



3rd European Tunnel Safety Officers Forum 2014 26 – 28 March 2014 Luxembourg

Tunnel Safety – A Joint Effort Workshop 3 : Critical Safety Functions



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3rd European Tunnel Safety Officers Forum - 26 – 28 March 2014, Luxembourg

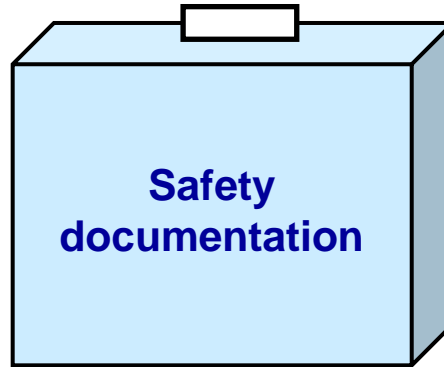
Presentation schedule

- **The context**
- **The Minimal Operating Requirements (MORs)**
- **The safety functions**
- **Using safety functions**

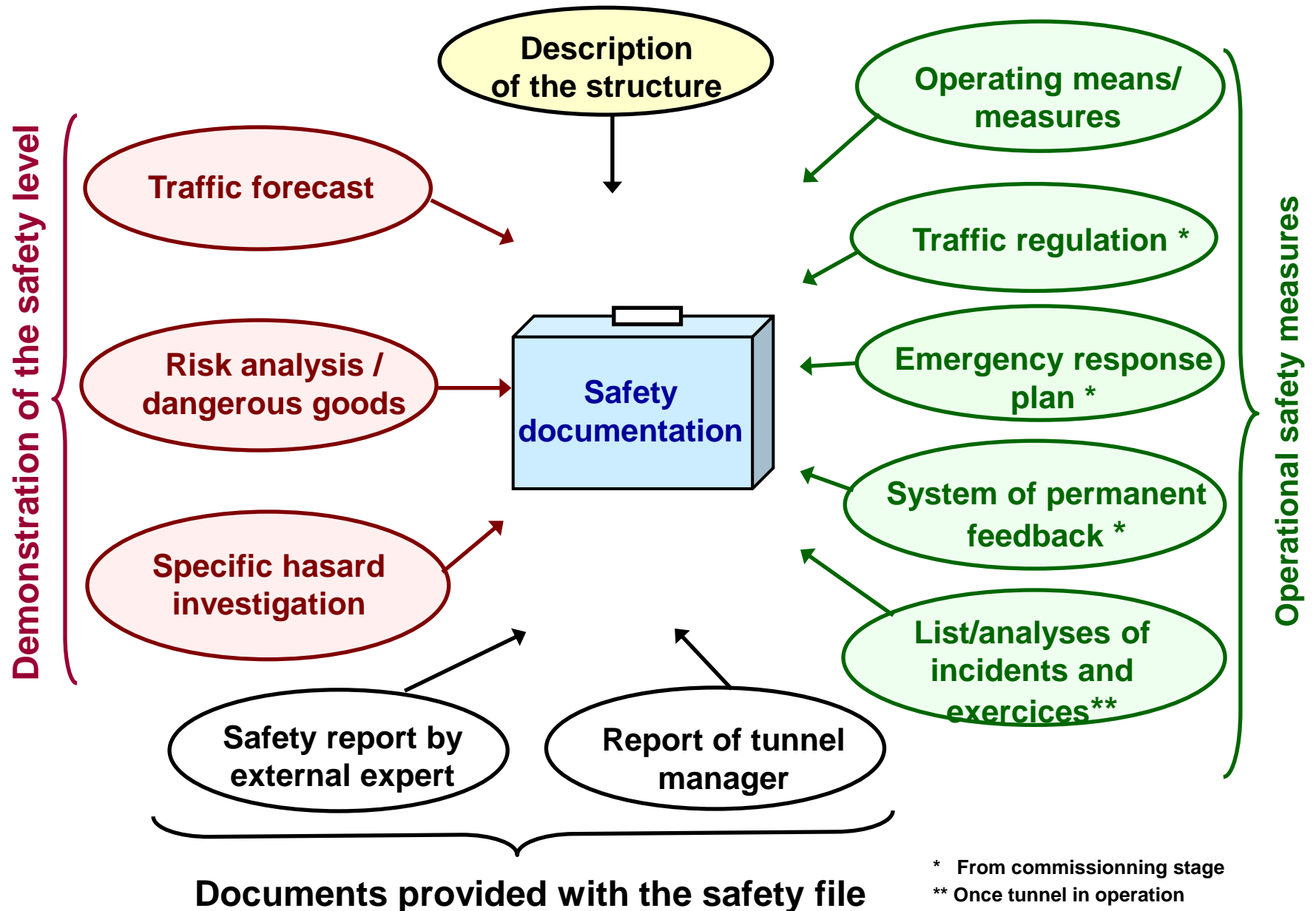
The context

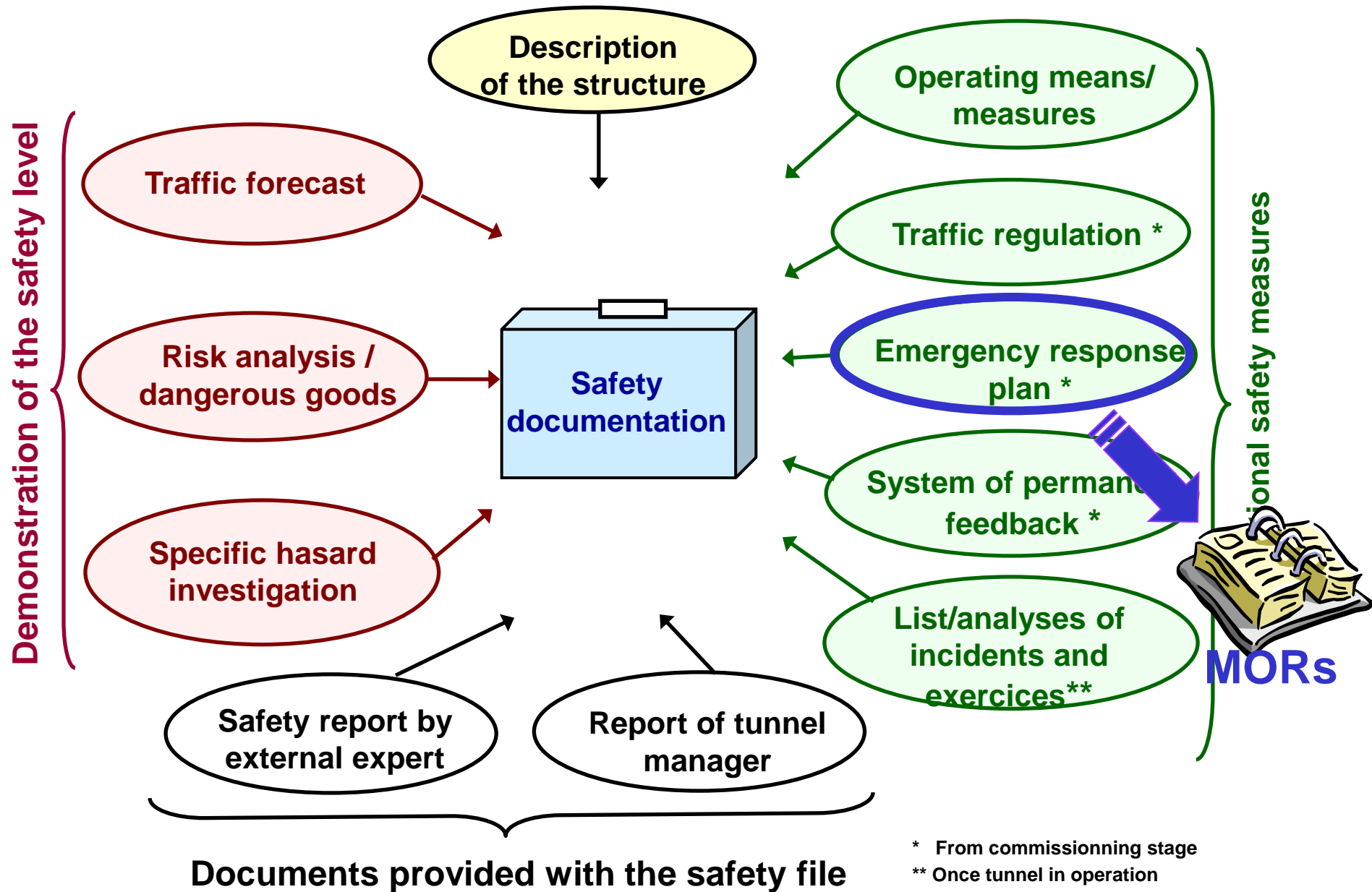
For tunnels longer than 300 m

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



... in accordance with the European Directive





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How to define the MORs ?

The events can be classified in two groups :

- In connection with traffic (or environment)

