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Item 6.2. of the provisional agenda

**Elements of common interest under 1958 and 1998 Agreements:****Guidance on Event Data Recorder (EDR) Performance Elements****Appropriate for Adoption in 1958 and 1998 Agreement Resolutions or Regulations****Guidance on Event Data Recorder (EDR) Performance  
Elements Appropriate for Adoption in 1958 and 1998  
Agreement Resolutions or Regulations****Submitted by the Working Party on General Safety \* \*\***

The text reproduced below was adopted by the Working Party on General Safety (GRSG) at its 120th session, held in January 2021 (see ECE/TRANS/WP.29/GRSG/99). It is based on ECE/TRANS/WP.29/2020/100 as amended by GRSG-120-01 and GRSG-120-05. It is submitted to World Forum for Harmonization of Vehicle Regulations (WP.29) for consideration at its March 2021 session.

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\* In accordance with the programme of work of the Inland Transport Committee for 2020 as outlined in proposed programme budget for 2020 (A/74/6 (part V sect. 20) para 20.37), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

\*\* This document was scheduled for publication after the standard publication date owing to circumstances beyond the submitter's control.



# Guidance on Event Data Recorder (EDR) Performance Elements Appropriate for Adoption in 1958 and 1998 Agreement Resolutions or Regulations

## 0. Foreword

- 0.1. The performance elements contained in this document provide guidance and/or specifications for vehicles fitted with Event Data Recorders (EDRs) concerning the minimum collection, storage, and crash survivability of motor vehicle crash event data. These performance elements do not include specifications for data retrieval tools and methods as that is subject to national/regional level requirement.
- 0.2. The purpose of these performance elements is to ensure that EDRs record, in a readily usable manner, data valuable for effective crash investigations and for analysis of safety equipment performance (e.g., advanced restraint systems). These data will help provide a better understanding of the circumstances in which crashes and injuries occur and will facilitate the development of safer vehicle designs.
- 0.3. Contracting parties may but are not required to make EDR requirements mandatory for M<sub>1</sub> or N<sub>1</sub> vehicles.

## 1. Scope

- 1.1. This document applies to all passenger cars and light duty vehicles (i.e., 1958 agreement M<sub>1</sub> and N<sub>1</sub> vehicle categories and 1998 agreement Category 1-1 vehicles and Category 2 vehicles).
- 1.2. This document is without prejudice to requirements of national or regional laws.
- 1.3. The following data elements are excluded from the scope: VIN, associated vehicle details, location/positioning data, information of the driver, ~~and~~ date and time of an event.
- 1.4. If there is no system or sensor designed to provide the data element to be recorded and stored under section 3, in the format (range, resolution, and sample rate) indicated in Annex 1. "DATA ELEMENTS" or it is not operational at the time of recording, this document requires neither recording of such data nor fitting or making such systems or sensors operational. However, if the vehicle is fitted with an original equipment manufacturer sensor or system designed to provide the data element in the format specified in Annex 1. "DATA ELEMENTS", then it is mandatory to report the data element in the specified format when the sensor or system is operational. In the case the reason for not being operational at the time of recording is a failure of this system or sensor, this failure state shall be recorded by the EDR as defined in the data elements Annex 1. Data elements.

## 2. Definitions

For the purposes of these performance elements:

- 2.1. "*ABS activity*" means the anti-lock brake system (ABS) is actively controlling the vehicle's brakes.
- 2.2. "*Air bag warning lamp status*" means whether the air bag malfunction warning is on or off.

