REPORT

MEDDTL

DGITM

Technical Department for Mechanical Lifts and Guided Transport systems

TramWay Division

December 2010

ACCIDENTOLOGY OF TRAMWAYS

Analysis of reported events

- year 2009

- evolution 2003 - 2009

Ressources, territoires, habitats et logement
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0.1	23 December 2010	Version 1
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Contents

INTRODUCTION

This report presents the results of the operation of the tramway accident database for 2009, with the evolution of accidentology since 2003, the first year for which data were recorded. This national database is created from declarations by operators.
The term “tramway” covers systems on rails and rail-guided systems on tyres.

The report largely follows the same format as for earlier years. We have slightly restructured the report by creating a separate section devoted to an analysis of collisions with third parties. A further change is the introduction of an analysis of collisions with pedestrians.
In addition, we have attempted a brief analysis of any effect of the tram colour on the risk of collision.

1. REMINDER ON THE SUBJECT OF THE DATABASE

More detailed information on the database is provided in the 2004 tramway accidentology report and the present Report will merely reiterate the essential points.

1.1 THE FIELDS IN THE DATABASE

The database fields contain the following information:

- Network identification (city and operator)
- Type of event, based on a predefined list of undesirable events
- Temporal position (date and time)
- Geographical position (line, tramway line, tram number, site of event)
- Configuration of the site of the event, using a predefined coding system
- Environment of the event (external conditions: adhesion, visibility, degraded operation, works, etc.)
- Bodily, material and operating consequences (duration of disruption)
- Record of system parameters (according to driver's statement or data from tachymetric system)
- Police report (yes or no)
- Circumstances of the event (summary of event, suicidal action, third-party manoeuvre, etc.)
- Follow-up action taken (investigation in progress, planned modification, action plan launched, etc.)

1.2 THE CODIFICATION OF TRAMWAY LINES

Codification consists of describing the various tramway line configurations in order to create a descriptive database common to all the lines. The system makes it possible to analyse events in all networks according to the characteristics of the sites where they occur, to make comparisons between configurations and to identify the most accident-prone.
New lines and extensions of existing lines are codified as and when they enter service.
Please note that the year 2010 was devoted to a total revision of codification. The new codification system aims to give a more precise description of the various existing configurations, particularly for intersections, by identifying crossings which permit "TURN" movements and the different signs or light signals.
This should be operational in 2011 and hence used for the accident report on 2010 events.

1.3 DATA

The information comes from operator declarations. The serious work by operators to complete the database should be underlined. However, not all the information to be entered in the database is yet available for all networks, and declaration procedures differ from one network to another. Some networks declare all events, while others declare only those events which are likely to result in a claim against their insurers. As in previous years, we again see significant differences between networks, **which leads us to remain prudent in considering the raw annual results and to give priority in the analysis of their evolution**.

2. SCOPE OF STUDY

2.1 SYSTEMS IN SERVICE

Operational tramways were present in 19 urban areas in 2009, representing 44 tramway lines – 41 lines on rails and 3 tramway lines on tyres.

2.2 SYSTEMS ANALYSED

In the analysis of accidentology, account was only taken of the network lines for which production in km or journeys was declared. Thus certain lines which were operated commercially for only a very short period in the year and for which no production declaration was made are excluded from analysis for the year concerned. This was the case, for example, in 2006 for Clermont-Ferrand Line 1, T3 in Lyon and Paris, Montpellier Line 2, etc.
The analysed networks are summarised in the following table:

Urban area	Type	Number of lines	Production in 2009		Opening	Remarks
			Mkm	Mjourneys		
Bordeaux	Rail	3	4.35	59.39	2003	A line December 2003 B and C lines May 2004
Caen	Tyres	2	1.23	8.54	2002	
Clermont-Ferrand	Tyres	1	1.13	14.27	2006	1rst line November 2006
Grenoble *	Rail	4	3.93	43.47	1987	C line may 2006 D line october 2007
Le Mans *	Rail	3	1.34	12.28	2007	November 2007
Lille	Rail	3	1.47	8.71	1874	
Lyon *	Rail	4	4.21	48.83	2000	T3 line december 2006 T4 line april 2009
Marseille *	Rail	2	1.15	14.02	2007	June 2007
Montpellier *	Rail	2	3.37	45.00	2000	2nd line december 2006
Mulhouse *	Rail	2	0.95	13.39	2006	1rst and 2nd line May 2006
Nancy	Tyres	1	1.00	9.94	2001	
Nantes	Rail	3	4.83	65.77	1985	
Nice *	Rail	1	1.01	21.90	2007	1rst line November 2007
Orléans	Rail	1	1.51	11.35	2000	
Paris Ile de France	Rail	3	3.50	89.10	1992	T3 line december 2006
Rouen	Rail	1	1.42	15.21	1994	
Saint-Étienne *	Rail	2	1.66	18.38	1881	Line n°5 october 2006
Strasbourg	Rail	5	5.55	61.00	1995	E line august 2007
Valenciennes *	Rail	1	1.16	6.61	2006	1rst line july 2006
19 urban areas		**44 lines**	**44.77**	**567.167**		

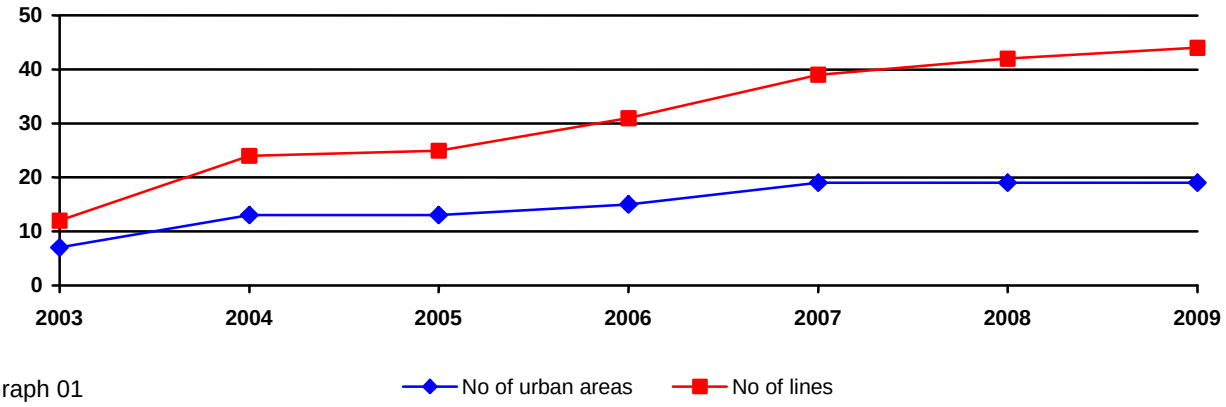
Table 00

* : networks including one or more lines which were not operated commercially for a full year in the analysis period 2003-2009.

2.3 *EVOLUTION OF THE SYSTEMS ANALYSED*

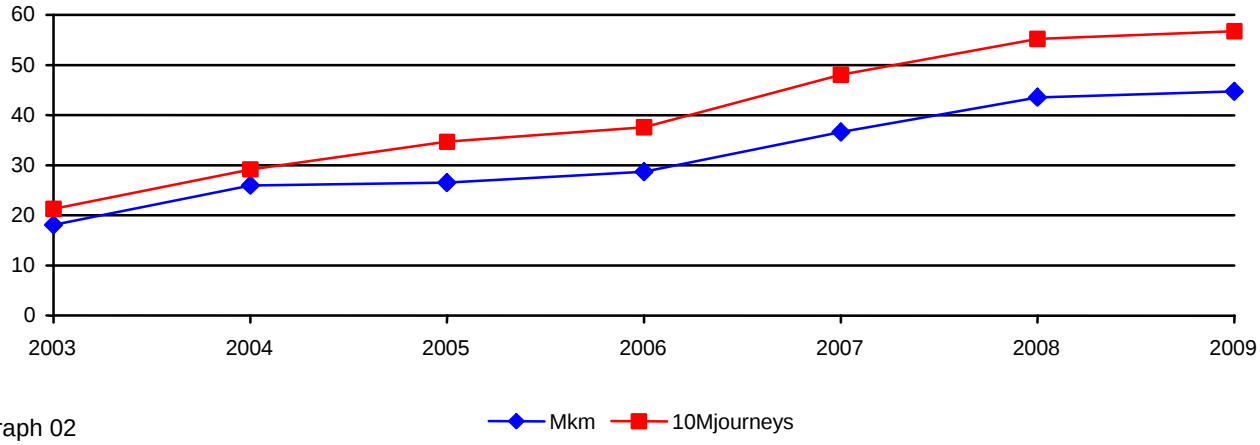
The evolution is represented by the graphs below: in numbers of urban areas and lines, then in production in km travelled and journeys.

Number of urban areas and lines



Graph 01

Elements of production



Graph 02

3. RESULTS

3.1 GENERAL

3.1.1 Overall data for 2009

The number of declarations processed was **1698**, breaking down as follows in accordance with the established list of undesirable events:

Events		Victims									
Type	No	Total	Totals:			Third party			Passengers		
			Slightly injured	Seriously injured	Fatalit.	Slightly injured	Seriously injured	Fatalit.	Slightly injured	Seriously injured	Fatalit.
Fire, explosion	3										
Panic	0										
Electrocution	0										
Derailment	17	1	1						1		
Passenger accidents	514	556	551	5					551	5	
Collision between trams	10	1	1						1		
Collision with fixed obstacle	11	2	2						2		
Collision with third parties	1082	380	357	17	6	271	17	6	86		
Other events	61	3	3			3					
Totals:	**1698**	**943**	**915**	**22**	**6**	**274**	**17**	**6**	**641**	**5**	**0**

Table 03

Three categories of event account for the majority of declarations: collisions with third parties, passenger accidents and other events.

