

# Triggering Conditions and Data Quality Adverse Weather Conditions

CAR 2 CAR Communication Consortium



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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 73 members, with 12 vehicle manufacturers, 33 equipment suppliers and 28 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 well as other road users. 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**

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13/09/2019	Minor corrections	Release Management	Steering Committee
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**Table 2: Changes since last version**

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## 1 Introduction

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### 1.1 Abstract

**Other (informational)**

**RS\_tcAdWe\_184**

This document describes the triggering conditions for adverse weather conditions for the following three use cases:

- adverse weather conditions - fog
- adverse weather conditions - precipitation
- adverse weather conditions - traction loss

## 2 Definitions and abbreviations

### 2.1 Abbreviations

**Other (informational)**

RS\_tcAdWe\_209

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
TC	Triggering Conditions
TTC	Time To Collision
V2V	Vehicle to Vehicle

**Table 3: Abbreviations**

### 2.2 Definitions

**Definition**

RS\_tcAdWe\_642

'*Vehicle speed*' is the length of the velocity-vector of the reference position point.

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## 3 Triggering conditions

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### 3.1 Adverse weather condition

#### 3.1.1 Adverse weather condition - fog

##### 3.1.1.1 Description of use case

###### Other (informational)

RS\_tcAdWe\_185

This section describes the triggering of V2V messages for the *Adverse Weather Condition - Fog* C-ITS service. A DENM shall be triggered, if fog interferes the driver at a particular extent.

###### Other (informational)

RS\_tcAdWe\_186

The following C-ITS services are related to this service, because they share similar triggering conditions:

- 'adverse weather conditions — precipitation'.

###### Requirement

RS\_tcAdWe\_93

A DENM signal shall be sent to the stack only if the triggering conditions described in this section are evaluated as valid. Such a signal prompts the stack to generate a new or an update DENM. If the triggering conditions are not fulfilled, a DENM signal shall not be generated.

Tested by:

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#### 3.1.1.2 Triggering conditions

##### 3.1.1.2.1 Preconditions

###### Requirement

RS\_tcAdWe\_94

The following preconditions shall be satisfied when this use case is triggered:

1. the vehicle speed is greater than 7 km/h;
2. the vehicle speed is less than 80 km/h. (vehicle speed greater 80 km/h is not reasonable for reduced visibility. Speed according to filtered vehicle bus signal).

Tested by:

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##### 3.1.1.2.2 Service-specific conditions

###### Requirement

RS\_tcAdWe\_95

If the preconditions in RS\_tcAdWe\_94 and at least one of the following conditions are satisfied, the triggering conditions for this C-ITS service are fulfilled and the generation of a DENM shall be triggered:

- driver reaction and light status:
  - a) the driver enables the rear fog-light and the low-beam light is enabled. All these conditions must be valid for more than 20 s (to minimise risk of misuse by driver, conditions have to be valid for a longer period);
  - b) the driver enables the rear fog-light, the low-beam light is enabled and the vehicle velocity is less than 60 km/h. All these conditions must be valid for a duration greater



than 20 s;

- visibility range measurement device:
  - c) the visibility due to fog is less than 80 m +/- 40 m tolerance for more than 5 s (the obscured view has to be detected for a reasonable period. The period is shorter than for conditions a) and b) due to more reliable information);
  - d) the visibility due to fog is less than 80 m +/- 40 m tolerance and the vehicle velocity is less than 60 km/h (if the vehicle is in a non-urban area, this speed could be an indication of reduced visibility) for more than 5 s.

Tested by:

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**Requirement**

**RS\_tcAdWe\_101**

A new or update DENM shall not be generated in the *Detection Blocking Time*. The *Detection Blocking Time* is launched after the event is detected and a DENM to that effect has been triggered. In this way, a single event cannot trigger a series of DENMs. For the visibility range measurement device (conditions c and d), the *Detection Blocking Time* shall be 15 s. For the other conditions there shall be no *Detection Blocking Time*.

Tested by:

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**Requirement**

**RS\_tcAdWe\_102**

In order to ensure consistent functional behaviour for the different triggering conditions and the *Detection Blocking Time*, the *Minimum Detection Interval* between two detected events shall be 20 s.