- 2.3. "*Capture*" means the process of buffering EDR data in a temporary, volatile storage where it is continuously updated at regular time intervals.
- 2.4. "*Delta-V, lateral*" means the cumulative change in velocity, as recorded by the EDR of the vehicle, along the lateral axis.
- 2.5. "*Delta-V, longitudinal*" means the cumulative change in velocity, as recorded by the EDR of the vehicle, along the longitudinal axis.
- 2.6. "*Deployment time, frontal air bag*" means (for both driver and front passenger) the elapsed time from crash time zero to the deployment command or for multi-staged air bag systems, the deployment command for the first stage.
- 2.7. "*End of event time*" means the moment at which the cumulative delta-V within a 20 ms time period becomes 0.8 km/h or less, or the moment at which the crash detection algorithm of the air bag control unit resets.
- 2.8. "*Engine RPM*" means:
- (a) For vehicles powered by internal combustion engines, the number of revolutions per minute of the main crankshaft of the vehicle's engine, and
  - (b) For vehicles not entirely powered by internal combustion engines, the number of revolutions per minute of the motor shaft at the point at which it enters the vehicle transmission gearbox, and
  - (c) For vehicles not powered by internal combustion engines at all, the number of revolutions per minute of the output shaft of the device(s) supplying motive power.
- 2.9. "*Engine throttle, percent full*" means the driver-requested acceleration as measured by the throttle position sensor on the accelerator control compared to the fully depressed position.
- 2.10. "*Event*" means a crash or other physical occurrence that causes the trigger threshold to be met or exceeded, or any non-reversible deployable restraint to be deployed, whichever occurs first.
- 2.11. "*Event data recorder*" (EDR) means a device or function in a vehicle that records the vehicle's dynamic, time-series data during the time period just prior to an event (e.g., vehicle speed vs. time) or during a crash event (e.g., delta-V vs. time), intended for retrieval after the crash event. For the purposes of this definition, the event data does not include audio and video data.
- 2.12. "*Frontal air bag*" means an inflatable restraint system that requires no action by vehicle occupants and is used to meet the applicable national frontal crash protection requirements.
- 2.13. "*If recorded*" means if data is recorded in non-volatile memory for the purpose of subsequent downloading.
- 2.14. "*Ignition cycle, crash*" means the number (count) of power mode cycles at the time when the crash event occurred since the first use of the EDR.
- 2.15. "*Ignition cycle download*" means the number (count) of power mode cycles at the time when the data was downloaded since the first use of the EDR.
- 2.16. "*Lateral acceleration*" means the component of the vector acceleration of a point in the vehicle in the y-direction. The lateral acceleration is positive from left to right, from the perspective of the driver when seated in the vehicle facing the direction of forward vehicle travel.
- 2.17. "*Longitudinal acceleration*" means the component of the vector acceleration of a point in the vehicle in the x-direction. The longitudinal acceleration is positive in the direction of forward vehicle travel.
- 2.18. "*Maximum delta-V, lateral*" means the maximum value of the cumulative change in velocity, as recorded by the EDR, of the vehicle along the lateral axis.