3.1.2 Remarks concerning the victims

It is important to define what is meant by a “victim” in this report.

Persons who do not emerge unharmed from an event are designated as victims and declared as such by the operators. This concept in no way prejudges the seriousness of personal injuries.

The definitions of serious injuries and fatalities are however those accepted and used within the European Union.
Seriously injured = duration of hospitalisation more than 24 h.
Fatal = death within the 30 days following the event.

These statistical elements on the nature of the victims clearly depend on the information available and the extent of the operator's knowledge.

3.1.3 Remarks concerning the events

3.1.3.1 Fire, explosion

3 events in 2009:

- Fire in a tram on tyres following heating caused by a seized wheel brake
- incipient fire on one axle of a tram on tyres caused by a brake seizure
- incipient fire in a tram wheel mud flap due to rubbing by the tyre

3.1.3.2 Derailment

Of the 17 events:

- 9 cases of guide rail malfunction on tram on tyres
- 1 derailment caused by running over an cowcatcher which had fallen onto the track
  - derailment in an tram junction caused by a switch automatic positioning when a train was passing (modification of the PLC)
- 1 derailment caused by a driver error : speed too high for the configuration of the site
- 3 derailments due to driver error when turning back at terminus
- 2 incidents of passing the end-of-line derailer, one of which resulted in significant damage

3.1.3.3 Passenger accidents

This category of event is analysed later in this document (Chapter 3.4).

3.1.3.4 Collision between trams

Of the 10 declared collisions, 8 were harmless events involving rear view mirror contact on tram on tyres. The 2 others resulted from low-speed driving errors

3.1.3.5 Collision with obstacle on track

These events require no particular comments for 2009.

3.1.3.6 Collision with third parties

A detailed analysis of the category can be found in Chapters 4 and 5 of this Report. We now relate the circumstances of the 7 fatal events.

- Five pedestrian events

Two losses of balance when crossing the track
Two pedestrians unexpectedly crossing in front of a tram
One pedestrian crossing in front of a tram which was restarting after a saturated junction cleared.

- One incident involving a scooter

Hidden by a bus, a scooter ran a red light at high speed and collided with a tram.

3.1.3.7 Other events

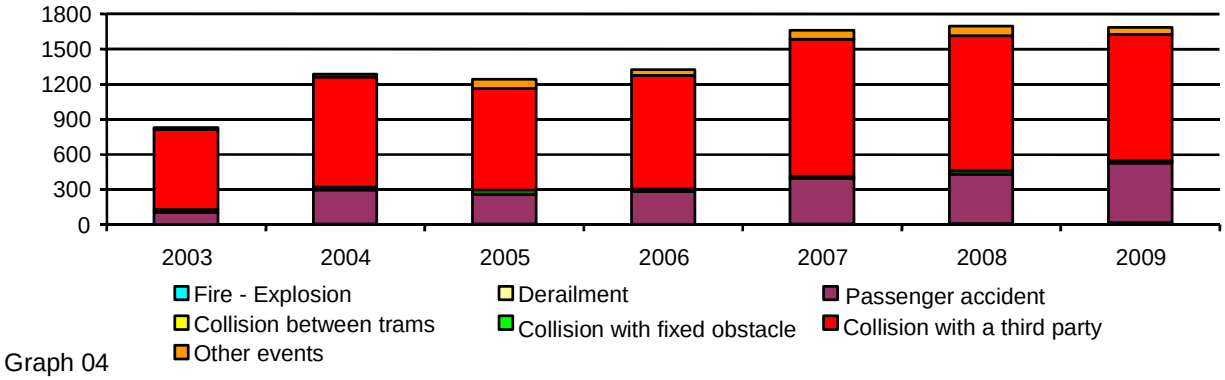
As the name suggests, this category covers events which do not fall within the other types. We therefore find mainly the following:

- Events affecting the system: 8 events, including 6 tram on tyres brake caliper breakages
- Acts of vandalism or incivility: 53 events, 43 of which were declared by a single network (a recurring item in declarations from this network)

3.2 EVENTS

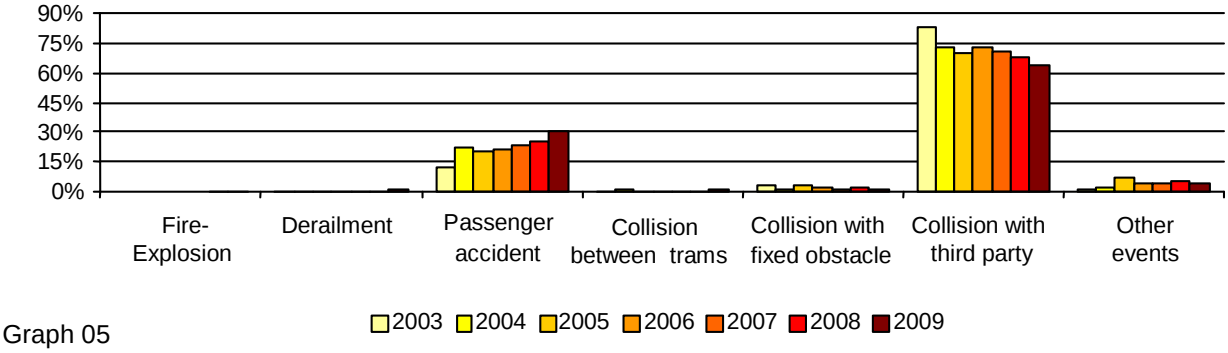
3.2.1 Breakdown by type – evolution 2003-2009

3.2.1.1 All events - raw data



Graph 04

3.2.1.2 All events - relative distribution

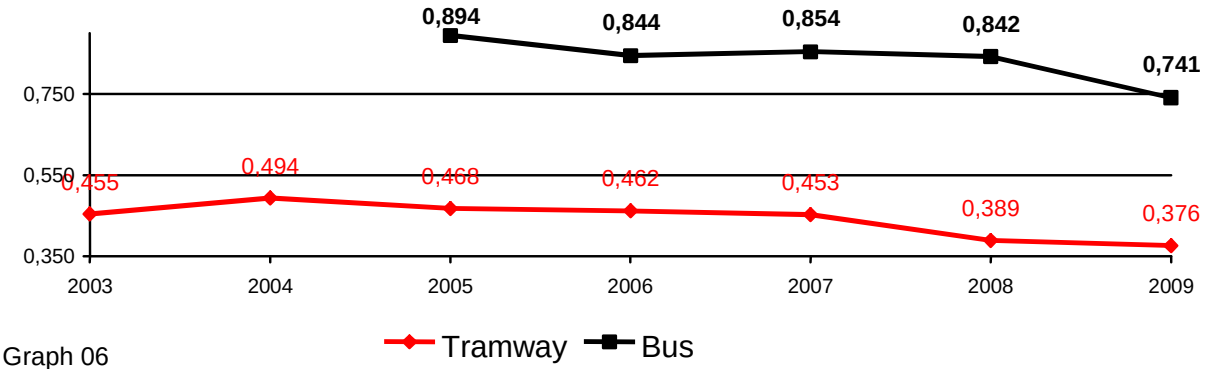


Graph 05

We observe a breakdown of events which is virtually identical for the seven years, with contrary trends in passenger accidents and collisions with third parties.

3.2.2 Possible indicator for event monitoring : comparison with bus systems

The number of events per 10,000 km is a routine indicator for certain tram and bus systems. We obtained accidentology information for 5 bus networks. These were the following networks: Bordeaux, Marseille, Nantes, Nice and Paris. The events taken into account for buses are broadly the same as those for trams: collisions with third parties, essentially passengers.
Applying this to all the networks which declared their production, we obtain the following graph:



Graph 06

Although there were different panels for the urban areas compared, it remains true that, for this indicator, the comparison with buses is advantageous to tram systems.

3.3 EVENTS – ANALYSIS OF "STPG LINES"

3.3.1 Introduction – definition of panel

We refer to "STPG" lines as opposed to "conventional" lines: this is a linguistic device to allow easy identification of tram systems constructed under the definition of the STPG Decree of 2003.

This means that STPG lines are those which entered commercial operation from the year 2006.

