REPORT

December 2018

Annual report on the fleet, traffic and tramway operating events

- Year 2017
- evolution 2008 – 2017

Technical department for ropeways and guided transport systems (STRMTG)
1461 rue de la Piscine – Domaine Universitaire 38400 Saint Martin d'Hères

www.strmtg.developpement-durable.gouv.fr

History of document versions

Version	Date	Comments
1.0	20/12/2018	Original version
1.1	25/01/2019	Corrective tables 03a, 201_a, 210_b, 210_c, 210_a7, graphs 90a, 90b, 90c
1.2	15/02/2019	Addition figures graphs 30d, 30e, 30f following operator request

Case followed by

Valérie de Labonnefon - STRMTG
Tel.:+33 4 76 63 78 78/Fax:+33 4 76 42 39 33
E-mail: valerie.de-labonnefon@developpement-durable.gouv.fr

Authors

Valérie de Labonnefon – Tramways Division

Jean-Michel Passelaigue – Tramways Division

Proof-reader

Alexandre Dusserre – Special assistant reporting to the Director

Internet reference(s)

http://www.strmtg.developpement-durable.gouv.fr/rapports-d-accidents-tramway-r137.html

TABLE OF CONTENTS

INTRODUCTION

The purpose of this report is to present the results from the use of the national database of tram events for 2017, as well as the developments in accidentology over the last ten years. This database is populated by declarations of accidents provided by operators.

The “tram” term covers systems on rails and rail-guided systems on tyres (mechanical guidance).

The statistical analysis is not intended to make a comparison between networks or present a classification based on safety levels. The different configurations, in terms of number and traffic of road crossings , as well as in terms ofthe urban structure would make such a comparison meaningless.

On the other hand, a comparative analysis of the accidentology of the various predefined and codified urban layouts, and its evolution over the period 2008-2017 is one of the main subjects of the report.

The basic developments that occurred from 2015 to 2017 have allowed to validate the data of the previous years, mainly for the following data:

- signalling and layouts of gyratories and roundabouts with traffic lights (in collaboration with CEREMA),
- signalling and layouts of road junctions with turning movements.

We can thus present detailed analyses of these configurations in this report.

Similarly, the possible deviations of this report with respect to the graphs of the previous reports will be clarified if required; this year they result from the specification of the criteria for the classification of the victims and the entry of passenger events, and also verifications that the operators and the STRMTG carry out with respect to the continuous data so as to ensure consistent reliability.

1 - Reminder on the database construction

1.1 - Data concerning events

The database of tram events contains the following main information for the events:

- Network identification (city + line)
- Type of event, based on a predefined list of undesirable events
- Details of the event, mainly for the passenger events and collisions between trams and details of the third party if need be
- Temporal position (date and time)
- Geographical situation (lane V1/V2, location of event via the section number)
- Configuration of the site of the event, using a predefined coding system
- Environment of the event (adherence, degraded operation, visibility, etc.)
- Bodily injuries (victims) for the passengers and third parties, material consequences and derailment following third party collision, duration of disruption of operation
- Circumstances of the event (summary of event, behaviour of the third party, aggravating factors, etc.)
- Record of system parameters (according to driver’s statement or data from tachymetric system, tram number)
- Police report and intervention of emergency services (yes/no)
- Analysis by the operator and action taken (investigation in progress, planned modification, action plan,etc.)

1.2 - Description of the networks via the codification of tram lines

The tram event database contains information on description of tram networks by means of codification data.

The codification consists of describing the various tram line configurations in order to create a descriptive database common to all the lines. It thus makes it possible to analyse events on all networks according to the characteristics of the sites where they occur, the comparison ofthe configurations between them and the identification ofthe most accident-prone configurations.

The latter thus allows characterising the following configuration categories:

- Station
- On-street/off-street section
- Pedestrian/cycle intersection- Crossroads intersection:
  - Simple junction
  - Turns to
  - Gyratory or roundabout with traffic lights
  - Resident's access
  - Starting of general traffic section
  - Other intersection

For the intersections, detailed traffic signals are available for eachconfiguration: static signals, light signals on close position of the tracks or before the conflict zone, etc. The possible presence of visual masks and ease of identification of the tram track are also new codified information.

Detailed principles of the new codification can be found in the guide “Codification des lignes de tramway”available on the STRMTG website.

It is recommended to note that the codification of the sections has been modified in 2018, allowing to refine the description of their characteristics of the layouts and integrate new types.To this effect, the evolutions will be integrated in 2019 in the networks.

This report also uses the data of the networks that are codified based on the previous guide “Codification des lignes de tramway, nouvelle édition 2010”.

1.3 - The adopted principles and definitions

1.3.1 - Operators' declarations.

In 2017, the criteria for the declaration of passenger events and the classification of the victims associated to the events have been specified, in order to standardise the practices.

Thus, a passenger event corresponds to any event reported at the handrail taking place in the rolling stock, at the interface with the doors, or at the interface between the platform and the track (excluding collision).

In this report, we present the operating events for the last 10 years; the configuration-wise event analyses can be analysed for a different time period.

/! *It is recommended to specify that the evolutions of declaration of the operators in 2014 and 2017 impact the graphs presenting the victims of the events and the passenger events; the analysis of data evolution should be taken in measure.*

1.3.2 - Victims

It is important to define the concept of victim used by the operators for the declaration of events and given in this report.

Since 2017, in the database of the tramway events, a victim (person involved in the event and who does not get through unharmed) is counted if there is intervention or request for intervention of emergency services or if there is proof provided of medical care. The person is then listed as minor injury, serious injury or fatality, if the information is available.

Definitions of serious injuries and fatalities (accepted and used within the European Union):

- Seriously injured = duration of hospitalisation more than 24 hours.
- Fatal = death within the 30 days following the event.

These statistical elements about the nature of the victims obviously remains dependent on the information available and “being brought to the knowledge” of the tram operator.

1.3.3 - Panels of networks

In this report, we distinguish between, particularly for the graphs of the ratios of events and collisions at 10,000 km, the “pure STPG” networks from the mixed networks.

This is a linguistic device to allow easy identification of tram networks built and commissioned fully in accordance with the STPG decree (safety of guided public transport systems) of 2003.

In practice, the “pure STPG” networks are those put in commercial operation from 2006 (included) and possibly having had line extensions.

In addition, the “mixed” networks are those put in commercial operation before 2006 and may have had extensions authorised in accordance with the STPG Decree or previously.

The “pure STPG” networks represent the following part of the production elements:

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Km	15,3%	15,1%	15,2%	19,0%	21,0%	23,9%	26,1%	26,1%	25,6%	25,1%
Journeys	14,0%	14,5%	14,4%	16,3%	18,7%	20,1%	21,4%	21,6%	21,1%	20,9%

Table 07d

1.3.4 - Serious events and severe victims

By convention and in accordance with the profession, serious events correspond to one of following criteria:

- serious physical consequences: fatality or serious injury or more than 5 victims,
- significant material damage (including for the third party) or derailment of the tram,
- derailment during commercial operation in a zone shared with third-parties.

Severe victims represent the sum of the injured persons and fatalities.

1.3.5 - Signalling of conflict

In the next part of the report, special analyses are carried out according to the signalling of conflict between the tram and the road vehicles.

The codification describes the signalling of conflict for a simple junction, resident's access, starting of general traffic section, another intersection. It pertains to the car/tram conflict. This signalling is called “crossing signalling”for the “turn left/right” road crossings and “entrance sign” for the “gyratory/roundabout with traffic lights”

In addition, the“upstream” signs manage the car/car conflict then possibly the car/tram conflict. It is set up at the “gyratories/roundabouts with traffic lights” and “turn left/right” road crossings. For the gyratories, this signalling is called “entrance signs”.

2 - Systems and traffic of the tramnetworks

2.1 - Analysed systems and 2017 production data

For the analysis of accidentology, we have taken into account the network lines appearing in the table below.

Urban areas	Type	Nb of lines	Mkm	Mjourneys	Opening	Remarks
Angers	Tram on rails	1	0.89	9.48	25/06/2011	
Aubagne	Tram on rails	1	0.16	2.25	01/07/2014	
Besançon	Tram on rails	2	1.08	11.08	01/09/2014	
Bordeaux	Tram on rails	3	6.85	96.77	20/12/2003	C line (extension) 2017
Brest	Tram on rails	1	1.01	9.38	23/06/2012	
Caen	Tram on tyres	2	1.31	9.38	18/11/2002	
Clermont-Ferrand	Tram on tyres	1	1.12	16.25	13/11/2006	
Dijon	Tram on rails	2	2.11	24.72	02/09/2012	
Grenoble	Tram on rails	5	5.34	55.05	05/09/1987	
Le Havre	Tram on rails	2	1.13	11.14	12/12/2012	
Le Mans	Tram on rails	2	1.83	18.01	14/11/2007	
Lille	Tram on rails	2	1.51	11.21	04/12/1909	
Lyon	Tram on rails	6	6.29	96.42	18/12/2000	
Marseille	Tram on rails	3	1.57	23.52	01/06/2007	
Montpellier	Tram on rails	4	5.46	67.93	01/07/2000	
Mulhouse	Tram on rails	4	1.27	15	12/05/2006	Including a “Tram-train” line
Nancy	Tram on tyres	1	1.04	10.35	28/01/2001	
Nantes	Tram on rails	3	5.26	70.58	07/01/1985	
Nice	Tram on rails	1	1.29	31.44	26/11/2007	
Orléans	Tram on rails	2	2.32	21.91	24/11/2000	
Paris / IdF	Tram on rails Tram on tyres	6 2	11.58	283.8	06/07/1992	
Reims	Tram on rails	2	0.99	14	16/04/2011	
Rouen	Tram on rails	2	1.46	18.7	16/12/1994	
Saint-Etienne	Tram on rails	3	1.69	22.1	01/01/1881	
Strasbourg	Tram on rails	6	6.13	70.28	26/11/1994	Extensions carried out in 2017
Toulouse	Tram on rails	2	1.62	12.02	11/12/2010	
Tours	Tram on rails	1	1.3	16.34	01/09/2013	
Valenciennes	Tram on rails	2	1.44	6.44	03/07/2006	
28 urban areas		74	75.05	1055.54		

Table 01g

(highlighted) network, new line or extension line opened in 2017 and included in the results

2.2 - Table of rolling stock in operation on the networks at the end of 2017

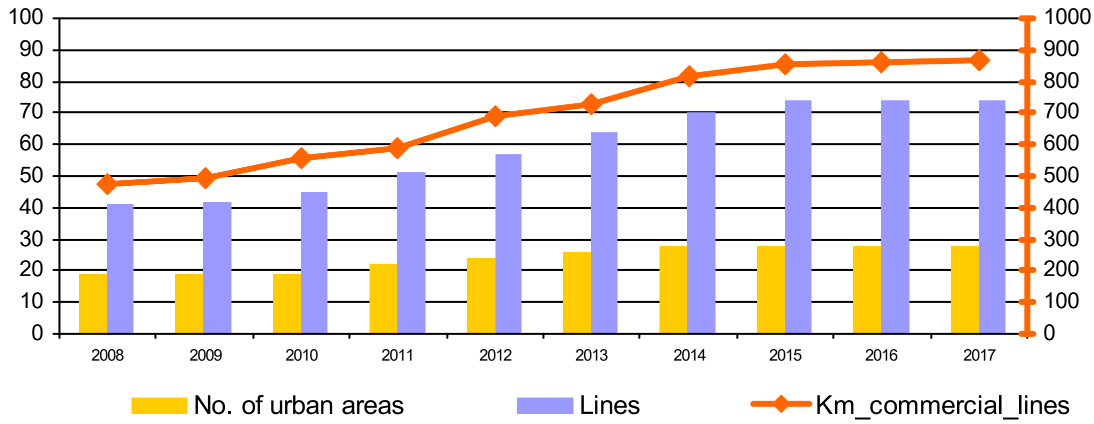
Urban area	Manufacturer	Model	umber of tram
Angers	ALSTOM	CITADIS 302	17
Aubagne	ALSTOM	CITADIS 202	8
Besançon	CAF	Urbos 3 – 3 modules	19
Bordeaux	ALSTOM	CITADIS 302	12
Bordeaux	ALSTOM	CITADIS 402	88
Brest	ALSTOM	CITADIS 302	20
Caen	BOMBARDIER	TVR	24
Clermont-Ferrand	TRANSLOHR	STE4	23
Dijon	ALSTOM	CITADIS 302	33
Grenoble	ALSTOM	CITADIS 402	50
Grenoble	ALSTOM	TFS	53
Le Havre	ALSTOM	CITADIS 302	22
Le Mans	ALSTOM	CITADIS 302	34
Lille	BREDA	VLC	24
Lyon	ALSTOM	CITADIS 302	73
Lyon	ALSTOM	CITADIS 402	19
Lyon	STAEDLER	Tango	6
Marseille	BOMBARDIER	(stretched out)	26
Montpellier	ALSTOM	CITADIS 302	27
Montpellier	ALSTOM	CITADIS 401	30
Montpellier	ALSTOM	CITADIS 402	30
Montpellier	ALSTOM	TFS	1
Mulhouse	ALSTOM	CITADIS 302	27
Mulhouse	SIEMENS	Avanto	12
Nancy	BOMBARDIER	TVR	25
Nantes	ALSTOM	TFS	45
Nantes	BOMBARDIER	Incentro	33
Nantes	CAF	Urbos 3 – 5 modules	12
Nice	ALSTOM	CITADIS 302	13
Nice	ALSTOM	CITADIS 402	15
Orléans	ALSTOM	CITADIS 301	22
Orléans	ALSTOM	CITADIS 302	21
Paris / IdF	ALSTOM	CITADIS 302	105
Paris / IdF	ALSTOM	CITADIS 402	46
Paris / IdF	ALSTOM	TFS	35
Paris / IdF	TRANSLOHR	STE3	15
Paris / IdF	TRANSLOHR	STE6	28
Reims	ALSTOM	CITADIS 302	18
Rouen	ALSTOM	CITADIS 402	27
Saint-Etienne	ALSTHOM / VEVEY	MR_SET1	15
Saint-Etienne	ALSTHOM / VEVEY	MR_SET2	20
Saint-Etienne	CAF	Urbos 3 – 5 modules	13
Strasbourg	ALSTOM	CITADIS 403	41
Strasbourg	BOMBARDIER	Eurotram	53
Toulouse	ALSTOM	CITADIS 302	24
Tours	ALSTOM	CITADIS 402	21
Valenciennes	ALSTOM	CITADIS 302	30
TOTAL			1355

2.3 - Evolution 2008-2017

2.3.1 - Systems in operation

The evolution of the systems in operation is represented by the diagram below.

Number of urban areas, lines and line km



graph 01b

The trams in operation in 2017 are present in 28 urban areas and represent 74 commercial lines including 68 tram on rails and 6 tram on tyres linesPlease note that, since 2008, the number of commercial lines has almost doubled , and that the km representing the length of these lines has increased by 80%.