Tested by:

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**3.1.1.2.3 Information quality**

**Requirement**

**RS\_tcAdWe\_103**

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

**Table 4: Information quality of ‘adverse weather condition — fog’**

Event detection	Value of InformationQuality
No TRCO-compliant implementation	unknown(0)
Condition a) is fulfilled	1
Condition b) is fulfilled	2
Condition c) is fulfilled	3
Condition d) is fulfilled	4

Tested by:

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**Requirement**

**RS\_tcAdWe\_104**

If the triggering conditions change 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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### 3.1.1.3 Termination conditions

#### Requirement

RS\_tcAdWe\_105

A termination of the C-ITS service shall not be considered.

Tested by:

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#### 3.1.1.3.1 Cancellation

#### Requirement

RS\_tcAdWe\_106

A cancellation DENM shall not be used for this C-ITS service.

Tested by:

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#### 3.1.1.3.2 Negation

#### Requirement

RS\_tcAdWe\_107

A negation DENM shall not be used for this C-ITS service.

Tested by:

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#### 3.1.1.4 Update

#### Requirement

RS\_tcAdWe\_108

The appropriate update procedure of the DENM shall be determined on the basis of the following conditions:

- (a) at least one of the conditions is fulfilled after the *Minimum Detection Interval* specified in section 3.1.1.2.2;
- (b) the *validityDuration* of the former DENM has not expired;
- (c) neither the value of the data element *DeltaLatitude* nor that of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude*.

If conditions (a), (b) and (c) as specified are fulfilled, an update DENM shall be generated. The information of the former DENM data elements (*eventPosition*, *eventDeltaTime*, *informationQuality*) shall be stored in the *eventHistory* as an additional *eventPoint*.

The event points shall be ordered in ascending order with respect to their lifetime, with the most recent *eventPoint* in first position. Event points in the *eventHistory* with lifetimes that exceed the *validityDuration* shall be deleted from the *eventHistory* for the update DENM. If the distance covered by the *eventHistory* exceeds the threshold allowed by the security, the oldest event points shall be deleted from the *eventHistory*.

The information of the current detected event shall be assigned to the DENM data fields of the

updated DENM.

If conditions (a) and (b) are fulfilled, but condition (c) is not fulfilled, no update DENM shall be generated. Instead, an additional new DENM shall be generated. The information of the current detected event shall be assigned to the DENM data fields of the additional new DENM. The former DENM shall continue to be transmitted as long as the *repetitionDuration* of the former DENM does not expire.

If condition (a) is fulfilled, but condition (b) is not fulfilled, no update DENM shall be generated, but a new DENM according to the currently detected event shall be generated.

If condition (a) is not fulfilled, the generation of an update DENM is not necessary.

Note: It is up to the receiver to handle event points with lifetimes that exceed the *validityDuration* after the update DENM has been generated.

Note: In this case, the transmission of the former DENM has already been terminated, because the *repetitionDuration* of the former DENM has expired.

Tested by:

### 3.1.1.5 Repetition duration and repetition interval

#### Requirement

RS\_tcAdWe\_113

DENMs that are new or have been updated, shall be repeated for a *repetitionDuration* of 180 s with a *repetitionInterval* of 4 s. Therefore, the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set in accordance with the above values.

Note: The *validityDuration* is set to 300 s. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM has expired and the update has not yet been received.

Note: Where two DENMs with the same *causeCode* originate from the same C-ITS station, the case shall be managed by the receiving C-ITS station.

Tested by:

### 3.1.1.6 Traffic class

#### Requirement

RS\_tcAdWe\_114

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

Tested by:

### 3.1.1.7 Message parameters

#### 3.1.1.7.1 DENM

#### Requirement

RS\_tcAdWe\_187

The following table specifies the data elements of the DENM that shall be set.