They are summarised in the table below:

Urban area	Name of line	Type of system	Entry into service:
Clermont-Ferrand	Line 1	Tram on tyres	13/11/2006
Grenoble	Line C	Rail	20/05/2006
Grenoble	Line D	Rail	06/10/2007
Le Mans	Line 1	Rail	14/11/2007
Lyon	T3	Rail	04/12/2006
Lyon	T4	Rail	20/04/2009
Marseille	Line 1	Rail	01/06/2007
Montpellier	Line 2	Rail	16/12/2006
Mulhouse	Tram 1	Rail	12/05/2006
Mulhouse	Tram 2	Rail	12/05/2006
Nice	Line 1	Rail	26/11/2007
Paris / Paris Region	T3	Rail	16/12/2006
Saint-Etienne	Line 5	Rail	06/10/2006
Valenciennes	Transvilles-1	Rail	03/07/2006

Table 06ter

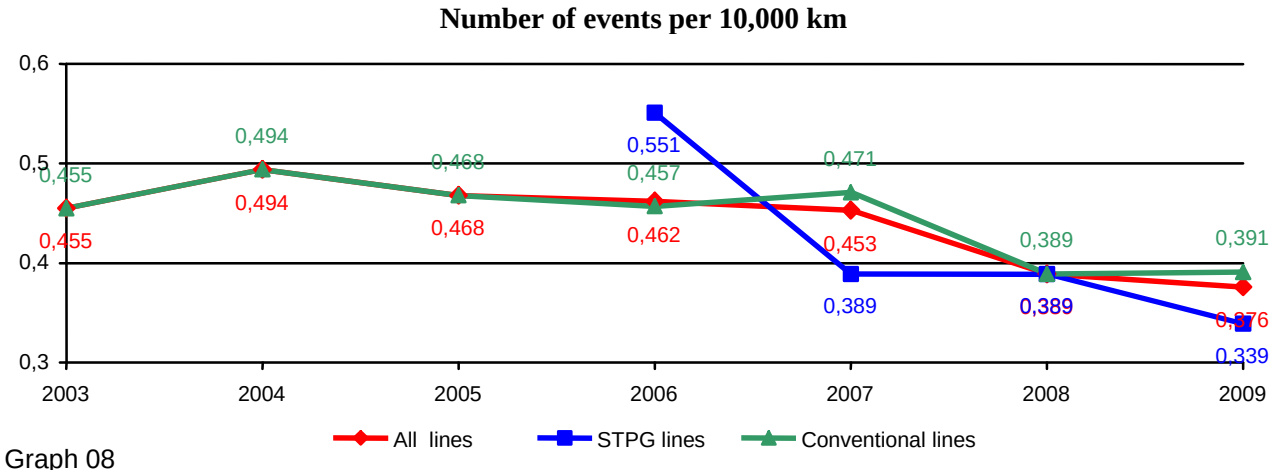
We point out, however, that the present configuration of the accident database does not allow us to identify STPG extensions of conventional lines and thus to make a comparative analysis of accidentology. The new database scheduled for 2011 should allow this.

These STPG lines together, for the years 2006-2009, represent the following production parameters :

	2006	2007	2008	2009
km	5%	22%	27%	28%
Journeys	4%	20%	27%	28%

Table 07

3.3.2 STPG lines – event monitoring indicator



Graph 08

After two opposite and significant deviations in 2006 and 2006, we observe an alignment of indicators in 2008, together with a more significant reduction of the indicator for STPG lines in 2009.

3.4 BREAKDOWN OF VICTIMS

3.4.1 Year 2009

3.4.1.1 All victims

The number of victims resulting from events in 2009 amounts to **943**. It breaks down as follows according to the nature of the events and the victims:

	Victims		Third party victims			Passenger victims		
			Total	%	Seriously inj. + fatalities	Total	%	Seriously inj. + fatalities
Fire, explosion								
Panic								
Electrocution								
Derailment	1	0.1%				1	0.2%	
Passenger accidents	556	59%				556	86.1%	5
Collision between trams	1	0.1%				1	0.2%	
Collision with fixed obstacles	2	0.2%				2	0.3%	
Collision with third parties	380	40.3%	294	99%	23	86	13.3%	
Other events	3	0.3%	3	1%				
Totals:	**943**	**100%**	**297**	**31.5%**	**23**	**646**	**68.5%**	**5**

Table 09

The two main events which result in victims are passenger accidents and collisions with third parties; the majority of the victims are passengers.

Collisions with third parties are however more serious consequence and account for the 23 serious injuries and fatalities observed.

3.4.1.2 Passenger victims of passenger accidents

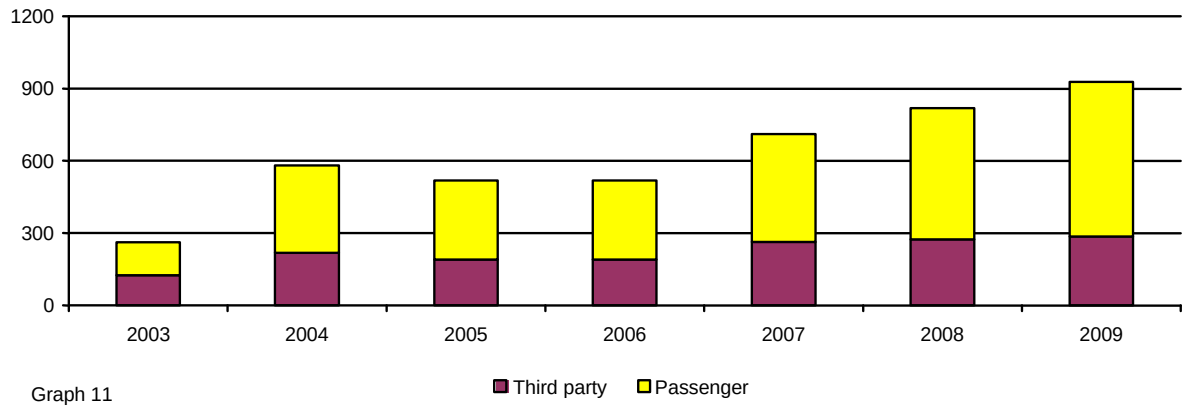
In addition to collisions with third parties, passengers can be the victims of “passenger accident” events, which represent more than 86% of all victims among passengers
This event breaks down into the following different types:

Falls in the tram	463	83.3%	Including 311 - 67% after an emergency braking The majority (72%) of passenger victims is caused by falls in the tram, most of these falls (67%) being a result of emergency braking
Falls from the tram onto the line	0		
Falls from the tram at the station	25	4.5%	
Falls from the platform	15	2.7%	
Trapping in the tram	50	9.0%	
Dragging by the tram	3	0.5%	

3.4.2 2003-2009 evolution

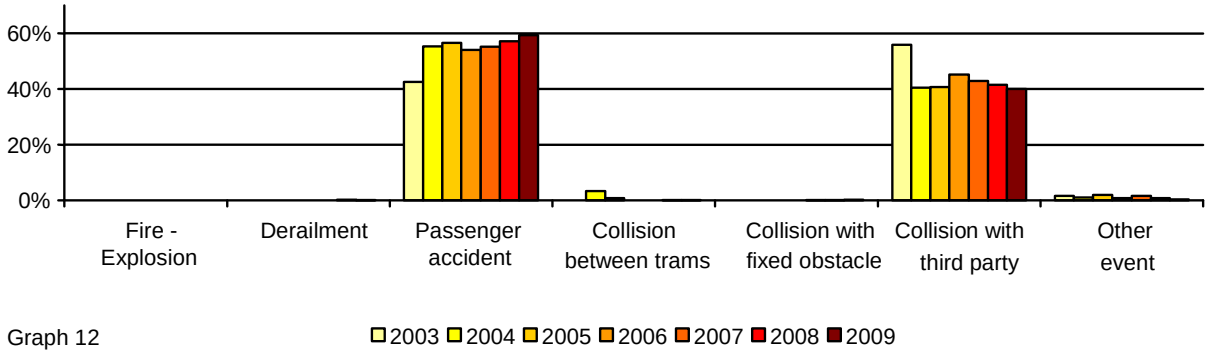
3.4.2.1 All victims

- Raw data



Graph 11

- Annual breakdown by event



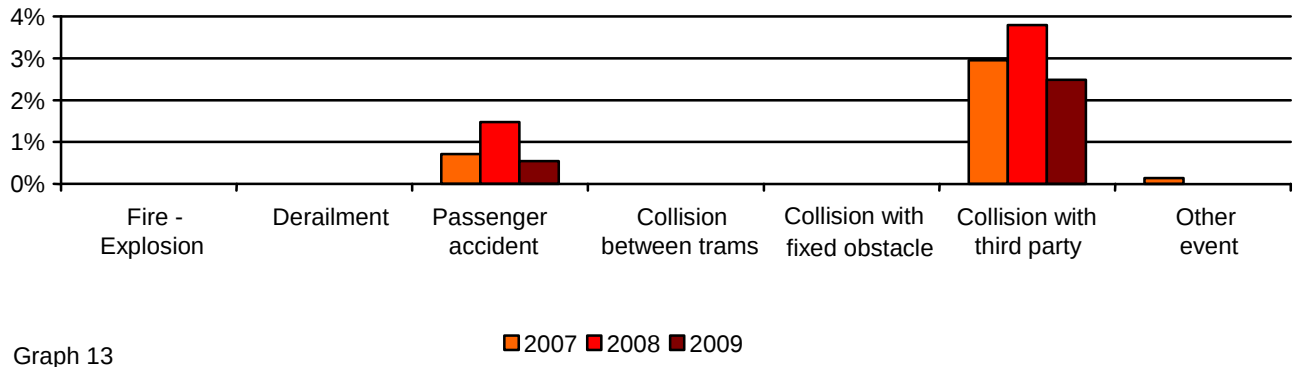
Graph 12

Passenger accidents and collisions with third parties continue to be the predominant events resulting in victims. We see a very slight reverse tendency in the breakdown of victims between these two events during the last period 2006-2009.

3.4.2.2 "Serious" victims

With effect from 2007, operators were asked to indicate, among the victims, those which correspond to the definition of seriously injured (more than 24 hours of hospitalisation). We feel it to be of interest to analyse the previous breakdown for serious victims (serious injuries + fatalities), restricted to the years 2007 to 2009.