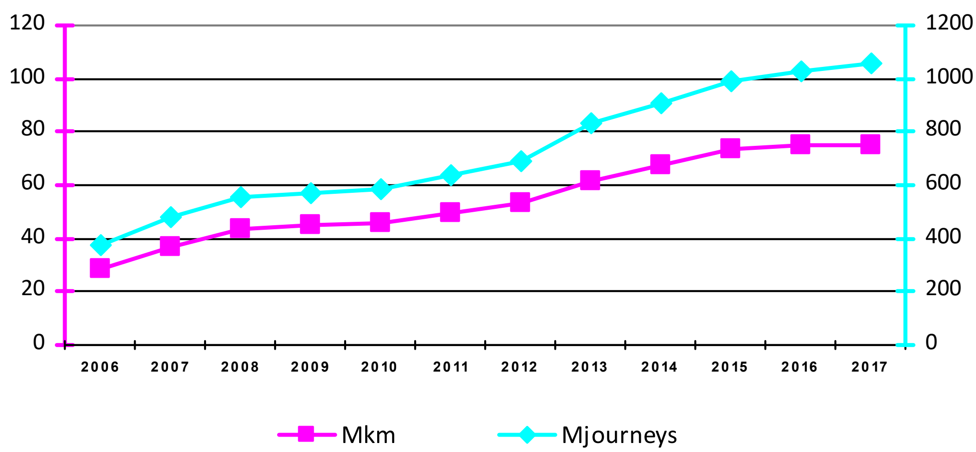
The systems tend to stabilise over the last 3 years even if a few extensions have been commissioned.

2.3.2 - Production data

The evolution of production data is represented by the diagram below.
The number of journeys as well as the number of km travelled has more than doubled since 2008.

The kilometres travelled also tend to stabilise over the last 3 years. Note that the number of journeys continues to grow over this period and now exceeds a billion passengers.

Km travelled and journeys



graph 02

3 - Events

3.1 - Overall data for 2017

The number of events declared by the operators and reported in the national database is 2707 for the year 2017; the table below gives the breakdown of the number of events and victims per category of event, according to the list of undesirable events.

Event Type	No. of evt	Total Victims	Total of those injured seriously	Total fatalities
Fire Explosion	6	0	0	0
Panic	0	0	0	0
Electrocution	0	0	0	0
Derailment/splitting point	10	0	0	0
Passenger event	1162	623	15	1
Collision between trams	7	0	0	0
Collision with obstacle on track	42	6	0	0
Collision with third parties	1434	456	57	3
End of track event	12	1	1	0
Other events	34	13	1	0
	2707	**1099**	**74**	**4**

Table 03b

For 2017, please note the 12 events declared End of track events (5 in 2016, 6 in 2015) and the 10 Derailment/splitting point events (8 in 2016, 5 in 2015).

The details about the circumstances of these events are provided in the following paragraph.

3.2 - Remarks concerning the events

3.2.1.a - Fire - explosion

6 fire explosion events were declared in 2017 (11 in 2016) but did not result in any victims:

- an outbreak of fire in the roof,
- four events related to brakes applied with emission of smoke,
- an event in connection with the intervention of an external company whose equipment has caught fire and spread to the tram.

3.2.1.b - Derailment/splitting point/off-rail

9 derailment, splitting point or off-rail events have been declared in 2017 (8 in 2016) but did not result in victims:

- five splitting point (one in the yard, three on the line at the marshalling yard, one on the line during a turn back manoeuvre),
- a derailment of the tram on the line due to the falling of the flange lubrication tank from a carrying bogie,
- one tram went off the rail following the presence of objects in the groove of the rail,
- one tram went off the rail and a tram went off the rail at the exit of the yard after failing to stop at the signal on danger.

3.2.1.c - Passenger event

This event category is the subject of a detailed analysis of victims later in the report, chapter§4 - Victims.

A fatal event occurred in 2017: case of being dragged by the tram.

3.2.1.d - Collision between trams

7 events in 2017 (3 in 2016) of this type resulting in no victims:

- one case of trams colliding with another tram on the line
- three cases of tram colliding with another tram stopped at a station.
- a collision between trams following the breaking of the towing bar
- a slanting collision during a turn back manoeuvre
- a collision on a crossingdue to fouling of the gauge

3.2.1.e - Collision with obstacle on track

29 collisions (35 in 2015) with obstacles on the track of different types: trolleys, garbage cans, barrier (construction site or not), site pipes, metal or concrete studs, cobblestones, wooden pieces, iron bars, etc. 6 slightly injured passengers, including 5 during the collision with a mechanical shovel bucket.

3.2.1.f - Collision with third parties

The analysis of this category is more detailed in chapter §5 The passenger events of this report.

Here, we explain the circumstances of four fatal events (7 in 2016), which resulted in the death of 3 pedestrians and a passenger on the platform.

3 fatal collisions with third-parties:

- 3 collisions with a pedestrian: crossing in front of the trams (2 on the pedestrian crossing, 1 at the road junction), the pedestrian did not see (or did not correctly see) the arrival of the tram.

A passenger event at the station:

- a passenger on the platform stuck between the platform and the car body of the rolling stock.

3.2.1.g - Other events

34 other events (42 in 2016), resulting in 1 seriously injured third party:

- 1 person falls from the tram during travel.

Most of the events are of the following nature: vandalism, catenary hanging, breaking of stay ropes, collisions of third party with tram system infrastructure, etc.

The phenomenon of “tram surfing” is seen again (3 events resulting in 1 seriously injured person mentioned previously).

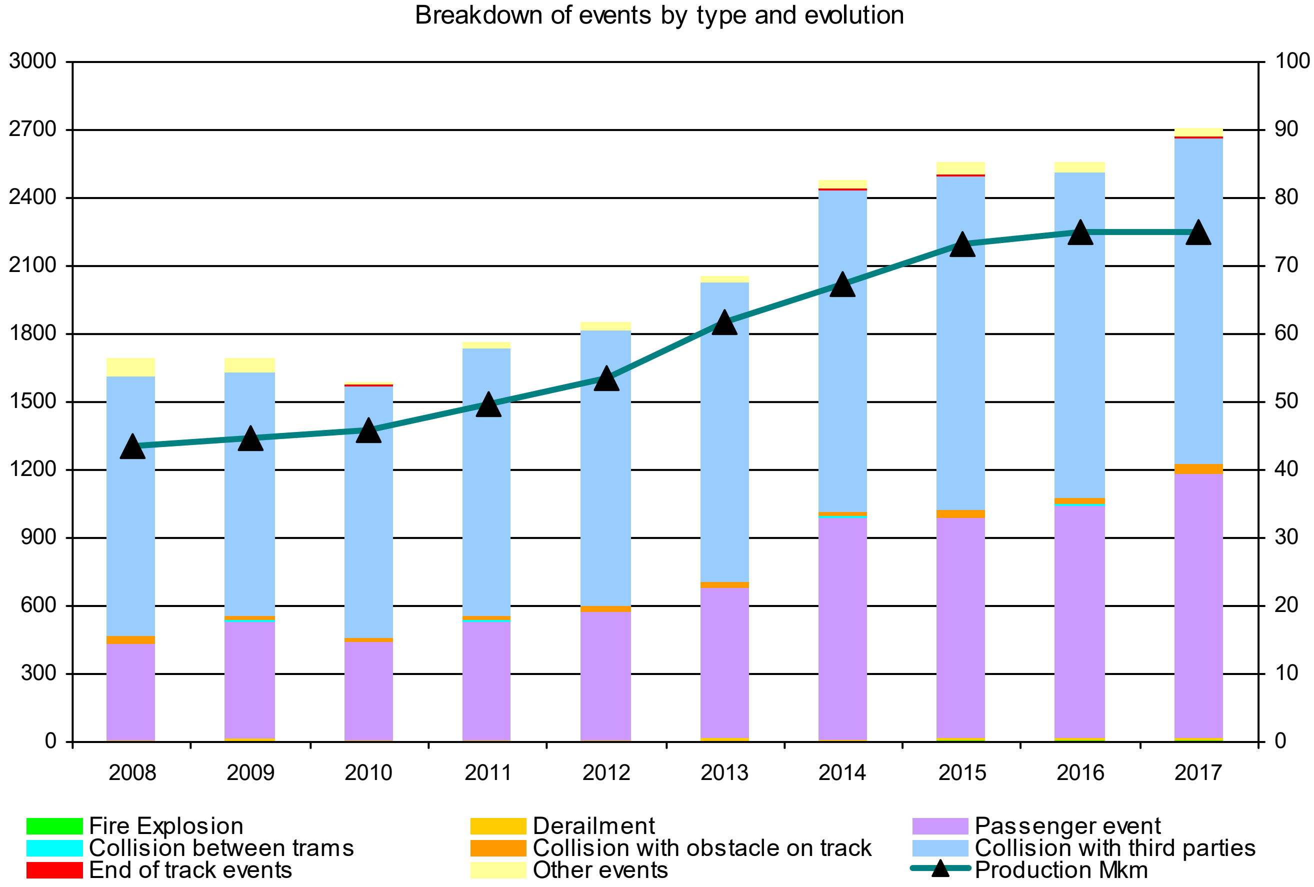
3.2.1.h - End of track event

12 track end stops overruns (5 in 2016), with 1 seriously injured passenger after a sudden application of brakes caused by the derailment of the first bogie following the intrusion in the sand box, have been observed (mainly 1 can be attributed to the reduced attention of the tram driver).

3.3 - 2008-2017 evolution

3.3.1 - Breakdown by type of event and evolution of travelled km

The graph below shows the evolution of the number of events over the 2008-2017, period, with breakdown per category, and shows the evolution in the number of travelled km at the same time.



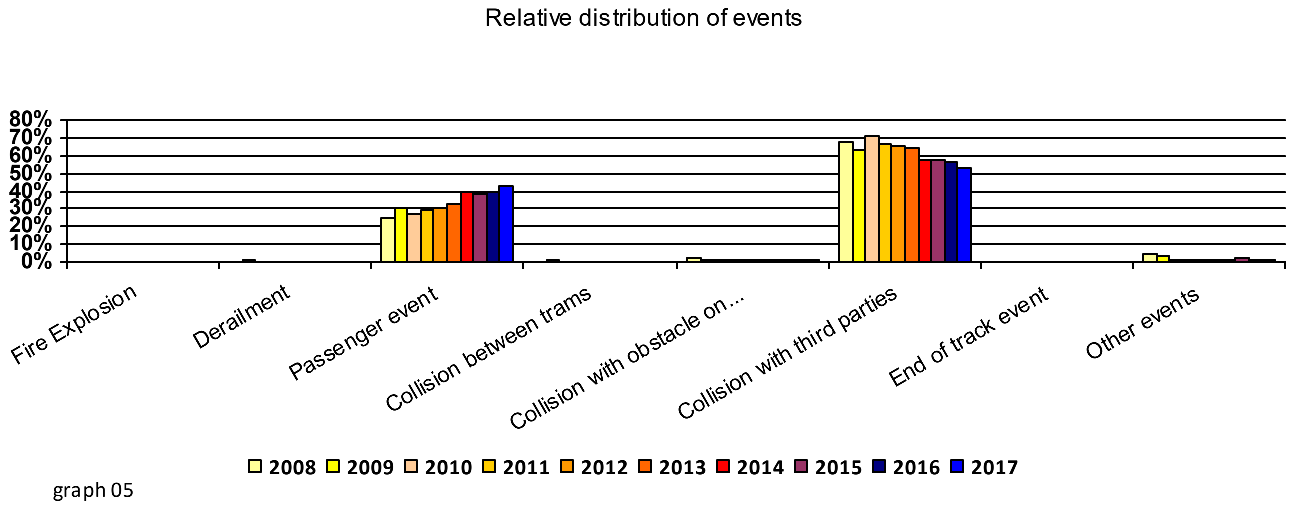
graph 04

Collisions with third parties always show the highest share of events.

/!\ The increasing number of passenger events since 2014 partly result from the evolutions of declaration of the operators (refer to 1.3 - The adopted principles and definitions).

3.3.2 - Evolution of the share of events by event type

The graph below shows the evolution of the relative proportion of each event type over the 2008-2017period, with breakdown per type.



graph 05

Overall, we still observe an upward trend in the proportion of passenger events and a slight reduction in the proportion of collision with third parties.

The proportion of the other types of events remains very low.

There are several explanations put forward by the operators concerning the evolution of the proportion of passenger events:

- Observation of a trend of the passengers holding on less frequently to the gripping devices present in the trams in view of a smoother ride in the trams, unlike buses.
- Tendency to claim for compensation
- Observation of an increasingly ageing clientele (considering the accessibility of trams).
- Increase in travel by soft modes (walking/ cycling) leading to emergency braking to avoid collisions and resulting in passengers falling.

This being the case, the majority of severe victims are from collisions with third parties (See 4.2.4.b Evolution of the proportion of severe victims according to the events).Event monitoring indicator

3.3.3 - Events per 10,000 km travelled

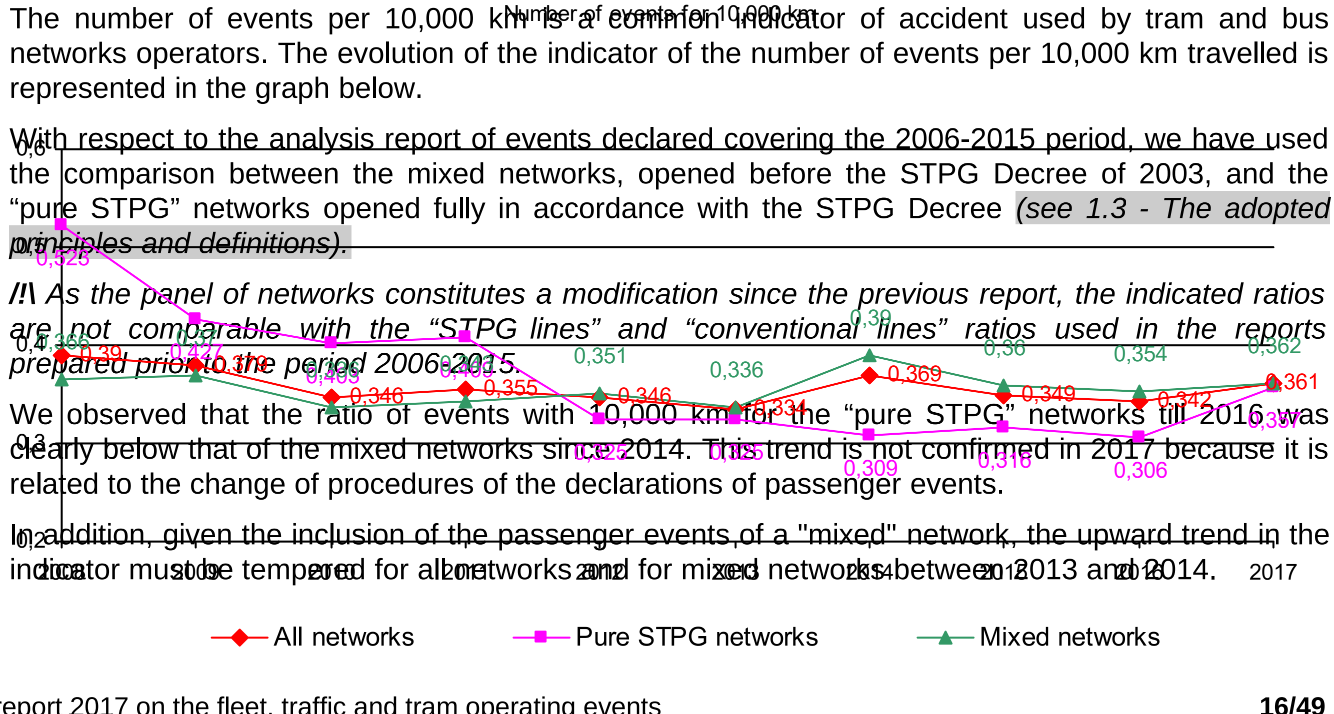
The number of events per 10,000 km is a common indicator of accident used by tram and bus networks operators. The evolution of the indicator of the number of events per 10,000 km travelled is represented in the graph below.

