ECE R160 - EDR Accuracy Assessment

A Review of Requirements and Recommended Practices

EDR Accuracy Assessment

Requirements and Recommended Practice

In this study, we look at the following regulations, protocols and recommended practices

- NHTSA CFR Part 563
- NHTSA TP-563-00
- SAE J1698-3
- Regulation 160

Areas of focus:

- Delta-V accuracy requirement
- Acceleration accuracy requirement

Delta-V Accuracy Requirement

Comparison

NHTSA CFR Part 563

Source: https://www.ecfr.gov/

Table III - Reported Data Element Format

Data element	Minimum range	Accuracy[1]	Resolution
Lateral acceleration	At option of manufacturer	At option of manufacturer	At option of manufacturer.
Longitudinal acceleration	At option of manufacturer	At option of manufacturer	At option of manufacturer.
Normal Acceleration	At option of manufacturer	At option of manufacturer	At option of manufacturer.
Longitudinal delta-V	−100 km/h to + 100 km/h	±10%	1 km/h.
Lateral delta-V	−100 km/h to + 100 km/h	±10%	1 km/h.
Maximum delta-V, longitudinal	−100 km/h to + 100 km/h	±10%	1 km/h.

NHTSA TP-563-00

Source: https://www.nhtsa.gov/

14.2 POST CRASH DATA ANALYSIS

a. Save the collected accelerometer and restraint system deployment data in unfiltered form. Default system filtering shall be set to 4 kHz or higher.
b. Filter x-axis accelerometer data to SAE J211 Class 180 and plot versus time.
c. Add error corridor of +/- TBD g's for entire data set. (Error corridor based on +/- 10% of sensor full scale range.)
d. Check data clip status for acceleration or delta –v in downloaded data
e. Compare recorded acceleration and delta-v against the manufacturer supplied full scale range of sensor(s).
f. Truncate longitudinal acceleration at the time where the sensor full scale range is exceeded in the raw laboratory data or the time recorded by the EDR for clipping of the longitudinal signal. Use the shortest time for the truncation
g. Integrate the accelerometer data to obtain velocity data and plot versus time.
h. Apply an error corridor of +/- 10 km/hr to the entire data set.
i. Plot the EDR reported longitudinal acceleration and/or delta-v on the respective plots.
j. Align the EDR data time with the Laboratory data time using the time of the first air

Regulation 160

Data element	*Condition for requirement[2]*	*Recording interval/time[3] (relative to time zero)*	*Data sample rate (samples per second)*	*Minimum range*	*Accuracy[4]*	*Resolution*	*Event(s) recorded for[5]*
Delta-V, longitudinal	Mandatory - not required if longitudinal acceleration recorded at ≥500 Hz with sufficient range and resolution to calculate delta-v with required accuracy	0 to 250 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	100	-100 km/h to + 100 km/h.	±10%	1 km/h.	Planar

SAE J1698-3

Equation 2: Upper Control Limit equation for upper delta velocity window

$$UCL = 35.304 * \sum_{t(0)}^{t\_final} a\_ref\_raw(t)dt + 10km/h$$

Equation 3: Lower Control Limit equation for lower delta velocity window

$$LCL = 35.304 * \sum_{t(0)}^{t\_final} a\_ref\_150Hzfilt(t)dt - 10km/h$$

Delta-V Accuracy Requirement

±10% Accuracy

- Where the requirement is ±10% accuracy (NHTSA CFR Part 563 and R160), there is no explicit reference to how to calculate the acceptance corridor?
  - ±10% of what value exactly?
    - Is it ±10% of the +/- 100 kph *Minimum Range* as specified in the regulation?
    - Is it ±10% of the max reported Delta-V value in the EDR record?
    - Is it ±10% of the OEM documented min/max (full range) Delta-V values?
    - Is it ±10% of the calculated Delta-V value (at each time increment)?