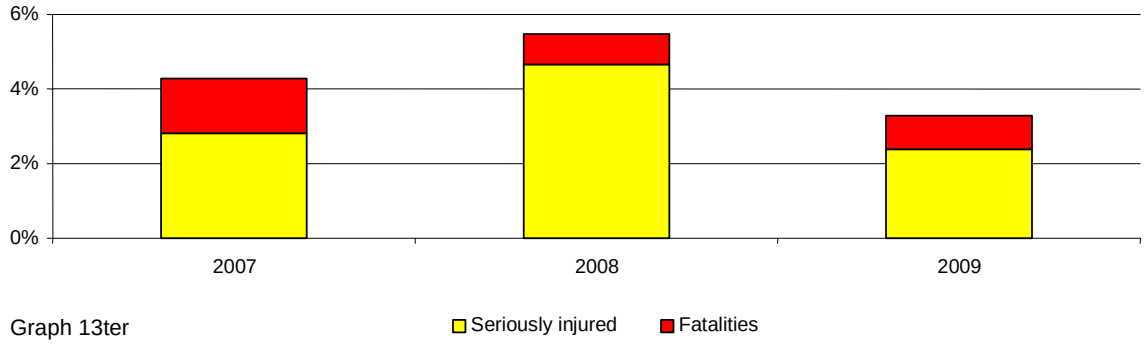
- Annual breakdown of the proportion of serious victims according to event



Graph 13

Collisions with third parties create a greater proportion of serious victims than passenger accidents.
Globally, this proportion of serious victims caused by all the events above remains at a low level : less than 1.5% for passengers and less than 4% for third parties.
Finally, we see no significant trend in the evolution of this proportion between 2007 and 2009.

- Annual evolution of the proportion of serious victims, distinguishing between serious injuries and fatalities

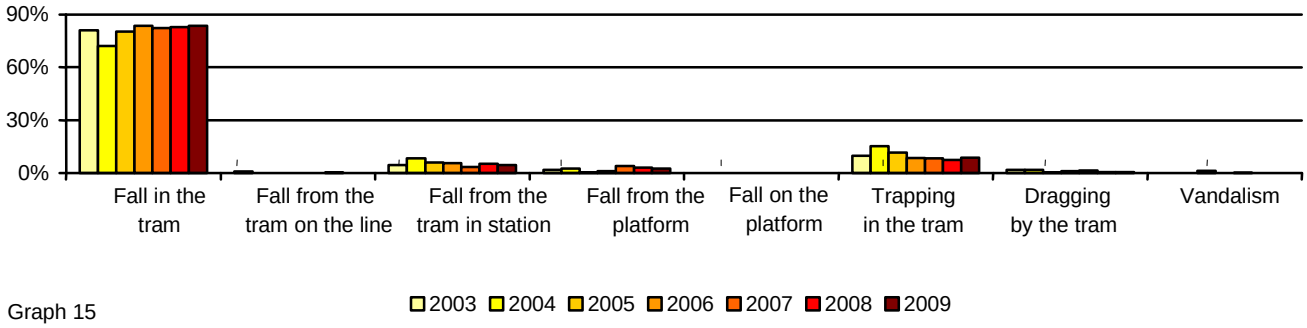


Graph 13ter

Here again, we underline the low proportion of serious victims (less than 6% of all victims). Furthermore, the essential part of the annual change concerns the variation in the number of seriously injured, although it is not possible to discern a trend over these three years

3.4.2.3 Passenger victims of passenger accidents

The comparison is done on the breakdown of passenger victims of the "passenger accident" event in accordance with the breakdown shown under 3.4.1.2 above.



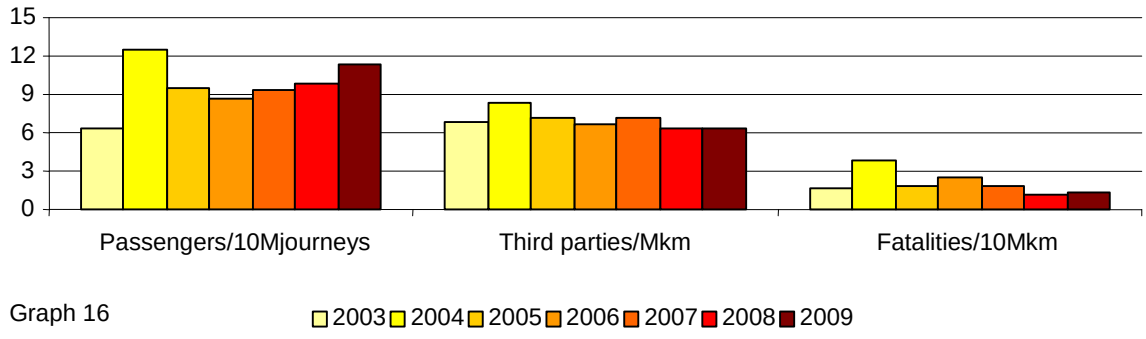
Graph 15

Falls in the tram remain predominant and no significant trend appears in the overall evolution for these four years.

3.4.3 Indicators for monitoring victims

3.4.3.1 Overall results

We propose to monitor the evolution of accidentology according to three indicators: the number of passenger victims per 10 million journeys, the number of third-party victims per million km and the number of fatalities per 10 million km. On the basis of these three indicators, we obtain the following evolution:

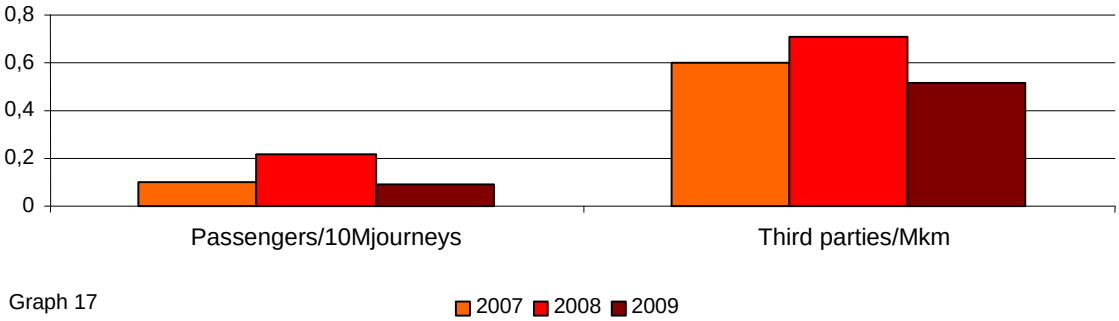


Graph 16

The trend in the passengers indicator follows that observed previously under § 3.4.2.1 on the annual breakdown by event (Graph 12).

We see a slight drop, but not significant, in the third party indicator, compared with the reduction observed above in the indicator for the number of events per 10,000 km (Graph 08).

3.4.3.2 Results for serious victims



Graph 17

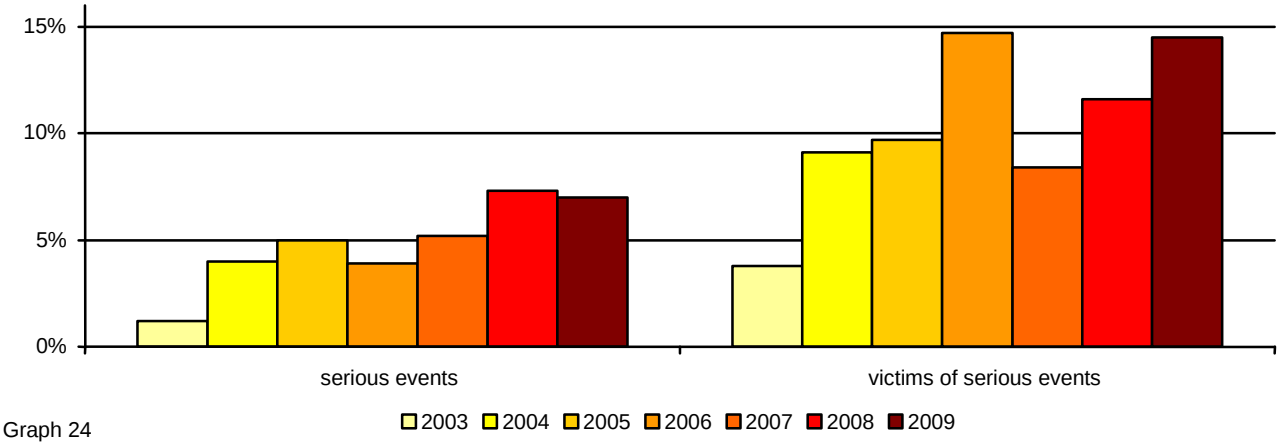
The monitoring indicator for serious victims, whether passengers or third parties, does not follow the previous overall indicator: preponderance of third parties, different evolution for the period 2007-2009.

3.5 SERIOUS EVENTS

For the purposes of a statistical analysis of the database, we have, with the agreement of the profession, defined serious events in terms of the following criteria:

- Serious body consequences : fatality or serious injury or more than 5 victims
- Significant physical damage (including for the third party) or derailment of the tram
- Derailment during commercial operation in a location shared with third parties

3.5.1 2003-2009 evolution



Graph 24

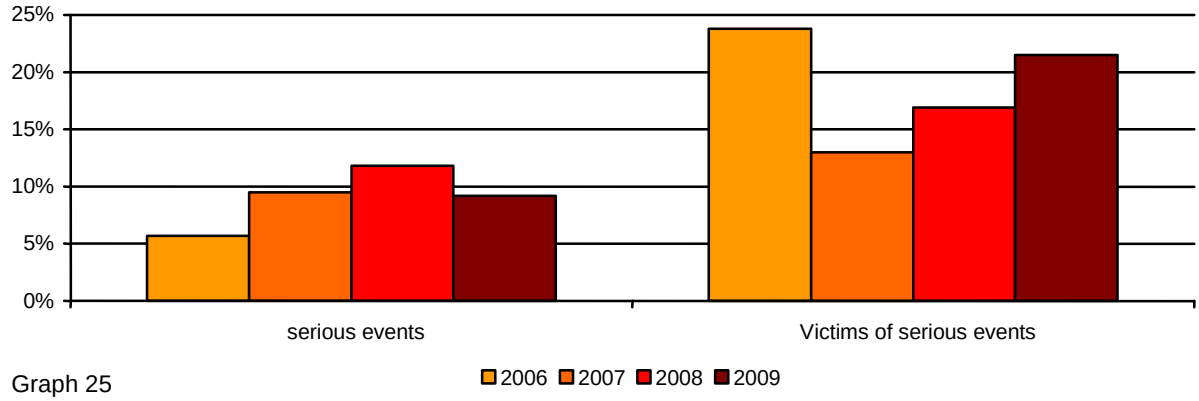
Serious events represent only a small proportion of all declared events, but a larger proportion of victims.