With respect to the analysis report of events declared covering the 2006-2015 period, we have used the comparison between the mixed networks, opened before the STPG Decree of 2003, and the "pure STPG" networks opened fully in accordance with the STPG Decree *(see 1.3 - The adopted principles and definitions).*

/!\ As the panel of networks constitutes a modification since the previous report, the indicated ratios are not comparable with the "STPG lines" and "conventional lines" ratios used in the reports prepared prior to the period 2006-2015.

We observed that the ratio of events with 10,000 km for the "pure STPG" networks till 2016 was clearly below that of the mixed networks since 2014. This trend is not confirmed in 2017 because it is related to the change of procedures of the declarations of passenger events.

In addition, given the inclusion of the passenger events of a "mixed" network, the upward trend in the indicator must be tempered for all networks and for mixed networks between 2013 and 2014.



graph 07b

3.3.4 - Comparison with buses

As a guideline, we were able to get the bus accident rate data for 5 typical tram networks. The events taken into account for buses are almost the same as those for trams, mostly collisions with third parties and passenger events.

We get the following table for the 5 networks being considered (events per 10,000 km):

Year	2010	2011	2012	2013	2014	2015	2016	2017
Bus	0.8	0.8	0.79	0.73	0.67	0.75	0.68	0.65
Tram	0.39	0.39	0.34	0.34	0.42	0.38	0.39	0.39

Table 06_e

The tramway maintains a ratio to its advantage, in comparison with the bus.

4 - Victims

4.1 - 2017 data - All events

The table below provides details for the events of 2017, the breakdown of the number of victims per category according to the event type. A total of 1092 victims has been recorded.

Event	Total Victims	% victims	Third-Party Slightly Injured	Third-Party Severely Injured	Third-Party Fatality	Passenger Slightly Injured	Passenger Severely Injured	Passenger Fatality
Fire Explosion	0	0%	0	0	0	0	0	0
Panic	0	0%	0	0	0	0	0	0
Electrocution	0	0%	0	0	0	0	0	0
Derailment/splitting point	0	0%	0	0	0	0	0	0
Passenger event	623	56,7%	0	0	0	607	15	1
Collision between trams	0	0%	0	0	0	0	0	0
Collision with fixed obstacle	6	0%	0	0	0	6	0	0
Collision with third parties	456	41,5%	274	55	3	122	2	0
End of track event	1	0%	0	0	0	0	1	0

Table 03a

Please note the proportion of passenger victims in the victims of collision with third parties: they constitute 27% of the victims of collision. This figure is higher with respect to previous year (25% in 2016).

The collisions with third-parties are more severe than the passenger events as the former reports 58 severely injured victims (including 3 fatalities).

4.2 - Evolution 2008-2017

4.2.1 - Table of evolution of the victims by level of severity

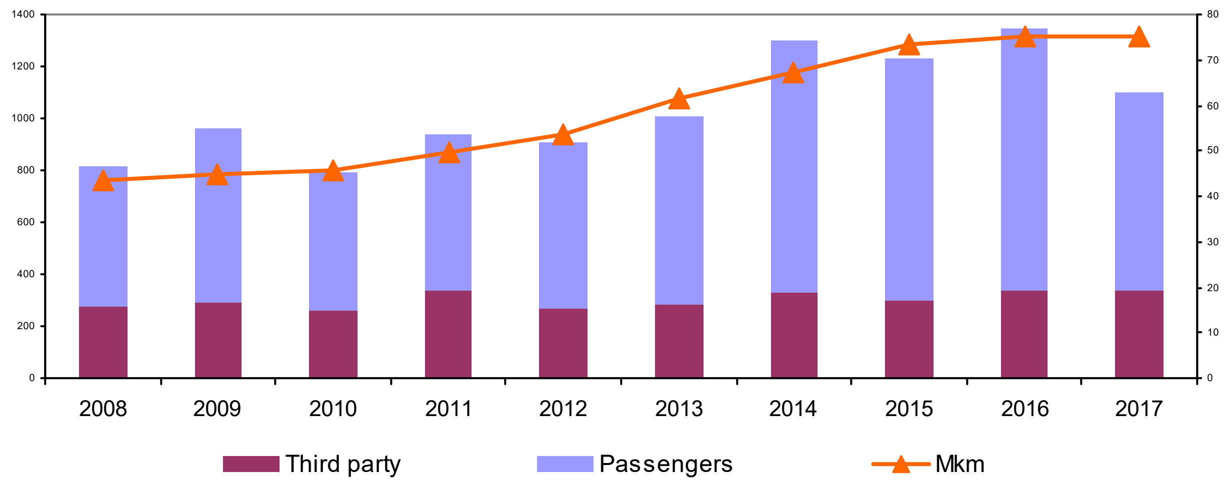
Year	Events	Victims	Seriously injured	Fatalities	Mjourneys	Mkm
2008	1694	819	38	5	552.53	43.43

Year	Events	Victims	Seriously injured	Fataliti es	Mjourneys	Mkm
2009	1695	958	23	6	567.17	44.77
2010	1586	789	32	9	584.58	45.85
2011	1762	941	44	2	636.36	49.58
2012	1851	908	33	3	690.36	53.55
2013	2057	1011	33	6	829.85	61.66
2014	2480	1300	44	6	908.65	67.22
2015	2555	1230	41	5	989.74	73.27
2016	2562	1345	57	7	1025.35	74.95
2017	2707	1099	74	4	1055.55	75.04

4.2.2 - Passenger and third party victims

The graph below shows the evolution ofthe number of third party and passenger victims over the 2008-2017 period, and shows the evolution in the number of travelled km at the same time.

Km travelled and proportion of the third party and passenger victims



graph 22

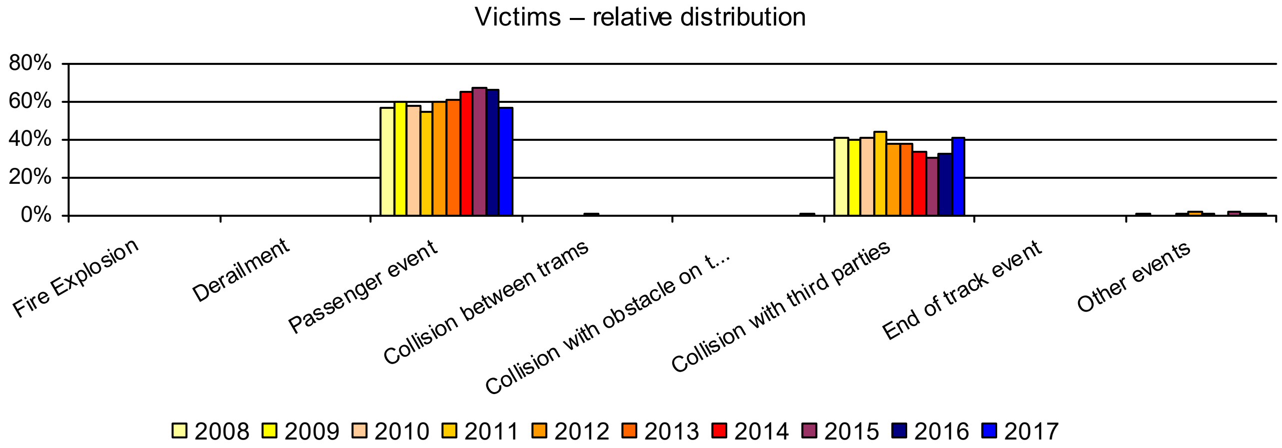
The passenger victims still represent the greatest proportion of victims (see explanations put forward in 3.3.2. concerning the passenger events).

!\ The significant decrease in the number of passenger victims for 2017 seems to be explained by the change of procedures of declaration (see 1.3 - The adopted principles and definitions). This trend should be confirmed in the years to come.

We would like to emphasise that the significant increase in distance (km) travelled over the past 10 years has not resulted in an increase in the number of victims of collisions with third parties.

4.2.3 - Evolution in the proportion of victims according to the type of event

The graph below shows the change in the relative proportion of victims during the 2008-2017 period with a breakdown according to the event type.



graph 23

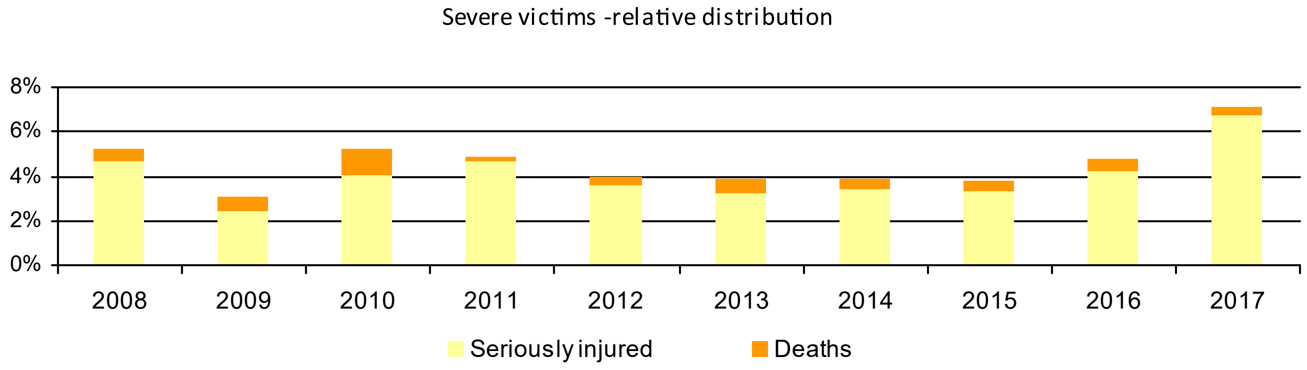
/!\ The significant decrease in theproportion of passenger victims for 2017 seems to be explainedby the change of procedures of declaration (see 1.3 - The adopted principles and definitions). This trend should be confirmed in the years to come.

Hence,we cannot make any deductions from the evolution trend for 2017.

4.2.4 - Severe victims

It is to be recalled that the severe victims comprise severely injured individuals and fatalities *(refer to 1.3The adopted principles and definitions).*

4.2.4.a - Evolution of the proportion of severe victims

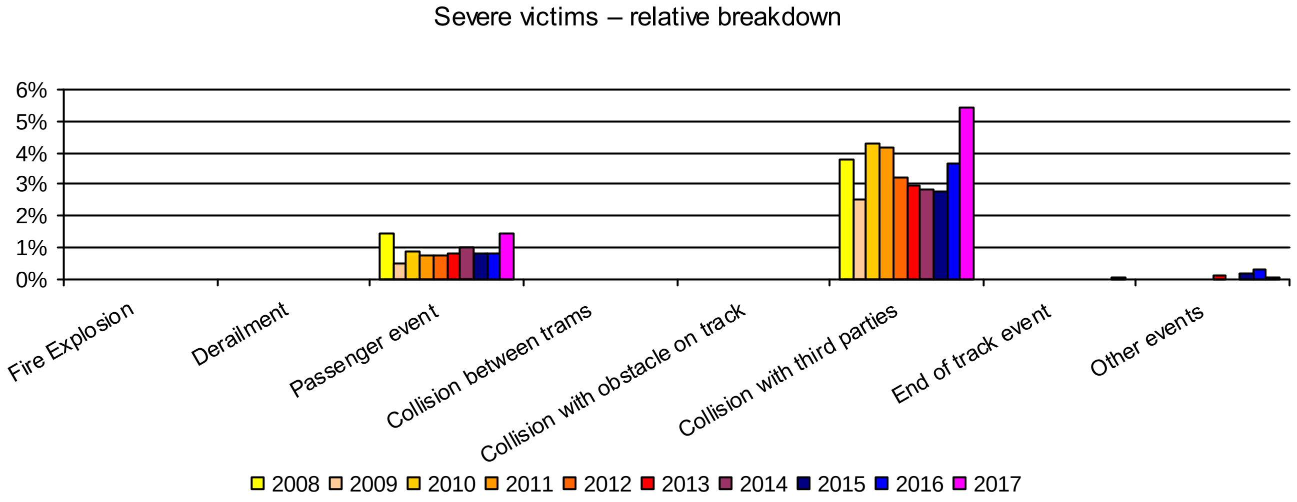


graph 25

The proportion of the severe victims has increased substantially in 2017 and represents 7% of the victims. This indicator will have to be monitored in the next reports.

It should be remembered that the statistical elements about the nature of the victims remain dependent on the information available and brought to the knowledge of the tram operator.

4.2.4.b - Evolution of the proportion of severe victims according to the events

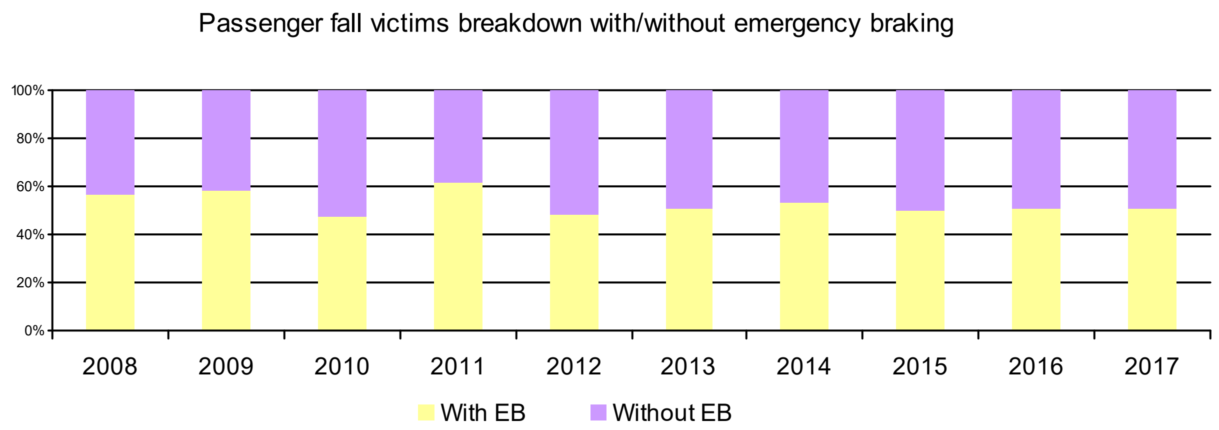


graph 24

Collisions with third parties remain the type of event generating the most severe victims. The details of the noticeable increase observed in 2017 are given later .

4.2.5 - Evolution of the proportion of victims of falls related to EB by the driver

The graph below shows the evolution of the proportion of passenger victims of fall events during the 2008-2017 period which is associated with an emergency braking initiated by the tram driver (controller handle action).



graph 26

The events taken into account are collisions with third-parties and passenger fall events.

