# Triggering Conditions and Data Quality Special Vehicle Warning

## CAR 2 CAR Communication Consortium

## About the C2C-CC

Enhancing road safety and traffic efficiency by means of Cooperative Intelligent Transport Systems and Services (C-ITS) is the dedicated goal of the CAR 2 CAR Communication Consortium. The industrial driven, non-commercial association was founded in 2002 by vehicle manufacturers affiliated with the idea of cooperative road traffic based on Vehicle-to-Vehicle Communications (V2V) and supported by Vehicle-to-Infrastructure Communications (V2I). Today, the Consortium comprises 88 members, with 18 vehicle manufacturers, 39 equipment suppliers and 31 research organisations.

Over the years, the CAR 2 CAR Communication Consortium has evolved to be one of the key players in preparing the initial deployment of C-ITS in Europe and the subsequent innovation phases. CAR 2 CAR members focus on wireless V2V communication applications based on ITS-G5 and concentrate all efforts on creating standards to ensure the interoperability of cooperative systems, spanning all vehicle classes across borders and brands. As a key contributor, the CAR 2 CAR Communication Consortium works in close cooperation with the European and international standardisation organisations such as ETSI and CEN.

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## Document information

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**Table 1: Document information**

## Changes since last version

| Title: | Triggering Conditions and Data Quality Special Vehicle Warning | | |
|---|---|---|---|
| Explanatory notes: | | | |
| | | | |
| 31.08.2018 | Minor corrections | Release Management | Steering Committee |
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**Table 2: Changes since last version**

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# 1 Introduction

## 1.1 Abstract

**Other (informational)** **RS_tcSpVe_220**

This document describes the triggering conditions for the emergency vehicle warning. The use case is divided in the following three sub use cases:

- Special Vehicle Warning - Emergency Vehicle in Operation
- Special Vehicle Warning - Stationary Safeguarding Emergency Vehicle
- Special Vehicle Warning - Stationary Wrecking Service Warning

# 2 Triggering conditions

## 2.1 Special Vehicle Warning

**Requirement** **RS_tcSpVe_242**

The Special Vehicle Warning Use Cases deals with vehicles which are "stationary".

A stationary vehicle is defined as follows:

- The vehicle is moving with an absolute speed <= 8 centimeter per second. This state shall be determined by internal vehicle sensors (e.g. wheel ticks)

Tested by:

### 2.1.1 Special Vehicle Warning - Emergency Vehicle in Operation

#### *2.1.1.1 Description of Use Case*

**Other (informational)** **RS_tcSpVe_221**

An emergency vehicle is any vehicle that is designated and authorized to respond to an emergency. These vehicles are usually operated by designated agencies, often part of the government, but also run by charities, non-governmental organizations and some commercial companies. Emergency vehicles are often permitted by law to break conventional road rules in order to reach their destinations in the fastest possible time, such as (but not limited to) driving through an intersection when the traffic lights are red, or exceeding the speed limit.

**Other (informational)** **RS_tcSpVe_222**

This chapter describes the triggering conditions for the emergency vehicles warning use case. The use case informs drivers of nearby vehicles about an emergency vehicle moving to an operation scene, which is reflected by the use of the light bar.

**Requirement** **RS_tcSpVe_117**

Once the use case is triggered, a DENM shall be transmitted by emergency vehicle ITS-S and parts of CAM data fields shall be set according to chapter 2.1.2.8.2.

NOTE: A parallel activation with the Use Case *Stationary Safeguarding Emergency Vehicle* has to be avoided. For an emergency vehicle ITS-S the default use case is *Emergency Vehicle In Operation*. A change to the use case *Stationary Safeguarding Emergency Vehicle* shall only be triggered under certain conditions, see chapter 2.1.2. Hence, an emergency vehicle ITS-S shall be either triggered as an *Emergency vehicle in Operation* or as a *Stationary Safeguarding Emergency Vehicle*.

Tested by:

#### *2.1.1.2 Relations to other Use Cases*

**Other (informational)** **RS_tcSpVe_224**

The following use cases are related to the *Special Vehicle Warning - Emergency Vehicle in Operation* use case, because they share similar triggering conditions:

- Special Vehicle Warning - Stationary Safeguarding Emergency Vehicle
- Special Vehicle Warning – Stationary Wrecking Service Warning

**Requirement** **RS_tcSpVe_118**

As mentioned above, the default use case for an emergency vehicle ITS-S is *Emergency Vehicle in Operation*. A change to the use case *Stationary Safeguarding Emergency Vehicle* shall only be triggered under the conditions defined in chapter 2.1.2.

Tested by:

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### *2.1.1.3 Triggering Conditions*

#### *2.1.1.3.1 Preconditions*

**Requirement** **RS_tcSpVe_119**

The following preconditions shall be satisfied every time before triggering of this use case is initialised:

- The *stationType* is confirmed to be a special vehicle (*stationType* of CAM is set to *specialVehicles*(10)). The Use Case is restricted to emergency vehicles as prescribed in chapter 2.1.1.1.
- The triggering conditions regarding "Stationary Safeguarding Emergency Vehicle" shall not be satisfied, see chapter 2.1.2.3

Tested by:

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#### *2.1.1.3.2 Use Case Specific Conditions*

**Requirement** **RS_tcSpVe_120**

Once the following condition is satisfied, the generation of a DENM shall be triggered.

a) The light bar is in use.

Tested by:

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**Requirement** **RS_tcSpVe_121**

The level of information quality can be improved by the following characteristics:

b) The siren is in use

c) The vehicle is not stationary.

Tested by:

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**Requirement** **RS_tcSpVe_122**

The vehicle speed shall be determined by the vehicle bus signal, not by GNSS. The filtered vehicle speed (with respect to sensor noise due to wheel ticks) shall be used.

