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ASSOCIATION



Centre for tunnel studies

5th International Seminar on Underground Space
Health & Safety in Underground Space
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Human Factors regarding road tunnel safety

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ORDEM
DOS
ENGENHEIROS



Società Italiana Gallerie
Italian Tunnelling Society



FGU Fachgruppe für Untertagbau
GTS Groupe spécialisé pour les travaux souterrains
GLS Gruppo specializzato per lavori in sotterraneo
STS Swiss Tunnelling Society

2001 / 2010

2011 / 2020

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2000

2001

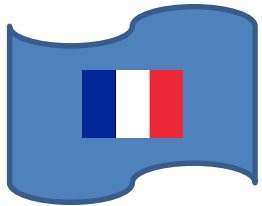
2004



Fires / alpine tunnels
1999 / 2001



- Initial implementation phases
- Feedback from actual events
- Stakeholders not very aware of issues related to human and organisational factors
- Users adopt inappropriate behaviour (fire)
- Agreement on need to improve these points



2001 / 2010

2011 / 2020

...

2000 2001 2004 2005 2009



Priority research topic at CETU

« Human factors and organisational aspects »

Methodology

- Mainly based on partnerships (owners, operators, designers, equipment providers, safety officers, firemen, research centres, universities and relevant experts, ...)
- Bibliography
- Feedback from actual events, exercises
- Questionnaires & surveys targeting users and operators
- Various experiments ...

Very close cooperation with PIARC Tunnel Committee



2001 / 2010

2011 / 2020

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2000 2001 2004 2005 2009



Priority research topic at CETU

« Human factors and organisational aspects »

Main lessons learnt regarding users

- They feel little apprehension when driving through a tunnel
- They are not very aware of available safety facilities
- Their level of attention varies whilst driving through a tunnel
- They do not appreciate having to interrupt their driving
- They find it difficult to grasp the seriousness of an emergency situation and to take the decision to evacuate
- They are concerned about having an inappropriate or excessive reaction

Very close cooperation with PIARC Tunnel Committee



2001 / 2010

2011 / 2020

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2000 2001 2004 2005 2009



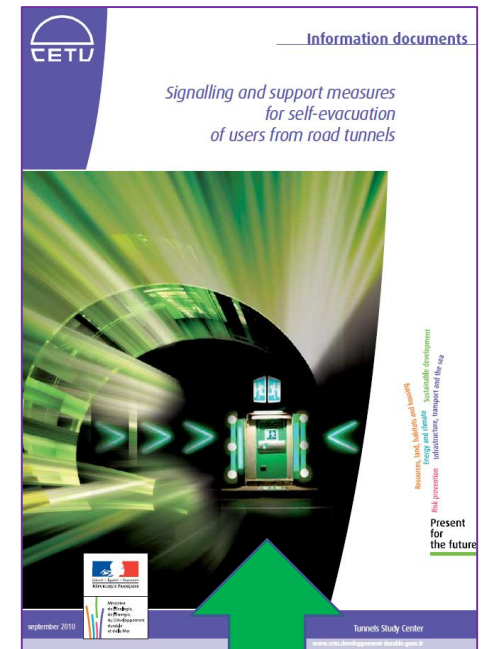
Priority research topic at CETU

« Human factors and organisational aspects »

Main lessons learnt regarding users

- They expect clear and precise information on the behaviour to adopt,
- They are more receptive to instructions when both audible and visual communication means are used
- They are highly sensitive to the « leadership » effect (often if one user takes the decision to evacuate, then the others will follow)

Very close cooperation with PIARC Tunnel Committee



Content

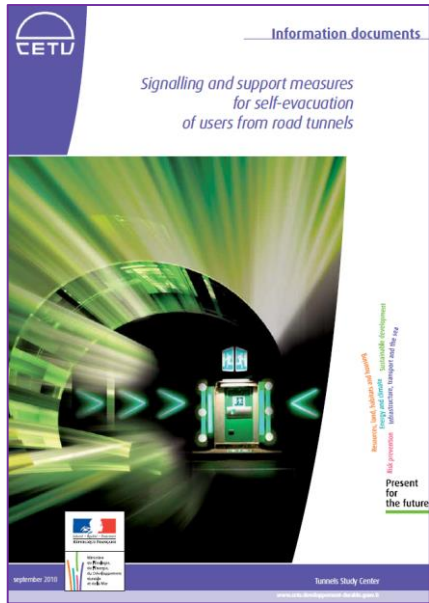
- Actions targeting the infrastructure
- Actions targeting users
- Conclusion