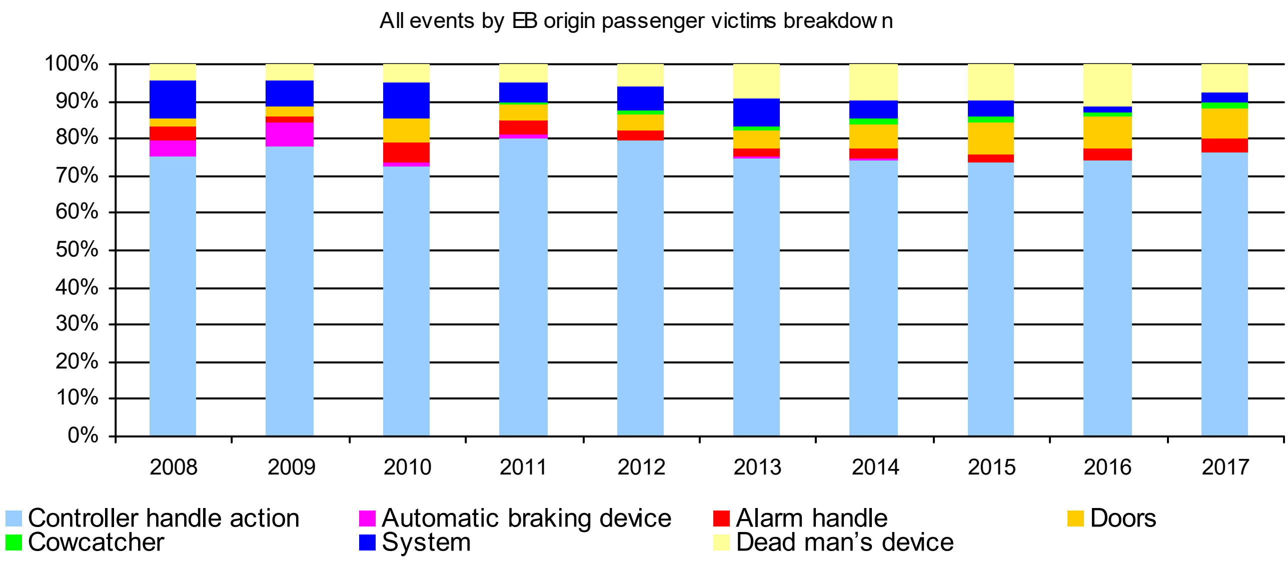
Over the last 5 years, we can observe a trend towards the stabilisation of the proportion of victims caused by a event of emergency braking by the driver.

4.2.6 - Evolution of the proportion of passenger victims according to the nature of the emergency braking

It seems interesting to analyse, using the graph below, the evolution of the breakdown of the passenger victims, for all the events, according to the nature of the emergency braking, while this analysis is dependent on the accuracy provided by operators in their declared events.

We have identified six categories of emergency braking whose significance is given below:

- Controller handle action: includes all the emergency braking by the tram driver and initially caused by traffic in urban areas. For the most part, it pertains to the actions made actively by tram drivers and designed to avoid a collision with third parties.
- Automatic braking device: some networks with specific configurations have "automatic braking device of trains" for example in tunnels or on single track.The networks with this device have been in commercial operation since 2008. The largest number of emergency braking occur during the testing period (one to two years after the commissioning).
- Alarm Handle: refers to the device available to passengers; this device is only active when tram is leaving the station.
- Doors: is the emergency braking caused by opening doors, either because of travellers (forcing) or due to maladjustment of doors' system.
- Cowcatcher: related to emergency braking caused by the detection of obstacle on the line and causing the falling of the cowcatcher device.
- System: denotes the technical malfunctions encountered on the rolling stock and causing an emergency braking. The operators' declaration do not enable their nature to be defined accurately.
- Dead man's device: corresponds to the absence of activation of the dead man's switch by the driver, resulting in emergency braking when the time-out is exceeded.



graph 27

Driving actions remain the main cause of passenger victims ofemergency braking, with a rate that is still higher than 70 %.

The proportion of the Doors Emergency Braking is to be co-related with a network declaring its passenger events since 2014.

As regards the proportion of the Dead man device Emergency Braking, it is also recommended to observe its evolution in the next reports, following the recommendation of the STRMTG of 14 February 2017 relating to the alert associated to the triggering of the emergency braking of the dead man device function. In fact, this recommendation recommended modifications over theduration of the alert in order to reduce the occurrence of the Dead man device Emergency Braking.

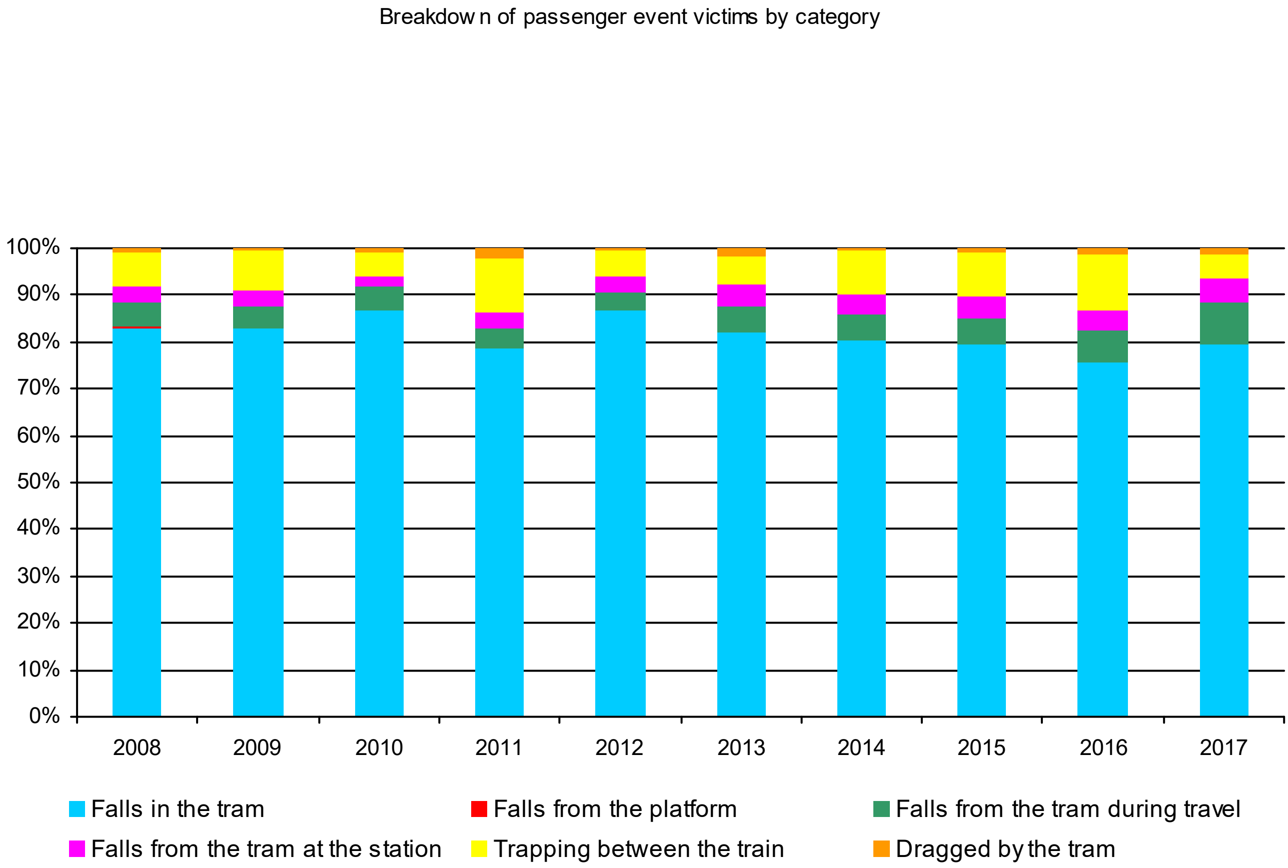
There are no more victims related to the Automatic braking device since 2016.

Additionally, the proportion of severe victims related to an emergency braking (all EB together) amongst all passenger victims is very low, it lies between 0% and 2.61% during the period 2008-2017 (1.6 % in 2017). By removing the "Controller handle action" EB, this proportion falls to a value between 0% and 0,56 % (0.5% in 2017).

4.2.7 - Evolution of the proportion of victims of passenger events per category

The graph below shows the evolution over the 2008-2017 period in the proportion of passenger victims per passenger event category.

We observe that the falling in the train remains the main cause of the victims of passenger events: the proportion of the victims related to a fall in the train has varied slightly over the last 10 years.



graph 15b

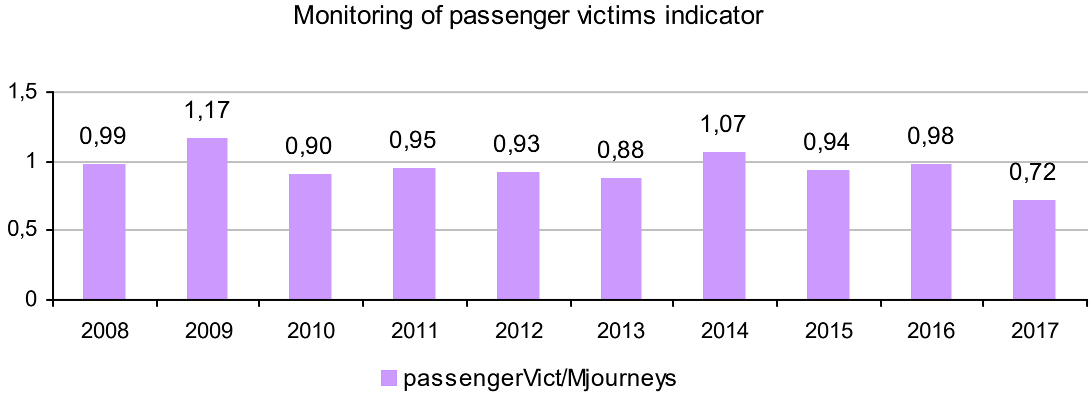
Trapping in the tram and the associated victims also increased significantly. A major part of these trappings is observed on a network anda rolling stock that are identified.

/!\ The modifications inthe proportion of the passenger victims per category for 2017 seems to be explained by the change of procedures of declaration (see 1.3 - The adopted principles and definitions).

Hence, we cannot make any deductions from the evolution trend for 2017.

4.3 - Other monitoring of victims and events indicators

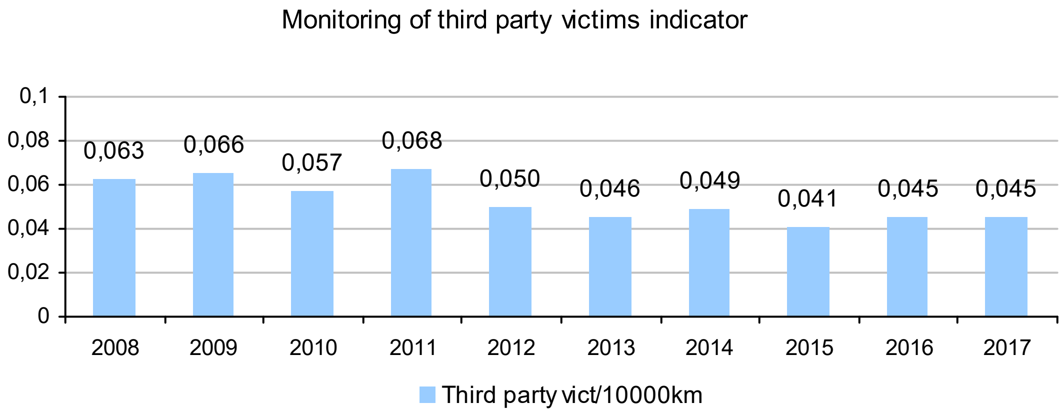
4.3.1 - Passenger victims per 1 million journeys



graph 30e

The indicator of the passenger victims per 1 million journeys is overall stable over the period and goes down again in 2017 following the modification of the procedures of declaration.

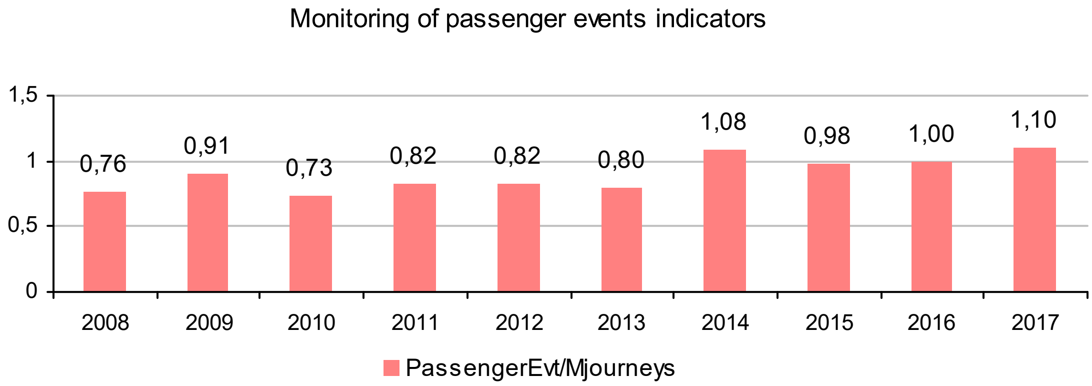
4.3.2 - Third-party victims per 10,000 km



graph 30d

The indicator of third-party victims per 10000 km is overall declining over the last 10 years.

4.3.3 - Passenger events per 1 million journeys



graph 30f

The indicator of the passenger events per 1 million journeys is increasing overall over the period and mainly in 2017 following the modification of the procedures of declaration.

5 - The passenger events

/!\ For the passenger events, the main difference between the number of passenger events and the number of passenger victims, mainly for 2017 seems to be explained by the change of procedures of declaration (see 1.3 - The adopted principles and definitions). This trend should be confirmed in the years to come.

The passenger events for which no specification is provided in their declaration are identified as “non-specified”.

5.1 - Evolution 2008-2017

5.1.1 - Breakdown of the passenger events by specification

Passenger accident subtype	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Falls in the tram	337	413	358	401	468	521	732	699	685	786
Falls from the tram during travel	1		1			1	1			1
Falls from the tram at the station	27	25	24	29	27	35	54	54	69	95
Falls from the platform	17	19	11	19	19	30	45	45	47	51
Trapping in the tram	36	52	28	65	44	43	117	107	144	127
Dragged by the tram	3	3	3	8	4	12	7	9	10	12
Not specified	1	2	2		4	22	25	55	69	91
TOTAL	422	514	427	522	566	664	981	969	1024	1163

Table 100_c

The declared passenger events predominantly pertain to the falls in the tram, mainly following a braking to avoid a collision. The falls during the passenger exchange (increasing) and the trappings in the tram remain to be monitored.

5.1.2 - Breakdown of the victims of passenger events by specification

Passenger accident subtype	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Falls in the tram	389	473	393	405	466	488	667	617	629	439
Falls from the tram during travel	1		1			1	1			1
Falls from the tram at the station	25	26	23	23	22	31	46	42	56	49
Falls from the platform	15	19	10	18	17	28	36	36	38	29
Trapping in the tram	35	49	24	59	30	37	76	75	99	27
Dragged by the tram	3	3	3	11	3	10	5	6	10	8
Not specified	1	2	2		3	24	23	48	58	70
TOTAL	469	572	456	516	541	619	854	824	890	623

Table 100_d

We observe that the victims of the passenger events are essentially concerned by falls in the train.

5.1.3 - Breakdown of the severely injured victims of passenger events by specification

Passenger accident subtype	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Falls in the tram	9	1	6	5	6	5	8	7	8	6
Falls from the tram during travel	0		0			0	0			1
Falls from the tram at the station	0	2	0	1	1	0	0	0	0	4
Falls from the platform	1	0	0	0	0	2	4	2	0	0
Trapping in the tram	1	1	0	0	0	0	0	0	0	0
Dragged by the tram	1	1	1	1	0	1	1	1	2	4
Not specified	0	0	0		0	0	0	0	1	1
TOTAL	12	5	7	7	7	8	13	10	11	16

Table 100_e

The severely injured victims of passenger events are divided between the falls in the tram, falls during passenger exchange, and being dragged by the tram. The severely injured victims of passenger events represent less than 3% of the victims of this type of event.