Tested by:

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#### *2.1.1.3.3 Information Quality*

**Requirement** **RS_tcSpVe_123**

The value of the data element *informationQuality* in the DENM depends on the way the event is detected. The *informationQuality* value shall be set in the following way (highest possible

value shall be used):

| Event detection | Value of InformationQuality |
|---|---|
| No TC compliant implementation | unknown(0) |
| Condition a) fulfilled | 1 |
| Conditions a) and b) fulfilled | 2 |
| Conditions a) and c) fulfilled | 3 |
| Conditions a), b), and c) fulfilled | 4 |

**Table 3: Information quality of "Emergency Vehicle in Operation"**

Tested by:

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**Requirement** **RS_tcSpVe_124**

If the Triggering Conditions change in between two updates, the *informationQuality* shall not be changed until the next update. If the changed conditions are still fulfilled while the DENM is updated, the *informationQuality* shall be updated.

Tested by:

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### *2.1.1.4 Termination Conditions*

**Requirement** **RS_tcSpVe_125**

The use case shall be terminated when the light bar is not in use any more. At the termination of the use case, updating of DENMs shall be terminated. The *vehicleRole* shall be set to *default*(0), if the light bar is no longer in use.

Tested by:

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#### *2.1.1.4.1 Cancellation*

**Requirement** **RS_tcSpVe_126**

A cancellation DENM shall not be used for this use case.

Tested by:

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#### *2.1.1.4.2 Negation*

**Requirement** **RS_tcSpVe_127**

A negation DENM shall not be used for this use case.

Tested by:

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### *2.1.1.5 Update*

**Requirement** **RS_tcSpVe_128**

The generated DENM shall be updated every 250 ms if the triggering conditions are still satisfied. All data fields that are assigned new values are defined in chapter 2.1.1.8.1. in Table

4.

Tested by:

### 2.1.1.6 Repetition Duration and Repetition Interval

**Requirement** **RS_tcSpVe_129**

A repetition of the DENM shall not be used for this use case.

Tested by:

### 2.1.1.7 Traffic class

**Requirement** **RS_tcSpVe_130**

New and update DENMs shall be set to *traffic class* 1.

Tested by:

### 2.1.1.8 Message Parameter

#### 2.1.1.8.1 DENM

**Requirement** **RS_tcSpVe_131**

Table 4 specifies the data elements of the DENM that shall be set.

<table>
<tr><th>Data Field</th><th>Value</th></tr>
<tr><td colspan="2">Management Container</td></tr>
<tr><td>actionID</td><td>Identifier of a DENM.Shall be set according to [TS 102 894-2].</td></tr>
<tr><td>detectionTime</td><td>TimestampIts-Timestamp at which the event is detected by the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>referenceTime</td><td>TimestampIts-Timestamp at which a new DENM or an update DENM is generated. Shall be set according to [TS 102 894-2].</td></tr>
<tr><td>termination</td><td>Shall not be set, because neither negation nor cancellation shall be used in this use case.</td></tr>
<tr><td>eventPosition</td><td>ReferencePosition. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>relevanceDistance</td><td>lessThan1000m(4)</td></tr>
<tr><td>relevanceTrafficDirection</td><td>If the roadType is known the value shall be set as follows:
<table>
<tr><th>RoadType</th><th>Direction</th></tr>
<tr><td>0</td><td>allTrafficDirections(0)</td></tr>
<tr><td>1</td><td>upstreamTraffic(1)</td></tr>
<tr><td>2</td><td>allTrafficDirections(0)</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>3</td><td>upstreamTraffic(1)</td></tr>
</table>
Otherwise, the value shall be set to allTrafficDirections(0)
</td></tr>
<tr><td>validityDuration</td><td>2 seconds</td></tr>
<tr><td>stationType</td><td>specialVehicles(10)</td></tr>
<tr><td colspan="2">Situation Container</td></tr>
<tr><td>informationQuality</td><td>See RS_tcSpVe_123. Shall be refreshed for every update DENM.</td></tr>
<tr><td>causeCode</td><td>emergencyVehicleApproaching (95)</td></tr>
<tr><td>subCauseCode</td><td>emergencyVehicleApproaching(1)</td></tr>
<tr><td colspan="2">Location Container</td></tr>
<tr><td>eventSpeed</td><td>Speed of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>eventPositionHeading</td><td>Heading of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>traces</td><td>PathHistory of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>roadType</td><td>RoadType of the road the detecting ITS-S is situated on.<br>Shall be refreshed for an update DENM.<br>Shall be set according to [TS 102 894-2] in combination with the following rules:
<table>
<tr><th>Urban / Non-Urban</th><th>Structural Separation</th><th>Data Element</th></tr>
<tr><td>Urban</td><td>No</td><td>urban-NoStructuralSeparationToOppositeLanes(0)</td></tr>
<tr><td>Urban</td><td>Yes</td><td>urban-WithStructuralSeparationToOppositeLanes(1)</td></tr>
<tr><td>Urban</td><td>unknown</td><td>urban-NoStructuralSeparationToOppositeLanes(0)</td></tr>
<tr><td>Non-Urban</td><td>No</td><td>nonUrban-NoStructuralSeparationToOppositeLanes(2)</td></tr>
<tr><td>Non-Urban</td><td>Yes</td><td>nonUrban-WithStructuralSeparationToOppositeLanes(3)</td></tr>
</table>
</td></tr>
</table>

| | | | |
|---|---|---|---|
| | Non-Urban | Unknown | nonUrban-NoStructuralSeparationToOppositeLanes(2) |
| | Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted. | | |
| **Alacarte Container** | | | |
| *lanePosition* | If the lanePosition is provided by an onboard sensor (e.g. radar, camera), the value shall be set according to [TS 102 894-2]. The use of GPS and a digital map for the estimation of the lane number is not legitimate for this version of the triggering condition.<br>If the lanePosition is unknown, the data element shall be omitted.<br>Shall be refreshed for an update DENM. | | |
| **Alacarte Container: StationaryVehicleContainer** | | | |
| *stationarySince* | Shall be set according to the duration in minutes of the detecting ITS-S being stationary.Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM. | | |

**Table 4: DENM data elements of "Emergency Vehicle in Operation"**

Tested by:

### *2.1.1.8.2 CAM*

**Requirement** **RS_tcSpVe_132**

The *vehicleRole* shall be initialised to be a "default" vehicle (*vehicleRole* of CAM set to *default*(0)). If at least one of the use case specific triggering conditions defined in RS_tcSpVe_120 is satisfied the *vehicleRole* shall be set to *emergency*(6).