We should state here again that not all victims were seriously injured.

If we disregard the peculiarity in the year 2006 concerning the victims of serious events, a point underlined in § 4.1.2.2, **we observe a rising trend in the proportion of serious events and victims.**

3.5.2 STPG lines - serious events

These lines entered service in 2006 (cf. § 3.3.1)
The following graph chows the evolution of serious events for these lines.



Graph 25

For STPG lines, the proportion of serious events and victims of those events is greater than for all lines taken together.

Annual variations for the period 2006-2009 follow those for all lines taken together.

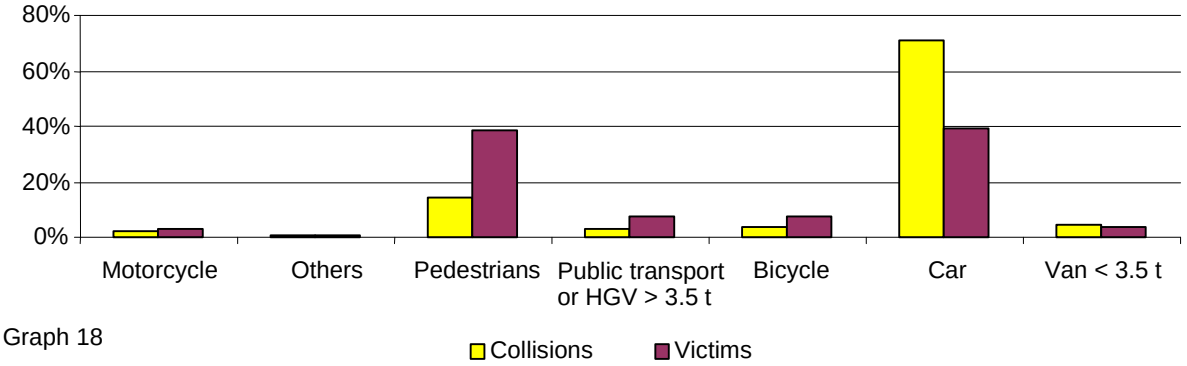
4. COLLISIONS WITH THIRD PARTIES

4.1 BREAKDOWN BY THIRD PARTY

4.1.1 Year 2009

With 1082 events in 2009, collisions with third parties represent 64% of all reported events and 40% of victims.

The breakdown of these collisions and the resulting victims according to the type of third party is shown in the following graphic.

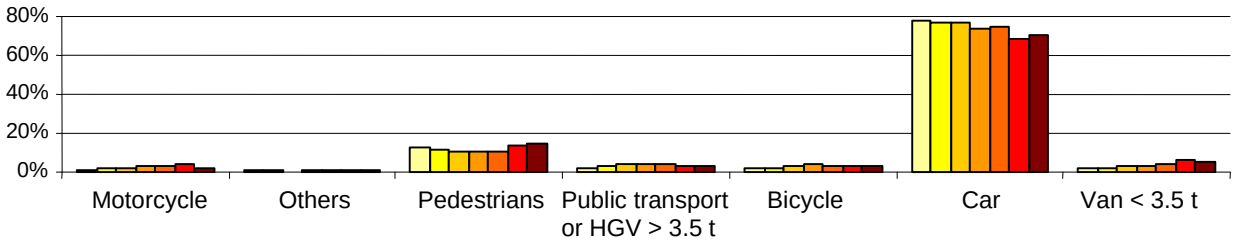


Graph 18

Collisions with private cars account for the great majority of cases. **Collisions with pedestrians are much less numerous but create an equivalent proportion of the victims**.

4.1.2 2003-2009 evolution

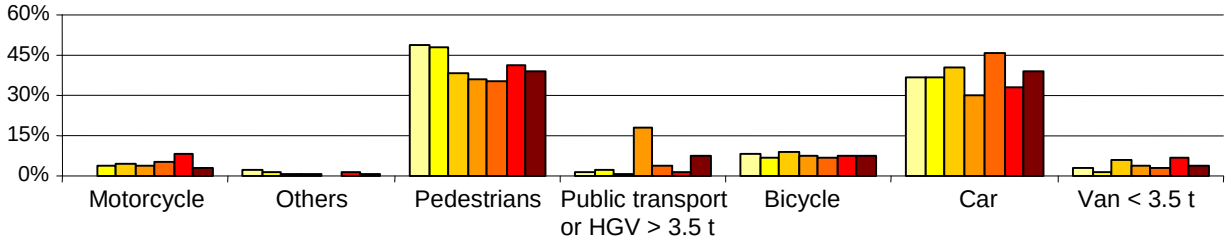
4.1.2.1 Collisions - Overall results



Graph 19

The overall variation in the breakdown of collisions according to the third party was small for the period analysed. Although we note a slight reduction in the proportion of cars and an increase in that of vans and pedestrians.

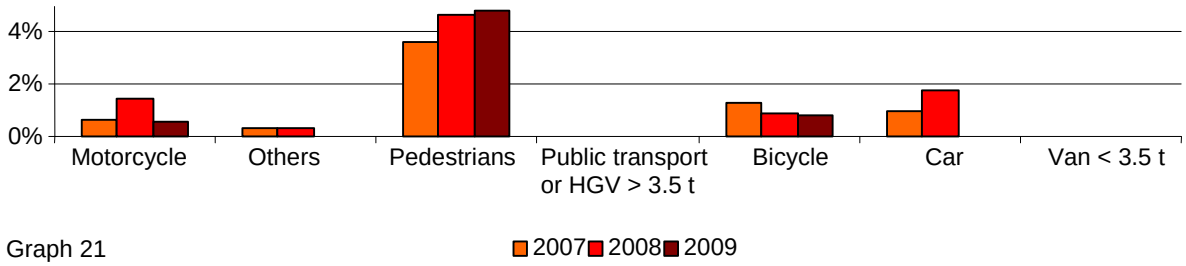
4.1.2.2 Collision victims - Overall results



Graph 20

The breakdown of victims is different: we see more marked variations for pedestrians and private cars. We note lorries as a particular feature in 2006 for the public transport category. Three collisions in this category resulted in a total of 29 victims.

4.1.2.3 Serious victims of collisions



Graph 21

The proportion of serious victims in collisions remains low (less than 5% of total pedestrian victims).
However, the latter category represents the largest fraction of serious victims and increased over the period.

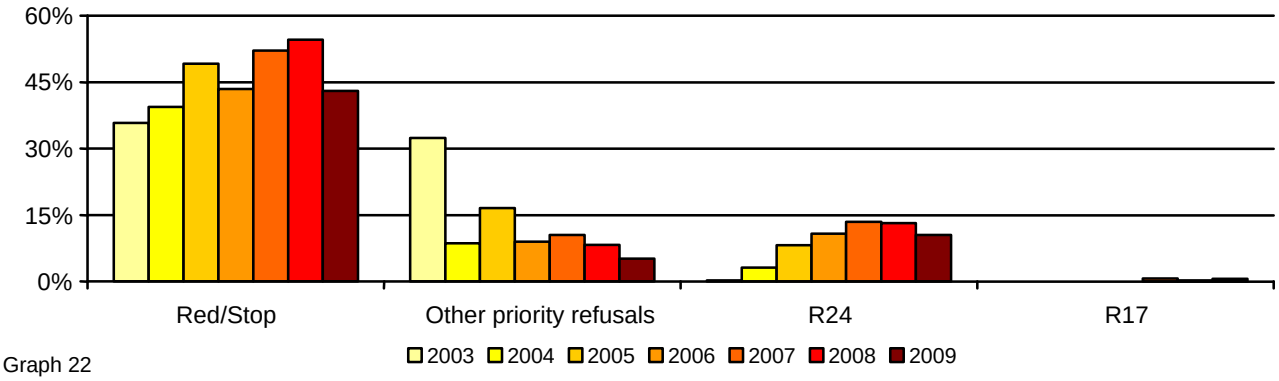
4.2 CAUSES OF COLLISIONS

4.2.1 Preliminary remark

Collisions with trams are essentially caused by third parties failing to comply with signals.
In the current state of the information available in the database, we can identify the following failures to comply with: red lights or STOP signs, R24 and other static signals such as C20c and AB3a (GIVE WAY).
The future codification system should allow an improved analysis by more precise identification of the configurations where collisions occur, in particular the type of light signals : R24, R11, etc.