6 - Collision with third parties

6.1 - 2017 data

6.1.1 - Number of collisions and victims by type of third-party

	Third party							Passengers
	Motorcycle	Other	Pedestrians	PT or HGV>3.5t	Bicycle	Car	Van <3.5t	
Collision with third parties	37	11	251	42	93	932	68	
Victims	12	1	147	18	36	108	10	124

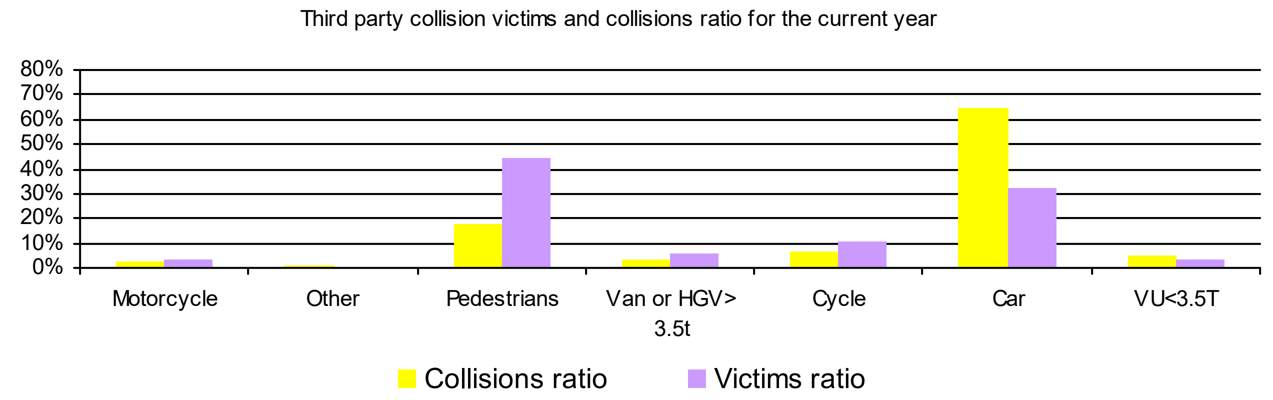
Table 18a

With 1434 events in 2017 collisions with third parties represent 52.9% of all reported events (2707 events).

As regards the victims of collisions with third parties, 456 in number, they are divided into 332 third party victims (30.2% of all events victims) and 124 passenger victims (11.3 % of all events victims) for 1099 victims in all.

6.1.2 - Ratio of collisions and third party victims of collisions by type of third party

Collisions with private cars account for vast majority of cases; **collisions with pedestrians, which are far fewer, however, causes the largest number of victims.**



graph 40

In 2017, the proportion of victims of the “Public transport or HGV > 3.5t” category is associated to a tram/bus collision with numerous victims reported.

6.2 - Evolution 2008-2017

6.2.1 - Breakdown of collisions according to third parties

6.2.1.a - Table of data

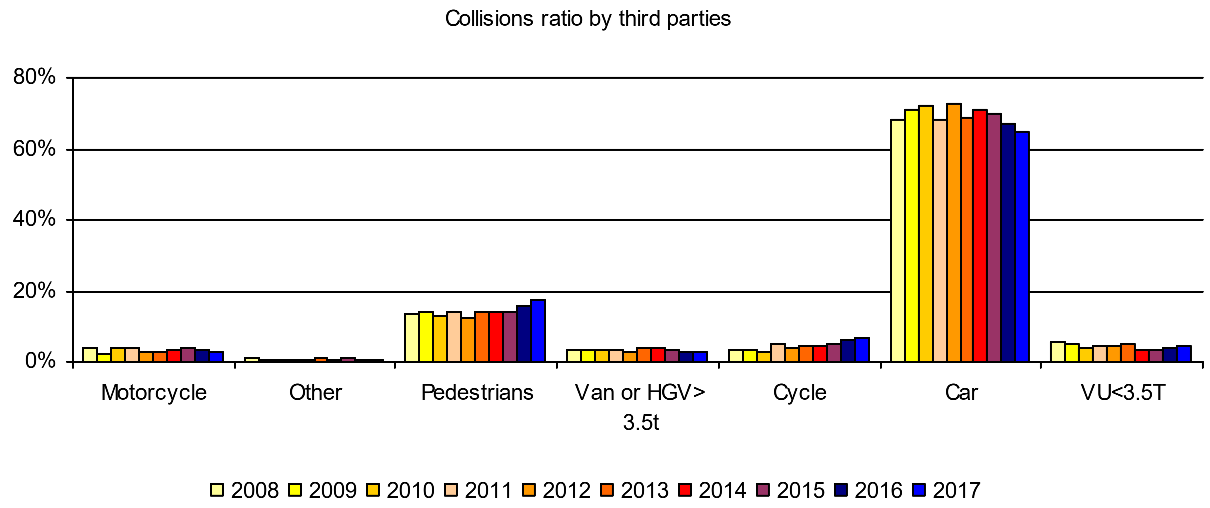
Third party	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Motorcycle	48	26	41	45	35	38	47	54	49	37
Other	11	7	8	4	7	14	5	14	10	11
Pedestrians	155	154	148	169	153	183	198	209	230	251
Van or HGV>3.5t	41	36	35	40	35	55	55	48	43	42
Bicycle	41	39	31	62	50	56	63	72	87	93
Car	785	763	808	806	883	911	1004	1027	964	932
Van <3.5t	67	54	47	54	54	64	48	48	56	68
TOTAL	**1148**	**1079**	**1118**	**1180**	**1217**	**1321**	**1420**	**1472**	**1439**	**1440**

Table 19f

The number of collisions with third parties is stable in2017. On the other hand, the collisions with pedestrians and bicycles are significantly increasing since 2008.

6.2.1.b - Evolution of **the proportion of collisions according to third-parties**

The global variation of the breakdown of collisions according to the third party is small for the period analysed.



graph 41

6.2.2 - Third party victims of collisions

For the graphs shown below, we have only taken the third party victims since the report of 2007-2016**.**

6.2.2.a - Table of data

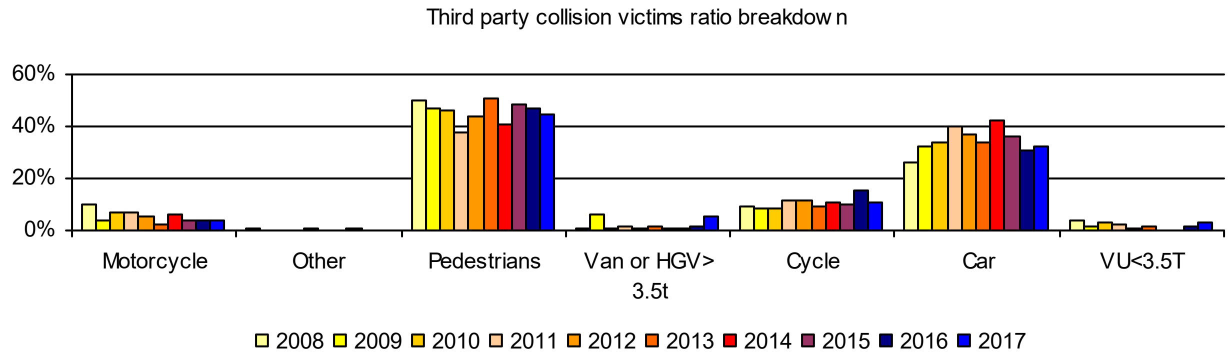
Third party	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Motorcycle	27	12	19	24	14	7	19	12	13	12
Other	3	1	1	0	2	1	0	2	1	1
Pedestrians	136	137	120	125	115	138	134	139	154	147
Van or HGV>3.5t	2	19	3	5	1	4	2	3	6	18
Bicycle	25	24	22	39	29	25	35	28	51	36
Car	71	94	88	132	97	94	139	104	101	108
Van <3.5t	10	4	8	8	2	5	0	1	4	10
TOTAL	**274**	**291**	**261**	**333**	**260**	**274**	**329**	**289**	**330**	**332**

Table 19g

We generally observe a regular variation in third-party victims of collisions each year.
It is important to note a stable number of victims with a stable number of collisions for 2017. The number of victims of the “Public transport or HGV > 3.5t” category is associated to a tram/bus collision.

The cycle and pedestrian victims are decreasingfor 2017 but the trend of their evolution remains to be monitored.

6.2.2.b - Evolution of the proportion of victims of collisions according to the third-party



graph 42

We observe that the breakdown of the third party victims by type of third party differs significantly every year, with marked variations for pedestrians and cars.

This graph confirms that the category that is most vulnerable to collisions and that, on average, they represent half the victims of collisions.

6.2.3 - Third party severely injured victims of collisions

6.2.3.a - Table of data

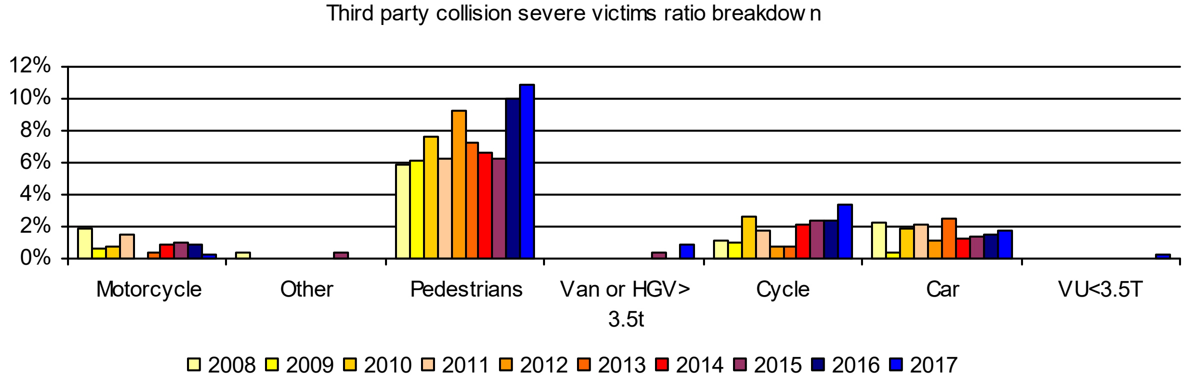
Third party	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Motorcycle	5	2	2	5	0	1	3	3	3	1
Other	1	0	0	0	0	0	0	1	0	0
Pedestrians	16	18	20	21	24	20	22	18	33	36
Van or HGV>3.5t	0	0	0	0	0	0	0	1	0	3
Bicycle	3	3	7	6	2	2	7	7	8	11
Car	6	1	5	7	3	7	4	4	5	6
Van <3.5t	0	0	0	0	0	0	0	0	0	1
TOTAL	**31**	**24**	**34**	**39**	**29**	**30**	**36**	**34**	**51**	**52**

Table 19i

This table confirms the vulnerability of pedestrian third parties thatrepresent the majority of the severely injured victims of collisions with third parties.

For 2016 and 2017, we highlight a significant increase in the number of severely injured pedestrian and cycle victims.The number of severely injured victims of the “Public transport or HGV > 3.5t” category is associated to a tram/bus collision.

6.2.3.b - Evolution of the proportion of third-party severe victims of collisions according to the third-party



graph 43

The proportion of the severely injured pedestrian victims continues to increase since 2016 to go beyond 10 % of all the victims over the period.

6.2.4 - Passenger victims of collisions

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
passengers	45	66	88	66	79	80	104	106	86	111	124

Table 19h

We also observe a significant variation of the passenger victims of collisions according to the years with an increase in 2016 and 2017. The passenger victims represent between a fifth and a quarter of the victims of collisions with third party.

6.2.5 - Data on the causes of collisions with third parties for motorised third parties

Since the previous analysis report of the reported events, we have only taken the collisions with bicycle or motorised third party. **The ratios of the graphs below are thus different from those presented for the previous periods.**

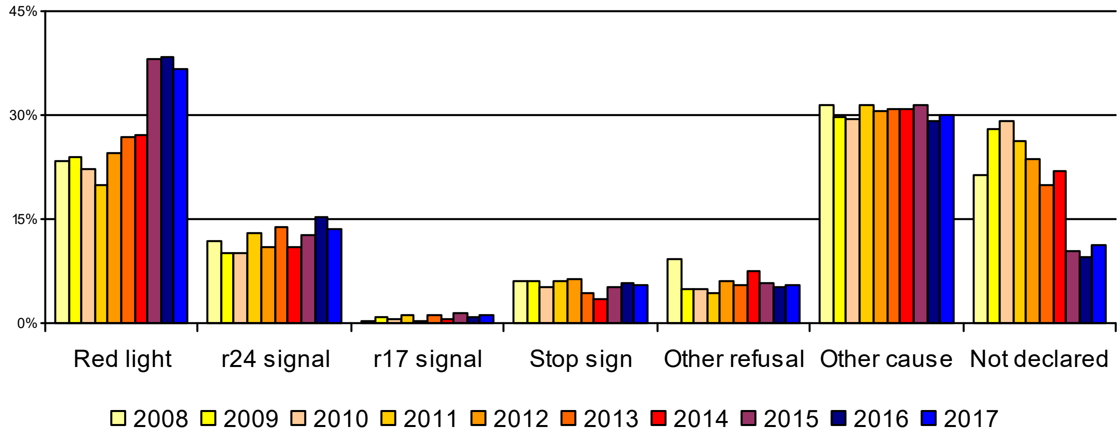
The main cause of collisions with a third-party is non-compliance with signals by the motorcyclist and cyclist third parties.

We later find the prohibited manoeuvres on the platform, and the encroachment of the platform by third parties, that mostly results in only material consequences**.**

6.2.5.a - Disrespect for traffic signals by motorised third parties, bicycles and trams

The graph below shows the ratio of the number of collisions with a third-party to the disrespect for traffic signals by motorised third parties, bicycles and by comparison, the tram driver.

Collisions with third party – disrespect for traffic signals and other causes



graph 29b

The “other refusal" category takes account of the C20c, the give-ways and also the case of a crossroads in degraded mode where the traffic lights signals are in flashing amber.

The other causes pertain to events that are not related to traffic signals. The details about the breakdown of these events is given in the graph below.

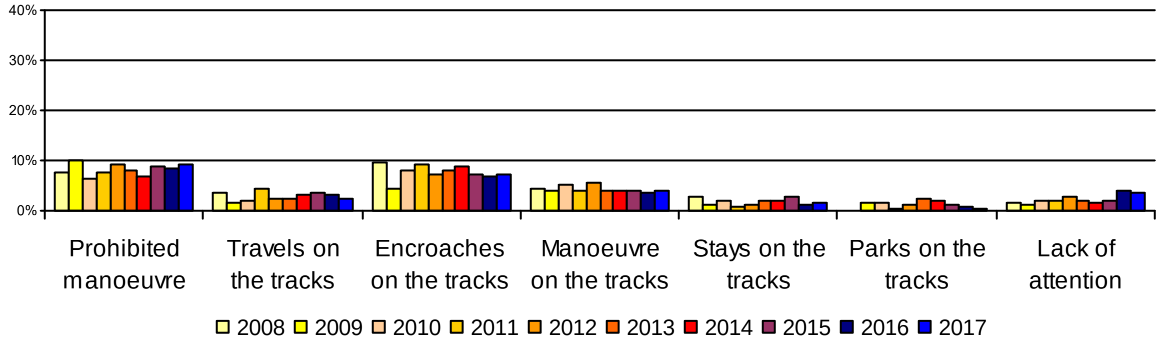
The signals concerned for the tram driver areR17 traffic lights (see Appendix – Main road signals).