**Table 5: DENM data elements of ‘adverse weather condition — fog’**

Data field	Value
<b>Management container</b>	

<i>actionID</i>	Identifier of a DENM. Shall be set in accordance with [TS 102 894-2].
<i>detectionTime</i>	<i>Timestamp</i> ts-timestamp at which the event is detected by the originating C-ITS station. The timestamp reflects the beginning of the detection of the current event. Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the detection time of the current event.
<i>referenceTime</i>	<i>Timestamp</i> ts-timestamp at which a new DENM or an update DENM is generated. Shall be set in accordance with [TS 102 894-2].
<i>termination</i>	Shall not be set, because neither negation nor cancellation are to be used in this C-ITS service.
<i>eventPosition</i>	<i>ReferencePosition</i> . Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.
<i>relevanceDistance</i>	<ul style="list-style-type: none"> <li>• New DENM: lessThan1000m(4)</li> <li>• Update DENM: lessThan5km(5) (By using updates, the distance covered by the eventHistory becomes longer. To address all relevant ITS stations, the relevanceDistance is longer in this case.)</li> </ul>
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)
<i>validityDuration</i>	300 s
<i>stationType</i>	The type of the originating C-ITS station. Shall be set in accordance with [TS 102 894-2].
<b>Situation container</b>	
<i>informationQuality</i>	See RS_tcAdWe_103. Shall be refreshed for every update DENM and set to the informationQuality of the current event point.
<i>causeCode</i>	adverseWeatherCondition-Visibility(18)
<i>subCauseCode</i>	unavailable(0) or fog(1)
<i>eventHistory</i>	This element shall be used for update DENMs only (see section 3.1.1.4).
<b>Location container</b>	
<i>traces</i>	<i>PathHistory</i> of the originating C-ITS station with reference to the current event point. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.
<i>roadType</i>	<i>RoadType</i> of the road on which the detecting C-ITS station is situated. Shall be refreshed for an update DENM. Shall be set in accordance with [TS 102 894-2] in combination with the following rules:

	Urban / non-urban	Structural separation	Data element
	Urban	No	urban-NoStructuralSeparationToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparationToOppositeLanes(1)
	Urban	Unknown	urban-NoStructuralSeparationToOppositeLanes(0)
	Non-urban	No	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	Non-urban	Yes	nonUrban-WithStructuralSeparationToOppositeLanes(3)
	Non-urban	Unknown	nonUrban-NoStructuralSeparationToOppositeLanes(2)
If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.			

Tested by:

### 3.1.1.7.2 CAM

#### Requirement

RS\_tcAdWe\_116

CAM adaption shall not be used for this C-ITS service.

Tested by:

### 3.1.1.8 Network and transport layer

#### Requirement

RS\_tcAdWe\_117

The interface parameter *DENM destination area* between the DEN basic service and the networking and transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Tested by:

### 3.1.1.9 Security layer

#### Requirement

RS\_tcAdWe\_119

If the triggering conditions as described in section 3.1.1.2 apply, an AT change shall be blocked for new and update DENMs for 15 minutes (starting from the moment the new DENM was generated). Corresponding new and update DENMs shall be sent with the same AT.

Tested by:

**Requirement** **RS\_tcAdWe\_120**

If the AT changes and there is an active DENM transmission (new or update DENM), the transmission shall be stopped. In addition, the *EventHistory* and the *PathHistory* shall be deleted. The regular DENM generation process shall then continue.

Tested by:

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**3.1.1.10 Scenarios**

**Other (informational)** **RS\_tcAdWe\_188**

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 C-ITS service:

**Table 6: ‘Adverse weather condition’ — fog scenarios**

Count	Description	Status
	tbd	
	tbd	

**3.1.2 Adverse weather condition - precipitation**

**3.1.2.1 Description of C-ITS service**

**Other (informational)** **RS\_tcAdWe\_191**

This section describes the triggering of V2V messages for the *Adverse Weather Condition - Precipitation* C-ITS service. A DENM shall be triggered, if precipitation interferes the driver at a particular extent.

**Other (informational)** **RS\_tcAdWe\_192**

The following C-ITS services are related to this service, because they share similar triggering conditions:

- ‘adverse weather conditions — fog’.

**Requirement** **RS\_tcAdWe\_121**

A DENM signal shall be sent to the stack only if the triggering conditions described in this section are evaluated as valid. Such a signal prompts the stack to generate a new or an update DENM. If the triggering conditions are not fulfilled, a DENM signal shall not be generated.

Tested by:

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**3.1.2.2 Triggering conditions**

**3.1.2.2.1 Preconditions**

**Requirement** **RS\_tcAdWe\_122**

The following preconditions shall be satisfied when this use case is triggered:

- the vehicle velocity is greater than 7 km/h (speed according to filtered vehicle bus

- signal);
- the vehicle velocity is less than 80 km/h (speed according to filtered vehicle bus signal);
- the windshield washer function is not active.

Tested by:

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### 3.1.2.2.2 Service-specific conditions

#### Requirement

**RS\_tcAdWe\_123**

If the preconditions in RS\_tcAdWe\_122 and at least one of the following conditions are satisfied, the triggering conditions for this C-ITS service are fulfilled and the generation of a DENM shall be triggered.