4.2.2 2003-2009 evolution

The evolution of causes is shown in the following graphic:



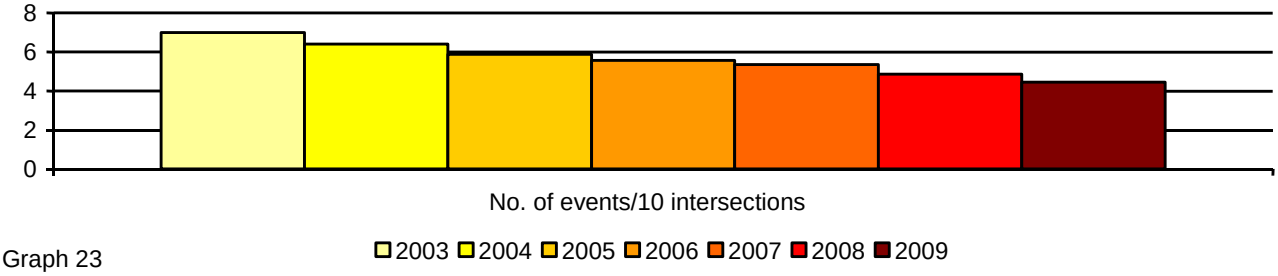
Graph 22

The evolution in the proportion of running red lights or stop signs in the last four years is close to that for R24's.
Non-compliance with R17 signals (a few cases per year) by tram drivers, declared since 2007, still occurred in 2009, even though the offence represents a very low proportion of causes of collision in the 3 last years.

4.3 POSSIBLE INDICATORS FOR MONITORING COLLISIONS WITH THIRD PARTIES

4.3.1 Indicators by intersection

With regard to collisions between trams and third party vehicles, it is interesting to relate their number to the number of intersections.



Graph 23

The indicator for the number of collisions per 10 intersections continues to fall.

However, we must observe that this indicator is imperfect, because of the operation of certain recent lines for a part of the year.

It also appears more appropriate to monitor the evolution of collisions with third parties on the basis of an indicator relating the number of collisions to the distance travelled.

4.3.2 Indicators per kilometre travelled

In § 3.3.2, we presented a kilometre-related indicator for monitoring events. We have however observed a marked disparity between networks in the modalities of declaring certain events, such as passenger accidents.

On the other hand, we are reasonably confident in the homogeneity of declarations concerning collisions with third parties, both between networks and in their continuity with time. **We therefore find a collision monitoring indicator related to kilometres travelled to be more relevant.**

The following graph shows the evolution in the number of collisions per 10,000 km, the specific evolution for STPG lines, defined in § 3.3, is also shown.

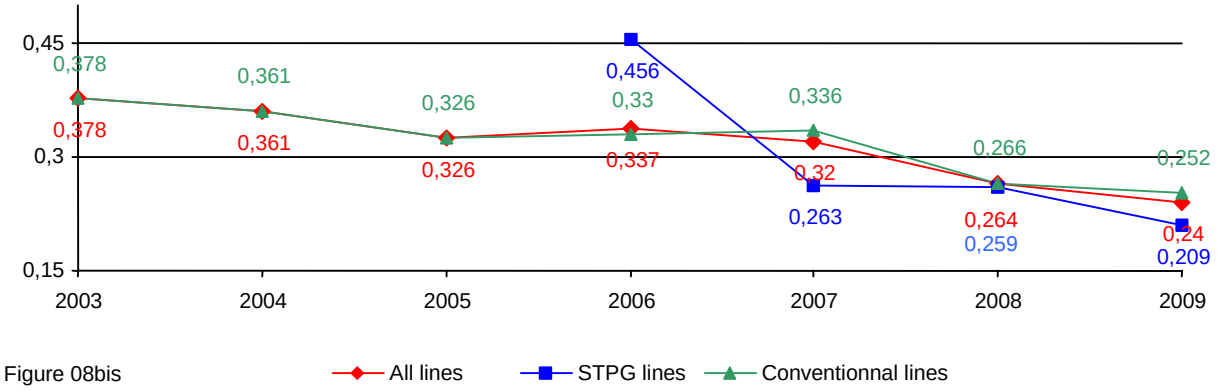


Figure 08bis

The general trend is a reduction: note the better performance of STPG lines over the last three years.

4.4 IMPACT OF THE COLOUR OF ROLLING STOCK

Certain urban areas have chosen high-visibility colour schemes for their trams:

- Le Mans
- Montpellier line 2
- Mulhouse

The liveries of these trams are shown in the photographs below. We have chosen the trams with bright colours, since we believe them to be clearly differentiated from the usual urban environment.

Le Mans

Montpellier L2

Mulhouse

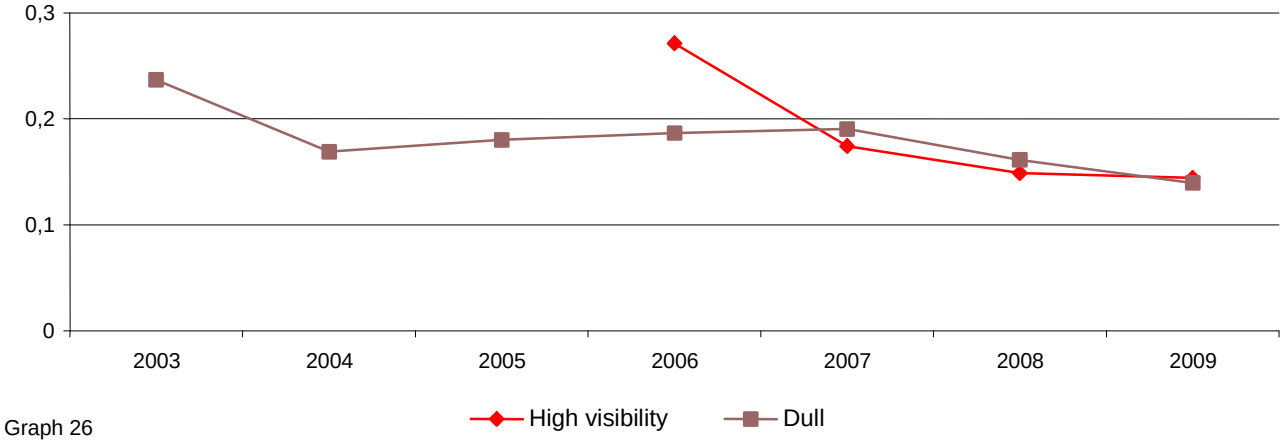
For the period 2006-2009, the number of these trams represents the following respective percentages:

	2006	**2007**	**2008**	**2009**
Number of trams	6.7%	9.4%	9.3%	8.8%
Number of km travelled	1.7%	6.6%	8.7%	8.5%

Are these high-visibility colours more likely to enable other road users to perceive the presence of a tram clearly ?

We consider the maximum effectiveness of these colours to be during the daylight hours (low light levels do not allow the colours to be distinguished clearly). In addition, and in order to simplify database queries, we have made no distinction between summer and winter: collisions included in the comparison are therefore those occurring between 8h and 17h over the whole of the year in question.

The graph below illustrates this comparison in the number of collisions per 10,000 km for high-visibility and "dull" trams.



Graph 26

According to this indicator, a high-visibility tram colour does not improve safety in terms of reducing the number of collisions with third parties.

The graphs are similar to those observed earlier under § 4.3.2; the (small) differences in the values of these indicators arise from the limitation of the period observed. The graph for high-visibility trams has the shape of the curve for STPG lines, which corroborates the fact that the high-visibility trams are indeed those in service on STPG lines !

5. ANALYSIS OF CONFIGURATIONS

The codification of lines allows an analysis of the breakdown of events according to the various line configurations, together with an identification of the most accident-prone zones, particularly for intersections.
Over a period of time successive verifications are performed on the database. These checks allow the fix errors errors concerning codification and location of events. It means that the results presented in this report may be slightly different from those in previous reports.

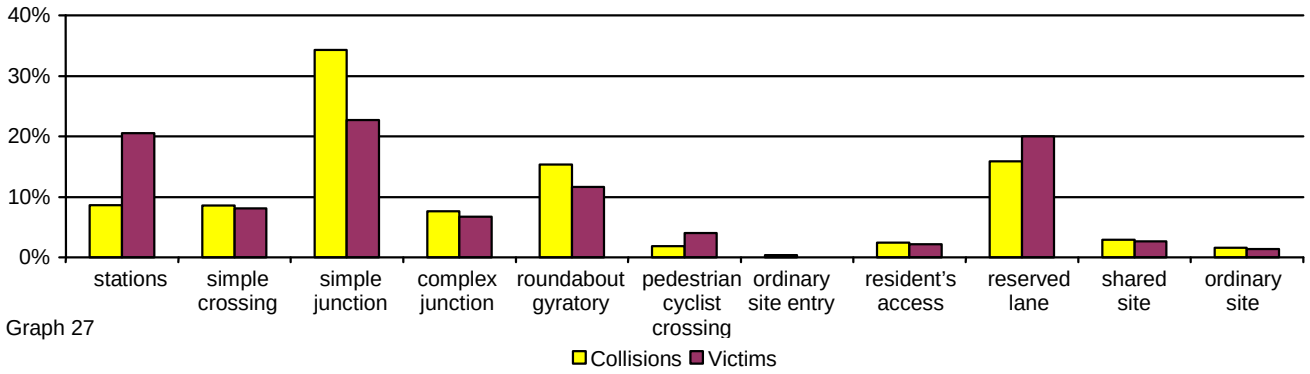
5.1 BREAKDOWN OF COLLISIONS ACCORDING TO PREDEFINED CONFIGURATIONS

In analysing collisions with third parties, we have adopted **11 basic configurations**: corresponding to all stations grouped together without distinguishing between the different types, 7 types of intersection and 3 types of running section.