We observe a marked increase in the proportion of red lights crossed since 2015. This can be explained by a better quality of declaration by the operators.

6.2.5.b - Other causes for bicycles and motorised third parties

In addition to the previous graph, the graph below provides a representation, for the collisions that are not related to traffic signals, of the ratio of the number of collisions with third party that are related to the behaviour of the bicycle and motorised third parties.This mainly concerns the prohibited movements, U-turns, encroachment of the platform, etc.

Cycles and motorised third party collision causes breakdown



graph 46b

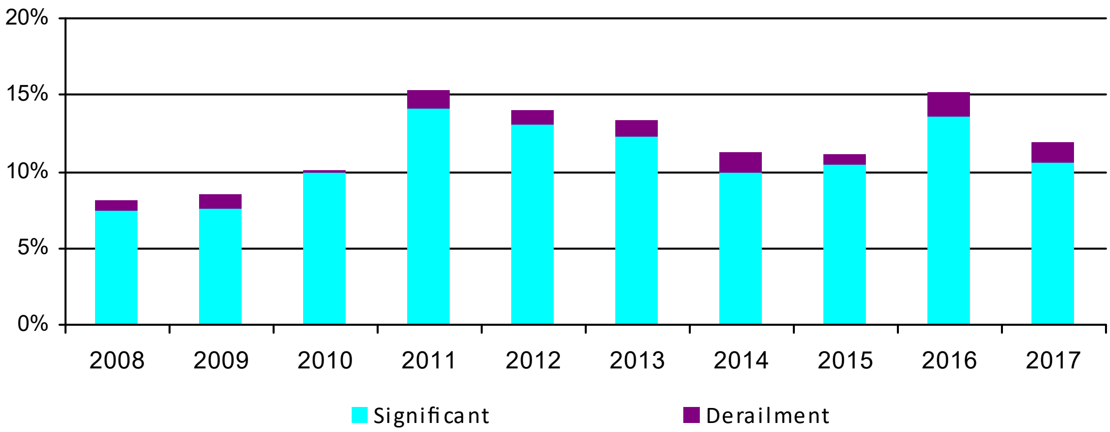
We observe that the main causes of collisions with a third-party, which are not related to the disrespect of conflict signalling, pertain to prohibited operations and encroachment of the platform (when the track clearance of the trams is occupied by third-party vehicles). No specific trend observed over the period.

6.2.6 - Material consequences of collisions with third parties – derailment

The graph below illustrates the material consequences of collisions with third-party: significant damage for third parties as to/for the system, and/or the tram derailment.

For this report, only the collisions with motorised vehicles have been taken into account.

Collisions with third parties – ratio of consequences



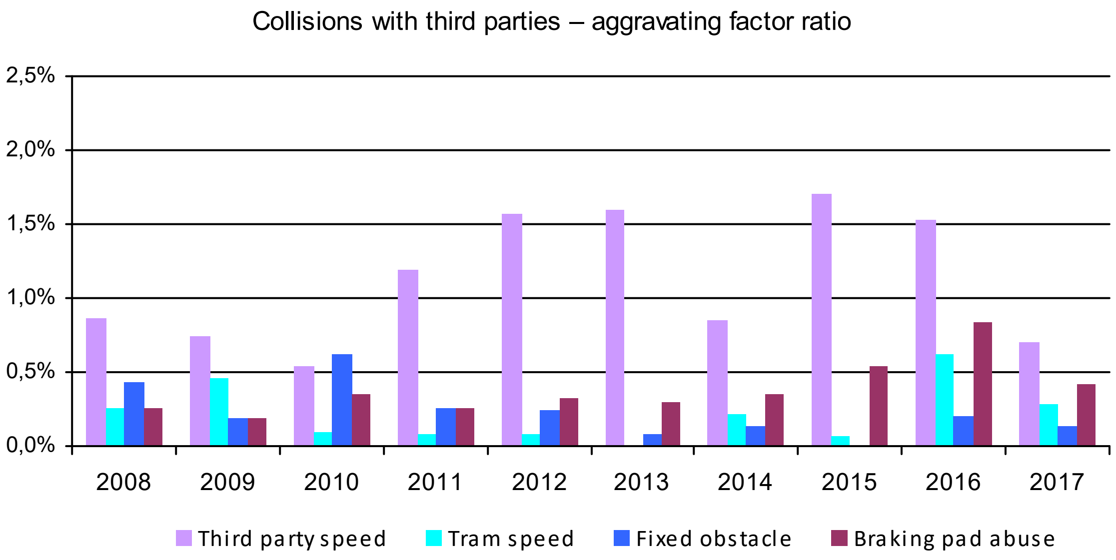
graph 48

The proportion of important physical impact remains below 15%. The increase observed in 2016 is not confirmed in 2017.

Theproportion of the derailments following a collision with a third party involving a car comes to 1.1% in 2017.

6.2.7 - Aggravating factors

The graph below shows the repartition of aggravating factors according to the assessment of the operators in the collisions with third parties.



graph 49

Aggravating factor	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Braking pad abuse	3	2	4	3	4	4	5	8	12	6
Fixed obstacle	5	2	7	3	3	1	3		3	2
Tram speed	3	5	1	1	1		3	1	9	4
Third party speed	10	8	6	14	19	21	12	25	22	10

Table 92_f

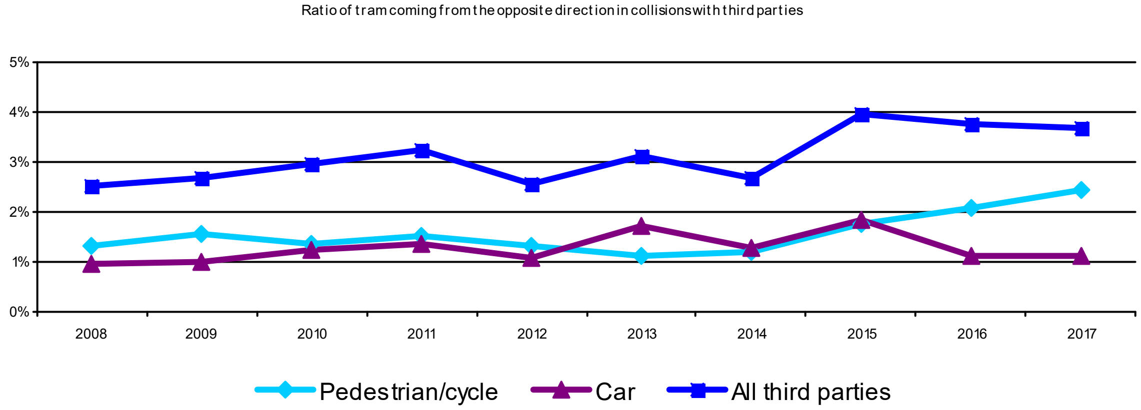
Four categories of aggravating factors have been identified:

- Third-party speed: corresponds to a speed assessed as excessive in view of the declaration of the tram driver and if it aggravated the consequences of the collision
- Tram speed: similarly, the tram speed is considered to be excessive when it significantly exceeds the maximum speed of the considered area or that of the instructions to be followed in view of the event scenario
- Fixed obstacle: pertains to the collisions whose consequences have been aggravated by the third party being caught between the obstacle and the tram
- “Braking pad abuse”: means the practice of using the magnetic brake pads instead of an emergency braking. This practice extends time and braking distances, thus leading to higher speed of tram when striking third parties.

Collisions with third parties for which an aggravating factor has been identified is a very small part of overall collisions; the maximum is reached in 2016 with a little over 1.7% of the total number of collisions concerning the third party speeds.

6.2.8 - Opposite direction tram

The graph below shows the proportion of collisions with third parties whose circumstances appear to involve a tram coming from the opposite direction while crossing a first tram.

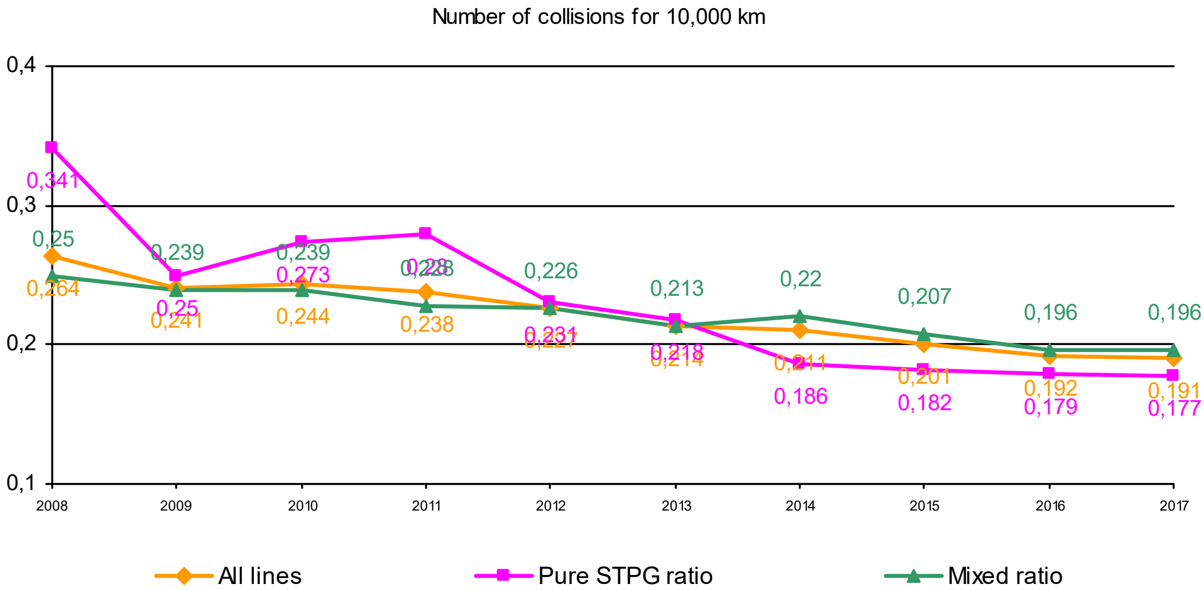


graph 47

With a ratio that is stable since 2015, it is an indicator that must be observed, although it represents a small proportion of collisions with third-parties, with an increase in the common core line operations (predominantly corresponding to the city-centre) and active modes.

6.3 - Monitoring of collisions indicators

6.3.1 - Collisions per 10,000 km travelled



graphi 08

For the indicator of the number of collisions with third parties per 10,000 km travelled, the general trend remains downward. It is important to note a more significant decrease, mainly since 2014, of the ratio of collisions per 10,000 travelled km for the “pure STPG” networks (the lowest ratio since 2006).

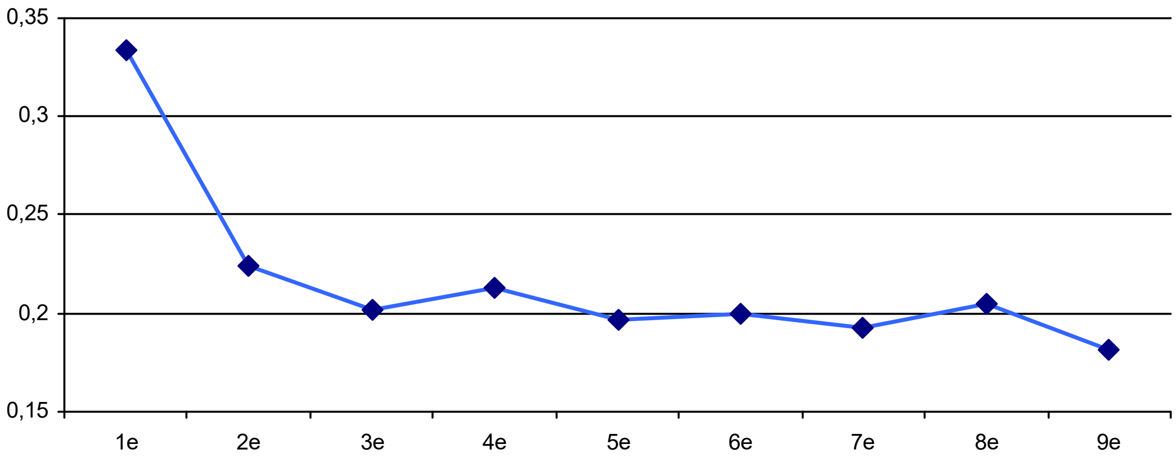
/!\ From the analysis report for the reported events during the period 2006-2015, we retained the comparison between the mixed networks, put into operation before the STPG Decree of 2003, and "pure STPG" networks put into operation in accordance with the STPG Decree (refer to 1.3 - The adopted principles and definitions) . The indicated ratios are not comparable with the "STPG lines" and "conventional lines" ratios presented in the previous annual reports.

6.3.2 - Collisions at the beginning of operating

Some STPG lines have now a significant number of years of operation (up to 10 years in 2017). We found it interesting to observe the rate of collisions at 10,000 km of "pure STPG" networks in the first 9 years of operation.

In order to determine this ratio, we have considered the date of the event and the date of opening of the section. As regards the production in km, it is always the complete year production that is used. As these two elements of information are not on the same temporal base, this rate is to be considered as an estimate.

Collisions ratio for 10,000 km –pure STPG netw orks over the first 9 years of operation



graph 09c

For the first five years of operation, it appears that the ratio of the collisions at 10,000 km, after a significant decrease in the first three years, slightly increases in the following year to again decrease and then become stable, approx. decreasing by 50% overall.

Observing the evolution of the annual rate for each network, we can see this increase for the fourth or fifth year for most of the networks.

As a reminder, the 2017 average ratio of the number of collisions at 10,000 km for the pure STPG networks is 0.177.

7 - Analysis of configurations

The codification of lines allows describing the present configurations on the tram networks and as a result analysing the breakdown of events according to the different configurations. The codification defines nine types of configurations: station, on-street/off-street section, pedestrian/cycle intersection, and six types of road intersection with the tram platform.

The road intersections with turning movement and the gyratories/roundabouts present from the origin the most unfavourable configuration vis-à-vis accidentology. In the next part of the report, there will be a special focus on these intersections.

Please note that, the distinction between gyratories (without the tram, the intersection works like a conventional gyratory with give-way signs and priority to the ring) and roundabouts (even in the absence of tram, all the conflicts between road vehicles are managed by traffic lights) is done by selecting the "R11v" type (red, yellow, flashing yellow) for the entrance light signal of the roundabout / gyratory.

In addition to the types of configuration, our objective sought with the codification is to describe the characteristics of the configurations, in order to identify the parameters of the most accident-prone places, particularly for the intersections.

7.1 - Panel of the sections

The table below shows the number of sections (according to the codification) in operation on 31 December of the year under consideration and their evolution over the last 10 years.

Configuration	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Station	867	892	920	956	1038	1201	1312	1419	1448	1458
On-street/off-street section	2894	3004	3092	3180	3575	4174	4598	4994	5113	5179
Simple junction	458	464	466	473	518	586	626	663	680	683
Turns to	960	1003	1051	1079	1178	1406	1557	1716	1774	1779
Roundabout	128	132	136	145	164	174	179	187	189	189
Gyratory	31	33	33	33	35	45	51	52	52	52
Pedestrian cyclist crossing	3571	3699	3826	3925	4336	5199	5707	6245	6415	6455
Private property access	259	270	279	296	311	381	413	453	458	458
General traffic section entry	23	26	26	27	54	66	77	80	81	86
Complex junction	293	301	307	318	343	394	421	472	482	499
TOTAL	9484	9824	10136	10432	11552	13626	14941	16281	16692	16838

Table 30_f

In 2017 and since the previous changes in the codification method, the most represented sections are the pedestrian/cycle intersections and the on-street/off-street sections.