- 2.19. "*Maximum delta-V, longitudinal*" means the maximum value of the cumulative change in velocity, as recorded by the EDR, of the vehicle along the longitudinal axis-
- 2.20. "*Maximum delta-V, resultant*" means the time-correlated maximum value of the cumulative change in velocity, as reported by the EDR along the vector-added longitudinal and lateral axis.
- 2.21. "*Multi-event crash*" means the occurrence of a minimum of 2 events, the first and last of which begin not more than 5 seconds apart.
- 2.22. "*Non-volatile memory*" means the memory reserved for maintaining recorded EDR data in a semi-permanent fashion. Data recorded in non-volatile memory is retained after a loss of power and can be retrieved with EDR data extraction tools and methods.
- 2.23. "*Normal acceleration*" means the component of the vector acceleration of a point in the vehicle in the z-direction. The normal acceleration is positive in a downward direction.
- 2.24. "*Occupant size classification*" means, for front passenger, the classification of an occupant as an adult and not a child, and for the driver, the classification of the driver as not being of small stature as indicated in the data format.
- 2.25. "*Operational*" means that the system or sensor, at the time of the event, is active or can be activated/deactivated by the driver.
- 2.26. "*Passenger air bag suppression status*" means the status of the passenger air bag (suppressed or not suppressed) switch indicating whether an air bag suppression system is on or off
- 2.27. "*Pretensioner*" means a device that is activated by a vehicle's crash sensing system and removes slack from a vehicle safety belt system.
- 2.28. "*Record*" means the process of saving captured EDR data into a non-volatile storage for subsequent retrieval.
- 2.29. "*Safety belt status*" means the feedback from the safety system that the vehicle's safety belt is fastened or unfastened.
- 2.30. "*Seat track position switch, foremost, status*" means the status of the switch that is installed to detect whether the seat is moved to a forward position.
- 2.31. "*Service brake, on and off*" means the status of the device that is installed in or connected to the brake pedal system to detect whether the pedal was pressed. The device can include the brake pedal switch or other driver-operated service brake control.
- 2.32. "*Side air bag*" means any inflatable occupant restraint device that is mounted to the seat or side structure of the vehicle interior, and that is designed to deploy in a side impact crash to help mitigate occupant injury and/or ejection.  
*Note* - Side air bags can also deploy in other crash modes as determined by the vehicle manufacturer.
- 2.33. "*Side curtain/tube air bag*" means any inflatable occupant restraint device that is mounted to the side structure of the vehicle interior, and that is designed to deploy in a side impact crash or rollover and to help mitigate occupant injury and/or ejection.  
*Note*: Side curtain/tube air bags can also deploy in other crash modes as determined by the manufacturer.
- 2.34. "*Speed, vehicle indicated*" means the vehicle speed indicated by a manufacturer-designated subsystem designed to indicate the vehicle's ground travel speed during vehicle operation.
- 2.35. "*Stability control*" means any device that complies with national, "Electronic stability control systems".

- 2.36. "*Steering input*" means the angular displacement of the steering wheel measured from the straight-ahead position (position corresponding to zero average steer angle of a pair of steered wheels).
- 2.37. "*Time from event 1 to 2*" means the elapsed time from time zero of the first event to time zero of the second event of a multi-event crash.
- 2.38. "*Time, maximum delta-V, lateral*" means the time from crash time zero to the point where the maximum value of the cumulative change in velocity is found, as recorded by the EDR, along the lateral axis.
- 2.39. "*Time, maximum delta-V, longitudinal*" means the time from crash time zero to the point where the maximum value of the cumulative change in velocity is found, as recorded by the EDR, along the longitudinal axis.
- 2.40. "*Time, maximum delta-V, resultant*" means the time from crash time zero to the point where the maximum delta-V resultant occurs, as reported by the EDR.
- 2.41. "*Time to deploy, pretensioner*" means the elapsed time from crash time zero to the deployment command for the safety belt pretensioner (for both driver and front passenger).
- 2.42. "*Time to deploy, side air bag/curtain*" means the elapsed time from crash time zero to the deployment command for a side air bag or a side curtain/tube air bag (for both driver and front passenger).
- 2.43. "*Time to first stage*" means the elapsed time between time zero and the time when the first stage of a frontal air bag is commanded to fire.
- 2.44. "*Time to nth stage*" means the elapsed time from crash time zero to the deployment command for the nth stage of a frontal air bag (for both driver and front passenger).
- 2.45. "*Time zero*" is the time reference for the EDR data timestamps of an event.
- 2.46. "*Trigger threshold*" means the appropriate parameter has met the conditions for recording an EDR event.
- 2.47. "*Vehicle roll angle*" means the angle between the vehicle y-axis and the ground plane as determined by the sensing system.
- 2.48. "*Volatile memory*" means the memory reserved for buffering of captured EDR data. The memory is not capable of retaining data in a semi-permanent fashion. Data captured in volatile memory is continuously overwritten and is not retained in the event of a power loss or retrievable with EDR data extraction tools.
- 2.49. "*Vulnerable road user secondary safety system*" means a deployable vehicle system outside the occupant compartment designed to mitigate injury consequences to vulnerable road users during a collision.
- 2.50. "*X-direction*" means in the direction of the vehicle's X-axis, which is parallel to the vehicle's longitudinal centerline. The X-direction is positive in the direction of forward vehicle travel.
- 2.51. "*Y-direction*" means in the direction of the vehicle's Y-axis, which is perpendicular to its X-axis and in the same horizontal plane as that axis. The Y-direction is positive from left to right, from the perspective of the driver when seated in the vehicle facing the direction of forward vehicle travel.
- 2.52. "*Z-direction*" means in the direction of the vehicle's Z-axis, which is perpendicular to the X and Y-axes. The Z-direction is positive in a downward direction.
- 2.53. "*Vehicle roll rate*" means the change in angle over time of the vehicle about its X-axis as determined by the sensing system.
- 2.54. "*Vehicle yaw rate*" means the change in angle over time of the vehicle about its Z-axis as determined by the sensing system.

