



# How to define “Minimal Operating Requirements” ?

**Session :**  
**Strategic issues regarding tunnel safety officers' tasks and functions**

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# Presentation schedule

- **The regulatory and institutional framework**
- **Degraded operation situations**
- **Relationship with safety functions**
- **Instruction book**

# The TSO tasks

**Why is it important to adopt a clear definition of Minimal Operating Requirements (MORs) ?**

***Ref article 6:***

- (a) ensure coordination with emergency services and take part in the preparation of operational schemes;**
- (c) take part in the definition of safety schemes and the specification of the structure, equipment and operation in respect of both new tunnels and modifications to existing tunnels;**
- (e) give advice on the commissioning of the structure, equipment and operation of tunnels;**
- (g) take part in the evaluation of any significant incident or accident as referred to in Article 5(3) and (4).**

# The TSO tasks

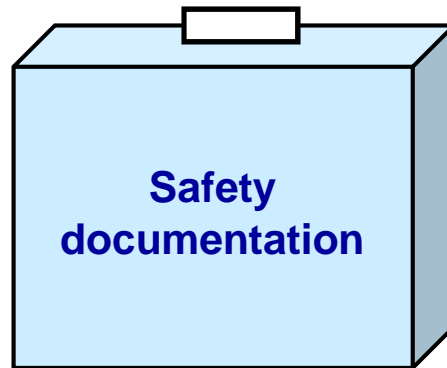
## How to define Minimal Operating Requirements (MORs) ?

- In consistency with *principles for actions* defined in the *Emergency Response Plan (ERP)*
- In connection with *degraded operating modes*
- With the objective of a clear definition of *situations for which the tunnel should be closed*
- ... relevant *instructions* will be derived for these situations

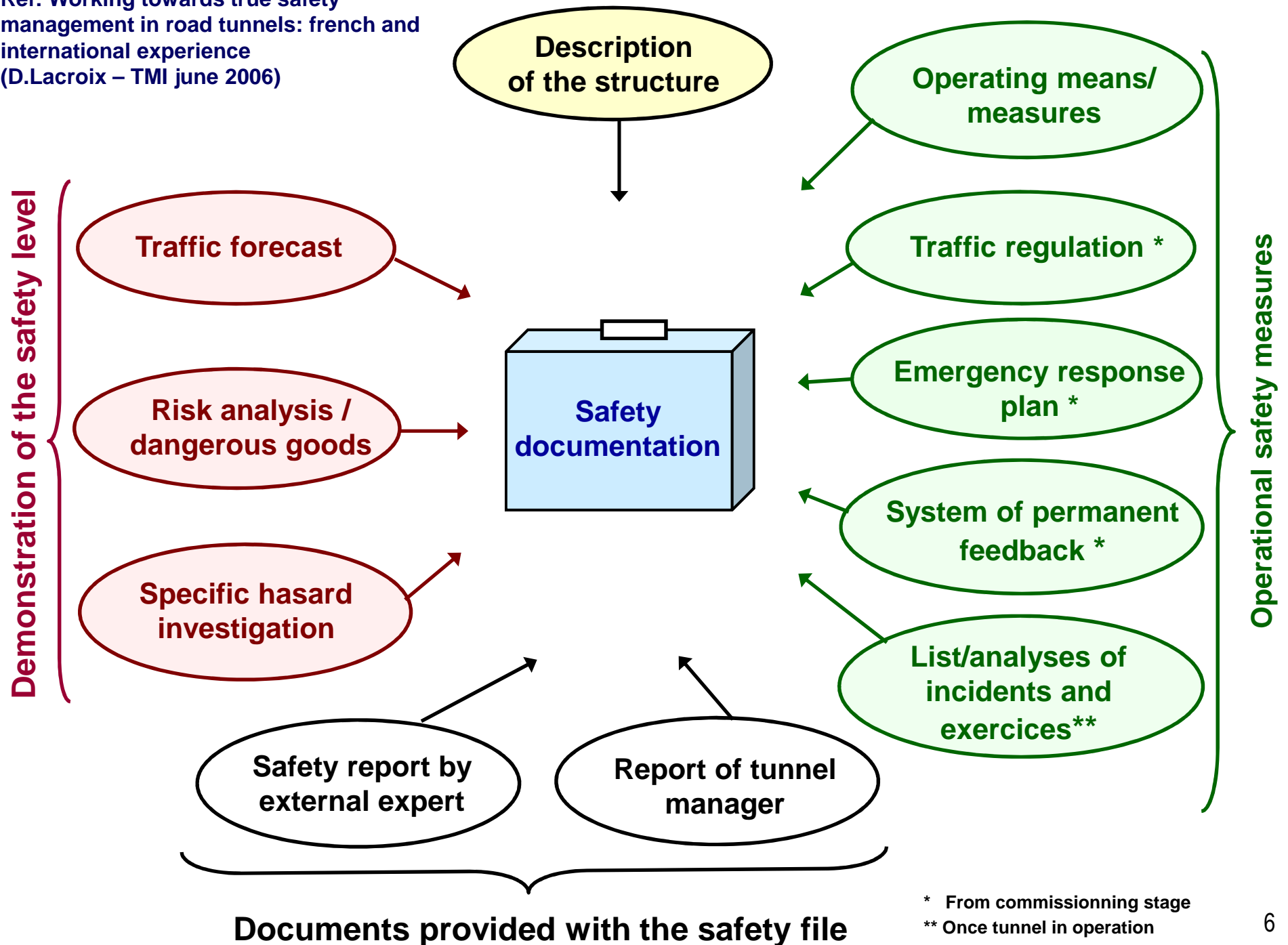
# The regulatory and institutional framework