Tested by:

**Requirement** **RS_tcSpVe_133**

Table 5 specifies the data elements of the CAM that shall be set if the use case is triggered.

| Data Field | Value |
|---|---|
| **CoopAwareness** | |
| *generationDeltaTime* | Time corresponding to the time of the reference position in the CAM, considered as time of the CAM generation.<br>Shall be set according to [EN 302 637-2]. |
| **BasicContainer** | |
| *stationType* | specialVehicles(10) |
| *referencePosition* | Position and position accuracy measured at the reference point of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |

| HighFrequencyContainer shall be set to BasicVehicleContainerHighFrequency | |
|---|---|
| *heading* | Heading direction of the originating ITS-S with regards to the true north.<br>Shall be set according to [TS 102 894-2]. |
| *speed* | Driving speed of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *driveDirection* | Vehicle drive direction (Forward or Backward) of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *vehicleLength* | Length of vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *vehicleWidth* | Width of a vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *longitudinalAcceleration* | Vehicle longitudinal acceleration of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *curvature* | Curvature of the vehicle trajectory and the accuracy.<br>Shall be set according to [TS 102 894-2]. |
| *curvatureCalcMode* | Describes whether the yaw rate is used to calculate the curvature for a reported curvature value.<br>Shall be set according to [TS 102 894-2]. |
| *yawRate* | Yaw rate of vehicle at a point in time.<br>Shall be set according to [TS 102 894-2]. |
| **LowFrequencyContainer shall be set to BasicVehicleContainerLowFrequency** | |
| *vehicleRole* | emergency(6) |
| *exteriorLights* | Describes the status of the exterior light switches of a vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *pathHistory* | Represents the vehicle's recent movement over some past time and/or distance.<br>Shall be set according to [TS 102 894-2]. |
| **SpecialVehicleContainer shall be set to EmergencyContainer** | |
| *lightBarSirenInUse* | lightBarActivated bit shall be set to 1(onChange), if the usage of the lightbar is detected, otherwise, it shall be set to 0.<br>sirenActivated bit shall be set to 1, if usage of the siren is detected, otherwise, it shall be set to 0. |
| *emergencyPriority* | Is not required |
| *causeCode* | As specified in DENM (2.1.1.8.1) |
| *subCauseCode* | As specified in DENM (2.1.1.8.1) |

**Table 5: CAM data elements of "Emergency Vehicle in Operation“**

Tested by:

#### *2.1.1.9 Networking and Transport Layer*

**Requirement** **RS_tcSpVe_134**

For the Day One version of this application, the destination area is the same as the relevance area - in this case, a circle of radius *relevanceDistance*. Therefore, the interface parameter *DENM destination area* between the DEN basic service and the Networking & Transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Tested by:

#### *2.1.1.10 Security Layer*

**Requirement** **RS_tcSpVe_136**

If the triggering conditions as described in chapter 2.1.1.3 apply, an AT change shall be blocked for DENMs as long as *validityDuration* is not expired (see chapter 2.1.1.8.1). Corresponding new and update DENMs shall be sent with the same authorization ticket.

Tested by:

### 2.1.2 Special Vehicle Warning - Stationary Safeguarding Emergency Vehicle

#### *2.1.2.1 Description of Use Case*

**Other (informational)** **RS_tcSpVe_225**

The emergency vehicle safeguards a stationary hazard area, e.g. caused by an accident or fire.

In this use case, the C2C-CC Basic System informs the driver of an emergency vehicle safeguarding a stationary hazard area.

**Requirement** **RS_tcSpVe_137**

Once the use case is triggered, the Stationary safeguarding emergency vehicle shall transmit a DENM and shall set data fields of CAM according to the rules specified in the current chapter.

NOTE: A parallel activation with the Use Case *Emergency Vehicle in Operation* has to be avoided, i.e. an emergency vehicle ITS-S shall be either triggered as an *Emergency Vehicle in Operation* or as a *Stationary Safeguarding Emergency Vehicle*. The default use case for an emergency vehicle ITS-S is *Emergency Vehicle in Operation*, a change to the *Stationary Safeguarding Emergency Vehicle* shall only be triggered under the conditions defined in this chapter.

Tested by:

#### *2.1.2.2 Relations to other Use Cases*

**Other (informational)** **RS_tcSpVe_227**

The following use cases are related to the *Special Vehicle Warning - Stationary Safeguarding*

*Emergency Vehicle* use case, because they share similar triggering conditions:

- Special Vehicle Warning – Emergency Vehicle in Operation
- Special Vehicle Warning – Stationary Wrecking Service Warning

### 2.1.2.3 Triggering Conditions

#### 2.1.2.3.1 Preconditions

**Requirement** **RS_tcSpVe_138**

The following preconditions shall be satisfied every time before triggering of this use case is initialised:

- The *stationType* is confirmed to be an emergency vehicle (*stationType* of CAM is set to *specialVehicles*(10)). The Use Case is restricted to emergency vehicles as prescribed in chapter 2.1.1.1.
- The *Standstill Timer* shall be initialised with zero.

