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ONE STEP CLOSER TO THE EFFICIENT MANAGEMENT OF SPEED-RELATED RAIL INCIDENTS

Cheila Duarte, Colardelle[1], Jacques Valancogne[2], Stéphanie Fond[3]

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Abstract

This paper aims to shed light on frequent and reoccurring rail-related speed incidents observed in the largest railway company in Paris, France, the RATP[4]. Based on internal examples in the RATP transportation rail system, we will identify, by means of a return-on experience method, the main causes behind these incidents. The causes may be of diverse nature and if identified can facilitate the analysis of each speed-related incident. This study therefore aims to demonstrate how to better address and efficiently manage such incidents with a view to better revealing the dysfunctional elements within the system, dealing with them efficiently and thus reducing their frequency and scale.

1. Introduction

Notre Dame de Lorette is the rail speed related incident that has had the most impact on the minds of rail RATP workers. On the 13 August 2000, on line 12 of the metropolitan RATP rail system, a metro[5] derailed and slid several metres on its side before entering onto a headline collision with the opposite track platform. Once come to a halt, the human damages were made public, 24 lightly injured due to overspeeding. The driver was 30km/h over the set speed limit of 30km/h (maximum speed on this part of line).

This incident has by no means influenced the number of speed related incidents, which are unfortunately recurrent. They may not be of similar gravity to the one experienced at Notre Dame de Lorette, but they are indeed very frequent in number and potentially serious. They are, for these reasons, becoming a matter of concern. In fact, between 1996 – 2001 there were, according to internal RATP sources, on average, over 5000 speed excess (a great part of them being of minor importance) related incidents per year.

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[1] Ms. Colardelle, research engineer at Ecole des Mines de Paris (France) and currently enrolled in a PhD on organizational management, ***colardelle@cindy.ensmp.fr***
[2] Mr. Valancogne, current director of Maîtrise des Risques Systèmes (MRS) department of the RATP
[3] Ms. Fond, trainee for a training period of 6 months in the MRS department of the RATP
[4] RATP : Réseau Autonome des Transports Parisiens, founded in 1948. RATP employs approximately 38 465 individuals. The RATP represents 80% of all human transports in the Parisien urban area and transported 2,5 billion people in 1999.
[5] Metro : subway or underground train used for transportation. Each train has four to six coachs. The RATP metropolitan network comprises 211 km of rail and 380 stations.

In 2001 the MRS[6] department of the RATP decided to look deeper into this matter, by means of an experience reflection study. Several questions were posed, namely:

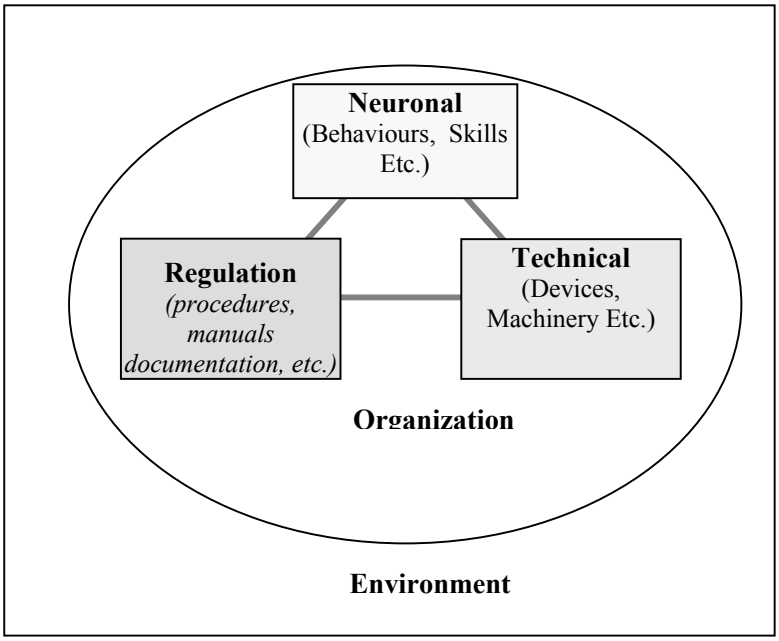
- Is there some kind of system dysfunction that contributes towards the redundancy of speed incidents?
- To what degree can the risk-taking behaviour of drivers, involved in these speeding incidents, be assessed and managed appropriately?