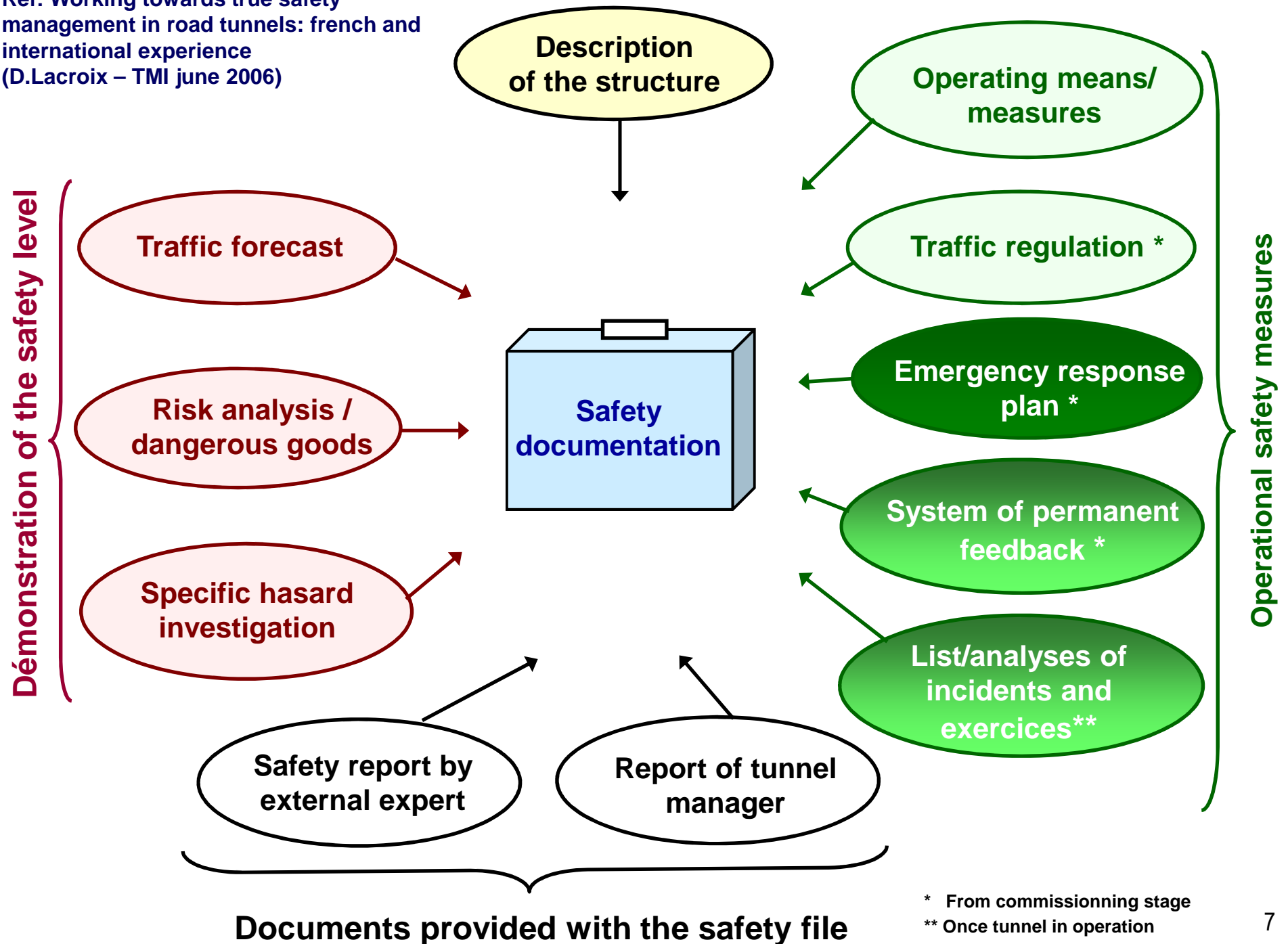
## Safety in road tunnels

French regulatory and institutional framework :  
a safety management system based on the