- SAE J1698-3 references the ±10% accuracy in CFR Part 563, but uses a 10 km/hr acceptance corridor:

> The 10 km/h is derived from the 10% tolerance for the 100 km/h allowed in Table III for Longitudinal delta-V in Part 563

Delta-V Accuracy Requirement

Acceptance Considerations and Proposal

- To avoid interpretation concerns globally, commonization of the accuracy requirement should be considered across all regulations
- **Proposal:** change the accuracy requirement to a velocity-based unit (ie. km/hr) to match the *minimum range* and *resolution* requirement units
  - This could be, for example, ± 10 km/hr to match TP-563-00 and J-1698-3
  - This way, there is no confusion on how to calculate this error corridor

NHTSA TP-563-00

g. Integrate the accelerometer data to obtain velocity data and plot versus time.
h. Apply an error corridor of +/- 10 km/hr to the entire data set.
i. Plot the EDR reported longitudinal acceleration and/or delta-v on the respective plots.

SAE J1698-3

Equation 2: Upper Control Limit equation for upper delta velocity window

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Equation 3: Lower Control Limit equation for lower delta velocity window

$$LCL = 35.304 * \sum_{t(0)}^{t\_final} a\_ref\_150Hzfilt(t)dt - 10km/h$$

Acceleration Accuracy Requirement

Comparison

NHTSA CFR Part 563

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NHTSA TP-563-00

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Regulation 160

Data element	*Condition for requirement*[2]	*Recording interval/time*[3] *(relative to time zero)*	*Data sample rate (samples per second)*	*Minimum range*	*Accuracy*[4]	*Resolution*	*Event(s) recorded for*[5]
Lateral acceleration (post-crash)	If Recorded	0–250 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	500	-50 to +50g	+/- 10%	1 g	Planar Rollover
Longitudinal acceleration (post-crash)	If Recorded	0–250 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	500	-50 to +50g	+/- 10%	1 g	Planar