This article endeavours to present the results obtained by a 6-month study of speed-related incidents in the RATP rail system. With a view to clarity the study is structured in three parts. Firstly, we will proceed with a cross section of rail driving context. This cross section will endeavour to set the groundwork, shed insight into the area of study and help evaluate its complexity. Secondly, the interest of the positive experience reflection method employed in the study will be discussed. Lastly, a succinct review of the study findings will be exposed.

2. A Complex Integrated System

Three main components of the navigational rail speed system (human, regulation and technical) need to be clearly established before tackling the subject of speed-related incidents. These 3 sub-systems make it possible to grasp the complexity of the system.

Figure 1: The complexity triangle of a system



Technical

Speed is measured automatically whilst the train is in motion by a chronotachygraph.

Each speed violation is apparent. Should a driver violate speed limits "too frequently" or "too far above the allowed level", his or her driving conduct will constitute an object of inquiry or sanction. However, what qualifies as "too frequently" or "too far" depends on the attention that the metro lines local authority desires to give each case.

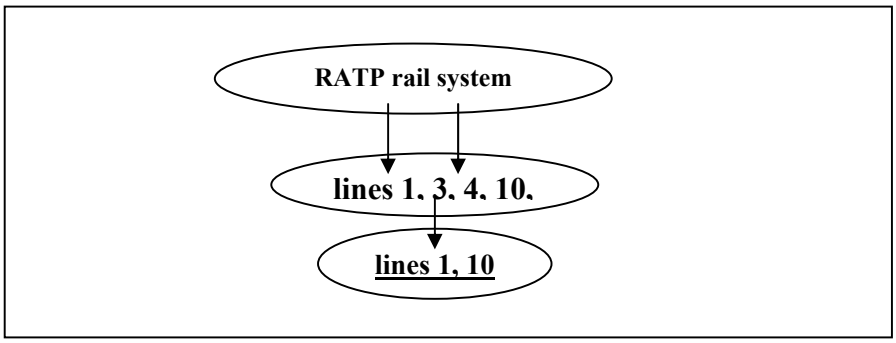
To better exemplify and analyse the existing behaviour on metro lines a deliberate selection of

[6] MRS : Maîtrise des Risques Systèmes, created on 1st July 1998

metro lines was made for the study. The sifting process consisted of 3 stages.

- The RATP metro network, constituted of 16 lines has lines on which navigation is either automatic, where the driver's role is limited, or manual. On these manually driven lines, the driver is almost solely responsible for the navigation. Therefore, the first selection of metro lines was made by narrowing down the metro lines that would participate in the study to manually driven metros.
- A second criterion of choice, which narrowed down our choice even further, was that of the existence of recent data on excess speed related incidents. The incidents that were studied were:
  - Deficient use of brakes when confronted with a repeater of a shunting signal at yellow indicating that the repeated signal is closed.
  - Various speed violations in 2 interstations.
- Thirdly, the metro lines personnel need to be conscious of the importance of the investigation. Therefore, those that demonstrated the maximum interest in participating in the study were selected. In the end, 2 metro lines remained and participated in our study, lines 1 and 10 of the RATP metro system.

Figure 2: Sifting process selection of metro lines



Regulation

In order to better apprehend the behavioural patterns of personnel in the RATP network rail system, we decided to focus our attention not exclusively on the literal unfolding of the speed incident itself, but on the driver's perception of the incident. Was the driver aware of the procedure to be respected whilst driving an underground train? What elements guided him during his driving shift? There are various reasons for this choice.