5.1.1 Collisions with third parties

5.1.1.1 Year 2009

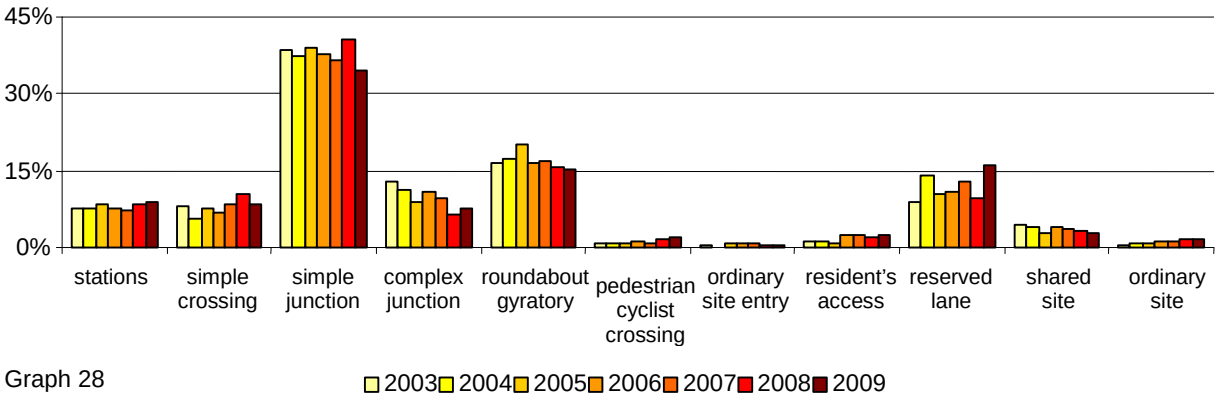
The following graphic shows the breakdown of collisions and victims observed (passengers + third parties) according to the various configurations adopted.
LEGEND for the diagram below



Graph 27

We see that the proportion of victims is generally less than that of collisions, except at stations and reserved lanes of running sections.

5.1.1.2 Evolution of the breakdown of collisions for 2003-2009

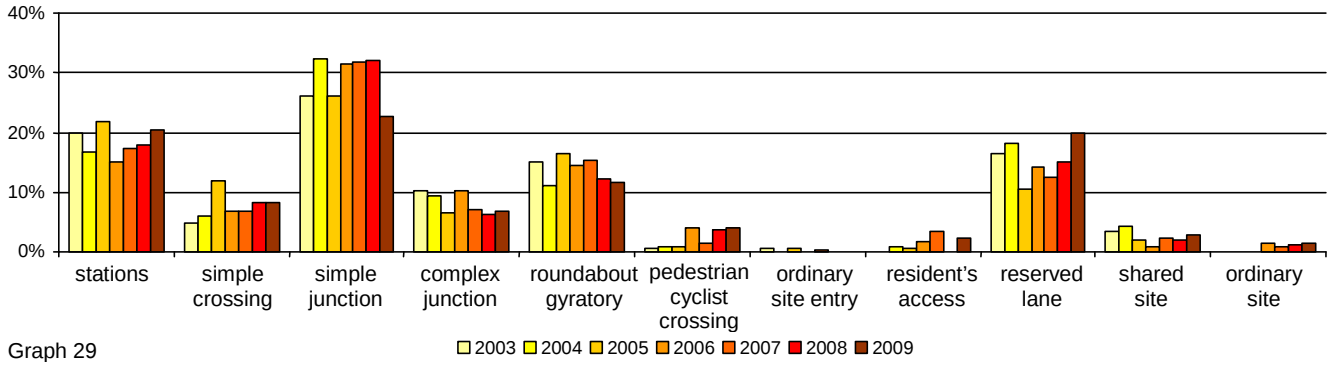


Graph 28

The majority of collisions with third parties occur in simple intersections, gyratories and reserved lanes of running sections.

We observe no significant trend in the evolution of the breakdown of collisions over the period 2003-2009.

5.1.1.3 Evolution of the breakdown of victims for 2003-2009



Graph 29

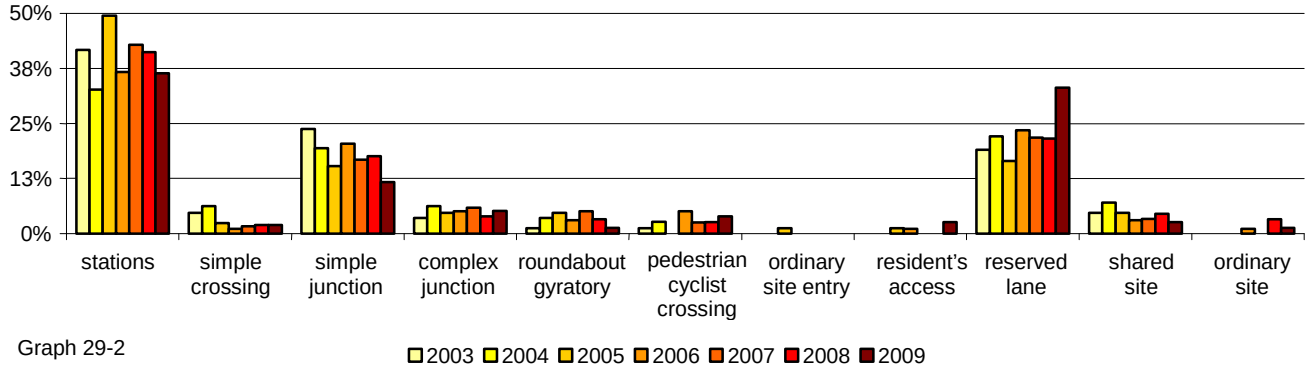
LEGEND for the diagrams above and below

The breakdown of victims is slightly different from that of collisions, with a greater proportion in stations.

We observe no significant trend in the evolution of the breakdown of victims over the period.

5.1.2 The case of pedestrian incidents

5.1.2.1 Evolution of the breakdown of collisions with pedestrians for 2003-2009

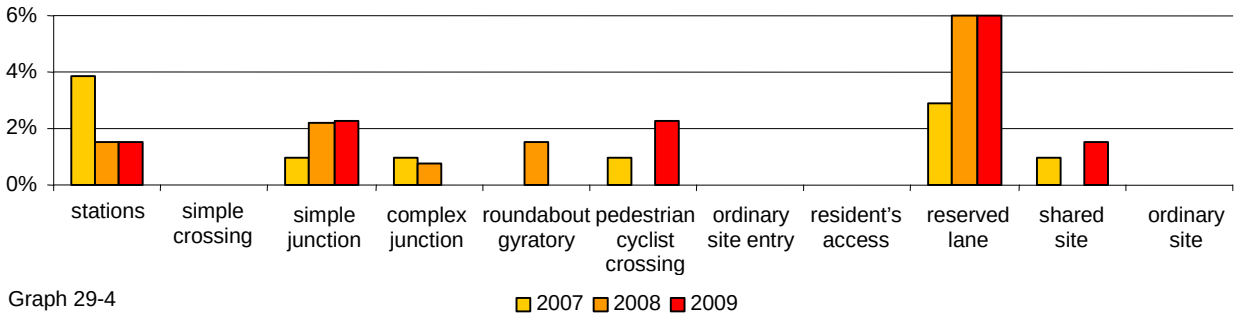


Graph 29-2

The majority of collisions with pedestrians occur in stations, then in running sections (reserved lanes) and simple intersections.
The year 2009 is distinguished by a high proportion of collisions with pedestrians in reserved lanes.

5.1.2.2 Breakdown of serious victims in collisions with pedestrians (2007-2009)

Graph 21 in § 4.1.2.3 on serious victims of collisions illustrates the preponderant proportion of pedestrians.We felt it was useful to identify the locations prone to serious pedestrian victims.
The graph below shows the proportion of serious pedestrian victims among all pedestrian victims, together with a breakdown by configuration.



Graph 29-4

Serious victims of collisions with pedestrians mostly occur when crossing platforms and not within stations or marked crossings.

This may be explained by the speed of trams in these locations and by the effect of driver surprise linked to the existence of visual masks which are often present in these places.

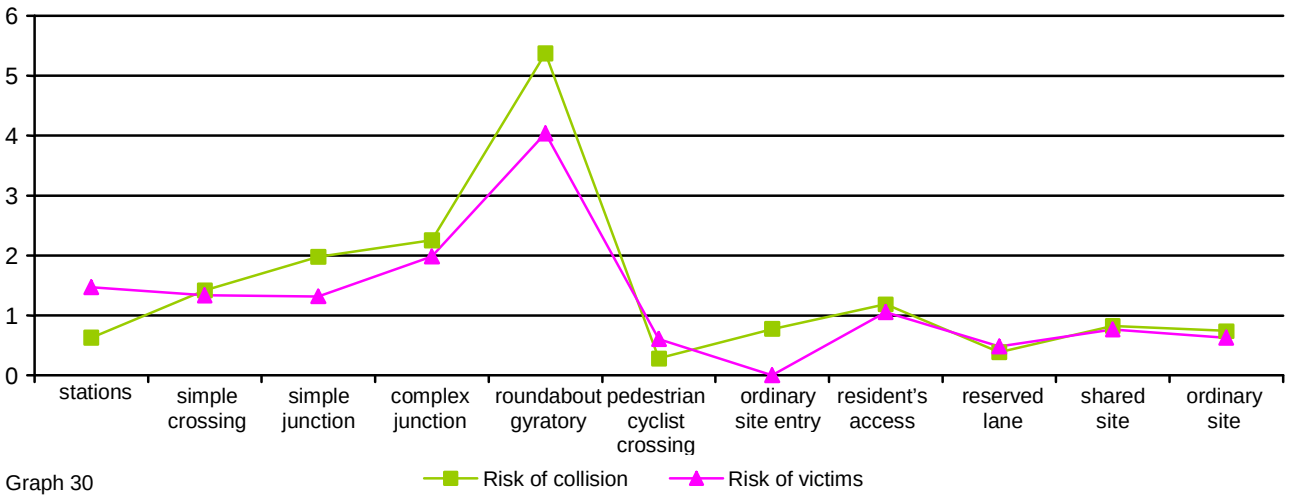
5.1.3 Breakdown of collisions with third parties by configuration

5.1.3.1 The value of a relative breakdown

The results presented above record the breakdown of collisions according to the configurations of the places where they occurred. We believe it be relevant to relate this breakdown to the number of configurations present in the networks.