- wiper level and light status:
  - a) the wiper operates at its maximum speed level. The low-beam light is enabled. All these conditions must be valid for more than 20 s;
  - b) the wiper operates at its maximum speed level and the vehicle velocity is less than 60 km/h (speed according to filtered vehicle bus signal). The low-beam light is enabled. All these conditions must be valid for more than 20 s;
- rain measurement device, wiper level and light status:
  - c) the quantity of rainfall is at least 90 % of the maximum output of the measurement device and the wiper operates at its maximum speed level. The low-beam light is enabled. All of this needs to be valid for more than 20 s;
  - d) the quantity of rainfall is at least 90 % of the maximum output of the measurement device and the wiper operates at its maximum speed level. The low-beam light is enabled and the vehicle velocity is less than 60 km/h (speed according to filtered vehicle bus signal). All these conditions must be valid for more than 20 s.

Tested by:

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#### Requirement

**RS\_tcAdWe\_129**

Due to the algorithm, the *Minimum Detection Interval* between two detected events shall be 20 s.

Tested by:

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### 3.1.2.2.3 Information quality

#### Requirement

**RS\_tcAdWe\_130**

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

**Table 7: Information quality of ‘adverse weather condition — precipitation’**

Event detection	Value of InformationQuality
-----------------	-----------------------------

No TRCO-compliant implementation	unknown(0)
Condition a) is fulfilled	1
Condition b) is fulfilled	2
Condition c) is fulfilled	3
Condition d) is fulfilled	4

Tested by:

**Requirement**

**RS\_tcAdWe\_131**

If the triggering conditions change 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:

**3.1.2.3 Termination conditions**

**Requirement**

**RS\_tcAdWe\_132**

A termination of the C-ITS service shall not be considered.

Tested by:

**3.1.2.3.1 Cancellation**

**Requirement**

**RS\_tcAdWe\_133**

A cancellation DENM shall not be used for this C-ITS service.

Tested by:

**3.1.2.3.2 Negation**

**Requirement**

**RS\_tcAdWe\_134**

A negation DENM shall not be used for this C-ITS service.

Tested by:

**3.1.2.4 Update**

**Requirement**

**RS\_tcAdWe\_135**

The appropriate update procedure of the DENM shall be determined on the basis of the following conditions:

- (a) at least one of the conditions is fulfilled after the *Minimum Detection Interval* specified in section 3.1.2.2.2;
- (b) the *validityDuration* of the former DENM has not expired;



- (c) neither the value of the data element *DeltaLatitude* nor that of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude*.

If conditions (a), (b) and (c) as specified are fulfilled, an update DENM shall be generated. The information of the former DENM data elements (*eventPosition*, *eventDeltaTime*, *informationQuality*) must be stored in the *eventHistory* as an additional *eventPoint*.

The event points shall be ordered in ascending order with respect to their lifetime, with the most recent *eventPoint* in first position. Event points in the *eventHistory* with lifetimes that exceed the *validityDuration* shall be deleted from the *eventHistory* for the update DENM. If the distance covered by the *eventHistory* exceeds the threshold that is allowed by the security, the oldest event points shall be deleted from the *eventHistory*.

The information of the current detected event must be assigned to the DENM data fields of the updated DENM.

If conditions (a) and (b) are fulfilled, but condition (c) is not fulfilled, no update DENM shall be generated. Instead, an additional new DENM shall be generated. The information of the current detected event must be assigned to the DENM data fields of the additional new DENM. The former DENM shall continue to be transmitted as long as the *repetitionDuration* of the former DENM does not expire.

If condition (a) is fulfilled, but condition (b) is not fulfilled, no update DENM shall be generated, but a new DENM according to the currently detected event shall be generated.

If condition (a) is not fulfilled, the generation of an update DENM is not necessary.

Note: It is up to the receiver to handle event points with lifetimes that exceed the *validityDuration* after the update DENM has been generated.

Note: In this case, the transmission of the former DENM has already been terminated, because the *repetitionDuration* of the former DENM has expired.

Tested by:

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### 3.1.2.5 Repetition duration and repetition interval

#### Requirement

RS\_tcAdWe\_140

DENMs that are new or have been updated, shall be repeated for a *repetitionDuration* of 180 s with a *repetitionInterval* of 4 s. Therefore the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set according to the above values.

Note: The *validityDuration* is set to 300 s. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM has expired and the update has not yet been received.

Note: Where two DENMs with the same *causeCode* originate from the same C-ITS station, the case shall be managed by the receiving C-ITS station.

Tested by:

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### 3.1.2.6 Traffic class

#### Requirement

RS\_tcAdWe\_141

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

Tested by:

### 3.1.2.7 Message parameters

#### 3.1.2.7.1 DENM

##### Requirement

RS\_tcAdWe\_193

The following table specifies the data elements of the DENM that shall be set.