... in accordance with the European Directive



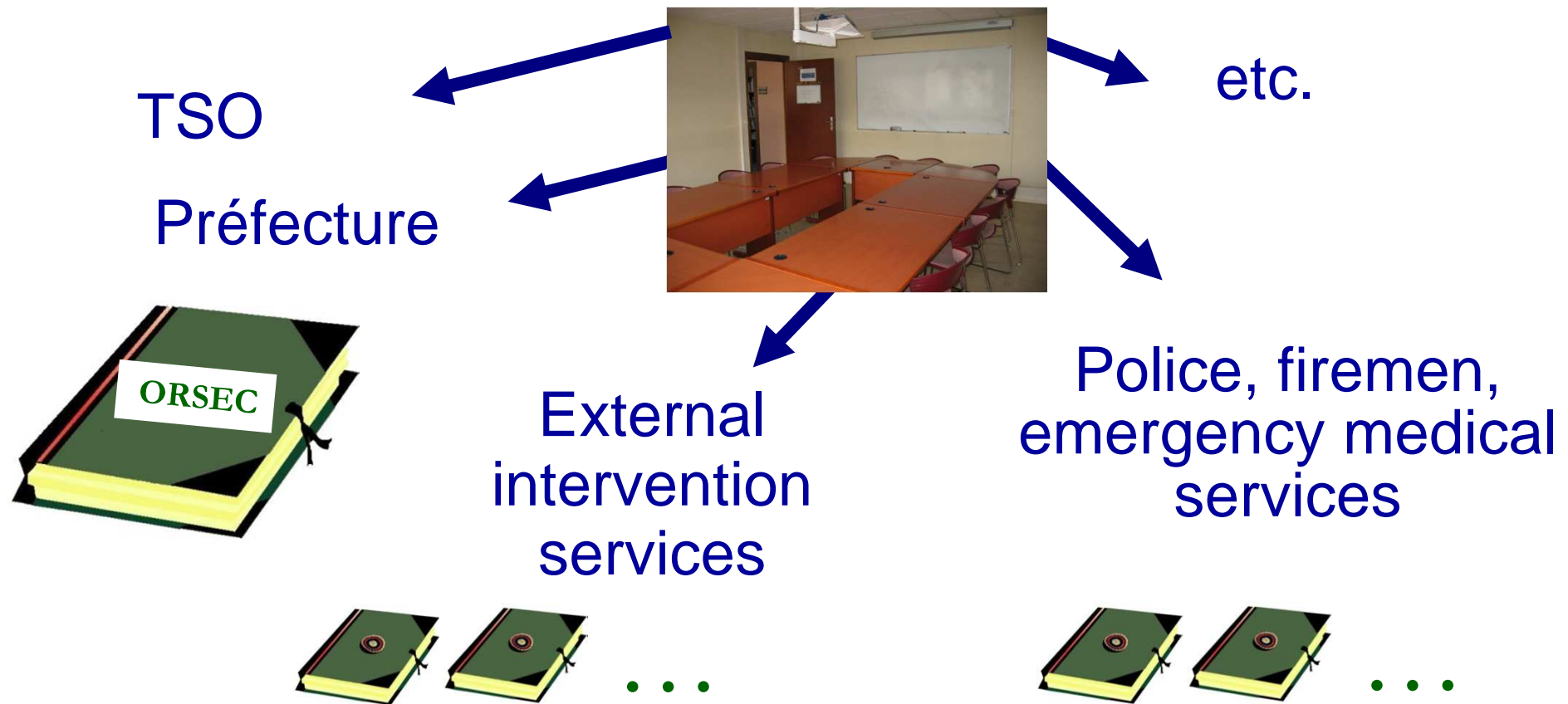


# The regulatory and institutional framework

Who works out the ERP <sup>(1/2)</sup> ?