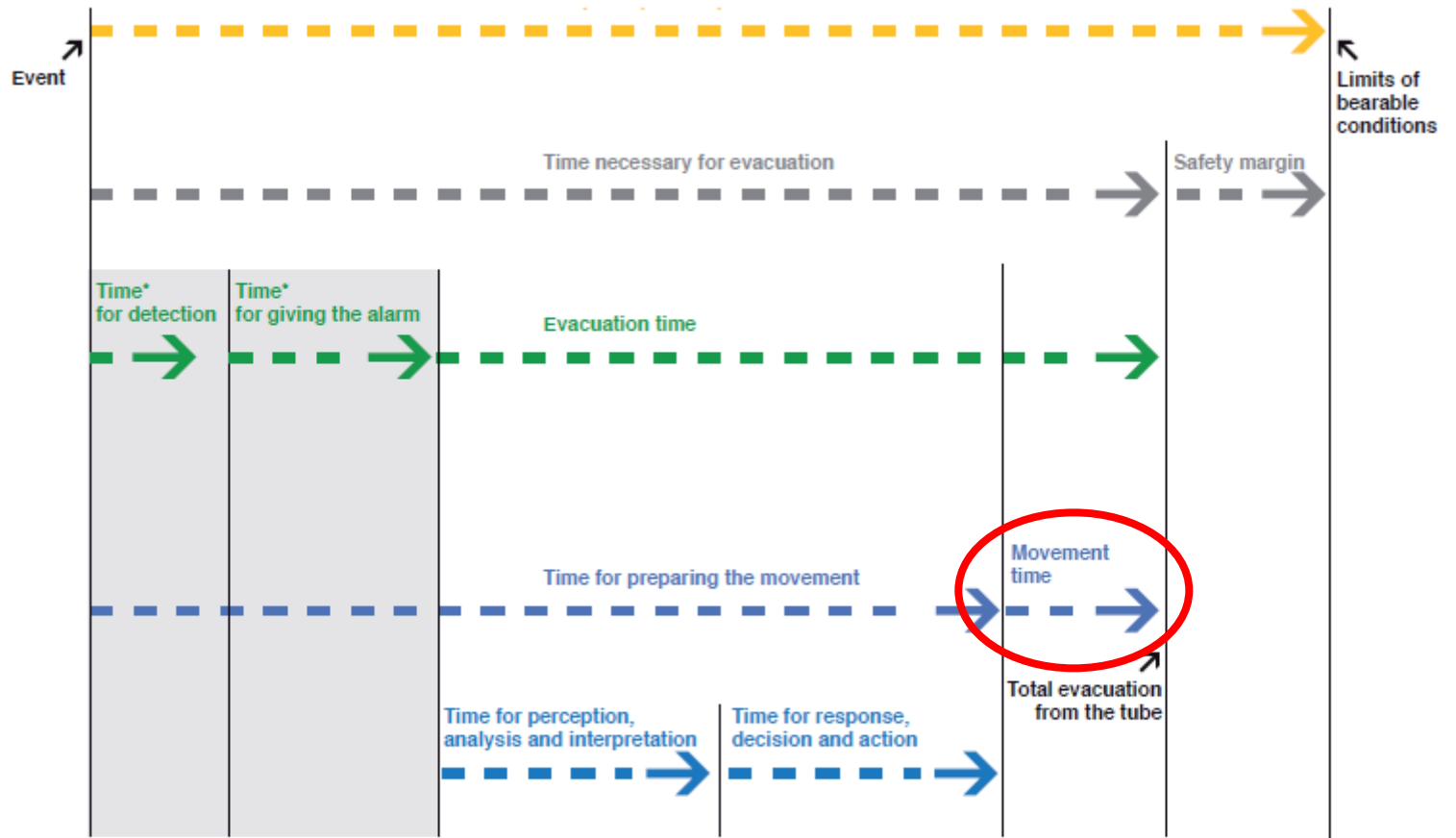
Content

- **Actions targeting the infrastructure**
- Actions targeting users
- Conclusion