Tested by:

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**Requirement** **RS_tcSpVe_139**

For an emergency vehicle ITS-S the default use case is *Emergency Vehicle In Operation*. A change to the use case *Stationary Safeguarding Emergency Vehicle* shall only be triggered under the use case specific conditions, defined in chapter 2.1.2.3.2.

Tested by:

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#### 2.1.2.3.2 Use Case Specific Conditions

**Requirement** **RS_tcSpVe_140**

If the vehicle is stationary and the light bar is in use a *Standstill Timer* shall be initialized with zero and started. If the light bar is no longer in use or the vehicle is no longer stationary the *Standstill Timer* shall be stopped and reset to zero.

Tested by:

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**Requirement** **RS_tcSpVe_240**

Once at least one of the following conditions is satisfied, the triggering conditions for this use case are fulfilled and the generation of a DENM shall be triggered.

a) Light bar is in use and engine relay is activated.

b) Light bar is in use, hazard light is activated and parking brake is activated or in case of automatic transmission parking position is chosen.

c) Light bar is in use, hazard lights are activated and the *Standstill Timer* is greater than or equal to 60 seconds.

Tested by:

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**Requirement** **RS_tcSpVe_142**

The vehicle speed shall be determined by the vehicle bus signal, not by GNSS. The filtered vehicle speed (with respect to sensor noise due to wheel ticks) shall be used. This requirement shall be applied for all following occurrences of vehicle speed analysis.

Tested by:

**Requirement** **RS_tcSpVe_143**

The level of information quality can be improved by the following characteristics:

d) Status of at least one door or trunk is "open"

e) Driver's seat is detected as "not occupied". The condition shall be detected by one of the following techniques:

a. Passenger compartment camera

b. State of the art technique for seat occupation used in seat belt reminder

Tested by:

**Requirement** **RS_tcSpVe_144**

If the use case is triggered due to fulfillment of condition a) or b), the *Standstill Timer* shall be stopped and set to 60 seconds. In the update phase, only the conditions shall be checked, but no timer shall be started.

Tested by:

### *2.1.2.3.3 Information Quality*

**Requirement** **RS_tcSpVe_145**

The value of the data element *informationQuality* in the DENM depends on the way the event is detected. The *informationQuality* value shall be set in the following way (highest possible value shall be used):

| Event detection | Value of InformationQuality |
|---|---|
| No TC compliant implementation | unknown(0) |
| Condition c) fulfilled | 1 |
| Condition b) fulfilled | 2 |
| At least one of conditions b) or c) fulfilled and condition d) fulfilled | 3 |
| At least one of conditions b) or c) fulfilled and condition e) fulfilled | 4 |
| Condition a) fulfilled | 5 |

**Table 6, Information quality of "Safeguarding Emergency Vehicle"**

Tested by:

**Requirement** **RS_tcSpVe_146**

If the Triggering Conditions change in between two updates, the *informationQuality* shall not be changed until the next update. If the changed conditions are still fulfilled while the DENM is updated, the *informationQuality* shall be updated.

Tested by:

### 2.1.2.4 Termination Conditions

**Requirement** **RS_tcSpVe_147**

This use case is terminated by a cancellation of the originating ITS-S. At the termination of the use case, update DENM request shall be terminated.

Tested by:

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#### 2.1.2.4.1 Cancellation

**Requirement** **RS_tcSpVe_148**

Once the following condition is satisfied before the time period set in the data element *validityDuration* is expired, the generation of a cancellation DENM shall be triggered.

- All of the use case specific conditions a) to c) in chapter 2.1.2.3.2 are no longer satisfied.

The *vehicleRole* shall be set to *default*(0), if the light bar is no longer in use.

Tested by:

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#### 2.1.2.4.2 Negation

**Requirement** **RS_tcSpVe_149**

A negation DENM shall not be used for this use case.

Tested by:

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### 2.1.2.5 Update

**Requirement** **RS_tcSpVe_150**

The generation of an update DENM shall be triggered every 60s, if the triggering conditions are still satisfied. All data fields that are assigned new values are defined in chapter 2.1.2.8.1 in Table 7.

Tested by:

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### 2.1.2.6 Repetition Duration and Repetition Interval

**Requirement** **RS_tcSpVe_151**

DENMs, that are new, have been updated or have been cancelled, shall be repeated for a *repetitionDuration* of 60 s with a *repetitionInterval* of 1 s. Therefore the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set according to the values above.

NOTE: The *validityDuration* is set to 180 *s*. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM is expired and the update has not been received yet.

NOTE: The case of managing two DENMs with the same *causeCode* from the same originating ITS-S has to be handled by the receiving ITS-S.

Tested by:

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#### 2.1.2.7 Traffic class

**Requirement** **RS_tcSpVe_152**

New, update and cancellation DENMs shall be set to *traffic class* 1.

Tested by:

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#### 2.1.2.8 Message Parameter

##### 2.1.2.8.1 DENM

**Requirement** **RS_tcSpVe_153**

Table 7 specifies the data elements of the DENM that shall be set.