### 3. Performance specifications

Performance specifications for vehicles fitted with an EDR include data elements, data format, data capture, and crash test performance and survivability.

#### 3.1. Data elements

- 3.1.1. Each vehicle fitted with an EDR shall record the data elements specified as mandatory and those required under specified minimum conditions during the interval/time and at the sample rate specified in Annex 1, Tables 1 and 2.

For application of the requirements in its domestic legislation, a Contracting Party may, provide appropriate lead-time, to require the EDR to record the data elements specified as mandatory and those required under specified minimum conditions during the interval/time and at the sample rate specified in Annex 1, Table 2.

#### 3.2. Data format

- 3.2.1. Each data element recorded shall be reported in accordance with the range, accuracy, and resolution specified in Annex 1, Tables 1 and 2.

- 3.2.2. Acceleration Time-History data and format: the longitudinal, lateral, and normal acceleration time-history data, as applicable, shall be filtered either during the recording phase or during the data downloading phase to include:

- 3.2.2.1. The Time Step (TS) that is the inverse of the sampling frequency of the acceleration data and which has units of milliseconds;

- 3.2.2.2. The number of the first point (NFP), which is an integer that when multiplied by the TS equals the time relative to time zero of the first acceleration data point;

- 3.2.2.3. The number of the last point (NLP), which is an integer that when multiplied by the TS equals the time relative to time zero of the last acceleration data point; and

- 3.2.2.4.  $NLP - NFP + 1$  acceleration values sequentially beginning with the acceleration at time  $NFP * TS$  and continue sampling the acceleration at TS increments in time until the time  $NLP * TS$  is reached.

#### 3.3. Data capture

The EDR non-volatile memory buffer shall accommodate the data related to at least two different events.

For application of the requirements in its domestic legislation, a Contracting Party may, provide appropriate lead-time to require vehicle types to be fitted with an EDR for which the non-volatile memory buffer is capable to accommodate the data related to at least three different events, if it decides this is appropriate.

The data elements for every event shall be captured and recorded by the EDR, as specified in section 3.1 in accordance with the following conditions and circumstances:

##### 3.3.1. Conditions for triggering recording of data

An event shall be recorded by the EDR if one of the following threshold values is met or exceeded:

- 3.3.1.1. Change in longitudinal vehicle velocity more than 8 km/h within a 150 ms or less interval.