Firstly, standard written navigational procedures exist and must be followed. In fact, written procedures insist on:

- The inculcation of respect and adherence awareness to the reglementation as a whole.
- Safe and smooth driving.
- Adherence to and respect for prescribed speed limits and traffic regulation signals/indicators.
- Adherence to and respect for operational practical driving procedures (eg: given set time taken to cover an interstation)
- The driving procedure to respect during an degraded situation

These written standard procedures exist in order to ensure a safe journey whilst navigating in the rail system as well as a non-violation of speed limits posted throughout the tracks. The drivers are well versed in these procedures not only due to the initial training period they are all subjected to, but also due to experience in navigating. Their professional experience should make them not

neglect the importance of respecting regulations.

Other than the existing code of written rules, there is a secondary form of regulation that is dispensed before a driver is considered as such. While a driver is a trainee he/she undergoes practical driving lessons. The training period of 3 months is dispensed by instructors. These instructors are themselves drivers with a licence who have solid driving experience on the RATP lines. Each monitor bases his/her teaching on what the written regulation requires and on personal experience. Each of them has his/her own personal set of golden rules what they call "les bons gestes du conducteur/the good conduct of the driver " (see Figure 4 in Annex).

Apart from the initial training dispensed, there is a continual check-up on the driving capacities of drivers. This is done through occasional surveys and by keeping a record of speed related incidents a driver may be implicated in. Continual monitoring is considered a good indicator or thermometer of the driver's level of professionalism and competence.

Human component

Speed incidents involve young drivers as well as older and more experienced ones. In the case of older and more experienced drivers, these should most probably capitalise on their professional experience and their skill should improve with time. So, there must be other reasons other than lack of training to account for the influx of speed excess incidents.

3. The Positive Experience Reflection Tool

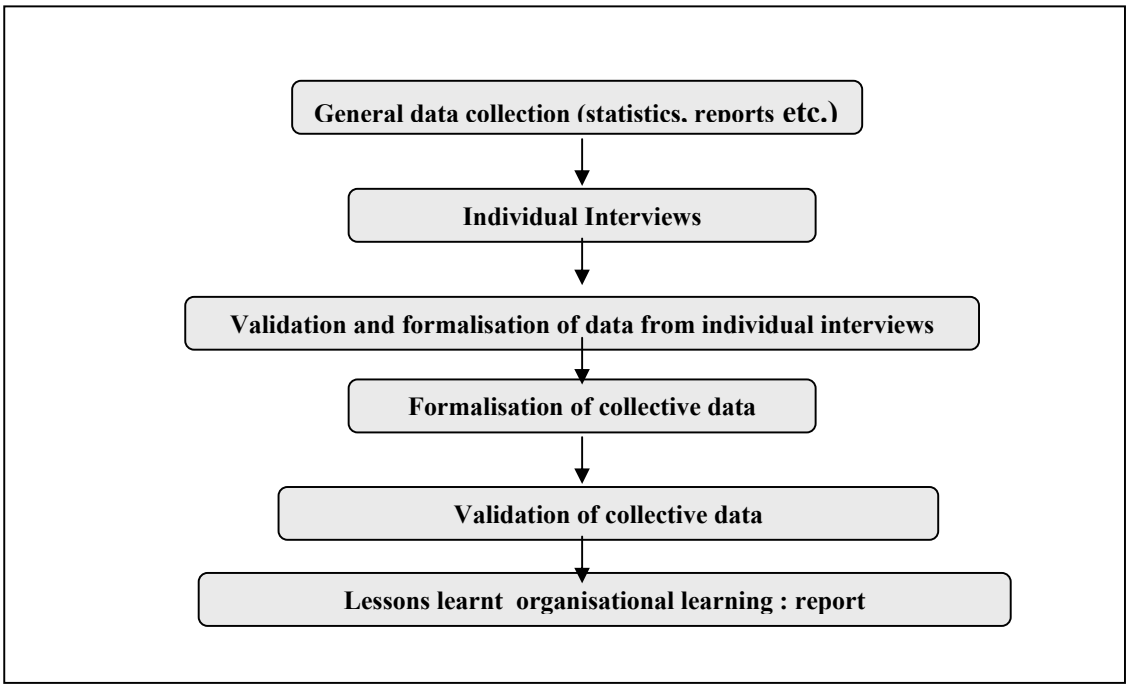
One of the main difficulties that companies have today is to tap into the invaluable sources of individual tacit information. Companies often become frustrated with not being able to reveal and to learn from the rich source of individual day to day learning experiences. Organizational learning depends on and stems forth from individual inputs [Nonaka & Takeuchi 1995].