<table>
<tr><th>Data Field</th><th>Value</th></tr>
<tr><td colspan="2">Management Container</td></tr>
<tr><td>actionID</td><td>Identifier of a DENM.Shall be set according to [TS 102 894-2].</td></tr>
<tr><td>detectionTime</td><td>TimestampIts-Timestamp at which the event is detected by the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>referenceTime</td><td>TimestampIts-Timestamp at which a new DENM, an update DENM or a cancellation DENM is generated. Shall be set according to [TS 102 894-2].</td></tr>
<tr><td>termination</td><td>Shall not be set in case of new or update DENM. Shall be set to isCancellation(0) in case of fulfillment of cancellation conditions, see chapter 2.1.2.4.1.</td></tr>
<tr><td>eventPosition</td><td>ReferencePosition. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>relevanceDistance</td><td>lessThan5km(5)</td></tr>
<tr><td>relevanceTrafficDirection</td><td>If the roadType is known the value shall be set as follows:
<table>
<tr><th>RoadType</th><th>Direction</th></tr>
<tr><td>0</td><td>allTrafficDirections(0)</td></tr>
<tr><td>1</td><td>upstreamTraffic(1)</td></tr>
<tr><td>2</td><td>allTrafficDirections(0)</td></tr>
<tr><td>3</td><td>upstreamTraffic(1)</td></tr>
</table>
Otherwise, the value shall be set to allTrafficDirections(0)</td></tr>
<tr><td>validityDuration</td><td>180 seconds</td></tr>
<tr><td>stationType</td><td>specialVehicles(10)</td></tr>
<tr><td colspan="2">Situation Container</td></tr>
<tr><td>informationQuality</td><td>See RS_tcSpVe_145. Shall be refreshed for every update DENM.</td></tr>
<tr><td>causeCode</td><td>rescueAndRecoveryWorkInProgress(15)</td></tr>
</table>

<table>
<tr><td>subCauseCode</td><td>emergencyVehicles(1)</td></tr>
<tr><td colspan="2">Location Container</td></tr>
<tr><td>eventSpeed</td><td>Speed of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>eventPositionHeading</td><td>Heading of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>traces</td><td>PathHistory of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.<br>If the PathDeltaTime is used in the PathPoints, the PathDeltaTime of the first PathPoint (closest point to the ReferencePosition) shall be refreshed for an update DENM. All other PathPoints shall not be refreshed. If the PathDeltaTime of the first PathPoint exceeds the maximum value according to [TS 102 894-2], the PathDeltaTime shall not be further refreshed.<br>If the PathDeltaTime is not used in the PathPoints, the PathHistory shall not be refreshed for an update DENM.</td></tr>
<tr><td>roadType</td><td>RoadType of the road the detecting ITS-S is situated on.<br>Shall be refreshed for an update DENM.<br>Shall be set according to [TS 102 894-2] in combination with the following rules:
<table>
<tr><th>Urban / Non-Urban</th><th>Structural Separation</th><th>Data Element</th></tr>
<tr><td>Urban</td><td>No</td><td>urban-NoStructuralSeparationToOppositeLanes(0)</td></tr>
<tr><td>Urban</td><td>Yes</td><td>urban-WithStructuralSeparationToOppositeLanes(1)</td></tr>
<tr><td>Urban</td><td>unknown</td><td>urban-NoStructuralSeparationToOppositeLanes(0)</td></tr>
<tr><td>Non-Urban</td><td>No</td><td>nonUrban-NoStructuralSeparationToOppositeLanes(2)</td></tr>
<tr><td>Non-Urban</td><td>Yes</td><td>nonUrban-WithStructuralSeparationToOppositeLanes(3)</td></tr>
<tr><td>Non-Urban</td><td>Unknown</td><td>nonUrban-NoStructuralSeparationToOppositeLanes(2)</td></tr>
</table></td></tr>
</table>

| | |
|---|---|
| | Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted. |
| **Alacarte Container** | |
| *lanePosition* | If the lanePosition is provided by an onboard sensor (e.g. radar, camera), the value shall be set according to [TS 102 894-2]. The use of GPS and a digital map for the estimation of the lane number is not legitimate for this version of the triggering condition.<br>If the lanePosition is unknown, the data element shall be omitted.<br>Shall be refreshed for an update DENM. |
| **Alacarte Container: StationaryVehicleContainer** | |
| *stationarySince* | Shall be set according to the duration in minutes of the detecting ITS-S being stationary.Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM. |

**Table 7: DENM data elements of "Stationary Safeguarding Emergency Vehicle"**

Tested by:

#### *2.1.2.8.2 CAM*

**Requirement** **RS_tcSpVe_154**

The *vehicleRole* is initialised to be a "default" vehicle (*vehicleRole* of CAM set to *default*(0)). If at least one of the use case specific triggering conditions defined in RS_tcSpVe_240 is satisfied the vehicleRole shall be set to *emergency*(6).

Tested by:

**Requirement** **RS_tcSpVe_155**

Table 8 specifies the data elements of the CAM that shall be set if the use case is triggered.

| **Data Field** | **Value** |
|---|---|
| **CoopAwareness** | |
| *generationDeltaTime* | Time corresponding to the time of the reference position in the CAM, considered as time of the CAM generation.<br>Shall be set according to [EN 302 637-2]. |
| **BasicContainer** | |
| *stationType* | specialVehicles(10) |
| *referencePosition* | Position and position accuracy measured at the reference point of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| **HighFrequencyContainer shall be set to BasicVehicleContainerHighFrequency** | |
| *heading* | Heading direction of the originating ITS-S with regards to the true north. |

| | |
|---|---|
| | Shall be set according to [TS 102 894-2]. |
| *speed* | Driving speed of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *driveDirection* | Vehicle drive direction (Forward or Backward) of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *vehicleLength* | Length of vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *vehicleWidth* | Width of a vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *longitudinalAcceleration* | Vehicle longitudinal acceleration of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *curvature* | Curvature of the vehicle trajectory and the accuracy.<br>Shall be set according to [TS 102 894-2]. |
| *curvatureCalcMode* | Describes whether the yaw rate is used to calculate the curvature for a reported curvature value.<br>Shall be set according to [TS 102 894-2]. |
| *yawRate* | Yaw rate of vehicle at a point in time.<br>Shall be set according to [TS 102 894-2]. |
| **LowFrequencyContainer shall be set to BasicVehicleContainerLowFrequency** | |
| *vehicleRole* | emergency(6) |
| *exteriorLights* | Describes the status of the exterior light switches of a vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *pathHistory* | Represents the vehicle's recent movement over some past time and/or distance.<br>Shall be set according to [TS 102 894-2]. |
| **SpecialVehicleContainer shall be set to EmergencyContainer** | |
| *lightBarSirenInUse* | lightBarActivated bit shall be set to 1(onChange), if the usage of the lightbar is detected, otherwise, it shall be set to 0.<br>sirenActivated bit shall be set to 1, if usage of the siren is detected, otherwise, it shall be set to 0. |
| *emergencyPriority* | Is not required |
| *causeCode* | As specified in DENM (2.1.2.8.1) |
| *subCauseCode* | As specified in DENM (2.1.2.8.1) |