**Table 8: DENM data elements of ‘adverse weather condition — precipitation’**

Data field	Value
<b>Management container</b>	
<i>actionID</i>	Identifier of a DENM. Shall be set in accordance with [TS 102 894-2].
<i>detectionTime</i>	<i>Timestamp</i> ts-timestamp at which the event is detected by the originating C-ITS station. The timestamp reflects the beginning of the detection of the current event point. Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the detection time of the current event point.
<i>referenceTime</i>	<i>Timestamp</i> ts-timestamp at which a new DENM or an update DENM is generated. Shall be set in accordance with [TS 102 894-2].
<i>termination</i>	Shall not be set, because neither negation nor cancellation are to be used in this C-ITS service.
<i>eventPosition</i>	<i>ReferencePosition</i> . Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the position of the current event point.
<i>relevanceDistance</i>	<ul style="list-style-type: none"> <li>New DENM: lessThan1000m(4)</li> <li>Update DENM: lessThan5km(5) (By using updates, the distance covered by the <i>eventHistory</i> becomes longer. To address all relevant ITS stations, the <i>relevanceDistance</i> is longer in this case.)</li> </ul>
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)
<i>validityDuration</i>	300 s
<i>stationType</i>	The type of the originating C-ITS station. Shall be set in accordance with [TS 102 894-2].
<b>Situation container</b>	
<i>informationQuality</i>	See RS_tcAdWe_130. Shall be refreshed for every update DENM and set to the informationQuality of the current event point.
<i>causeCode</i>	adverseWeatherCondition-Precipitation(19)

<i>subCauseCode</i>	unavailable(0), heavyRain(1) or heavySnowfall(2)		
<i>eventHistory</i>	This element shall be used for update DENMs only (see section 3.1.2.4).		
<b>Location container</b>			
<i>traces</i>	<p><i>PathHistory</i> of the originating C-ITS station with reference to the current event point.                  Shall be set in accordance with [TS 102 894-2].                  Shall be refreshed for an update DENM.</p>		
<i>roadType</i>	<p><i>RoadType</i> of the road on which the detecting C-ITS station is situated.                  Shall be refreshed for an update DENM and set to the roadType of the current event point.                  Shall be set in accordance with [TS 102 894-2] in combination with the following rules:</p>		
	<b>Urban / Non-Urban</b>	<b>Structural separation</b>	<b>Data element</b>
	Urban	No	urban-NoStructuralSeparationToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparationToOppositeLanes(1)
	Urban	Unknown	urban-NoStructuralSeparationToOppositeLanes(0)
	Non-urban	No	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	Non-urban	Yes	nonUrban-WithStructuralSeparationToOppositeLanes(3)
	Non-urban	Unknown	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.		

Tested by:

**3.1.2.7.2 CAM**

**Requirement**

**RS\_tcAdWe\_143**

CAM adaption shall not be used for this C-ITS service.

Tested by:

**3.1.2.8 Network and transport layer**

**Requirement**

**RS\_tcAdWe\_144**

The interface parameter *DENM destination area* between the DEN basic service and the networking and transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Tested by:

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**3.1.2.9 Security layer**

**Requirement**

**RS\_tcAdWe\_146**

If the triggering conditions as described in section 3.1.2.2 apply, an AT change shall be blocked for new and update DENMs for 15 minutes (starting from the moment the new DENM was generated). Corresponding new and update DENMs shall be sent with the same AT.

Tested by:

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**Requirement**

**RS\_tcAdWe\_147**

If the AT changes and there is active transmission of a new or update DENM, the transmission shall be stopped. In addition, the *EventHistory* and the *PathHistory* shall be deleted. Afterwards, the regular DENM generation process shall continue.

Tested by:

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**3.1.2.10 Scenarios**

**Other (informational)**

**RS\_tcAdWe\_194**

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:

**Table 9: 'Adverse weather condition' — precepitation scenarios**

Count	Description	Status
	tbd	
	tbd	

**3.1.3 Adverse weather condition - traction loss**

**3.1.3.1 Description of C-ITS service**

**Other (informational)**

**RS\_tcAdWe\_197**

This section describes the triggering of V2V messages for the *Adverse Weather Condition - Traction Loss* C-ITS service. A DENM shall be triggered, if a traction loss caused by slipperiness is detected at a particular extent.