**the tunnel manager (operating body)**

in coordination with TSO and the emergency services (outside parties)



# The ERP achievement

Who works out the ERP (2/2) ?

The participants :

<b>Tunnel operating body</b>	<b>Outside (of tunnel operation service) parties</b>
<ul style="list-style-type: none"><li>• Duty operator</li><li>• Duty operation manager</li><li>• In house intervention services :<ul style="list-style-type: none"><li>- Patrols</li><li>- Dedicated fire fighters</li></ul></li><li>• Maintenance services</li></ul>	<ul style="list-style-type: none"><li>• Prefet (Administrative Authority)</li><li>• TSO</li><li>• Services responsible for managing the route on which the tunnel is located and other road networks</li><li>• External control centers</li><li>• External intervention services:<ul style="list-style-type: none"><li>– law enforcement</li><li>– public emergency services</li></ul></li><li>• Other parties (roadside assistance services, subcontractors)</li></ul>

# The ERP objectives

## What are the ERP objectives ?

### To define

- the organisation and duty of the tunnel operating body's staff for situations likely to question people's safety
- the modalities for alerting outside intervention services



- The general action principles of the tunnel operating body
- Their interaction with the Police own procedures and Public rescue services' own procedures

### To act



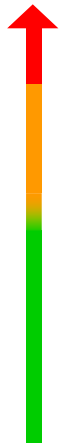
as promptly as possible and under the best possible conditions for each situation

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# Events affecting safety

How can the events likely to question people's safety be identified ?



- In connection with traffic or environment
- Relative to the available operating means ... (equipments – people)