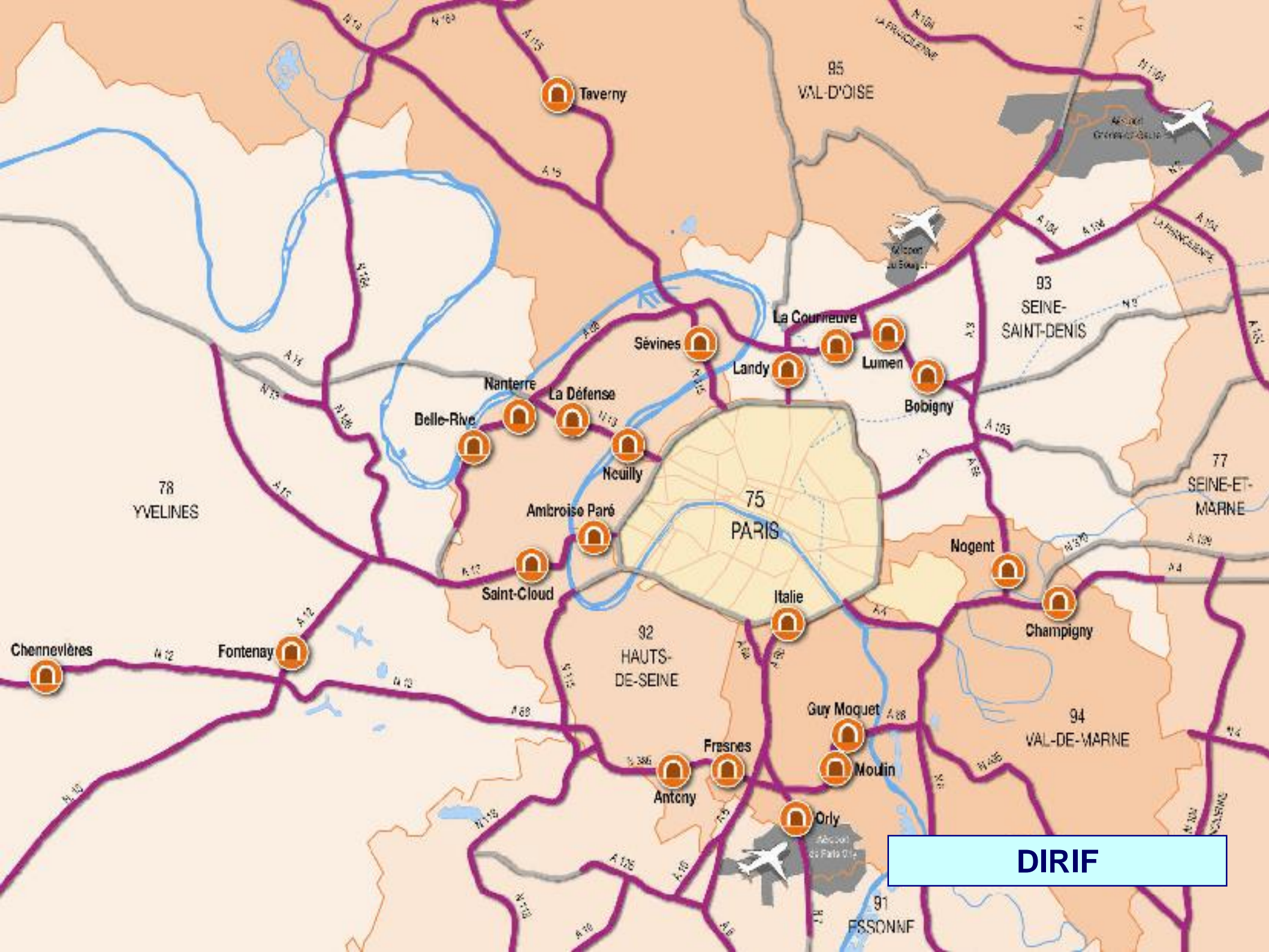
MODEL OF EVACUATION TIME OF USERS IN ROAD TUNNEL



* Action of the tunnel operating body
08/10/2007 Sylvie Lavedrine and Audrey Auboyer based on Egress Time Model (ISO Draft TC92, 2005)

Figure 1: Elements for comparing the time necessary for evacuation with the time available for evacuation

Model taken into account when implementing communication means



DIRIF



Noord tunnel



Noord tunnel



Exit here !