**Other (informational)**

**RS\_tcAdWe\_198**

The following use cases are related to the *Adverse Weather Condition - Traction Loss* use case, because they share similar triggering conditions:

- none

**Requirement**

**RS\_tcAdWe\_148**

A DENM signal shall be sent to the stack only if the triggering conditions described in this section are evaluated as valid. Such a signal prompts the stack to generate a new or an update DENM. If the triggering conditions are not fulfilled, a DENM signal shall not be generated.

Tested by:

**3.1.3.2 Triggering conditions**

**3.1.3.2.1 Preconditions**

**Requirement**

**RS\_tcAdWe\_149**

The following preconditions shall be satisfied when this use case is triggered:

- reverse gear is not enabled;
- no errors concerning engine, drive train and braking system are reported.

Tested by:

**3.1.3.2.2 Service-specific conditions**

**Requirement**

**RS\_tcAdWe\_150**

If the precondition in RS\_tcAdWe\_149 and at least one of the following conditions are satisfied, the triggering conditions for this C-ITS service are fulfilled and the generation of a DENM shall be triggered.

- on the basis of positive acceleration:
  - a) on the basis of Anti-Slip Regulation (ASR), acceleration pedal, vehicle acceleration and vehicle velocity. An ASR-request must be active for at least 200 ms (as for other safety functions depending on ASR). The acceleration pedal is pressed on average more than 30 % while ASR intervention is active. The acceleration of the vehicle (acceleration according to filtered vehicle bus signal) is less than 40 % of the vehicle acceleration on  $\mu$ -High (dry asphalt 0.85) at the same start speed and driving manoeuvre (No detailed values have been put here to cover different drive configurations, e.g. two-wheel vs. four-wheel drive);
  - b) on the basis of ASR, acceleration pedal, vehicle acceleration and vehicle velocity. An ASR-request must be active for at least 200 ms. The acceleration pedal is pressed on average more than 30 % while ASR intervention is active. The acceleration of the vehicle (acceleration according to filtered vehicle bus signal) is less than 20 % of the vehicle acceleration on  $\mu$ -High (dry asphalt 0.85) at the same start speed and driving manoeuvre;
  - c) on the basis of ASR, acceleration pedal, vehicle acceleration and vehicle velocity. An ASR-request must be active for at least 200 ms. The acceleration pedal is pressed on average more than 30 % while ASR intervention is active. The acceleration of the

vehicle (acceleration according to filtered vehicle bus signal) is less than 10 % of the vehicle acceleration on  $\mu$ -High (dry asphalt 0.85) at the same start speed and driving manoeuvre;

d) on the basis of ASR and acceleration pedal. An ASR-request must be active for at least 200 ms. The acceleration pedal is pressed on average less than 30 % (so as not to cause an ASR intervention on ground with high friction value) while ASR intervention is active;

- on the basis of negative acceleration (deceleration):

e) on the basis of Anti-lock Braking System (ABS), braking pressure and deceleration. ABS intervention is active for more than 200 ms (according to other safety functions depending on ABS). Braking pressure is more than 20 % of maximum capable braking pressure. The deceleration of the vehicle (deceleration according to filtered vehicle bus signal) is less than 50 % of the vehicle deceleration on  $\mu$ -high (dry asphalt 0.85) at the same start speed and driving manoeuvre;

f) on the basis of ABS, braking pressure and deceleration. ABS intervention is active for more than 200 ms. Braking pressure is more than 20 % of maximum capable braking pressure. The deceleration of the vehicle (deceleration according to filtered vehicle bus signal) is less than 25 % of the vehicle deceleration on  $\mu$ -high (dry asphalt 0.85) at the same start speed and driving manoeuvre;

g) on the basis of ABS, braking pressure and deceleration. ABS intervention is active for more than 200 ms. Braking pressure is more than 20 % (so as not to cause an ABS intervention on ground with high friction value) of maximum capable braking pressure. The deceleration of the vehicle (deceleration according to filtered vehicle bus signal) is less than 10 % of the vehicle deceleration on  $\mu$ -high (dry asphalt 0.85) at the same start speed and driving manoeuvre;

h) on the basis of ABS and braking pressure. ABS intervention is active for more than 200 ms. Braking pressure is less than 20 % of maximum capable braking pressure;

- on the basis of friction coefficient estimation:

i) the friction coefficient is less than 0.3 for at least 5 s (the friction coefficient of ice is  $< 0.2$ ; for snow and loose chippings, it is approx. 0.4. The friction coefficient needs to be detected for a certain period);

j) the friction coefficient is less than 0.2 for at least 5 s.