SAE J1698-3

No reference to acceleration accuracy assessment

Acceleration Accuracy Requirement

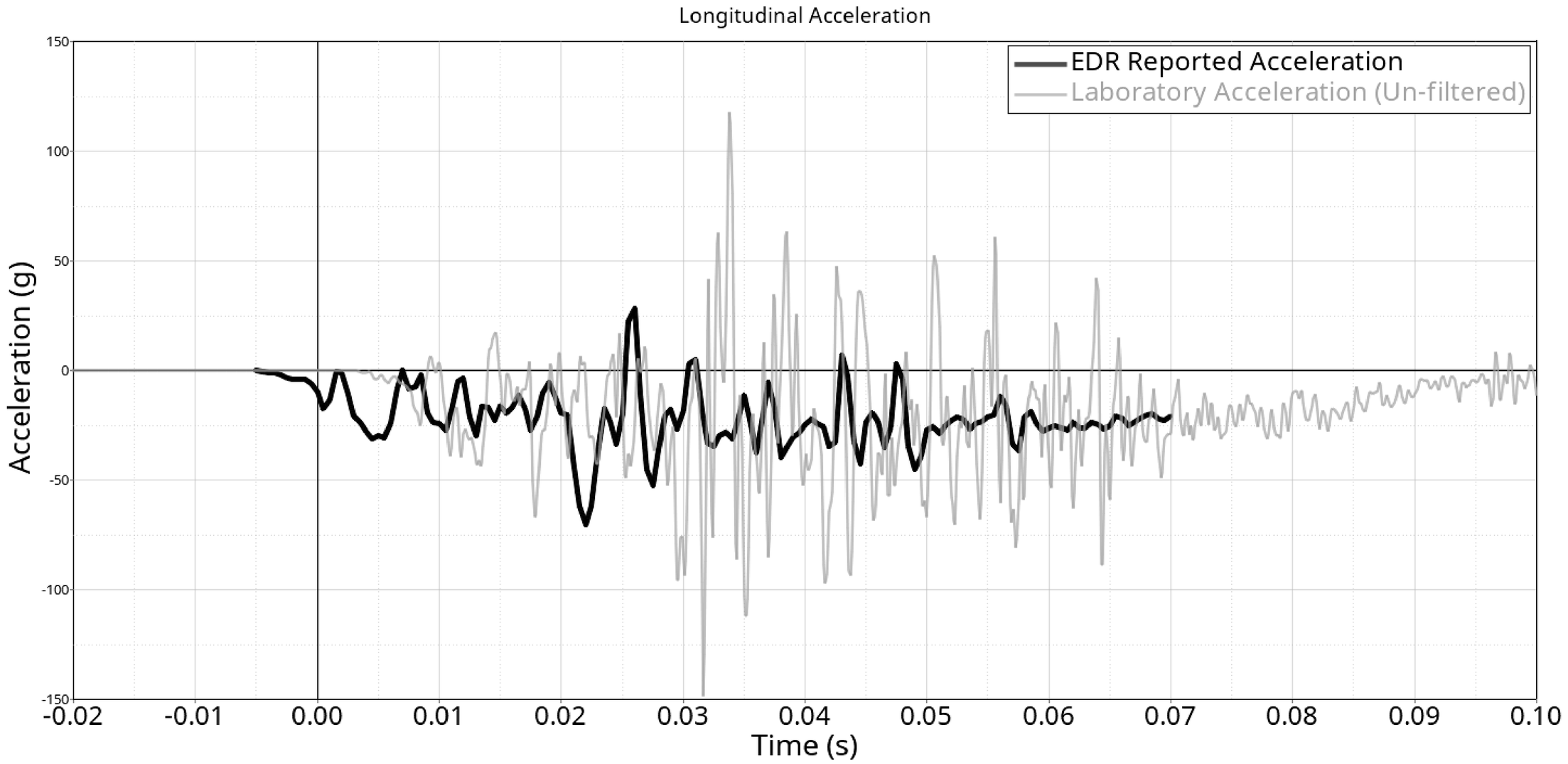
±10% Accuracy

- Where the requirement is ±10% accuracy (TP-563-00 and R160), there is no explicit reference to how to calculate the acceptance corridor?
  - ±10% of what value exactly?
    - Is it ±10% of the +/- 50 g *Minimum Range* as specified in the regulation?
    - Is it ±10% of the max reported acceleration value in the EDR record?
    - Is it ±10% of the OEM documented min/max (full range) acceleration values?
    - Is it ±10% of the calculated acceleration value (at each time increment)?
  - There is no references to filter parameters or data processing in R160
    - TP-563-00 references SAE J211 class 180 filter

- Let's assume the first option (±10% of the +/- 50 g *Minimum Range*) and go through an example (next slide)