Siren: to alert users more effectively
SBS: to help users to locate the exits
... and to encourage them to enter the
exits

even more important in urban tunnels with
dense traffic
or
in tunnels where recurrent congestion makes it very
difficult for the user to perceive real crisis situations



Experiment « real situation »

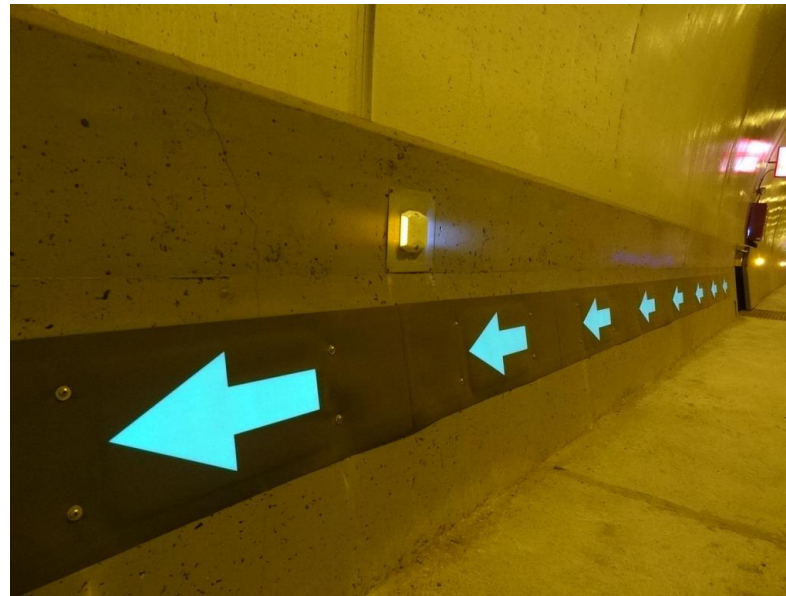
Actions targeting the infrastructure

- **Main lessons learnt:**
 - The siren alerts the user
 - The SBS encourages him/her to get out of the vehicle
 - When 2 or 3 users decide to enter the exit, the others spontaneously follow them
 - The arrows on the side walls improve evacuation efficiency
- Importance of the combination of different means (visual – audible) – already mentioned in the PIARC report

Actions targeting the infrastructure



Actions targeting the infrastructure



Content

- Actions targeting the infrastructure
- **Actions targeting users**
- Conclusion



2001 / 2010

2011 / 2020

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Training for road tunnel drivers (France)

- « ACTEURS » project - 2005

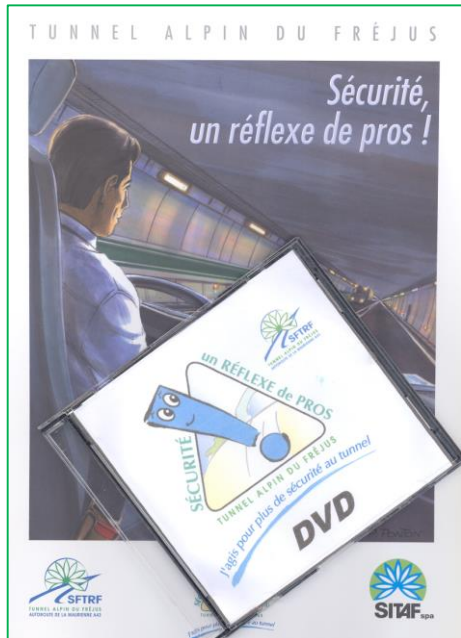
Projet ACTEURS

Améliorer le Couplage Tunnels / Exploitants / Usagers
pour Renforcer la Sécurité

**Lot 2 D3.1 : Education des usagers
des tunnels**

Note préparatoire aux fiches pédagogiques avant ajout
de questions concernant les tunnels dans l'Epreuve
Théorique Général (ETG) pour l'obtention du permis
de conduire