Note: For PTW the throttle position or any other device providing this functionality in the future shall be taken as equivalent to the accelerator pedal of the cars.

Tested by:

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## Requirement

RS\_tcAdWe\_162

A new or update DENM shall not be generated in the *Detection Blocking Time*. The *Detection Blocking Time* is launched after the event is detected and a DENM to that effect has been triggered. This way, a single event is not able to trigger a series of DENMs. For friction coefficient estimation (condition i) and j) ) the *Detection Blocking Time* shall be 15 seconds. For the other conditions the *Detection Blocking Time* shall be 20 s.

Tested by:

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**Requirement**

**RS\_tcAdWe\_163**

In order to ensure consistent functional behaviour for triggering conditions a)-d) and the *Detection Blocking Time*, the *Minimum Detection Interval* between two detected events shall be 20 s.

Tested by:

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**3.1.3.2.3 Information quality**

**Requirement**

**RS\_tcAdWe\_164**

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

**Table 10: Information quality of ‘adverse weather condition — traction loss’**

Event detection	Value of InformationQuality
No TRCO compliant implementation	unknown(0)
Condition a) or e) is fulfilled	1
Condition b) fulfilled	2
Condition c) or f) is fulfilled	3
Condition g) fulfilled	4
Condition d) or h) fulfilled	5
Condition i) is fulfilled	6
Condition j) is fulfilled	7

Tested by:

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**Requirement**

**RS\_tcAdWe\_165**

If the triggering conditions change 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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**3.1.3.3 Termination conditions**

**Requirement**

**RS\_tcAdWe\_166**

A termination of the C-ITS service shall not be considered.

Tested by:

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**3.1.3.3.1 Cancellation**



**Requirement**

RS\_tcAdWe\_167

A cancellation DENM shall not be used for this C-ITS service.

Tested by:

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**3.1.3.3.2 Negation****Requirement**

RS\_tcAdWe\_168

A negation DENM shall not be used for this C-ITS service.

Tested by:

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**3.1.3.4 Update****Requirement**

RS\_tcAdWe\_169

The appropriate update procedure of the DENM shall be determined on the basis of the following conditions:

- (a) at least one of the conditions is fulfilled after the *Minimum Detection Interval* specified in section 3.1.3.2.2;
- (b) the *validityDuration* of the former DENM has not expired;
- (c) neither the value of the data element *DeltaLatitude* nor that of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude*.

If conditions (a), (b) and (c) as specified are fulfilled, an update DENM shall be generated. The information of the former DENM data elements (*eventPosition*, *eventDeltaTime*, *informationQuality*) must be stored in the *eventHistory* as an additional *eventPoint*.

The event points shall be ordered in ascending order with respect to their lifetime, with the most recent *eventPoint* in first position. Event points in the *eventHistory* with lifetimes that exceed the *validityDuration* shall be deleted from the *eventHistory* for the update DENM. If the distance covered by the *eventHistory* exceeds the threshold that is allowed by the security, the oldest event points shall be deleted from the *eventHistory*.

The information of the current detected event must be assigned to the DENM data fields of the updated DENM.

If conditions (a) and (b) are fulfilled, but condition (c) is not fulfilled, no update DENM shall be generated. Instead, an additional new DENM shall be generated. The information of the current detected event shall be assigned to the DENM data fields of the additional new DENM. The former DENM shall continue to be transmitted as long as the *repetitionDuration* of the former DENM does not expire.

If condition (a) is fulfilled, but condition (b) is not fulfilled, no update DENM shall be generated, but a new DENM according to the currently detected event shall be generated.

If condition (a) is not fulfilled, the generation of an update DENM is not necessary.



Note: It is up to the receiver to handle event points with lifetimes that exceed the *validityDuration* after the update DENM has been generated.

Note: In this case, the transmission of the former DENM has already been terminated, because the *repetitionDuration* of the former DENM has expired.

Tested by:

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### 3.1.3.5 Repetition duration and repetition interval

**Requirement** **RS\_tcAdWe\_174**

By default, DENMs that are new or have been updated shall be repeated for a *repetitionDuration* of 300 s with a *repetitionInterval* of 1 s.

Tested by:

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**Requirement** **RS\_tcAdWe\_175**

However, if the DENM is triggered in an urban area, which as determined by a digital map or an on-board sensor algorithm, it shall be repeated for a *repetitionDuration* of 180 s with a *repetitionInterval* of 4 s.