The main reason is the absence of tools enabling companies to exploit individual experience, to disseminate its lessons and to translate them into effective action [Kleiner & Roth 1997]. The RATP has several tools (eg: employee surveys, database etc.) that endeavour to capture the best practices, individual experiences and implicit ideas.

As generally observed, these often fall short, failing to give the full picture. Hidden factors and logic are not taken into account. Also, once the hidden logic has been acquired, managers have difficulty in exploiting them. Transferring newly acquired knowledge, in order to modify certain behaviours, is no easy task [Garvin 1993].
The RATP therefore turned its attention to an external qualitative positive experience reflection method comprising six different steps. This method had been implemented by the RATP in 1999 and, having been well perceived, was implemented once again in 2001. The positive experience reflection approach complements other existing risk management methods. It allows for an identification and capitalisation of individual practices and personal experiences in their entirety. It also legitimises organizational changes in that all persons feel involved and feel that they contribute to the better functioning of the system.

The 6-step positive return on experience reflection method referred to above (see Figure 3 hereunder) was developed by the Cindyniques research Centre of Ecole des Mines de Paris.

Figure 3: Positive experience reflection method



By means of this 6-step process, the positive experience reflection method analysed 3 types of driving practices: prescribed navigation; normal or operational navigation; and abnormal navigation (eg: in an incident, during works etc.): crisis or incident management

Rich qualitative data was collected on these three modes of driving. Drivers were questioned on which actions correctly characterised, according to their own experiences, each type of driving practice. The data, collected from individual anonymous and open interviews, was represented graphically, in the string of key events graph[7][Colardelle 2000]. Each key action, particle of experience, has 4 steps [Wybo 2000]:

- Context
- Analysis of the context and options
- Decision(s) taken
- Effects of the decisions

Two types of key moments are identified - real actions and hypothetical actions that can be acted out. Hypothetical actions can be of two natures, positive ones (that improve the functioning of the system/ systems function) and negative actions (that contribute to the deterioration of the system) [Colardelle 2000].

To better exemplify, a key of string events graph (Annex Figure 5) representing a collective example, construed after a number of interviews, has been included for consultation. This simplified version of the collective string of key event graph applies to the standard written code of rules which need to be respected while navigating.

Each string of key events is basically evidence of the democratisation process through science. The string of key events graph allows for an understanding of the key moments or actions undertaken during navigation as perceived or as experienced first hand by the drivers. Each driver has stored

[7] From the French expression "Fil Conducteur".

his/her information into a scientific information collection model, the string of key events graph. Each individual account is fragmented as no drivers can have the complete picture and possibilities of action. Not having the complete story is not a problem seeing as how the interviews are a pretext to congregate drivers and to initiate an introspective process and to initiate dialogue.