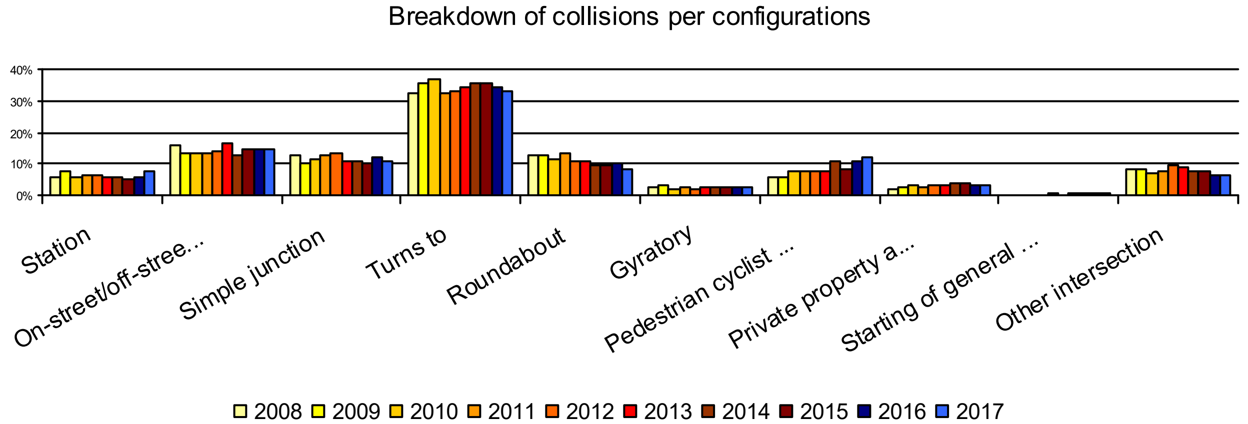
Amongst the road crossings, those with turning movements (the turn left/right) are highest in number, followed by the road junctions of the type “simple intersection”.

/!\ Since 2015, a data reliability operation of the codification has been initiated with the Cerema in connection with the operators, starting with the road intersections. This approach led to changing the types of road intersection, which makes the comparison with the figures of the previous reports unsuitable.

7.2 - Evolution 2008 - 2017

Events considered in this chapter are collisions with a third-party.

7.2.1 - Evolution of the proportion of the number of collisions according to the configuration

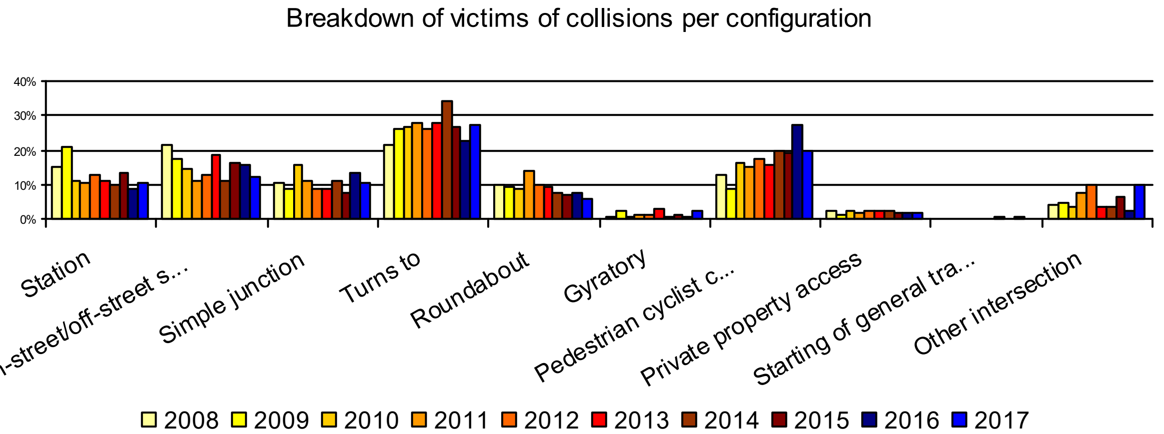


graph 50

Collisions with third parties occur in majority in turn left/right junctions, on-street/off-street sections, simple crossings followed by at the roundabouts. The proportion of the pedestrian/cycles intersections tends to noticeably increase over the period. There is no marked trend for the other types of intersection.

7.2.2 - Evolution of the proportion of victims of collisions according to the configuration

All the victims of collisions with a third party are taken into account in this graph (third party and travellers).

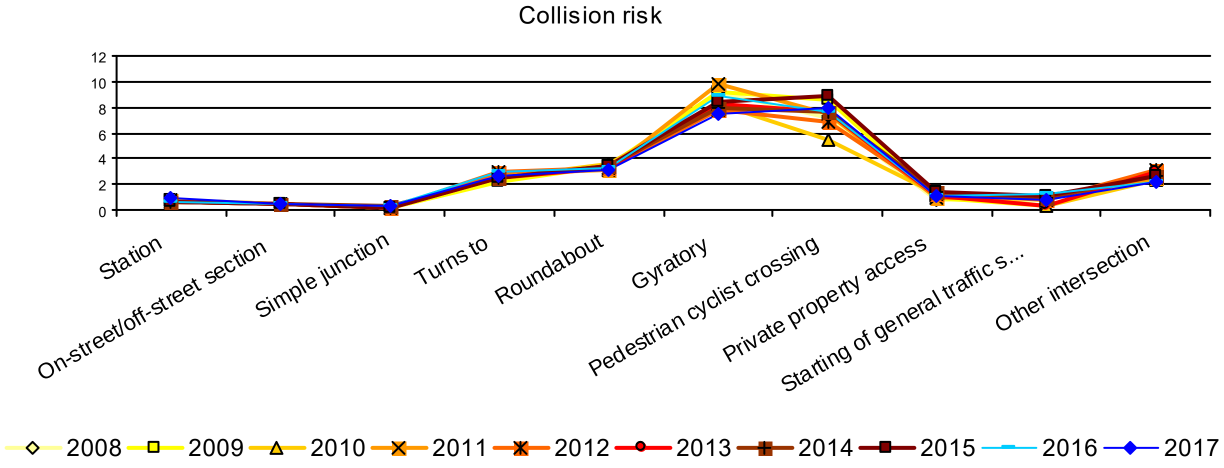


graph 51

The upward trend in the proportion of collisions at the pedestrian/cycle intersections is confirmed by that of the victims. The proportion of the victims of the "other intersection" category is associated to a tram/bus collision.

7.2.3 - Estimated risk

The estimated collision risk corresponds to the ratio between the relative proportion of the collisions for each type of intersection, with the relative proportion of the number of intersections for each type of intersection.



graph 52

We observe that the estimated collision risk ofthe roundabouts and gyratories clearly remains above the other intersections over the entire period.

7.2.4 - Logged and active sections

7.2.4.a - Definitions

We define "**active**" sections which correspond to the sections in service with their current configuration and "**logged**" sections which correspond to their configuration before modification (or abandoned)

This is necessary to ensure the monitoring of accidentology according to the evolution of the urban environment of the tram during its life. This is mainly the case of road crossings whose characteristics are led to be modified: geometry, traffic signals or other components.

For this, the codification allows the conservation of historical configurations.

The collisions are taken into account over the 2007-2017 period (11 years) and the active sections towards the end of 2017.

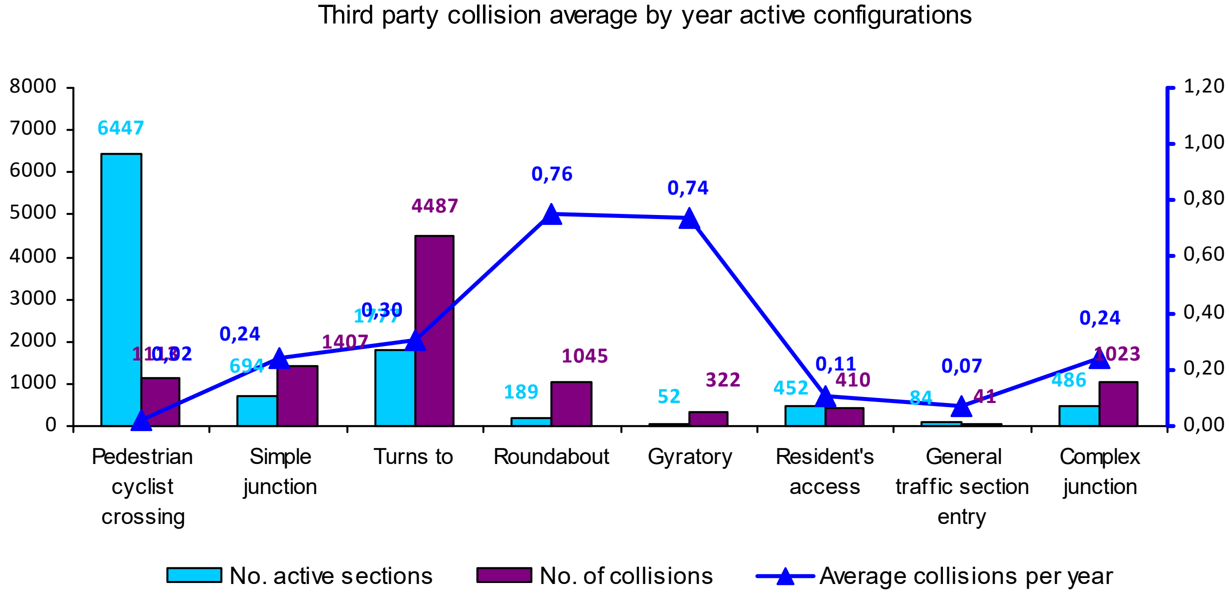
7.2.4.b - Average of the number of third party collisions by year and by type of active configuration

The graph below represents the following data:

- left scale: number of sections and collisions with a third-party allocated to these sections

- right scale: curve of the average number of collisions per year and per type of intersection

/!\ As the calculation of the ratio for accidentology has been changed in this report, the ratios indicated in this chapter are not comparable with the values of the reports generated before 2006-2015.



graph 54b

We observe a significant quantitative difference between the numbers of the different intersection types.

In addition, the trend for the average of the number of collisions per year is the same as the one observed in graph 52 (estimated risk) presented in §7.2.3.

7.2.4.c - Comparison of average number of third-party collisions per year

For the section panel that has been historised in the database since 2007 and according to the category of intersection, the table below indicates the number of logged sections, the yearly average number of collisions for the logged sections, as well as the yearly average number of collisions for the active sections.

Type of intersection	Number of “logged” intersections	No. of associated collisions	Average collisions per year by configuration on "logged" sections	Average collisions per year by configuration on active sections
Pedestrian cyclist cro	174	32	0,03	0,02
Simple junction	86	171	0,62	0,24
Turns to	103	341	0,80	0,30
Roundabout	106	474	1,51	0,76
Gyratory	4	17	0,97	0,74
Resident's access	18	24	0,29	0,11
General traffic sectior	2	0	0,00	0,07
Complex junction	34	54	0,40	0,24

Table 200_a10_a11

This table allows us to see that the "number of collisions per logged configuration" ratio is higher than the one for the current configurations. This will globally demonstrate (for the data for which the sample size is sufficient) a certain effectiveness of the changes implemented over the tram networks.

In the following part of the document, the impact of signalling is analysed for the roundaboutsand gyratories.For a purpose of good understanding, a description of the different types of signs and light signals can be found at Appendix – Main road signals.

7.3 - Roundabouts and gyratories

It should be noted at the beginning that we have not been able to analyse the possible link between the average rate of events per year, size parameters of roundabout and gyratories, width of the ring and the number of entrance lanes, and the road traffic volumes, in the absence of traffic data.

The average collision figures per year represent the average of the number of collisions observed for the configuration, divided by the number of observation years of the configuration.

The collisions are taken into account over the 2007-2017 period (11 years) and the active sections towards the end of 2017.

/!\ As the calculation of the ratio for accidentology has been changed in this report, the ratios indicated in this chapter are not comparable with the values of the reports generated before 2006-2015.

7.3.1 - Average collision ratio for all the roundabouts and gyratories

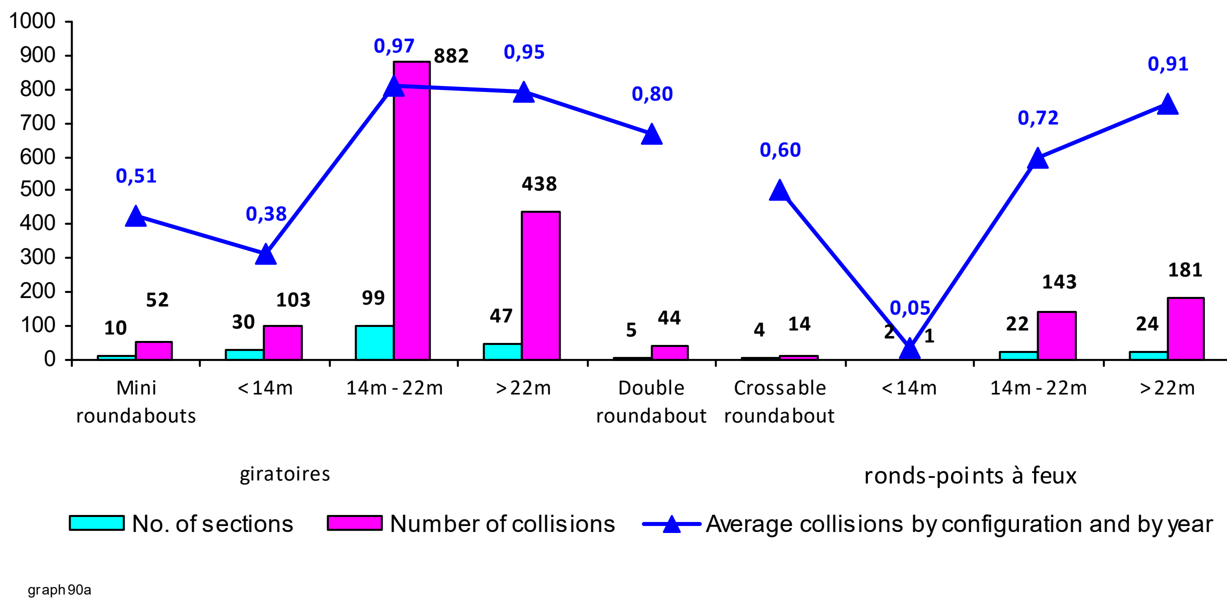
In the graph below, the gyratories are divided into five main categories according to their size, and the roundabouts are divided into four categories.

At the start, we observe the low number of mini roundabouts and double roundabouts, as well as for the gyratories with crossable island and size < 14m.

For these categories, the values of the statistical analyses should be interpreted carefully.

We observe that the average of the number of collisions by configuration and by year for the roundabouts becomes higher for the roundabouts with radius > 14m.

Roundabouts and gyratories – Average collisions by configuration and by year and according to the size



However, comparing some combinations according to this single criterion of size remains irrelevant due to the impact of other criteria in the database (for example: entrance signs).