- 3.3.1.2. Change in lateral vehicle velocity more than 8 km/h within a 150 ms or less interval
- 3.3.1.3. Activation of Non-reversible occupant restraint system.
- 3.3.1.4. Activation of Vulnerable road user secondary safety system
- If a vehicle is not fitted with any Vulnerable Road User (VRU) secondary safety system, this document requires neither recording of data nor fitting of such systems. However, if the vehicle is fitted with such a system, then it is mandatory to record the event data following activation of this system whenever the Contracting Party so requires.
- 3.3.2. Conditions for triggering locking of data
- In the circumstances provided below, the memory for the event shall be locked to prevent any future overwriting of the data.
- 3.3.2.1. In all the cases where a non-reversible occupant restraint system is deployed.
- 3.3.2.2. In the case of a frontal impact, if the vehicle is not fitted with a non-reversible restraint system for front impact, when the vehicle's velocity change in x-axis direction exceeds 25 km/h within 150ms or less interval.
- 3.3.2.3. Activation of Vulnerable road user secondary safety system
- 3.3.3. Conditions for establishment of time zero
- Time zero is established at the time when any of the following first occurs:
- 3.3.3.1. For systems with "wake-up" air bag control systems, the time at which the occupant restraint control algorithm is activated; or
- 3.3.3.2. For continuously running algorithms,
- 3.3.3.2.1. The first point in the interval where a longitudinal, cumulative delta-V of over 0.8 km/h is reached within a 20 ms time period; or
- 3.3.3.2.2. For vehicles that record "delta-V, lateral," the first point in the interval where a lateral, cumulative delta-V of over 0.8 km/h is reached within a 5 ms time period; or
- 3.3.3.3. Deployment of a non-reversible deployable restraint or activation of VRU secondary safety protection system.
- 3.3.4. Overwriting
- 3.3.4.1. If an EDR non-volatile memory buffer void of previous-event data is not available, the recorded data shall, subject to the provisions of paragraph 3.3.2., be overwritten by the current event data, on a first-in first-out basis, or according to different strategies decided by the manufacturer and made available to the relevant authorities of Contracting Parties.
- 3.3.4.2. Furthermore, if an EDR non-volatile memory buffer void of previous-event data is not available, data originating from non-reversible restraint system or Vulnerable road user secondary safety system deployment events referred to in paragraph 3.3.2 shall always overwrite any other data that is not locked per 3.3.2.
- 3.3.5. Power failure
- Data recorded in non-volatile memory is retained after loss of power.
- 3.4. Crash test performance and survivability
- 3.4.1. Each vehicle subject to the requirements of National or regional frontal crash test regulations, shall conform with the specifications in paragraph 3.4.3.
- 3.4.2. Each vehicle subject to the requirements of National or regional side impact crash test regulations, shall conform with the specifications of paragraph 3.4.3.

- 3.4.3. The data elements required by paragraph 3.1, shall be recorded in the format specified by paragraph 3.2, exist at the completion of the crash test and the complete data recorded element shall read "yes" after the test. Elements that are not operating normally in crash tests (e.g., those related to engine operation, braking, etc.) are not required to meet the accuracy or resolution requirements in these crash tests. <sup>1</sup>

The data shall be retrievable after an impact of a severity level set by UN-R94, /95 or/137, or other relevant national crash test procedures.

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<sup>1</sup> *Note:* Task Force on EDR currently working to further clarify that this does not apply to low speed test (e.g., bumper) that would not meet established trigger thresholds.



## Annex 1

### Data elements and format<sup>1</sup>

Table 1

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Delta-V, longitudinal	Mandatory - not required if longitudinal acceleration recorded at $\geq 500$ 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.	$\pm 10\%$	1 km/h.	Planar
Maximum delta-V, longitudinal	Mandatory - not required if longitudinal acceleration recorded at $\geq 500$ Hz	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	N/A	-100 km/h to + 100 km/h.	$\pm 10\%$	1 km/h.	Planar
Time, maximum delta-V, longitudinal	Mandatory - not required if longitudinal acceleration recorded at $\geq 500$ Hz	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	N/A	0–300 ms, or 0- End of Event Time plus 30 ms, whichever is shorter.	$\pm 3$ ms	2.5 ms.	Planar
Speed, vehicle indicated	Mandatory	-5.0 to 0 sec	2	0 km/h to 250 km/h	$\pm 1$ km/h	1 km/h.	Planar VRU Rollover
Engine throttle, % full (or accelerator pedal, % full)	Mandatory	-5.0 to 0 sec	2	0 to 100%	$\pm 5\%$	1%	Planar Rollover VRU

<sup>1</sup> Format requirements specified below are minimum requirements and manufacturers can exceed them.

<sup>2</sup> "Mandatory" is subject to the conditions detailed in Section 1.

<sup>3</sup> Pre-crash data and crash data are asynchronous. The sample time accuracy requirement for pre-crash time is -0.1 to 1.0 sec (e.g., T = -1 would need to occur between -1.1 and 0 seconds.)