A collective string of key events graph is obtained by piecing all individual accounts into one full collective account, a bit like a puzzle. In the end, three collective key of string events graphs remained, sometimes with contradictions. The information contained in each of them was discussed until all drivers came to a collective consensus. The information was in this way authenticated and validated by all the drivers that participated in the study. The objective of the validation step is to encourage a discussion of the three types of key of string events driving possibilities. This convivial exercise has several positive effects on drivers:

- Allows for communication between drivers of the same and different lines, with different years of experience, backgrounds and practices.
- Elicitation of and capitalisation on tacit knowledge
- Sharing and transfer of knowledge
- Dynamic individual and collective reflection

The outcome of this study also has several positive effects on management, making it possible:

- To identify with greater precision the causes or origin of frequent speed incidents
- To understand the drivers' perception on risk taking when these show no regard for regulation
- To identify the drivers' risk perception concerning a stretch of rail, a metro line and the metropolitan rail system.
- To be better equipped in formulating appropriate, accepted and legitimate measures that can be ensued in the three main system components:
    - Technical. By means of an up-date on ergonomy, modification of localisation and speed limits of traffic speed indicators etc.
    - Procedural. By means of an up-date on regulation by taking into account practiced golden rules if positive
    - Human. By means of training and sanctions, if necessary.

The validation stage of the method, meetings, offers a platform for wide-spread concerns or beliefs which are usually non-existent in formal proceedings. It is a moment characterised by free dialogue within the framework of a scientific model, the string of key events graph. The situation is normally de-dramatised and the conversation oriented around positive actions that were taken or positive actions to be encouraged.

4. Findings

The implementation of the positive experience reflection method met with a number of obstacles, namely:

- Difficulty in obtaining information due to the absence of data on past speed excess incidents.
- Difficulty in getting the agents of the lines to participate in the interviews.

The lack of exhaustive and organized data on speed related incidents encouraged us to suggest the creation of an up-dated and tailored speed excess incidents data base. The new data base would enable the RATP to characterise the nature, origin and circumstances surrounding each incident and therefore constitute a typology of speed related incidents. Once an incident is identified and classified in a particular group, a more in-depth return on experience process inquiry can be initiated if deemed necessary by the RATP management.

A certain number of indicators need however to be taken into consideration when compiling the data base. Factors permitting a better analysis of the circumstances involving speed excess incidents have to be identified. The investigated Metro lines were scouted in order to identify the areas at risk (areas that have been the object of various and frequent speed excess incidents). Finally, the new data base has to be simple and concise. In other words, appealing enough to interest the drivers.

The positive experience reflection method, based on the driver input and experiences, allowed for the beginnings of construction of a new data base on excess speed related incidents (see table 1 hereunder). According to the drivers, three areas are at the core of speed related incidents: the environment, a conjunction of circumstances and human factors.

Table 1: Typology of speed-related rail incidents

Environmental or Structural Indicators	Static	**Example:** Straight line Curbed zone Gradient / slope Ergonomics of signal placement Others:
Conjunctural Indicators	Dynamic	**Example** : Licensed driver / titularized driver Non disponibility of Automatic Pilot/ degraded driving Others:
Human Indicators	Behaviour	**Example:** Actions due to human error Recurrent speed infractions Others:

The second difficulty encountered in this study pertained to the data collection, obtained during individual interviews. Most drivers have a very tight schedule and work at varying hours, so they are difficult to reach and to interview. By accompanying the drivers in their driving routines, we were able, by observation, to note down various reactions and identify each action that the drivers took. Then, after the driver had finished his/her shift or during his/her coffee breaks we were able to ask why they reacted the way they did or decided in favour of a particular course of action.
The positive experience reflection method therefore revealed:

- Existing palpable gaps between the behaviour expected by the company, as exposed in regulation manuals and during training periods, and the real behaviour of the driver, the theory in use [Argyris & Schön 1978]. Some of these practical adaptations practiced by the drivers are spontaneous. A number of these adaptations are positive and should eventually be taken into account and shared with other drivers of the RATP rail system. Others, however, may be dangerous and the company would need to counteract divergent behaviour.
- Three principal explanations for excess speed related incidents :
  - Environment: Structural elements that complicate operational driving, namely complicating braking and leading to speed excess (the network configuration, differences in speeds in various signals, speed limits that are not apparently always coherent etc.)