5.1.3.2 Results for 2009

The following graphic evaluates the relative proportions of collisions and victims (third parties and passengers) according to the number of configurations in existence. This can be described, somewhat inaccurately, as the "level of risk" presented by each configuration for collisions and victims.



Graph 30

- Collisions

The "simple junction" configuration, which accounted for the greatest proportion of collisions (35%) is "only" of level **2**, while the "roundabout/gyratory" configuration (15%) almost reached level **5.5**.

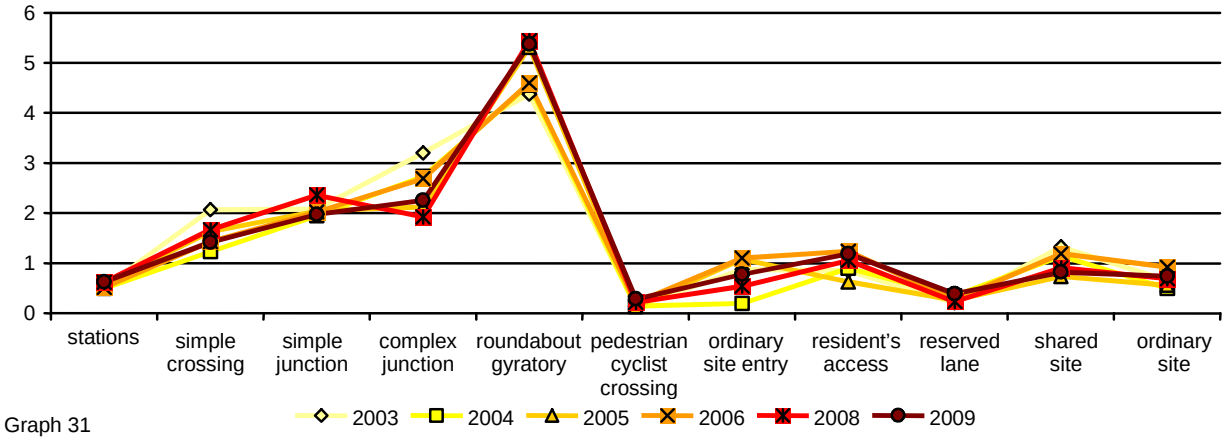
- Victims

We have seen above that a significant proportion of victims (23%) occurs at simple intersections, but its "risk level" is **1.3** against a value of **4** for a "roundabout/gyratory" intersection (around 12%).

For the year 2009, among all the types of intersection between tramways and roads, the "roundabout or gyratory" configuration is always the most problematic in terms of collisions and victims.

5.1.3.3 Evolution of the relative breakdown of collisions for 2003-2009

The following graphic shows the 2003-2009 evolution in the relative proportion of collisions according to configuration.

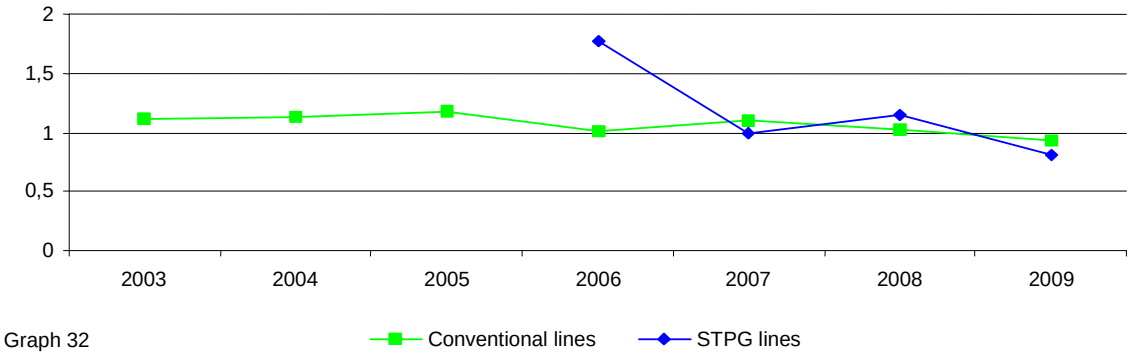


Graph 31

It confirms the characteristic position of "roudabout/gyratory" configurations for collisions with third parties.

5.1.3.4 Collisions in roundabouts/gyratories – STPG lines

The following graph represents the number of collisions per roundabout/gyratory and its evolution over the period 2003-2009.
It identifies STPG lines according to the definition in § 3.3.



Graph 32

We observe stability in the indicator for the number of collisions per roundabout/gyratory over the period, and convergence of the indicator for STPG lines with the indicator for conventional lines: to be monitored.

5.1.4 Comparison of gyratory configurations and "TURN" junctions

5.1.4.1 Preliminary remark

The comparison made previously of accidentology for different intersections was criticised because we compared the gyratory configuration, which allows all vehicle movements (left turn, right turn, U-turn, etc.) with other configurations, some of which only offer simple trajectories, most frequently with direct crossing of the tram platform.

TURN manoeuvres (to the left or right) in intersections are reputed to be more hazardous than simple platform crossings. A road user follows a road parallel to the platform then, at the intersection, carries out a TURN manoeuvre to cross it. In these conditions, the user may not have a clear view of the presence of a tram behind him, and may also be misled by a light signal authorising STRAIGHT ON but prohibiting TURN when crossing the tramway.

Line codification is not at present sufficiently refined for precise identification of intersections in which TURN movements are permitted and performed, and the associated signal type.
However, in anticipation of the new codification, we suggest a first approach.

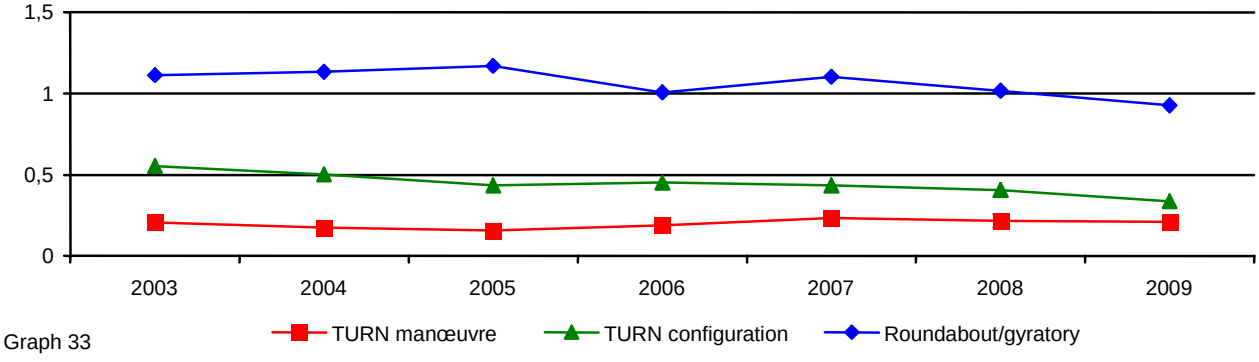
5.1.4.2 Intersections with TURNS

In the present codification system, this concerns the following three configurations:

- Local access
- Simple junction
- Complex junction

The database also includes third party movements when collisions occur, in particular TURN manoeuvres.

5.1.4.3 2003-2009 evolution of the relative distribution of collisions in gyratories and junctions with TURNS



Graph 33

The illustration above shows graphs for the following indicators:

In red: The number of collisions caused by TURN **manoeuvres** in intersections with "TURN", related to the number of those intersections.

In green: The number of collisions in intersections with TURN, related to the number of those intersections.
In practice, as we are not certain of the exhaustiveness of the indications provided in operator declarations, we have included all collisions in this graph, even if TURN movements by third parties are not mentioned.

In blue: The number of collisions in roundabouts/gyratories, relative to the number of roundabouts/ gyratories.

Whether we only target, in intersections with a "TURN" possibility, events caused by third party "TURN" movements, or extend the analysis to all events, the number of collisions per gyratory is always greater (more than double) than for "TURN" intersections.

6. CONCLUSIONS

The conclusions of the preceding report for the years 2007-2008 and dealing with the period 2003-2008 remain globally valid.

➢ **Constant factors**

- The heterogeneous nature of operator declarations, although each is mainly based on the same modalities over the period.
- The breakdown of events according to type (passenger accident, collision with third party, etc.).
- The breakdown of events according to tramway configurations
- The position of roundabouts /gyratories in hazardous configurations

➢ **Satisfactions**

- The effort devoted by operators for completing the database
- The drop in the indicator based on number of events per 10,000 km, particularly in 2009 for STPG lines
- The favourable comparison of this indicator with that for bus networks
- The low proportion of serious victims: 0.5% for passengers and 2.5% for third parties in 2009
- The low proportion of serious events: 7% in 2009.

➢ **What remains preoccupying**

- A rise in the proportion of serious victims (2007-2009), for pedestrians in particular
- A rise in the proportion of serious events (2003-2009)
- The significant proportion of STPG lines (entering service since 2006) in serious events

➢ **A new codification system**

This should allow a finer analysis of configurations
It should be operational for 2011 (with retroactive effect for the analysis of earlier accidents).