<sup>4</sup> Accuracy requirement only applies within the range of the physical sensor. If measurements captured by a sensor exceed the design range of the sensor, the reported element shall indicate when the measurement first exceeded the design range of the sensor.

<sup>5</sup> "Planar" includes triggered events in sections 3.3.1.1, 3.3.1.2, and 3.3.1.3 and "VRU" includes triggered events in section 3.3.1.4.

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Service brake, on/off	Mandatory	-5.0 to 0 sec	2	On or Off	N/A	On or Off.	Planar VRU Rollover
Ignition cycle, crash	Mandatory	-1.0 sec	N/A	0 to 60,000	±1 cycle	1 cycle.	Planar VRU Rollover
Ignition cycle, download	Mandatory	At time of download <sup>6</sup>	N/A	0 to 60,000	±1 cycle	1 cycle.	Planar VRU Rollover
Safety belt status, driver	Mandatory	-1.0 sec	N/A	Fastened, not fastened	N/A	Fastened, not fastened	Planar Rollover
Air bag warning lamp <sup>7</sup> ,	Mandatory	-1.0 sec	N/A	On or Off	N/A	On or Off.	Planar Rollover
Frontal air bag deployment, time to deploy, in the case of a single stage air bag, or time to first stage deployment, in the case of a multi-stage air bag, driver.	Mandatory	Event	N/A	0 to 250 ms	±2ms	1 ms.	Planar
Frontal air bag deployment, time to deploy, in the case of a single stage air bag, or time to first stage deployment, in the case of a multi-stage air bag, front passenger.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar

<sup>6</sup> The ignition cycle at the time of download is not required to be recorded at the time of the crash but shall be reported during the download process.

<sup>7</sup> The air bag warning lamp is the readiness indicator specified in national air bag requirements and may also illuminate to indicate a malfunction in another part of the deployable restraint system.

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Multi-event crash, number of events	If Recorded <sup>8</sup>	Event	N/A	1 or more	N/A	1 or more.	Planar VRU Rollover
Time from event 1 to 2	Mandatory	As needed	N/A	0 to 5.0 sec	±0.1 sec	0.1 sec.	Planar Rollover
Complete file recorded	Mandatory	Following other data	N/A	Yes or No	N/A	Yes or No.	Planar VRU Rollover
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
Normal acceleration (post-crash)	If recorded	-1.0 to 5.0 sec <sup>9</sup>	10 Hz	-5 g to +5 g	± 10%	0.5 g	Rollover
Delta-V, lateral	Mandatory - not required if lateral acceleration recorded at ≥500 Hz and with sufficient range and resolution to calculate delta-v with required accuracy	0–250 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

<sup>8</sup> "If recorded" means if the data is recorded in non-volatile memory for the purpose of subsequent downloading.