**Table 8: CAM data elements of "Stationary Safeguarding Emergency Vehicle"**

Tested by:

#### 2.1.2.9 Networking and Transport Layer

**Requirement** **RS_tcSpVe_156**

For the Day One version of this application, the destination area is the same as the relevance area - in this case, a circle of radius *relevanceDistance*. Therefore, the interface parameter *DENM destination area* between the DEN basic service and the Networking & Transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Tested by:

---

#### 2.1.2.10 Security Layer

**Requirement** **RS_tcSpVe_158**

If the triggering conditions as described in chapter 2.1.2.3 apply, an AT change shall be blocked for DENMs as long as *validityDuration* is not expired (see chapter 2.1.2.8.1). Corresponding new, update and cancellation DENMs shall be sent with the same authorization ticket.

Tested by:

---

### 2.1.3 Special Vehicle Warning - Stationary Wrecking Service Warning

#### 2.1.3.1 Description of Use Case

**Other (informational)** **RS_tcSpVe_229**

The wrecking service supports a broken vehicle, i.e. standing on the right lane of the road representing a hazardous location. The use case of the moving wrecking service e.g. carrying a broken vehicle is covered by the common CAM.

#### 2.1.3.2 Relations to other Use Cases

**Other (informational)** **RS_tcSpVe_230**

The following use cases are related to the *Special Vehicle Warning - Stationary Wrecking Service Warning* use case, because they share similar triggering conditions:

- Special Vehicle Warning – Emergency Vehicle in Operation
- Special Vehicle Warning – Stationary Safeguarding Emergency Vehicle

#### 2.1.3.3 Triggering Conditions

##### 2.1.3.3.1 Preconditions

**Requirement** **RS_tcSpVe_159**

The following preconditions shall be satisfied every time before triggering of this use case is initialised:

- The *stationType* is confirmed to be an special vehicle (*stationType* of CAM is set to specialVehicles(10)). The Use Case is restricted to wrecking service cars.
- The *Standstill Timer* shall be initialised with zero.

Tested by:

---

#### 2.1.3.3.2 Use Case Specific Conditions

**Requirement** **RS_tcSpVe_160**

If the vehicle is stationary and the light bar is in use a *Standstill Timer* shall be initialized with zero and started. If the light bar is no longer in use or the vehicle is no longer stationary the *Standstill Timer* shall be stopped and reset to zero.

Tested by:

---

**Requirement** **RS_tcSpVe_241**

Once at least one of the following conditions is satisfied, the triggering conditions for this use case are fulfilled and the generation of a DENM shall be triggered.

a) Light bar is in use, hazard lights are activated and parking brake is activated or in case of automatic transmission parking position is chosen.

b) Light bar is in use, hazard lights are activated and the *Standstill Timer* is greater than or equal 60 seconds.

Tested by:

---

**Requirement** **RS_tcSpVe_162**

The vehicle speed shall be determined by the vehicle bus signal, not by GNSS. The filtered vehicle velocity (with respect to sensor noise due to wheel ticks) shall be used. This requirement shall be applied for all following occurrences of vehicle speed analysis.

Tested by:

---

**Requirement** **RS_tcSpVe_163**

The level of information quality can be improved by the following characteristics:

c) Status of driver door is "open"

d) Driver's seat is detected as "not occupied". The condition shall be detected by one of the following techniques:

a. Passenger compartment camera

b. State of the art technique for seat occupation used in seat belt reminder

Tested by:

---

**Requirement** **RS_tcSpVe_164**

If the use case is triggered due to fulfillment of condition a), the *Standstill Timer* shall be stopped and set to 60 seconds. In the update phase, only the conditions shall be checked, but no timer shall be started.

Tested by:

---

#### 2.1.3.3.3 Information Quality

**Requirement** **RS_tcSpVe_165**

The value of the data element *informationQuality* in the DENM depends on the way the event is detected. The *informationQuality* value shall be set in the following way (highest possible value shall be used):

| Event detection | Value of InformationQuality |
|---|---|
| No TC compliant implementation | unknown(0) |
| Condition b) fulfilled | 1 |
| Conditions a) fulfilled | 2 |
| At least one of conditions a) or b) fulfilled and condition c) fulfilled | 3 |
| At least one of conditions a) or b) fulfilled and condition d) fulfilled | 4 |

**Table 9: Information quality of "Stationary Wrecking Service Warning"**

Tested by:

---

**Requirement** **RS_tcSpVe_166**

If the Triggering Conditions change in between two updates, the *informationQuality* shall not be changed until the next update. If the changed conditions are still fulfilled while the DENM is updated, the *informationQuality* shall be updated.

Tested by:

---

### *2.1.3.4 Termination Conditions*

**Requirement** **RS_tcSpVe_167**

This use case is terminated by a cancellation of the originating ITS-S. At the termination of the use case, update DENM request shall be terminated.

Tested by:

---

#### *2.1.3.4.1 Cancellation*

**Requirement** **RS_tcSpVe_168**

Once the following condition is satisfied before the time period set in the data element *validityDuration* is expired, the generation of a cancellation DENM shall be triggered.

- Use case specific conditions a) to b) in chapter 2.1.3.3.2 are not satisfied.

The *vehicleRole* shall be set to *default*(0).

Tested by:

---

#### *2.1.3.4.2 Negation*

**Requirement** **RS_tcSpVe_169**

A negation DENM shall not be used for this use case.