**Severity thresholds**

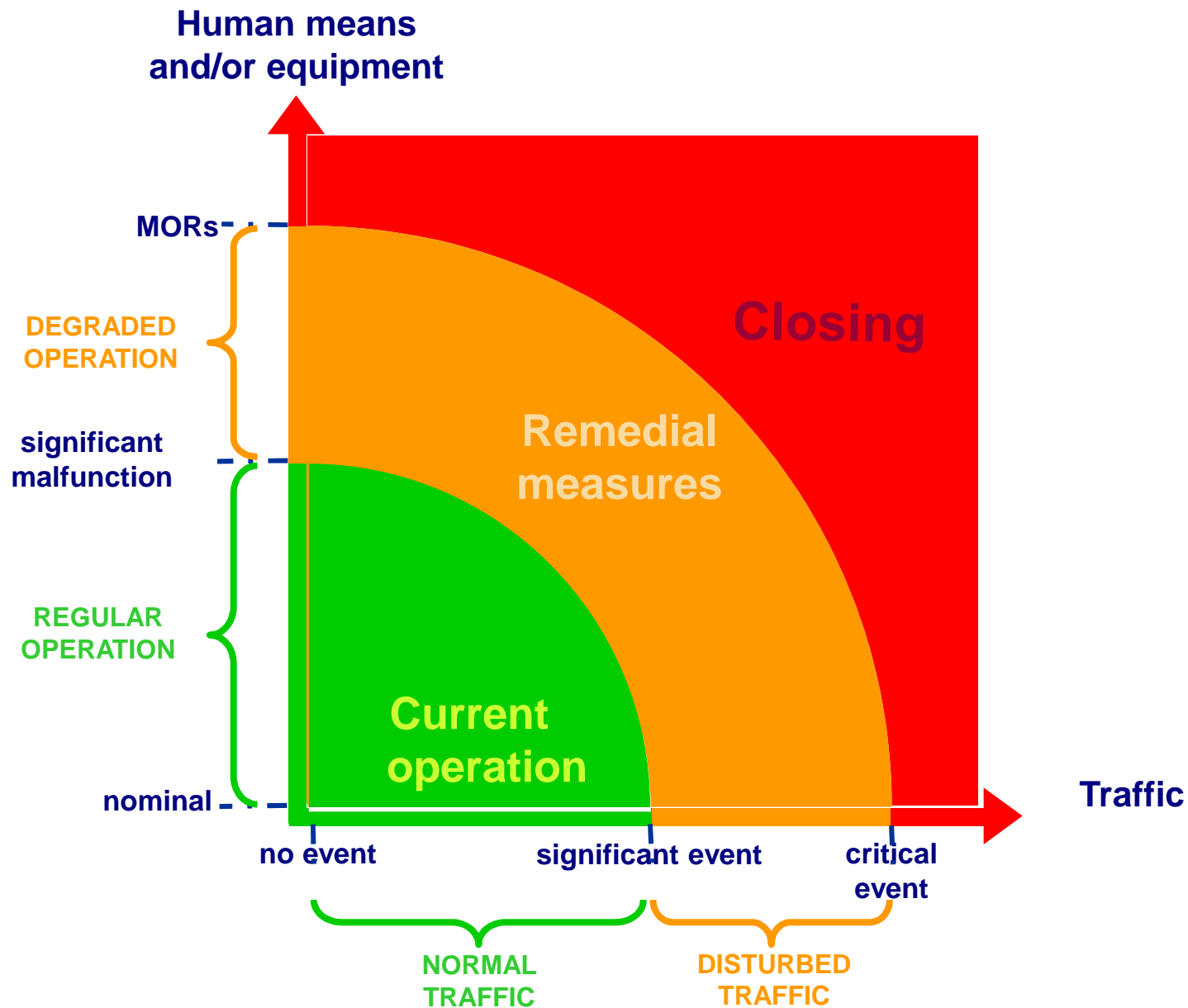
minor

important

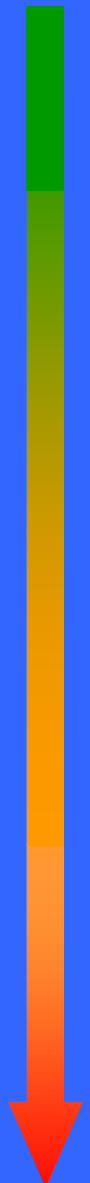
critical

.... MOR

# Various operating situations



# Degraded operating modes

- 
- **Nominal mode** 100% of the available resources
  - **Degraded mode** : defined by 3 criteria
    - ➔ **qualification** and **quantification** of the unavailable operating means (equipment family(ies) or personnel)
    - ➔ **remedial measure(s)** to warrant a sufficient safety level and maintain traffic inside the tunnel
    - ➔ **time limit** after which the degraded mode is no longer acceptable
  - **Critical mode** : **minimal operating requirements (MOR)** or minimal availability condition beneath which the tunnel must be **closed to traffic**  
*(i.e. as soon as one of the 3 criteria is no more observed)*

# Degraded operating modes

They give rise to specific operating measures :

- ➡ initiate maintenance action
- ➡ request intervention of external intervention services
- ➡ require implementation of **remedial measures** that ensure an adequate level of safety and allow traffic through the tunnel

## EXAMPLES

**Lane closure**

**Implementation of contra-flow measures outside of the tunnel**

**Speed control**

**Ban a category of traffic**

**More frequent patrols**

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# Relationship with safety functions

Relationship between:

Prevention and protection means

**X**

Safety functions

# Relationship with safety functions

<b>F1 Preventing incidents / accidents</b>
F 1.1 Monitoring the tunnel, its equipment and the traffic in it
F 1.1 Monitoring weather conditions, traffic and the external environment
F 1.1 Ensuring safe, comfortable driving conditions
F 1.1 Keeping users informed about traffic conditions
<b>F 2 Detection</b>
F 2.1 Detecting an incident / accident
F 2.2 Classifying the incident / the accident
<b>F 3 Alerts and information given by the tunnel operating body</b>
F 3.1 Alerting the emergency services
F 3.2 Alerting users in the tunnels and at the tunnel portals
F 3.3 Informing users on the network outside the tunnel
<b>F 4 Limiting the consequences of the incident</b>
F 4.1 Minimising the number of users in the tunnel and avoiding further accidents
F 4.2 Limiting escalation of the incident while waiting for the emergency services to arrive
F 4.3 Aiding evacuation, getting users to safety (self evacuation)
F 4.4 Aiding and supporting access and action by emergency services
<b>F 5 Ensuring a return to normal</b>
Checking the condition of the tunnel and carrying out any necessary emergency work to restore traffic flows

# Relationship with safety functions

## Resources (prevention and protection means)

- Civil engineering
- Tunnel management system
- Power supplies
- Lighting
- Ventilation
- Fire fighting equipment
- Incident and fire detection
- Communication
- Traffic signs
- Human resources connected to the tunnel
- External human resources