- Conjunctures: driving in an abnormal, degraded or failing context (eg: works).
- Human errors: not paying sufficient attention, not enough practice when it comes to manual driving, relying too much on automatic pilot, personal problems, under the influence of drugs, risk taking, the need for training.

5. Conclusion

By means of the positive experience reflection method, speed excess driving incidents were sorted out and characterised according to their kind. Also, the analysis of qualitative data made it possible to better tune into and attend to the various risk perceptions and obstacles faced each day on rail lines by drivers.

Management is better equipped to understand, to manage and to capitalise on speed related incident situations. By identifying the real cause of the incident, managers can treat drivers fairly and thus improve relations between the two bodies, which are often tense. Indeed, a main source of tension was due to the handling of speed related incidents. The study therefore allowed for a better understanding of underlying causes and enabled managers to deal with the incidents in an appropriate manner. In this way, the sanctions that were administered in general to all speed related incidents without distinction, now have a wider acceptance because drivers are sanctioned on "real mistakes"on human errors.

6. References

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Author biographies

Ms. Cheila Colardelle received a MSc in Geography and completed a post-graduate course in risks and crisis global management from the University of La Sorbonne, Paris, France. She is a research engineer at Ecole des Mines de Paris, France, in a laboratory specializing in risk and crisis management (Pôle Cindyniques). She is also currently enrolled in a PhD in organizational management at Ecole des Mines de Paris, France.

Mr. Jacques Valancogne is the Director of the Management of Systems Department of the RATP, largest french metropolitan rail and bus company in Paris, France.

Ms. Stéphanie Fond graduated from the University of Cergy Pontoise , France, with a degree in Transport**,** Territory and Environment .

7. Annex

Figure 4 : The good conduct of the driver, « les bons gestes du conducteur »

Train in movement
- The driving must be smooth

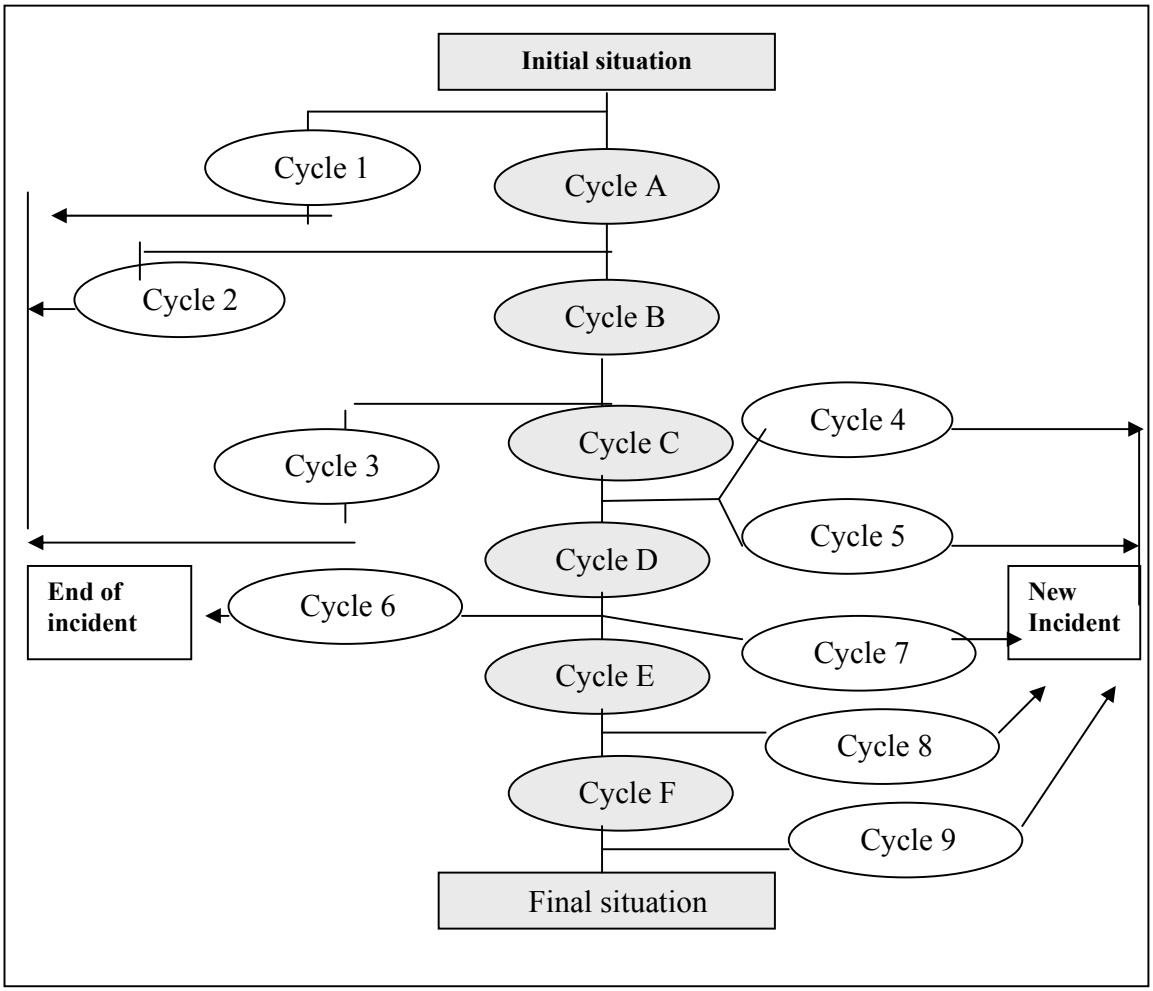
On entering a station
- Must be in a position to brake before entering a station in order not to break the standard speed limit of 40km/h
- Engage in a smooth, constant and progressive breaking in order to:
  - not break the standard speed limit of 30km/hr at the mid level of the train quai
  - Never open train doors if the train has not come to a halt.
  - Always keep a braking margin whilst pulling up into a station and until the train halts.