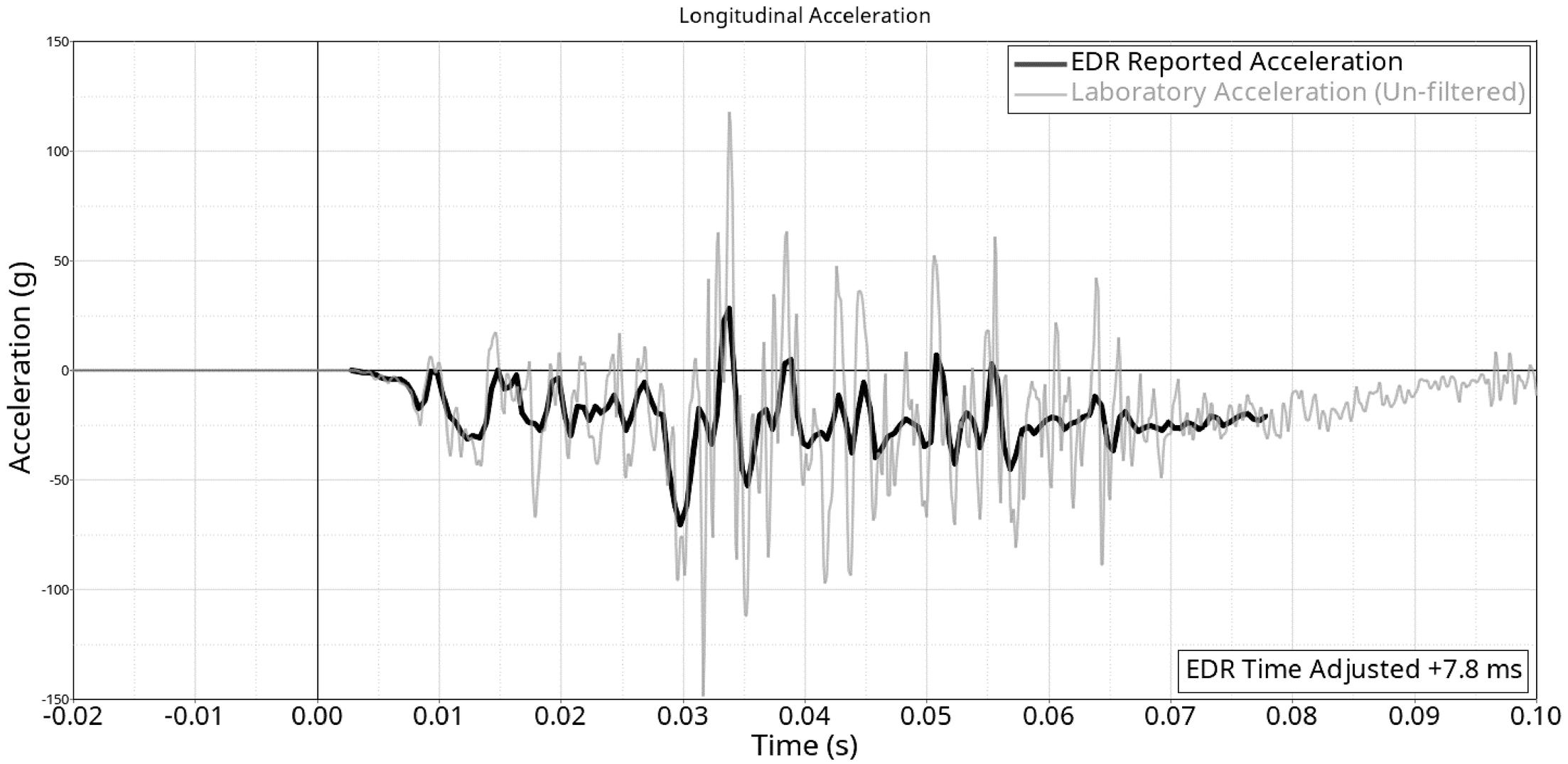
Acceleration Accuracy Requirement

Example – Frontal Crash Test



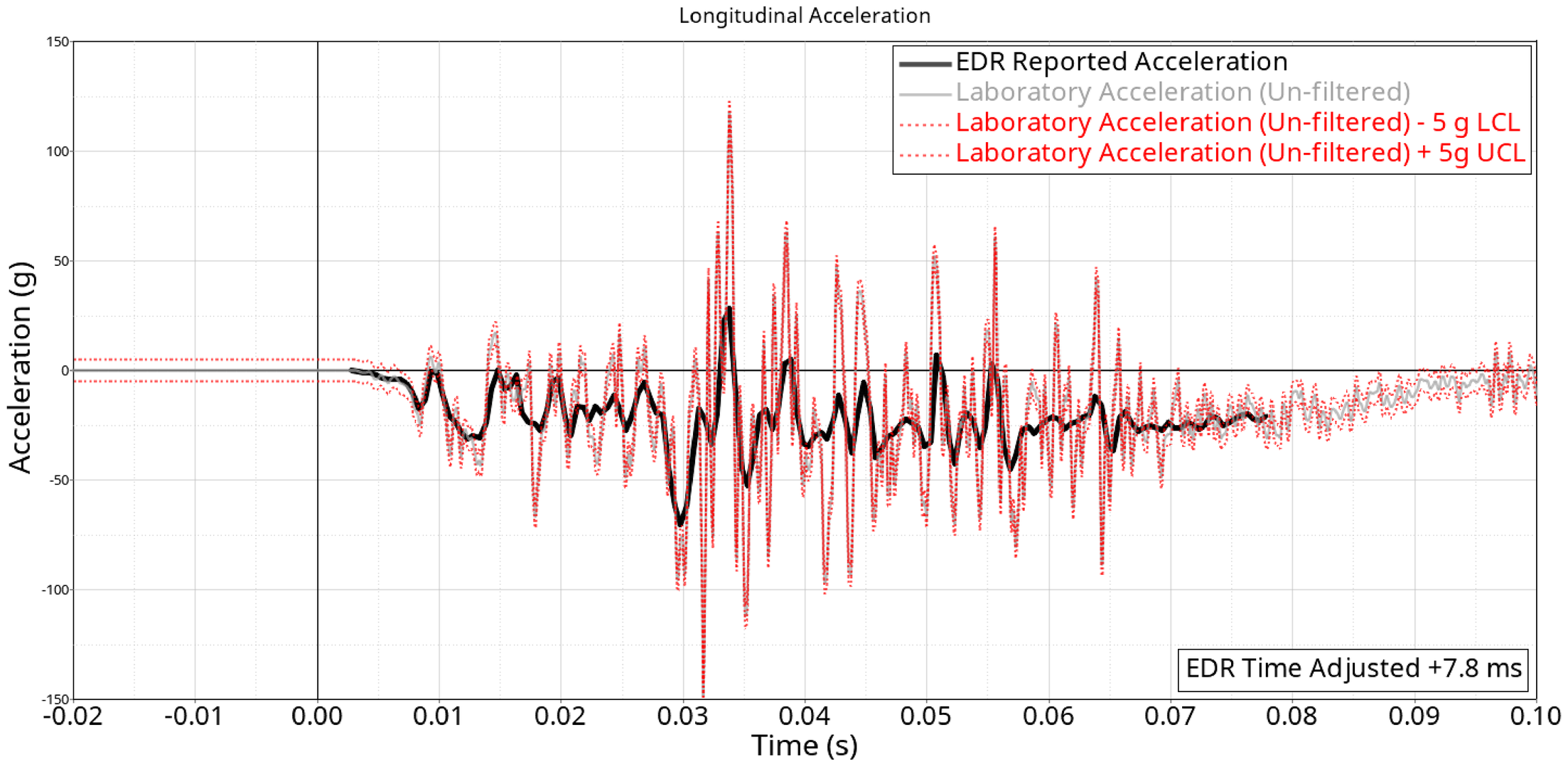
Acceleration Accuracy Requirement

Example – Frontal Crash Test



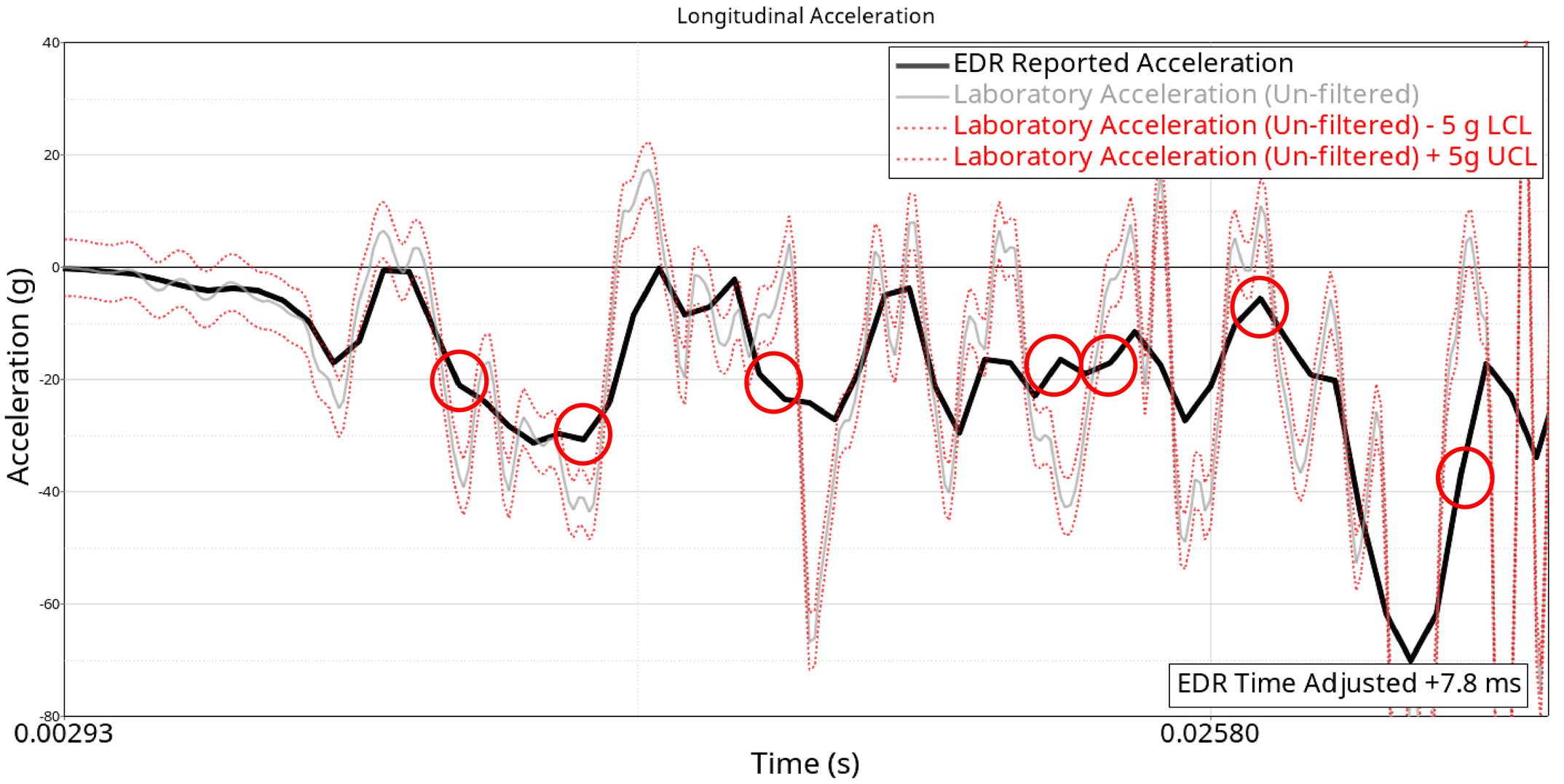
Acceleration Accuracy Requirement