Therefore, the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set in accordance with to the above values.

Note: The *validityDuration* is set to 600 s or 300 s, respectively. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM has expired and the update has not yet been received.

Note: Where two DENMs with the same *causeCode* originate from the same C-ITS station, the case shall be managed by the receiving C-ITS station.

Tested by:

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### 3.1.3.6 Traffic class

**Requirement** **RS\_tcAdWe\_176**

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

Tested by:

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### 3.1.3.7 Message parameters

#### 3.1.3.7.1 DENM

**Requirement** **RS\_tcAdWe\_177**

The following table specifies the data elements of the DENM that shall be set.

**Table 11: DENM data elements of ‘adverse weather condition — traction loss’**

Data field	Value
<b>Management container</b>	

<i>actionID</i>	Identifier of a DENM. Shall be set in accordance with [TS 102 894-2].
<i>detectionTime</i>	<i>Timestamp</i> ts-timestamp at which the event is detected by the originating C-ITS station. The timestamp reflects the beginning of the detection of the current event point. Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the detection time of the current event point.
<i>referenceTime</i>	<i>Timestamp</i> ts-timestamp at which a new DENM or an update DENM is generated. Shall be set in accordance with [TS 102 894-2].
<i>termination</i>	Shall not be set, because neither negation nor cancellation are to be used in this C-ITS service.
<i>eventPosition</i>	<i>ReferencePosition</i> . Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the position of the current event point.
<i>relevanceDistance</i>	<ul style="list-style-type: none"> <li>• New DENM: lessThan1000m(4)</li> <li>• Update DENM: lessThan5km(5) (By using updates, the distance covered by the <i>eventHistory</i> becomes longer. To address all relevant ITS stations, the <i>relevanceDistance</i> is longer in this case.)</li> </ul>
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)
<i>validityDuration</i>	Default: 600 s In urban areas, as determined by digital map or on-board sensor algorithm: 300 s (If the vehicle has no information about the urban/non-urban status, the default value shall be used.)
<i>stationType</i>	The type of the originating C-ITS station. Shall be set in accordance with [TS 102 894-2].
<b>Situation container</b>	
<i>informationQuality</i>	See RS_tcAdWe_164. Shall be refreshed for every update DENM and set to the informationQuality of the current event point.
<i>causeCode</i>	adverseWeatherCondition-Adhesion(6)
<i>subCauseCode</i>	unavailable(0)
<i>eventHistory</i>	This element shall be used for update DENMs only (see section 3.1.3.4).
<b>Location container</b>	
<i>traces</i>	<i>PathHistory</i> of the originating C-ITS station with reference to the current event point. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.
<i>roadType</i>	<i>RoadType</i> of the road the detecting C-ITS station is situated on.

	Shall be refreshed for an update DENM and set to the <i>roadType</i> of the current event point.		
	Shall be set in accordance with [TS 102 894-2] in combination with the following rules:		
	Urban / non-urban	Structural separation	Data element
	Urban	No	urban-NoStructuralSeparationToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparationToOppositeLanes(1)
	Urban	Unknown	urban-NoStructuralSeparationToOppositeLanes(0)
	Non-urban	No	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	Non-urban	Yes	nonUrban-WithStructuralSeparationToOppositeLanes(3)
	Non-urban	Unknown	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.		

Tested by:

### 3.1.3.7.2 CAM

**Requirement**

**RS\_tcAdWe\_178**

CAM adaption shall not be used for this C-ITS service.

Tested by:

### 3.1.3.8 Network and transport layer

**Requirement**

**RS\_tcAdWe\_179**

The interface parameter *DENM destination area* between the DEN basic service and the networking and transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Tested by:

### 3.1.3.9 Security layer

**Requirement**

**RS\_tcAdWe\_181**

If the triggering conditions as described in section 3.1.3.2 apply, an AT change shall be blocked for new and update DENMs for 15 minutes (starting from the moment the new DENM was

generated). Corresponding new and update DENMs shall be sent with the same AT.

Tested by:

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**Requirement**

**RS\_tcAdWe\_182**

If the AT changes and there is active transmission of a new or update DENM, the transmission shall be stopped. In addition, the *EventHistory* and the *PathHistory* shall be deleted. The regular DENM generation process shall then continue.

Tested by:

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**3.1.3.10 Scenarios**

**Other (informational)**

**RS\_tcAdWe\_206**

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:

**Table 12: ‘Adverse weather condition’ — traction loss scenarios**

Count	Description	Status
	tbd	
	tbd	