When the train has come to a halt
- The train must be in a brake position

Adhering to speed limitations
- Test the breaking capacity after all change of technical material
- Never hesitate to engage automatic pilot when one's attention is taken/attention level is low.
- Be familiar with the location and speed limitations of all traffic indicators posted along the train lines
- Cease accelerating before having reached the allowed speed limit.
- Anticipate braking

Adhering to traffic regulation
- Slow down as soon as a one sees a restrictive traffic signal (ex: signal with an orange or red light)
- Never anticipate the go-ahead signal of a traffic indicator
- Traffic signals must never be arranged according to hierarchy for what they are but rather for what they are conveying/according to what they indicate.
- Do not come to halt to close to a closed signal

Figure 5: The string of key events graph for the navigational standard written regulation



Real Cycles

Initial situation: Context (Metro leaves a station in direction of another, hour of less traffic, train manually navigated etc.)
Cycle A: Move train forward
Cycle B: Visual contact with traffic indicators orange light
Cycle C: Crossing of orange light traffic indicator and observance of the written regulation to apply in these cases
Cycle D: Visual recognition of traffic speed indicator of 45km/hr
Cycle E: Train comes to a halt at the traffic manœuvre signal
Cycle F: Train on the move again
Final situation: Train come sto a stop in the next station

Hypothetical Positive Cycles
Cycle 1: Encourage drivers to navigate manually
Cycle 2: Anticipate the orange light traffic indicator

Cycle 3: Better clarify all possible options when confronted with a traffic indicator with orange light.
Cycle 6: Delocalise the traffic speed indicator

Hypothetical Negative Cycles
Cycle 4: Ignore traffic indicator displaying an orange light
Cycle 5: Partial application of written regulation
Cycle 7: The driver keeps on moving and attains a velocity of 45km/hr
Cycle 8: Train violates traffic regulation (it moves instead of halting)
Cycle 9: Train on the move before its time