Example – Frontal Crash Test



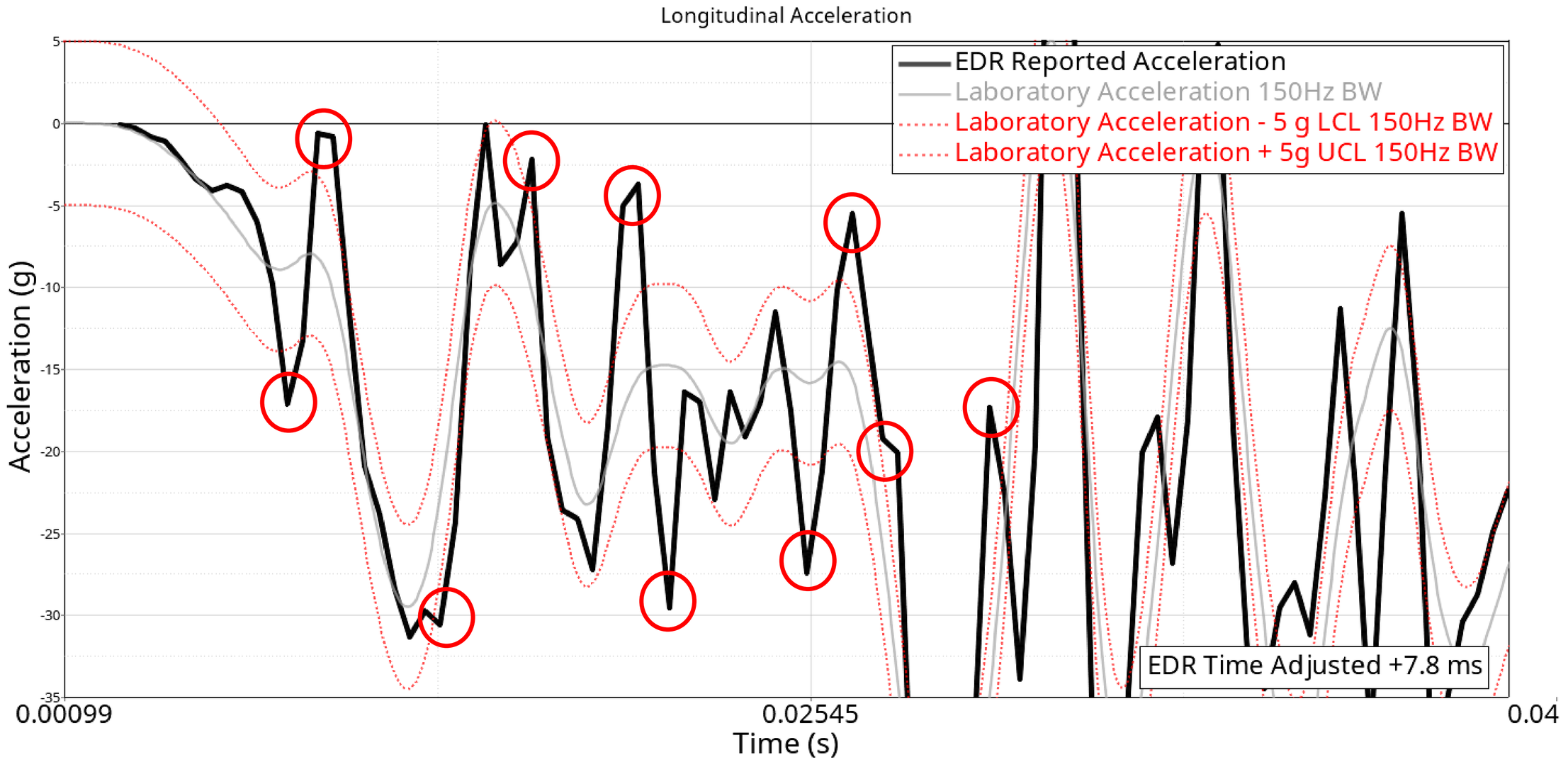
Acceleration Accuracy Requirement

Example – Frontal Crash Test



Acceleration Accuracy Requirement

Example – Frontal Crash Test (Filtered)



Acceleration Accuracy Requirement

Acceptance Considerations and Proposal

- To avoid interpretation concerns globally, commonization of the accuracy requirement should be considered across all regulations
- Complying with this requirement is extremely challenging due to the nature of acceleration data in crash tests and the internal processing of EDR data
- **Proposal:** remove the accuracy requirement or allow it to be *at the option of the manufacturer* (communize with NHTSA CFR Part 563)
  - Verifying the accuracy of Delta-V is a more appropriate way to validate crash pulse data from EDR

NHTSA CFR Part 563

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