<sup>9</sup> May be recorded in any time duration; -1.0 to 5.0 sec is suggested

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Maximum delta-V, lateral	Mandatory - not required if lateral acceleration recorded at $\geq 500$ Hz	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	N/A	-100 km/h to + 100 km/h.	$\pm 10\%$	1 km/h.	Planar
Time maximum delta-V, lateral	Mandatory - not required if lateral acceleration recorded at $\geq 500$ Hz	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	N/A	0–300 ms, or 0- End of Event Time plus 30 ms, whichever is shorter.	$\pm 3$ ms	2.5 ms.	Planar
Time for maximum delta-V, resultant.	Mandatory - not required if relevant acceleration recorded at $\geq 500$ Hz	0–300 ms or 0 to End of Event Time plus 30 ms, whichever is shorter.	N/A	0–300 ms, or 0- End of Event Time plus 30 ms, whichever is shorter.	$\pm 3$ ms	2.5 ms.	Planar
Engine rpm	Mandatory	-5.0 to 0 sec	2	0 to 10,000 rpm	$\pm 100$ rpm <sup>10</sup>	100 rpm.	Planar Rollover
Vehicle roll angle	If recorded	-1.0 up to 5.0 sec <sup>9</sup>	10	-1080 deg to + 1080 deg.	$\pm 10\%$	10 deg.	Rollover
ABS activity	Mandatory	-5.0 to 0 sec	2	Faulted, Active, Intervening <sup>11</sup>	N/A	Faulted, Active, Intervening <sup>12</sup>	Planar VRU Rollover
Stability control	Mandatory	-5.0 to 0 sec	2	Faulted, On, Off, Intervening <sup>12</sup>	N/A	Faulted, On, Off, Intervening <sup>12</sup>	Planar VRU Rollover
Steering input	Mandatory	-5.0 to 0 sec	2	-250 deg CW to + 250 deg CCW.	$\pm 5\%$	$\pm 1\%$ .	Planar Rollover VRU
Safety belt status, front passenger	Mandatory	-1.0 sec	N/A	Fastened, not fastened	N/A	Fastened, not fastened	Planar Rollover
Passenger air bag suppression status,	Mandatory	-1.0 sec	N/A	Suppressed or not suppressed	N/A	Suppressed or not suppressed	Planar Rollover

<sup>10</sup> These elements do not need to meet the accuracy and resolution requirements in specified crash tests.

<sup>11</sup> Manufacturers can include other system states

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Frontal air bag deployment, time to nth stage, driver <sup>4</sup> .	Mandatory if fitted with a driver's frontal air bag with a multi-stage inflator.	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar
Frontal air bag deployment, time to nth stage, front passenger <sup>12</sup> .	Mandatory if fitted with a front passenger's frontal air bag with a multi-stage inflator.	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar
Side air bag deployment, time to deploy, driver.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar
Side air bag deployment, time to deploy, front passenger.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar
Side curtain/tube air bag deployment, time to deploy, driver side.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar Rollover
Side curtain/tube air bag deployment, time to deploy, passenger side.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar Rollover
Pretensioner deployment, time to fire, driver.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar Rollover
Pretensioner deployment, time to fire, front passenger.	Mandatory	Event	N/A	0 to 250 ms	±2 ms	1 ms.	Planar Rollover

<sup>12</sup> List this element n - 1 times, once for each stage of a multi-stage air bag system.

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Seat track position switch, foremost, status, driver.	Mandatory if fitted and used for deployment decision	-1.0 sec	N/A	Yes or No	N/A	Yes or No.	Planar Rollover
Seat track position switch, foremost, status, front passenger.	Mandatory if fitted and used for deployment decision	-1.0 sec	N/A	Yes or No	N/A	Yes or No.	Planar Rollover
Occupant size classification, driver	If recorded	-1.0 sec	N/A	5th percentile female or larger.	N/A	Yes or No.	Planar Rollover
Occupant size classification, front passenger	If recorded	-1.0 sec	N/A	6yr old HIII US ATD or Q6 ATD or smaller	N/A	Yes or No.	Planar Rollover

Table 2

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
Vehicle roll rate	Mandatory if fitted and used for rollover protection system control algorithm	-1.0 up to 5.0 sec <sup>13</sup>	10	-240 to + 240 deg/sec	+/- 10% <sup>14</sup>	1 deg/sec	Rollover
Tyre Pressure Monitoring System (TPMS) Warning Lamp Status	Mandatory	-1.0 second relative to time zero	N/A	N/A	N/A	On, Off	Planar Rollover
Longitudinal acceleration (pre – crash)	Mandatory	-5.0 to 0 second relative to time zero	2	-1.5g to +1.5g	+/- 10%	0.1g	Planar VRU
Lateral acceleration (pre – crash)	Mandatory	-5.0 to 0 second relative to time zero	2	-1.0g to +1.0g	+/- 10%	0.1g	Planar
Yaw Rate	Mandatory	-5 to 0 seconds relative to time zero	2	-75 to +75 degrees / second	± 10% of the full range of the sensor	0.1	Planar Rollover
Traction Control Status	Mandatory if not fitted with ESC	-5.0 to 0 second relative to time zero	2	N/A	N/A	Actively controlling, Faulted, Commanded Off, or On but Not Controlling	Planar Rollover

<sup>2</sup> "Mandatory" is subject to the conditions detailed in Section 1.