Tested by:

---

#### 2.1.3.5 Update

**Requirement** **RS_tcSpVe_170**

The generation of an update DENM shall be triggered every 60s, if the triggering conditions are still satisfied. All data fields that are assigned new values are defined in chapter 2.1.2.8.1 in Table 10.

Tested by:

---

#### 2.1.3.6 Repetition Duration and Repetition Interval

**Requirement** **RS_tcSpVe_171**

DENMs, that are new, have been updated or have been cancelled, shall be repeated for a *repetitionDuration* of 60 s with a *repetitionInterval* of 1 s. Therefore the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set according to the values above.

NOTE: The *validityDuration* is set to 180 s. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM is expired and the update has not been received yet.

NOTE: The case of managing two DENMs with the same *causeCode* from the same originating ITS-S has to be handled by the receiving ITS-S.

Tested by:

---

#### 2.1.3.7 Traffic class

**Requirement** **RS_tcSpVe_172**

New, update and cancellation DENMs shall be set to *traffic class* 1.

Tested by:

---

#### 2.1.3.8 Message Parameter

##### 2.1.3.8.1 DENM

**Requirement** **RS_tcSpVe_173**

Table 10 specifies the data elements of the DENM that shall be set.

| Data Field | Value |
|---|---|
| **Management Container** | |
| *actionID* | Identifier of a DENM.Shall be set according to [TS 102 894-2]. |
| *detectionTime* | *TimestampIts*-Timestamp at which the event is detected by the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM. |
| *referenceTime* | *TimestampIts*-Timestamp at which a new DENM, an update DENM or a cancellation DENM is generated. Shall be set according to [TS 102 894-2]. |

<table>
<tr><td>termination</td><td>Shall not be set in case of new or update DENM. Shall be set to isCancellation(0) in case of fulfillment of cancellation conditions, see chapter 2.1.3.4.1.</td></tr>
<tr><td>eventPosition</td><td>ReferencePosition. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>relevanceDistance</td><td>lessThan5km(5)</td></tr>
<tr><td>relevanceTrafficDirection</td><td>If the roadType is known the value shall be set as follows:
<table>
<tr><th>RoadType</th><th>Direction</th></tr>
<tr><td>0</td><td>allTrafficDirections(0)</td></tr>
<tr><td>1</td><td>upstreamTraffic(1)</td></tr>
<tr><td>2</td><td>allTrafficDirections(0)</td></tr>
<tr><td>3</td><td>upstreamTraffic(1)</td></tr>
</table>
Otherwise, the value shall be set to allTrafficDirections(0)</td></tr>
<tr><td>validityDuration</td><td>180 seconds</td></tr>
<tr><td>stationType</td><td>specialVehicles(10)</td></tr>
<tr><td colspan="2">Situation Container</td></tr>
<tr><td>informationQuality</td><td>See RS_tcSpVe_165. Shall be refreshed for every update DENM.</td></tr>
<tr><td>causeCode</td><td>rescueAndRecoveryWorkInProgress(15)</td></tr>
<tr><td>subCauseCode</td><td>unavailable(0)</td></tr>
<tr><td colspan="2">Location Container</td></tr>
<tr><td>eventSpeed</td><td>Speed of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>eventPositionHeading</td><td>Heading of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td>traces</td><td>PathHistory of the originating ITS-S. Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.<br>If the PathDeltaTime is used in the PathPoints, the PathDeltaTime of the first PathPoint (closest point to the ReferencePosition) shall be refreshed for an update DENM. All other PathPoints shall not be refreshed. If the PathDeltaTime of the first PathPoint exceeds the maximum value according to [TS 102 894-2], the PathDeltaTime shall not be further refreshed.<br>If the PathDeltaTime is not used in the PathPoints, the PathHistory shall not be refreshed for an update DENM.<br>If the PathDeltaTime is not used in the PathPoints, the PathHistory shall not be refreshed for an update DENM.</td></tr>
</table>

<table>
<tr><td>roadType</td><td>
RoadType of the road the detecting ITS-S is situated on.<br>
Shall be refreshed for an update DENM.<br>
Shall be set according to [TS 102 894-2] in combination with the following rules:
<table>
<tr><th>Urban / Non-Urban</th><th>Structural Separation</th><th>Data Element</th></tr>
<tr><td>Urban</td><td>No</td><td>urban-NoStructuralSeparation ToOppositeLanes(0)</td></tr>
<tr><td>Urban</td><td>Yes</td><td>urban-WithStructuralSeparation ToOppositeLanes(1)</td></tr>
<tr><td>Urban</td><td>unknown</td><td>urban-NoStructuralSeparation ToOppositeLanes(0)</td></tr>
<tr><td>Non-Urban</td><td>No</td><td>nonUrban-NoStructuralSeparation ToOppositeLanes(2)</td></tr>
<tr><td>Non-Urban</td><td>Yes</td><td>nonUrban-WithStructuralSeparation ToOppositeLanes(3)</td></tr>
<tr><td>Non-Urban</td><td>Unknown</td><td>nonUrban-NoStructuralSeparation ToOppositeLanes(2)</td></tr>
<tr><td colspan="3">Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Alacarte Container</td></tr>
<tr><td>lanePosition</td><td>If the lanePosition is provided by an onboard sensor (e.g. radar, camera), the value shall be set according to [TS 102 894-2]. The use of GPS and a digital map for the estimation of the lane number is not legitimate for this version of the triggering condition.<br>If the lanePosition is unknown, the data element shall be omitted.<br>Shall be refreshed for an update DENM.</td></tr>
<tr><td colspan="2">Alacarte Container: StationaryVehicleContainer</td></tr>
<tr><td>stationarySince</td><td>Shall be set according to the duration in minutes of the detecting ITS-S being stationary.Shall be set according to [TS 102 894-2].<br>Shall be refreshed for an update DENM.</td></tr>
</table>

**Table 10: DENM data elements of "Stationary Wrecking Service Warning"**

Tested by:

### *2.1.3.8.2 CAM*

**Requirement** **RS_tcSpVe_174**

The *vehicleRole* shall be initialised as a "default" vehicle (*vehicleRole* of CAM set to *default*(0)). If at least one of the use case specific triggering conditions defined in RS_tcSpVe_241 is satisfied the *vehicleRole* shall be set to *rescue*(5).