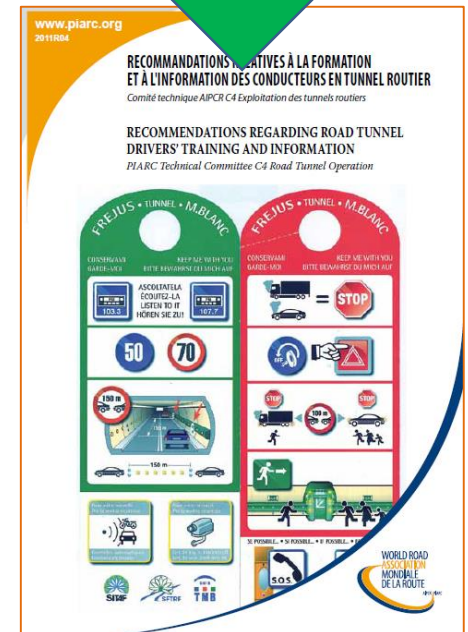
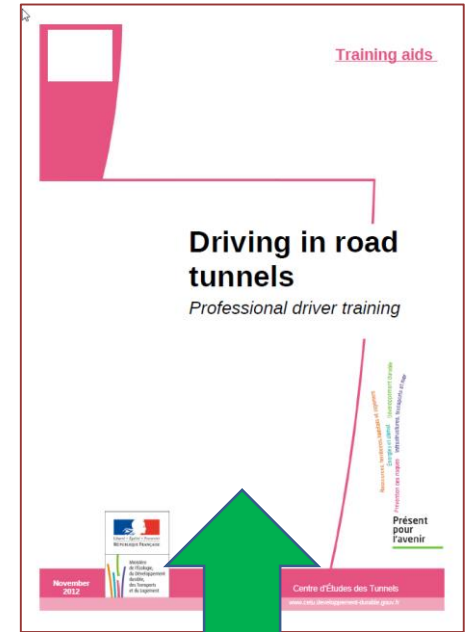
Version du document : 4.0
Date : 8 décembre 2005
Auteurs : A. Noizet / M. Tesson
Personne à contacter : A. Noizet (01.58.39.30.93)





Training for road tunnel drivers (France)

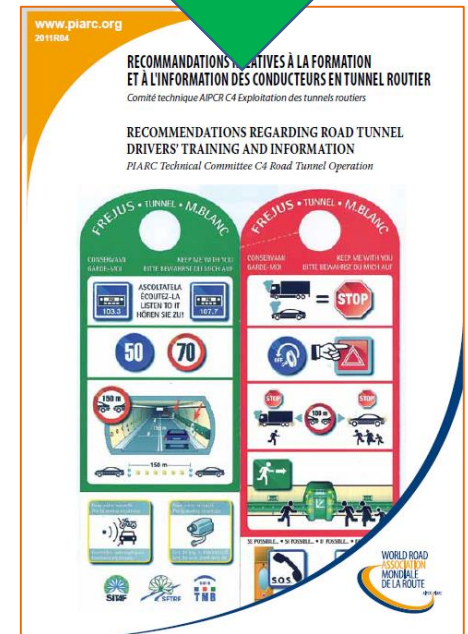
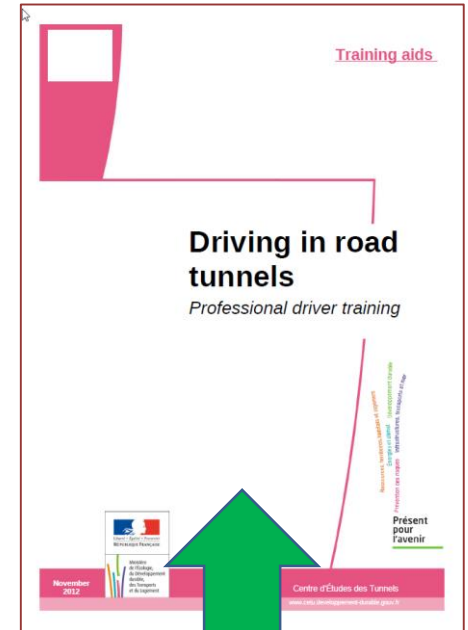
- Added to the highway code test – 2005
- Specific questions dealing with safety in tunnels





Training for road tunnel drivers (France)

- Professional drivers
- French initiative based on PIARC recommendations (2011)



Professional driver training

- Initiative consistent with:
 - EU Directive 2008/65/CE on driving licences
 - one of the main objectives of the PIARC report:
“To focus training actions on professional drivers”
- Joint action undertaken by CETU, French organisations and companies in charge of training actions



Professional driver training

- **Why?**

- Goods vehicles are the **source of aggravating factors** in the event of a fire in a tunnel,
- Evacuation situations: once some users take the initiative to flee towards exits, **the others follow them spontaneously**
- A lot is at stake when training professional users (**leadership role**)
- These users are normally aware of safety issues
- They follow **initial** and **further training courses** ; very useful for setting a good example in a crisis situation



Professional driver training

- **Organisation regarding the training of professional drivers in France:**
 - Accredited organisations and agencies
 - Accredited road haulage companies
 - Secondary schools for vocational training



Professional driver training

- Aims of the action:
 - to work with these organisations
 - to define a training approach that is tailored to the context of road tunnels
 - to develop annotated training aids for instructors
- Dissemination: 2012



A « reference » presentation

Formation des conducteurs professionnels - Mozilla Firefox

file:///P:/recherche/Axe_03/ARD_03-03/volet 2 Formation conducteurs professionnels/02 Produits/P3. Diaporama/Version definitive janv 2012/site_tunnel_v2/html/preambule.html

Formation des conducteurs professi...