<sup>3</sup> Pre-crash data and crash data are asynchronous. The sample time accuracy requirement for pre-crash time is -0.1 to 1.0 sec (e.g., T = -1 would need to occur between -1.1 and 0 seconds.)

<sup>4</sup> Accuracy requirement only applies within the range of the physical sensor. If measurements captured by a sensor exceed the design range of the sensor, the reported element shall indicate when the measurement first exceeded the design range of the sensor.

<sup>5</sup> "Planar" includes triggered events in sections 3.3.1.1, 3.3.1.2, and 3.3.1.3 and "VRU" includes triggered events in section 3.3.1.4.

<sup>13</sup> "vehicle roll angle" may be recorded in any time duration; -1.0 sec to 5.0 sec is suggested.

<sup>14</sup> Relative to the full range of the sensor

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>	<i>Event(s) recorded for<sup>5</sup></i>
AEBS status	Mandatory	-5.0 to 0 second relative to time zero	2	N/A	N/A	Actively Warning, Actively Engaged, Faulted, Off, Not Active	Planar VRU Rollover
Cruise Control System	Mandatory	-5.0 to 0 second relative to time zero	2	N/A	N/A	Actively Controlling, Faulted, Commanded Off, On but Not Controlling	Planar VRU Rollover
Adaptive Cruise Control Status (driving automation system level 1)	Mandatory	-5.0 to 0 second relative to time zero	2	N/A	N/A	Actively Controlling, Faulted, Commanded Off, On but Not Controlling	Planar VRU Rollover
VRU secondary safety system deployment, time to deploy	Mandatory	Event	N/A	0 to 250 ms	± 2 ms	1 ms	VRU
VRU secondary safety system warning indicator status <sup>15</sup>	Mandatory	-1.1 to 0 relative to time zero	N/A	N/A	N/A	On or Off	VRU
Safety belt status mid-position front	Mandatory	-1.0 sec	N/A	Fastened, not fastened	N/A	Fastened, not fastened	Planar Rollover
Far side impact center airbag	Mandatory	Event	N/A	0 to 250 ms	+/-2 ms	1 ms	Planar Rollover
[Lane departure warning system status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not warning, On – Warning left, On – Warning right]	

<sup>15</sup> Multiple safety system status indications can be combined into the air bag warning indicator or VRU can be its own warning indication.



<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>
[Corrective steering function (CSF) status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not intervening, On – Actively intervening]
[Emergency steering function (ESF) status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not intervening, On – Actively intervening]
[Automatically commanded steering function (ACSF) category A status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not controlling, On – Actively controlling]
[Automatically commanded steering function (ACSF) category B1 status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not controlling, On – Actively controlling]
[Automatically commanded steering function (ACSF) category B2 status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not controlling, On – Actively controlling]
[Automatically commanded steering function (ACSF) category C status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not controlling, On – Actively controlling]

<i>Data element</i>	<i>Condition for requirement<sup>2</sup></i>	<i>Recording interval/time<sup>3</sup> (relative to time zero)</i>	<i>Data sample rate (samples per second)</i>	<i>Minimum range</i>	<i>Accuracy<sup>4</sup></i>	<i>Resolution</i>
[Automatically commanded steering function (ACSF) category D status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not controlling, On – Actively controlling]
[Automatically commanded steering function (ACSF) category E status]	[Mandatory]	[-5.0 to 0 sec]	[2]	[N/A]	[N/A]	[Faulted, Off, On but not controlling, On – Actively controlling]
[Accident emergency call system status]	[Mandatory]	[Event]	[N/A]	[N/A]	[N/A]	[Faulted, On but emergency call not automatically triggered, On – Emergency call automatically triggered]