Tested by:

**Requirement** **RS_tcSpVe_175**

Table 11 specifies the data elements of the CAM that shall be set if the use case is triggered.

| **Data Field** | **Value** |
|---|---|
| **CoopAwareness** | |
| *generationDeltaTime* | Time corresponding to the time of the reference position in the CAM, considered as time of the CAM generation.<br>Shall be set according to [EN 302 637-2]. |
| **BasicContainer** | |
| *stationType* | specialVehicles(10) |
| *referencePosition* | Position and position accuracy measured at the reference point of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| **HighFrequencyContainer shall be set to BasicVehicleContainerHighFrequency** | |
| *heading* | Heading direction of the originating ITS-S with regards to the true north.<br>Shall be set according to [TS 102 894-2]. |
| *speed* | Driving speed of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *driveDirection* | Vehicle drive direction (Forward or Backward) of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *vehicleLength* | Length of vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *vehicleWidth* | Width of a vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *longitudinalAcceleration* | Vehicle longitudinal acceleration of the originating ITS-S.<br>Shall be set according to [TS 102 894-2]. |
| *curvature* | Curvature of the vehicle trajectory and the accuracy.<br>Shall be set according to [TS 102 894-2]. |
| *curvatureCalcMode* | Describes whether the yaw rate is used to calculate the curvature for a reported curvature value. |

| | |
|---|---|
| | Shall be set according to [TS 102 894-2]. |
| *yawRate* | Yaw rate of vehicle at a point in time.<br>Shall be set according to [TS 102 894-2]. |
| **LowFrequencyContainer shall be set to BasicVehicleContainerLowFrequency** | |
| *vehicleRole* | rescue(5) |
| *exteriorLights* | Describes the status of the exterior light switches of a vehicle.<br>Shall be set according to [TS 102 894-2]. |
| *pathHistory* | Represents the vehicle's recent movement over some past time and/or distance.<br>Shall be set according to [TS 102 894-2]. |
| **SpecialVehicleContainer shall be set to SafetyCarContainer** | |
| *lightBarSirenInUse* | lightBarActivated bit shall be set to 1(onChange), if the usage of the lightbar is detected, otherwise, it shall be set to 0.<br>sirenActivated bit shall be set to 1, if usage of the siren is detected, otherwise, it shall be set to 0. |
| *causeCode* | As specified in DENM (2.1.3.8.1) |
| *subCauseCode* | As specified in DENM (2.1.3.8.1) |

**Table 11: CAM data elements of "Stationary Wrecking Service Warning"**

Tested by:

### *2.1.3.9 Networking and Transport Layer*

**Requirement** **RS_tcSpVe_176**

For the Day One version of this application, the destination area is the same as the relevance area - in this case, a circle of radius *relevanceDistance*. Therefore, the interface parameter *DENM destination area* between the DEN basic service and the Networking & Transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Tested by:

### *2.1.3.10 Security Layer*

**Requirement** **RS_tcSpVe_178**

If the triggering conditions as described in chapter 2.1.3.3 apply, an AT change shall be blocked for DENMs as long as *validityDuration* is not expired (see chapter 2.1.3.8.1). Corresponding new, update and cancellation DENMs shall be sent with the same authorization ticket.

Tested by:

# 3 Appendix

## 3.1 Scenarios

**Other (informational)** **RS_tcSpVe_232**

This section has an informational character and is not part of the requirement specification.

The following list encompasses scenarios which are regarded as relevant or irrelevant considering the present use case:

| Count | Description | Status |
|---|---|---|
| SC_0 | Urban/nonurban environment | Irrelevant |
| SC_1 | Current road situation and conditions | Not directly relevant |
| SC_2 | Traffic in the opposite driving direction. | Irrelevant |
| SC_3 | The special vehicle drives to an emergency site using the light bar. The sirene might be used. | Relevant |
| SC_4 | The special vehicle stops at an emergency site in order to safeguard the situation. The intention of the special vehicle and the crew has to be detected. A change in the use-cases from “in operation” to “safeguarding” must be detected. | Relevant |
| SC_5 | The special vehicle leaves an emergency site. A change in the use-cases from “safeguarding” to “in operation” might be detected depending on situation. | Relevant |
| SC_6 | The wrecking service carries a broken vehicle using the light bar. This case is covered by usual CAMs. The wrecking service is considered as a usual vehicle in road traffic. | Irrelevant |

**Table 12: Scenarios**

## 3.2 List of abbreviations

**Other (informational)** **RS_tcSpVe_236**

| | |
|---|---|
| ABS | Anti-lock Braking System |
| ASN.1 | Abstract Syntax Notation One |
| ASR | Anti-Slip Regulation |
| AT | Authorization Ticket |
| AUT | Automatic Transmission |
| CAM | Cooperative Awareness Message |
| C2C-CC | Car to Car Communication Consortium |
| CDD | Common Data Dictionary |
| DEN | Decentralized Environmental Notification |
| DENM | DEN Message |

| | |
|---|---|
| ECE | Economic Commission for Europe |
| ETSI | European Telecommunications Standards Institute |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| ITS | Intelligent Transport System |
| ITS-S | ITS Station |
| KAF | Keep-Alive Forwarding |
| TTC | Time To Collision |
| V2V | Vehicle to Vehicle |
| TC | Triggering Conditions |

**Table 13: Abbreviations**