- Examples of inappropriate behaviour
- Normal situation
- Minor events
- Major events (crisis)
- Particular cases:
 - Mont Blanc tunnel
 - Urban tunnels (high level of traffic)

Accueil
Préambule
Introduction
Situation normale de traversée
Événements mineurs
Situation de crise
Cas 1 : Mont-Blanc / Fréjus / Lemaire
Cas 2 : Tunnels urb. fort trafic
Conclusion

Ce docum
Régionale
Le Centre

Les part

APTH

AFT-IFTIM
La formation transport logistique

groupe promotrans
Promoteur intelligent, logistique et assistance

STEF-TFE

brun invest

Surl Formation
CORGIER

Sommaire

L'utilisation des vidéos présentées dans ce support de formation doit se faire dans le cadre exclusif des formations de conducteurs professionnels. Une copie partielle ou totale du présent

Terminé

Démarrer

Calendrier - Microsoft Ou...

Courrier entrant - TESSO...

site_tunnel_v2

Formation des condu...

FR 15:08

Professional driver training

Conclusions

- Fruitful cooperation between experts in the field of driver education and those in the field of road tunnel safety
- 360,000 French professional drivers concerned
- 50,000 of them targeted every year

Professional driver training

Conclusions

- French educational material can easily be adapted to fit an international context
- Possible further action: to translate the material into English and to encourage other countries to implement it

Very close cooperation with PIARC Tunnel Committee



2001 / 2010

2011 / 2020

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2000

2001

2004



Communication actions:

- 3 short videos
- Updated survey (users' knowledge regarding safety issues in tunnels)

2001 / 2010

2011 / 2020

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2016

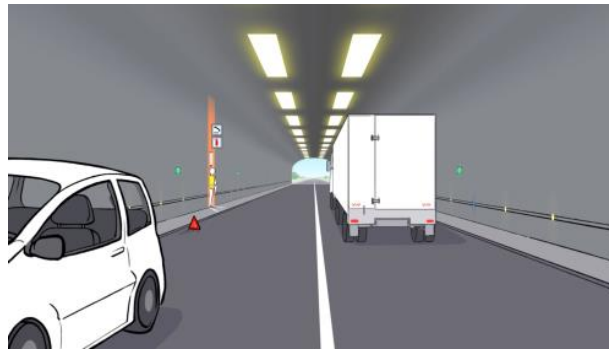
2019



3 short videos on « driving in tunnels » (summer 2018) - various web sites



normal operation (170.000)