# Relationship with safety functions

<div>Resources</div> <div>Safety Functions</div>		F1: Preventing incidents/accidents				F2: Detection		F3: Alerts and information given by the tunnel operating body			F4: Limiting the consequences of the incident				F5: Ensuring a return to normal
		F1-1 Monitoring the tunnel, its equipment and the traffic in it	F1-2 Monitoring weather conditions, traffic and the external environment	F1-3 Ensuring safe, comfortable driving conditions	F1-4 Keeping users informed about traffic conditions	F2-1 Detecting an incident/accident	F2-2 Classifying the incident/accident	F3-1 Alerting the emergency services	F3-2 Alerting users in the tunnels and at tunnel portals	F3-3 Informing users on the network outside the tunnel	F4-1 Minimising the number of users in the tunnel and avoiding further Accidents	F4-2 Limiting escalation of the incident while waiting for the emergency services to arrive	F4-3 Aiding evacuation, getting users to safety (self-evacuation)	F4-4 Aiding and supporting access and action by emergency services	F5 Checking the condition of the tunnel and carrying out any necessary emergency work to restore traffic flows
M1: Civil engineering	M1-1 Roadway and emergency stopping lanes														
	M1-2 walkways														
	M1-3 Drainage systems														
	M1-4 Emergency exits - shelters														
M2: Tunnel management system	M2-1 Sensors and actuators														
	M2-2 Site network														
	M2-3 Industrial programmable logic controller														
	M2-4 Transport / transmission network														
	M2-5 Tunnel control centre (supervision)														
M3: Power supplies	M3-1 External power supply														
	M3-2 Power substations / low voltage master distribution panel														
	M3-3 Uninterruptible emergency power supply														
	M3-4 Water supply														
M4: lighting	M4-1 Normal lighting														
	M4-2 emergency lighting														
	M4-3 Emergency-evacuation equipment lighting														
	M4-4 Marker lights														
M5: Ventilation	M5-1 sanitary														
	M5-2 Smoke extraction														
	M5-3 Emergency exits - shelters														
M6: Fire fighting equipment	M6-1 Fire extinguishers														
	M6-2 Fire pipe and hydrant														
M7: Incident and fire detection	M7-1 Close-circuit television														
	M7-2 Automatic incident detection														
	M7-3 Smoke opacimeters and gas analysers														
	M7-4 anemometers														
	M7-5 Fire detectors (local housings)														
	M7-6 Fire detectors (tunnel)														
	M7-7 Break contacts and extinguisher on-off switches														
	M7-8 Loop-based counting system														
M8: communication	M8-1 Emergency telephones														
	M8-2 Tunnel operator / emergency service radio broadcasting facilities														
	M8-3 User radio relay facilities														
	M8-4 Mobile telephone broadcasting facilities														
M9: Traffic signs	M9-1 Stop light														
	M9-2 Tunnel closure barriers														
	M9-3 Variable message signs														
	M9-4 Lane allocation signals														
	M9-5 Safety and evacuation equipment signage														
M10: human resources connected to the tunnel	M10-1 Tunnel operator														
	M10-2 Patrols														
	M10-3 Trouble shooting team														
	M10-4 In-house fire service														
M11: External human resources	M11-1 Emergency services														
	M11-2 Law enforcement services														
	M11-3 Traffic control centre														

# Relationship with safety functions : EXAMPLE 1

- Total loss of AID
  - Discriminant safety function (« Detecting an incident/accident »)
  - Requires immediate tunnel closure

Safety Functions			F2: Detection	
			F2-1	F2-2
Resources			Detecting an incident/accident	Classifying the incident/accident
M7: Incident and fire detection	M7-1	Close-circuit television		
	M7-2	Automatic incident detection		
	M7-3	Smoke opacimeters and gas analysers		
	M7-4	anemometers		
	M7-5	Fire detectors (local housings)		
	M7-6	Fire detectors (tunnel)		
	M7-7	Break contacts and extinguisher on-off switches		
	M7-8	Loop-based counting system		
M8: communication	M8-1	Emergency telephones		
	M8-2	Tunnel operator / emergency service radio broadcasting facilities		
	M8-3	User radio relay facilities		
	M8-4	Mobile telephone broadcasting facilities		

## Relationship with safety functions : EXAMPLE 2

- Partial loss of Emergency telephone
- Partial loss of closed-circuit TV
  - 2 resources involved in the same safety function (« Detecting an incident/accident »)
  - By associating the 2 resources, the safety function can be fulfilled

Safety Functions			F2: Detection	
			F2-1	F2-2
Resources			Detecting an incident/accident	Classifying the incident/accident
M7: Incident and fire detection	M7-1	Close-circuit television		
	M7-2	Automatic incident detection		
	M7-3	Smoke opacimeters and gas analysers		
	M7-4	anemometers		
	M7-5	Fire detectors (local housings)		
	M7-6	Fire detectors (tunnel)		
	M7-7	Break contacts and extinguisher on-off switches		
	M7-8	Loop-based counting system		
M8: communication	M8-1	Emergency telephones		
	M8-2	Tunnel operator / emergency service radio broadcasting facilities		
	M8-3	User radio relay facilities		
	M8-4	Mobile telephone broadcasting facilities		

