scene map. Check for witnesses at the location of illegal or negligent behavior.

ACCEL PEDAL OR THROTTLE DATA

1. Use ***time of accel pedal release*** to impact as first reaction to possible threat condition. Check time between accel pedal release and brake application – if fast, accel pedal release = reaction to perception of pending crash
2. Driver intent: ___0% coast ___1-19% slow down ___20-30% maintain ___31-50% accel ___ 51-100% heavy accel
3. Calculate **distance** to impact and overly on scene diagram. Use ***non-release or late release*** of pedal as ***possible*** evidence of obstructed vision, driver impairment by substance abuse, medical event, driver distraction (cell?)
4. Correlate to **witness statements** (heard engine race)

BRAKING DATA

1. Brake light on but no decrease in speed - hovering on pedal not applying pressure
2. Two brake switches – one on, other not on – hovering on pedal not applying pressure
3. Calculate distance to impact for first brake pedal touch using speed data, overlay on scene diagram or map, use late reaction or non-reaction as possible evidence of distracted driving. Overlay stop distance @ vehicle speed to avoid collision.

Memo: Avoid saying “NEVER hit brake” – suggest using “No evidence in EDR driver braked prior to impact”

ABS ACTIVE DATA

1. Indicates one wheel turning slower than others – can mean max braking intent OR loss of control. Brake does NOT have to be on for ABS to engage to try and relieve slowest wheel brake pressure.
2. No ABS on = driver did not push on pedal as hard as they could have.
3. Slow decel rate but ABS active may indicate ice, snow , hydroplaning – not enough friction available .

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STEERING ANGLE

1. Sign changes/overcorrection leading to rollover?
2. Swerve just before impact changing approach angle?
3. Swerve well before impact, in response to path intrusion, leading to going off road or crash into another object?
4. No visible input may indicate no clear alternative path available, or falling asleep, or medical event (check resolution before reaching conclusion of no input– early GM 16 degrees) .

YAW RATE

1. When/how far from impact did vehicle first begin to yaw?
2. Integrate yaw rate to calculate cumulative yaw angle/heading change prior to impact. Use to determine approach angle, also use to quantify speed under-reporting – divide speed by cosine of yaw angle = ground speed.

LATERAL ACCELERATION (PRE crash from stability control, not crash accelerometer)

Is vehicle in a yaw? G's show how far sideways it got – sideways if => drag factor $0.7G = 22\text{ft}/\text{sec}^2$

LONGITUDINAL ACCELERATION (PRE crash from stability control, not crash accelerometer)

If in max braking, average of Longitudinal Accel should be equal to drag factor.

TIRE PRESSURE - Did low tire pressure contribute to heat buildup causing blowout followed by rollover?

TRACTION CONTROL

Did tires enough friction available to prevent wheel slip due to torque application?

ELECTRONIC STABILITY CONTROL ACTIVE -Use to indicate vehicle is yawing out of control

ROLL RATE OR ANGLE

Use to determine how quickly or slowly the trip or ramp roll initiating the rollover began. Integrate roll rate to get roll angle versus time. Be aware of max values, some clip at +/-240 degrees /sec or +/-60 degrees

ACM RECORDER ACCELERATION DATA

Use to determine if clipping occurred – look for flat lines at values at or above 32G (most are above 50)

RPM – Calculate Speed IF manual trans & clutch engaged OR auto trans torque converter is locked (not in 1st gear, not within 2 seconds of a shift, accel pedal applied 1-99%. $\text{Speed} = \text{RPM}/\text{trans gear}/\text{final drive gear}/\text{tire revs}/\text{mile} * 60\text{min}/\text{hr} = \text{MPH}$

Example: $3200 \text{ rpm}/0.7 \text{ overdrive}/3.23 \text{ final drive}/(750 \text{ revs}/\text{mile}) * 60 \text{ min}/\text{hr} = 113 \text{ mph}$.

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Speed at Impact from Speed Data Worksheet

MIN

MAX

Last Data Sample

When wheel speed equals ground speed except for ABS slip

Speed Change from last sample

To time of impact (if any)

(Time Interval x Accel Rate)

For Braking: Drag Factor*G/1.466 fps/mph

EX: 1.0 sec * -0.7g*32.2/1.466 = -15.4 mph

Can be positive if vehicle is speeding up

If driver is still on accel pedal at last sample then
allow 0.5 sec to move foot accel to brake pedal

- _____

SLIP of wheel in ABS braking +5%

(more during initial engagement)

+ _____

+ _____

Speedometer Error +/- 4%

(unless there is data indicating it's better)

- _____

+ _____

Range of Speeds at Impact

(from the speed data alone)

MIN

MAX

Last sample before impact means last data point where wheel speed equaled ground speed except for stabilized ABS wheel slip, either during max ABS braking after initial engagement, or before wheel lockup in non-ABS vehicles. If you are not sure a vehicle is in max braking, run the worksheet both ways, first in max braking (usually results in most conservative value) and again without max braking.

Vehicles without ABS have little wheel slip (approx. 1%) until lockup is imminent, do not use 5% adjustment on non-ABS vehicles. When wheel lockup is imminent the speed drop from the prior point may appear to violate laws of physics, disregard these points and start from prior (last good) point.

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SPEED AT IMPACT FROM DELTA V WORKSHEET

$$\text{Speed at Impact} = |V_3| \cos(\beta) - \Delta V_1$$

Where

ΔV_1 = The Longitudinal ΔV of the Vehicle of Interest

$|V_3|$ = The absolute value of the post crash speed of the Vehicle of Interest (some use V_1')

β = (Beta) The angle measured between the approach and departure of the Vehicle of Interest.

Beta can be between 0 and 360 degrees. For inline collisions $\cos \beta$ is 1..

This equation can be used in an inline or angular collision to calculate the Speed at Impact along the approach axis of either vehicle when the ΔV , the post collision speed and the departure angle Beta are known. It is necessary that the vehicle of interest is not side slipping (must be pointed in the +X direction) at impact. It is important to pay attention to the sign of the ΔV and the post crash velocity by carrying the sign of the cosine of Beta. For example if Beta = 135 degrees then $\cos(135) = -.707$

EXAMPLE: Vehicle travels 42 feet with an equivalent drag factor of 0.35

$$|V_3| = \sqrt{30Df} = \sqrt{30 \cdot 42 \cdot 0.35} = 21.0 \text{ mph}$$

Departure angle β is 40 degrees relative to approach angle

$$\Delta V_x = -31.0 \text{ mph from EDR}$$

$$V_1 = 21.0 \text{ mph} \cdot (\cos 40^\circ) - 31.0 \text{ mph } \Delta V_x$$

$$V_1 = 21.0 \cdot (.766) - (-31.0)$$

$$V_1 = 16.1 - - 31.0$$

$$V_1 = 47.1 \text{ mph}$$

Range of speeds at impact = +/-10% of ΔV plus any range due to drag factor uncertainty

Range = +/- 10% of -31 mph ΔV = +/- 3.1mph = 44.0 to 50.2 mph plus any range due to drag factor.

ΔV OF OTHER VEHICLE FROM SUBJECT VEHICLE ΔV

ΔV of other vehicle is inversely proportional to mass

$$\Delta V_1 = -\Delta V_2 \frac{W_2}{W_1}$$

Combine the two Delta V's to get closing speed:

$$\text{Inline Closing Speed} = (|\Delta V_1| + |\Delta V_2|) \cdot (1/(1+e))$$

Combine closing speed with speed of known vehicle speed at impact to get speed of unknown.