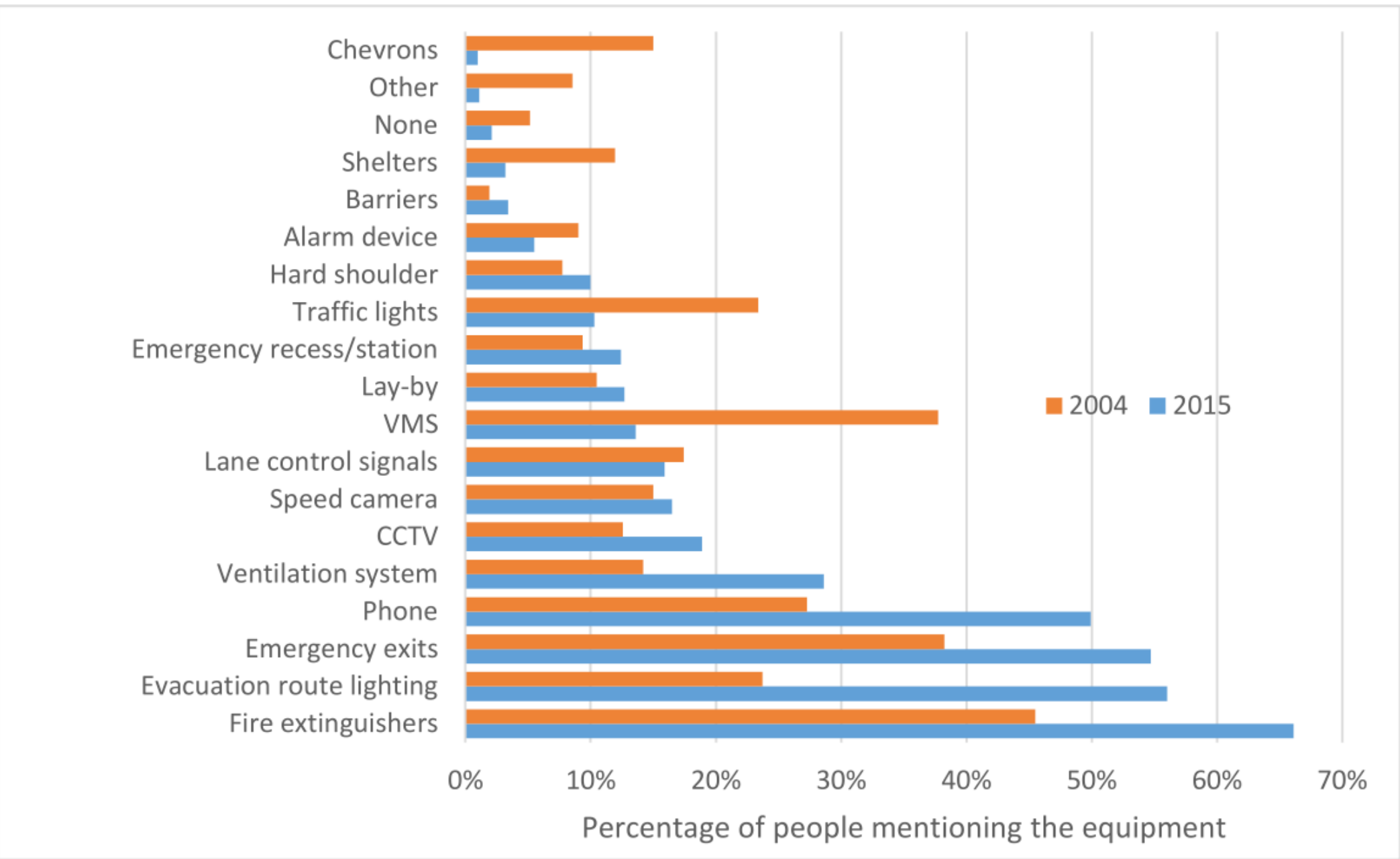
breakdown (356.000 views)



Fire (278.000 views)

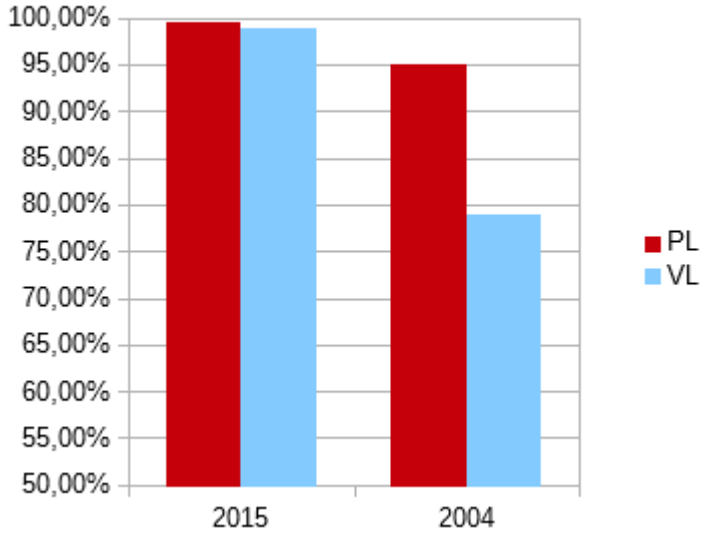
English, Italian, Spanish versions available

Updated survey (knowledge of safety issues)