# Example

CCTV		
Condition	Definition of condition	Measures to be taken
Nominal	All cameras operational	N/A
Degraded 1	Quantitative unavailability: 10 % (non-consecutive cameras) Remedial measure: none. Maximum acceptable duration: 1 week.	Schedule expedited maintenance.
Degraded 2	Quantitative unavailability: 30 % (non-consecutive cameras) Remedial measure: emergency call system operational throughout tunnel. Maximum acceptable duration: 4 hours.	Schedule emergency maintenance. Check correct operation of emergency telephones.
MOR	Quantitative unavailability threshold: 2 consecutive cameras Remedial measure: corresponding emergency telephones operational; heightened surveillance on site. Maximum acceptable duration: 4 hours.	Schedule emergency maintenance. Check correct operation of emergency telephones concerned. Set up heightened surveillance.

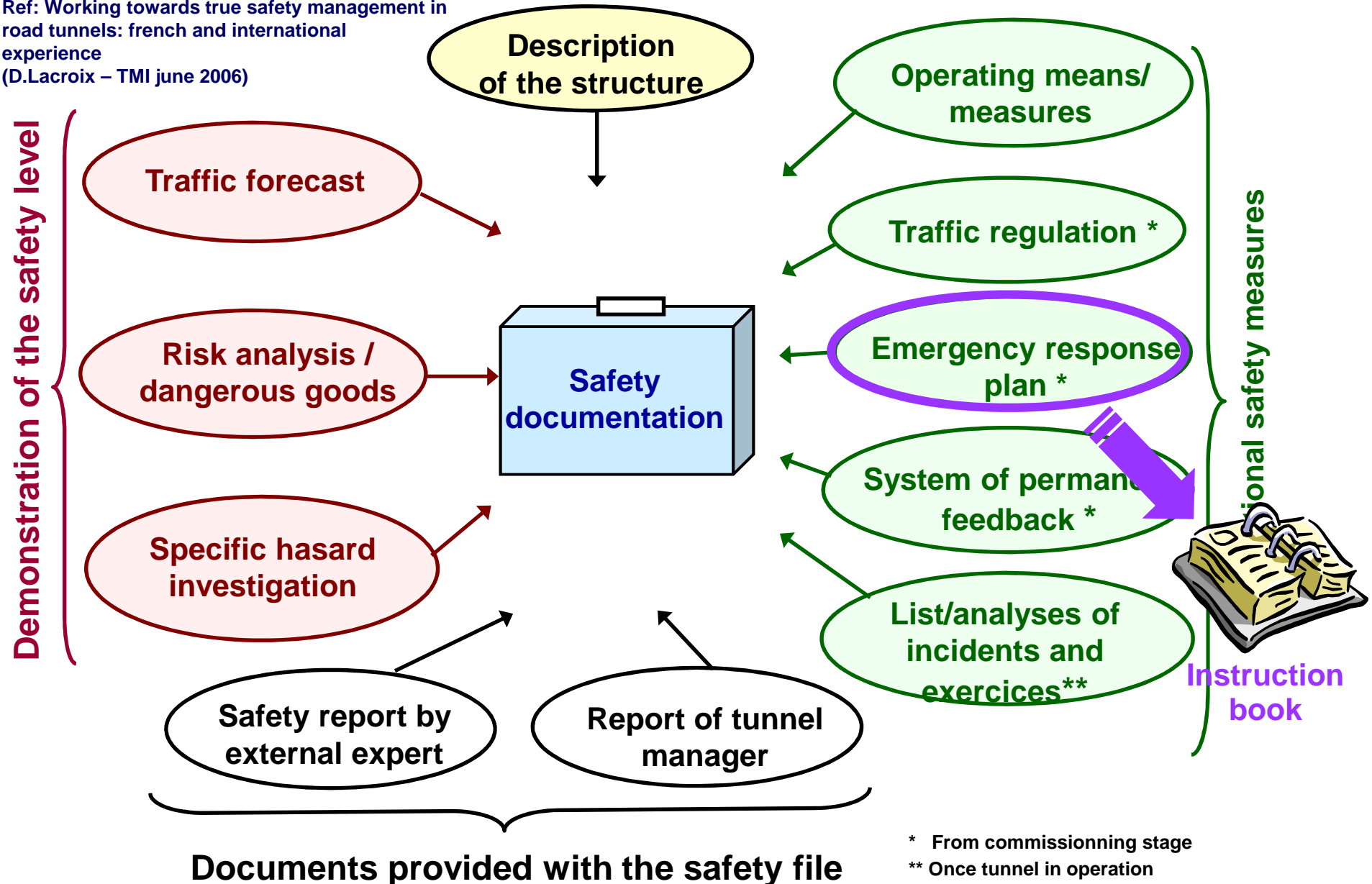
In this example, under minimal operating requirements, if one of the criteria is no longer met, the tunnel must be closed to traffic immediately.