We observe that the average rate of the “14-22m” category is close to that of the “more than 22m” category; today, it seems necessary to understand this result. In the ongoing study on gyratories, jointly conducted by STRMTG/CEREMA, the influence of the radius of the gyratory in the “14-22 m” category will be studied, which could, if required, lead to deducing two relevant sub-categories from the same.

We will provide details in the following paragraphs about the influence of the size of the ring and the number of entrance lanes for the roundabouts, with a breakdown by roundabout size, as well as the influence of the entrance sign and crossing sign (and their evolution), for roundabouts and gyratories.

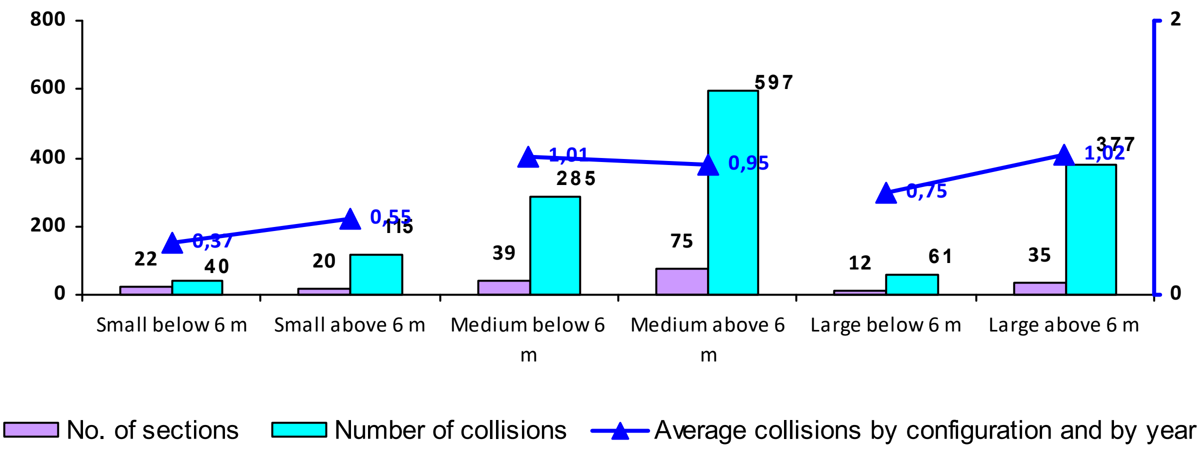
7.3.2 - Impact of the geometry for roundabouts

The criteria of the width of the ring and the number of entrance lanes are only analysed for the roundabouts as the sample relating to the gyratories is very low.

The graphs below represent the impact of the width of the ring and the number of entrance lanes for the roundabouts classified into three “families” according to size: small roundabouts (R<14m), medium-sized roundabouts (14m<R<22m) and large roundabouts (R> 22m).

7.3.2.a - Width of the ring

Roundabouts – collisions ratio according to the ring



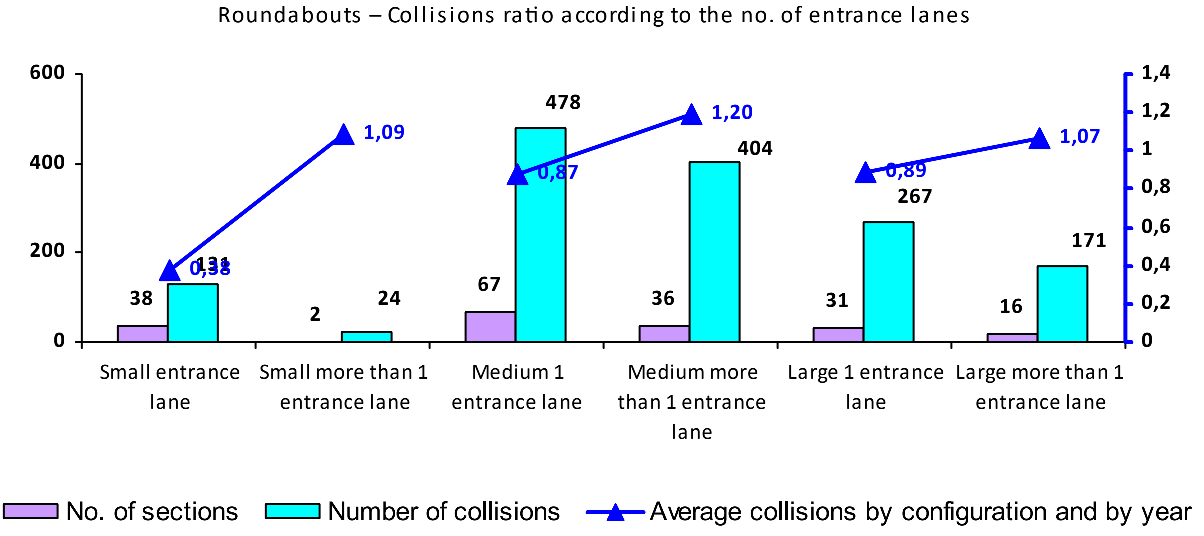
graph 90b

The lowest ratios are observed for the small and big roundabouts whose ring size is below 6 m. However, for the medium-sized roundabouts, the lowest ratio is observed for the roundabouts whose ring size is above 6 m.

We also observed that the small roundabouts have the lowest ratios.

7.3.2.b - Number of entrance lanes

Whatever the size of the roundabouts, the lowest ratios are observed for the roundabouts with a single entrance lane. Beyond the configuration itself, this could be partly explained, particularly by the traffic data, with the sizing of the number of tracks entering the roundabout possibly being linked to this data.



graph 90c

7.3.2.c - Conclusion

The results shown in the graphs above notably demonstrate that small roundabouts have lower ratios in terms of collisions with third parties. This ratio decreases as the width of the ring becomes smaller or the number of entrance lanes reduce. **This seems logical because such a geometry limits the traffic and speed near the platform.**

7.3.3 - Impact of traffic lights for roundabouts

In the following, the concept of "reinforced signalling" means more than 2 signals per crossing.

As the codification of the roundabouts has been fully verified in 2015, we are committed to understanding the impact of the evolutions of the sections for the upstream (entrance) (ES) and crossing (CS) signalling. For this, we have determined the following 10 categories:

Category	No. of sections	ES_earlier	CS_earlier	ES_present	CS_present
cat0	127	unchanged	unchanged	unchanged	unchanged
cat1	26	Nothing or static	R24	Nothing or static	R24 reinforced
cat2	1	Nothing or static	R24 reinforced	R24 reinforced	R11j
cat3	28	R11j	R24	Nothing or static	R24 reinforced
cat4	2	R11j	unchanged	R24	unchanged
cat5	1	unchanged	R11v	unchanged	R24
cat6	1	R11j	R24	R11j	R24 reinforced
cat7	1	R11j	R24	R24	R24 reinforced
cat8	1	Nothing or static	R11j	Nothing or static	R11v
cat9	1	Nothing or static	Nothing or static	Nothing or static	R24
cat10	1	Nothing or static	R11j	Nothing or static	R24 reinforced

Table 09 – Signalling evolution category

This made it possible to observe the roundabouts in greater detail by distinguishing between the sections without any evolution in signalling and those that have had an evolution in signalling.

7.3.3.a - The roundabouts whose signals did not change

The roundabouts concerned are those of category 0: this means that the roundabouts may have undergone a change in codification but without any change in the traffic lights.The other changes often pertain to the visibility conditions (visual mask or visibility of the tram track).

The summary table below shows the overall results for the sections in this category. For each crossing and upstream signal configuration, we recalled the number of active sections at the end of2017, and the average of the number of collisions by configuration and by year.

The boxes in red correspond to configurations for which the samples are the most important

	Upstream Entrance					
Crossing sign	Nothing or static		R11j		R24	
Nothing or static	3	0,89	8	0,42	3	0,10
R1	1	2,18				
R24 simple	19	0,94	1	0,18		
R24 reinforced	35	0,60			1	0,00
R11v simple	26	0,76	8	0,80		
R11v reinforced	4	1,07				
R11j simple	2	0,30	5	0,70		
R11j reinforced	2	0,82	1	0,00		

We … iding the size of
- A …
the …
- fo … R24 reinforced"
sign … s lower than the
one … R24 simple for
cros …

7.3 …

The table below presents the following data for the roundabouts of category other than 0 and whose number is statistically significant:

- The number of sections concerned (validity of the sample) active at the end of2017,
- the average of the number of collisions per configuration and per year, before and after the modification of signalling.

Categ.	No. of sections	Sig. before(entry + crossing)	Avg. before	Sig. after (entry + crossing)	Avg. after
cat1	26	nothing or static + R24 simple	1.73	nothing or static + R24 reinforced	1.14
cat3	27	R11j + R24 simple	1.26	nothing or static + R24 reinforced	0.99

Table 210_b

We can therefore analyse the categories 1 and 3 that pertain to the roundabouts whose upstream signalling has been changed to have no light signalling, and whose crossing sign has been changed to "R24 reinforced" in place of "R24 simple".

We observe that ratios obtained for configuration with "R24 reinforced" crossing type signalling enable a lowering of the number of collisions per configuration with respect to the one with "R24 simple" crossing sign.

7.3.4 - Impact of traffic lights of the gyratories

The table below shows the overall results for the gyratories whose signalling has not changed.For each crossing signal configuration, we recalled the number of active sections at the end of2017 and the average of the number of collisions by configuration and by year.

The boxes in red correspond to configurations for which the samples are the most important

Upstream Entrance	Crossing sign	No. of sections	Evt average per year
R11v	Nothing or static	11	0,57
R11v	R24 reinforced	4	0,72
R11v	R11v simple	17	0,62
R11v	R11v reinforced	6	1,40
R11v	R11j	12	0,65

Table 210_c

It appears that in the case of gyratories no trend stands out particularly as long as the samples are low. It seems that having a light signalling for crossing sign does not improve ratios.

We did not carry out an analysis of the sections with a modification in signalling insofar as only two sections were affected.

It should be noted however that these elements should be treated with caution since they do not take into account the local context and in particular the road traffic data.

7.4 - Turn left/right - Impact of traffic signs type

As the verification of the codification of the "turn left/right" is completed at the end of 2017, with the active collaboration of the operators, the reliability of the data for this configuration allows us to carry out an analysis of the accidentality.

For this, in order to refine the analyses related to this category for better understanding of the risk associated to the turn left/right manoeuvre, we have taken into account only those collisions for which the third-party (car, van or public transport) in question was reported to be carrying out this operation.

This leads to retaining only 2196 collisions out of the 4250 collisions occurring on this type of intersection; for others, the reported operation is "go straight" or is not reported.

The summary table below shows the overall results of the possible configurations in "turn left/right", grouped into upstream and crossing signalling; for each of them, we are dealing with the number of active configurations and the average number of collisions per year.

	Sig. Crossing									
Sig. Upstream	Nothing or static		R11v		R24		R24_barriers		Other	
Nothing or static	83	0,16	48	0,18	69	0,21	12	0,02	15	0,14
R11v	1128	0,11	39	0,28	70	0,18	13	0,02	6	0,08
R11v_dedicated	37	0,27	8	0,27	4	0,00				

Table 210_a7

The boxes filled in red correspond to configurations for which the samples appear to be sufficient enough (more than 30 configurations) to be able to make relevant analyses.

Overall, we observe the following items:

- the ratio obtained in configurations without upstream and crossing signalling is quite low (0.16). After examination, it appears that these configurations are mainly lateral layout configurations with a street crossing the platform giving access to general residential areas with low traffic.

- the configurations without upstream signalling have a similar ratio with R11v (0.18) or with R24 (0.21) with crossing; they generally correspond to the crossings with low traffic.

- the ratio with the upstream R11v signal is very favourable with no crossing signalling (0.11). These configurations correspond to road crossings in which no other vehicle is permitted to pass during the tram phase, which enables obtaining a better ratio.

- we also note that configurations with **R14 upstream signs do not give a very good ratio and confirm the comments of the National technical instruction for road safety on the difficulty for the user to understand it well.**

8 - Conclusions

8.1 - Constant factors

- The collision with third parties and passenger events are in the majority.
- The occurrence of severe victims is higher during collisions with third party with respect to passenger events.
- The “roundabout”, “gyratory” and “turn left/right” configurations present the highest estimated collision risk.

8.2 - Reasons for satisfaction

- The decreasing trend for number of collisions at 10,000 km for all networks.
- The advantageous comparison for the tramway of the number of collisions at 10,000 km with respect to the bus, on a significant sample of 5 networks.
- The low proportion of aggravating factors, including fixed obstacles and tramway speed, in collisions with third parties.

8.3 - Confirmations

- The proportion of the "opposite direction tram" is low in the accidentology: around 4% collisions. However, this point is to be monitored taking into account its evolution since 2015 even if it tends to become stable
- The proportion of severely injured passenger victims, related to an emergency braking (all EB together), remains lower than 3% (1.6 % in 2017) of all the passenger victims; the proportion of passenger victims related to a “dead man device” emergency braking will have to be observed following the implementation of the recommendation of the STRMTG of 14 February 2017 pertaining to the alert associated to the triggering of the emergency braking of the dead man device function.
- The existence of end of track events whose risk has been taken into account by the recommendation relating to the setting up of end of track devices close to spaces used by third-parties of 4 November 2016.
- The following points are confirmed in relation to roundabouts:
  - For criteria relating to geometry, the “average of the number of collisions per year” ratio is lower for the small roundabouts with a radius less than 14 m. The possible link with traffic levels cannot be established as we have no data
  - For criteria related to signalling, considering the different samples sizes, only a global analysis of the roundabouts was made (without including the dimension of the external radius). We essentially observe that the “average of the number of collisions by configuration and by year” ratios obtained for the roundabouts without upstream light signalling, and whose signalling has not changed, are lower with “R24 reinforced” for crossing sign with respect to the configurations with “R24 simple” for crossing sign.

8.4 - Analysis of “turn left/right”

- The road crossings where no vehicle is allowed to pass during the tram phase have the lowest ratio of the “average number of collisions per year”. This confirms the effectiveness of the “full red” during a tram phase.
- The configurations with R14 upstream do not give a very good ratio and confirm the comments of the National technical instruction for road safety.

8.5 - Remaining cause of concern

- The severely injured cycle and pedestrian victims (increasingover the period) that now represent approx. 14% of the third-party collision victims.

9 - Appendix – Main road signals

Type of signal	Name of signal	Number NATIONAL TECHNICAL INSTRUCTION FOR ROAD SAFETY	Representation
Priority signs	Give way – Position sign	AB3a	
	Stop sign – Position sign	AB4	
Mandatory signs	Trams only	B27b	
Information signs	Trams crossing (position sign)	C20c	
Warning signs	Trams crossing ahead (advanced sign)	A9	
Intersection traffic light signals	Intersection signals	R11	R11j
	Intersection pedestrian signals	R12	
	Three-colour modal signals	R13b	
		R13c	
	Directional signals	R14	
Intersection traffic light signals	Anticipation signals with flashing arrows	R16	
	Public transport signals	R17	R17
	Public transport directional signals	R18	R18g R18d
Other traffic light signals	Flow control signals	R22	R22j

Type of signal	**Name of signal**	**Number NATIONAL TECHNICAL INSTRUCTION FOR ROAD SAFETY**	**Representation**
	Public transport line crossing - pedestrian/cyclist signals	R24	R24
	Public transport line crossing	R 25	

Technical department for ropeways
and guided transport systems
STRMTG

1461 rue de la piscine - Domaine Universitaire
38400 Saint Martin d'Hères
Tel: +33 (0)4 76 63 78 78
strmtg@developpement-durable.gouv.fr