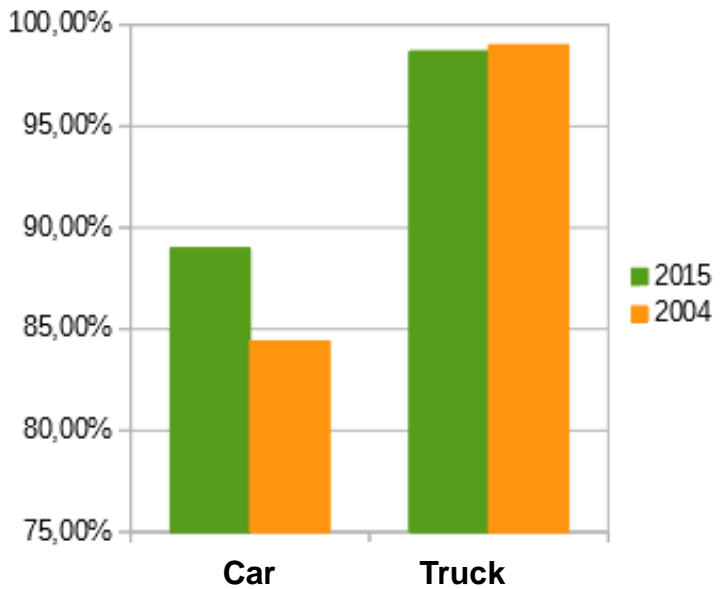


Updated survey (knowledge of safety issues)

Knowledge of emergency exit



Knowledge of safety distance



Behaviour in crisis situation

Fire on its own vehicle		Vehicle	
		Car	Truck
escape by driving	2015	10%	4%
	2004	24%	31%
Stop and actions (fire extinguish, go to emergency exit, call operator, ...)	2015	85%	91%
	2004	68%	64%
Stop and wait passively	2015	5%	5%
	2004	8%	5%

Content

- Actions targeting the infrastructure
- Actions targeting users
- **Conclusion**



2001 / 2010										2011 / 2020										...		
2000	2001			2004	2005			2009							2016			2019				



End results:

- About 20 years of experiments, research actions, projects, feedback, ...
- 2 theses – around 20 contributors from CETU
- **Highly fruitful synergy (PIARC / CETU) - 12 years (3 cycles)**

2001 / 2010

2011 / 2020

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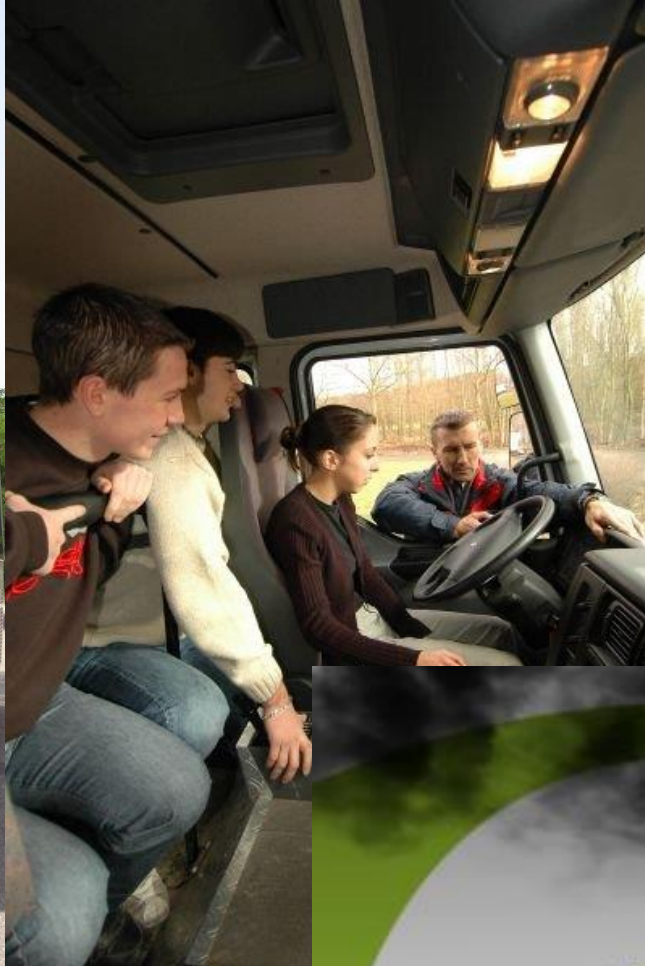
2016

2019



Perspectives for future work

- **Sound systems**
- **Paint effects** and implementation of **flashing lights** at emergency exits
- **Intelligent Transportation Systems (next PIARC Cycle – priority topic):**
 - Continuity of service when approaching a tunnel and driving through it
 - Existing functions to be improved and expected benefits of new ITS
- **Safety Management Systems** (priority topic for CETU)
 - Organisational aspects – links with safety documentation, exercises, feedback, inspections and maintenance, ...
 - On-going audits by CETU (8 operators)



Thank you for your attention
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<http://www.cetu.developpement-durable.gouv.fr/>