# Presentation schedule

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# Interaction between ERP and instruction book

Ref: Working towards true safety management in road tunnels: french and international experience  
(D.Lacroix – TMI june 2006)



# « Who? What? How? »

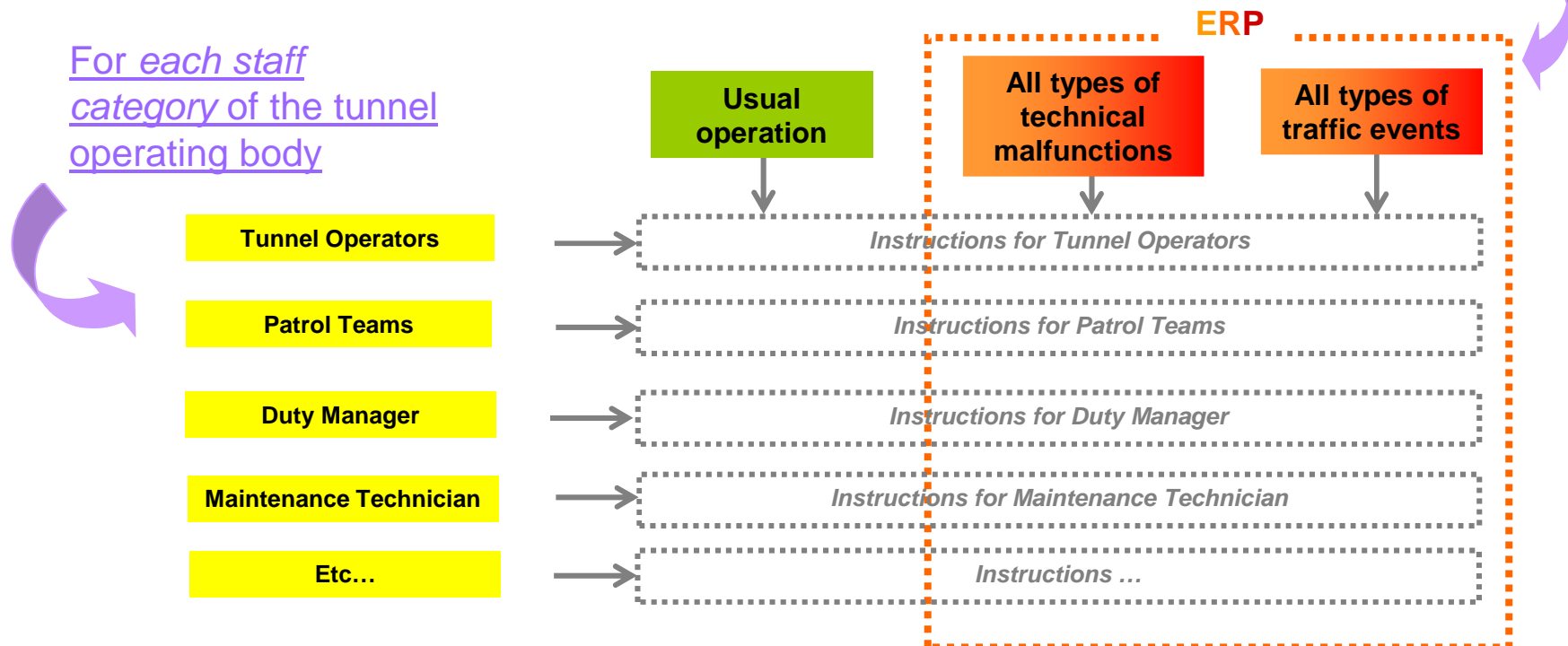
Instructions are defined by the **tunnel operating body**

They are derived from **general principles for actions**

They define :

- the operation of, and how to use safety devices and equipment of the tunnel
- what to do in various operating modes (normal conditions, technical malfunctions, incidents and/or accidents)

For each staff  
category of the tunnel  
operating body





*Thank you for your attention*