normal traffic

disturbed traffic

critical conditions

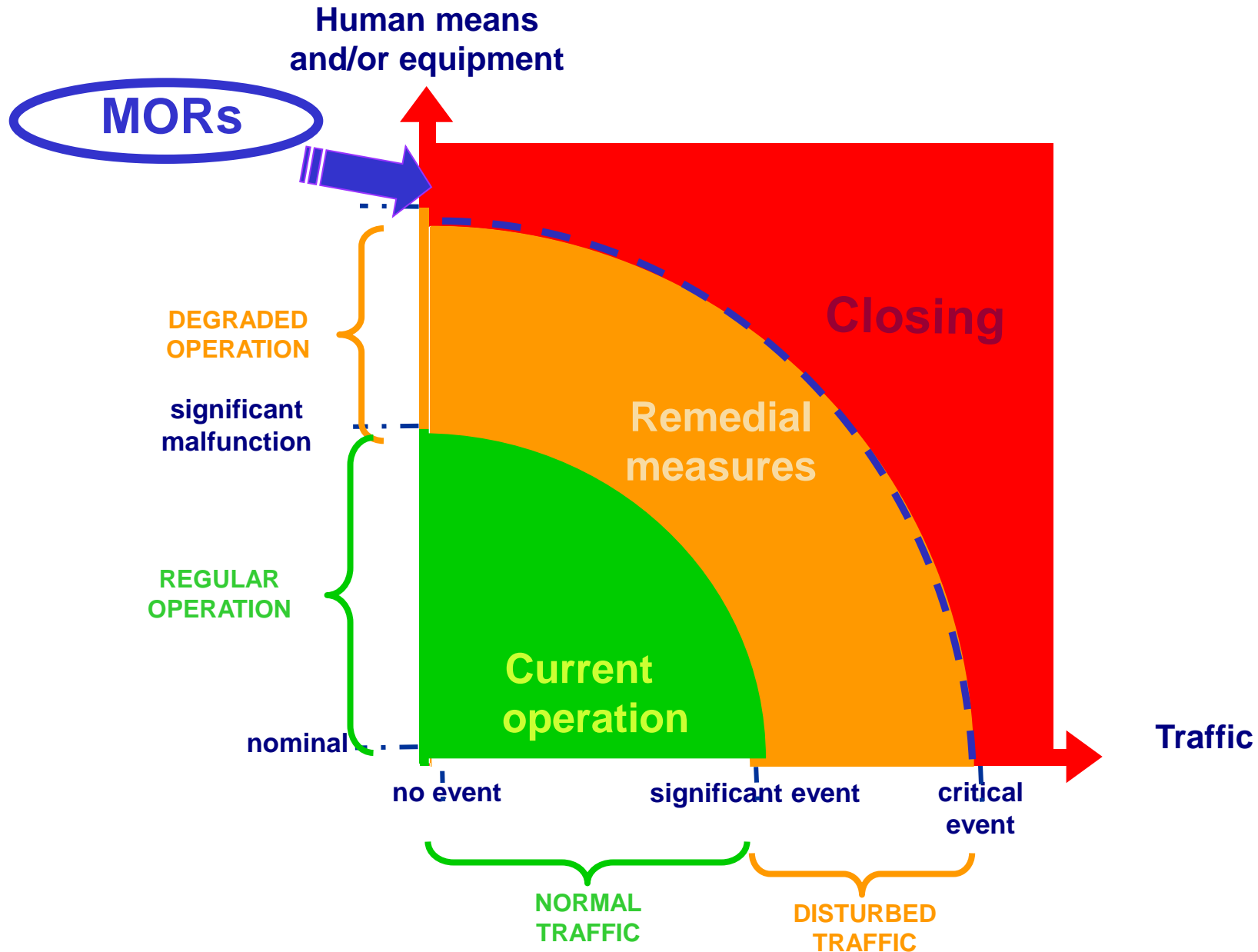
- Relative to the available operating means ...
(equipments – staff)

regular operation

degraded operation

critical operation

How to define the MORs ?

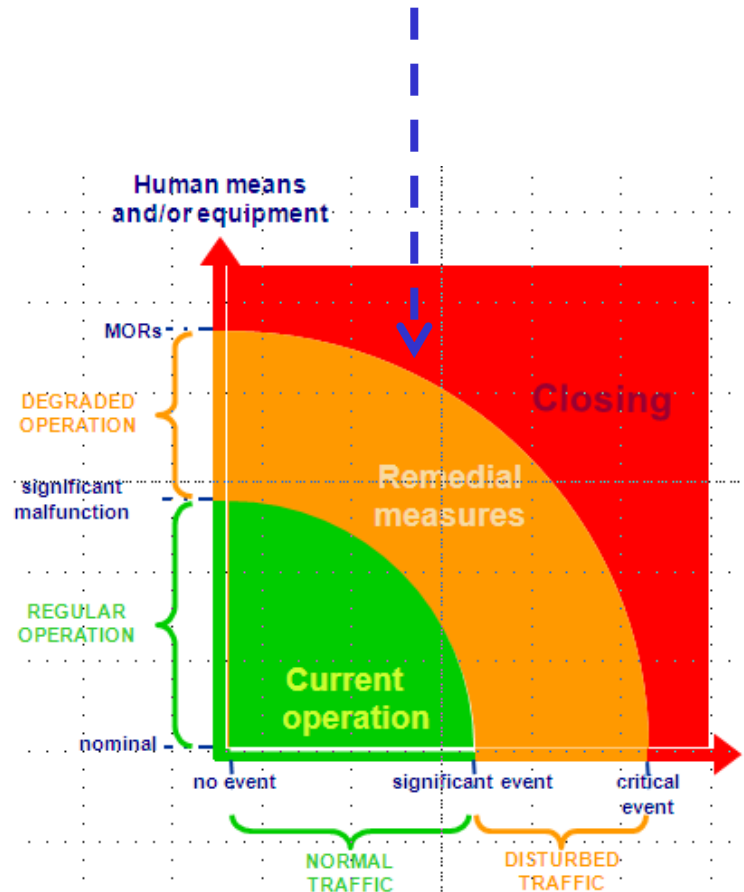


How to define the MORs ?

- We have to define the border between

- the **orange area**

- the **red area**

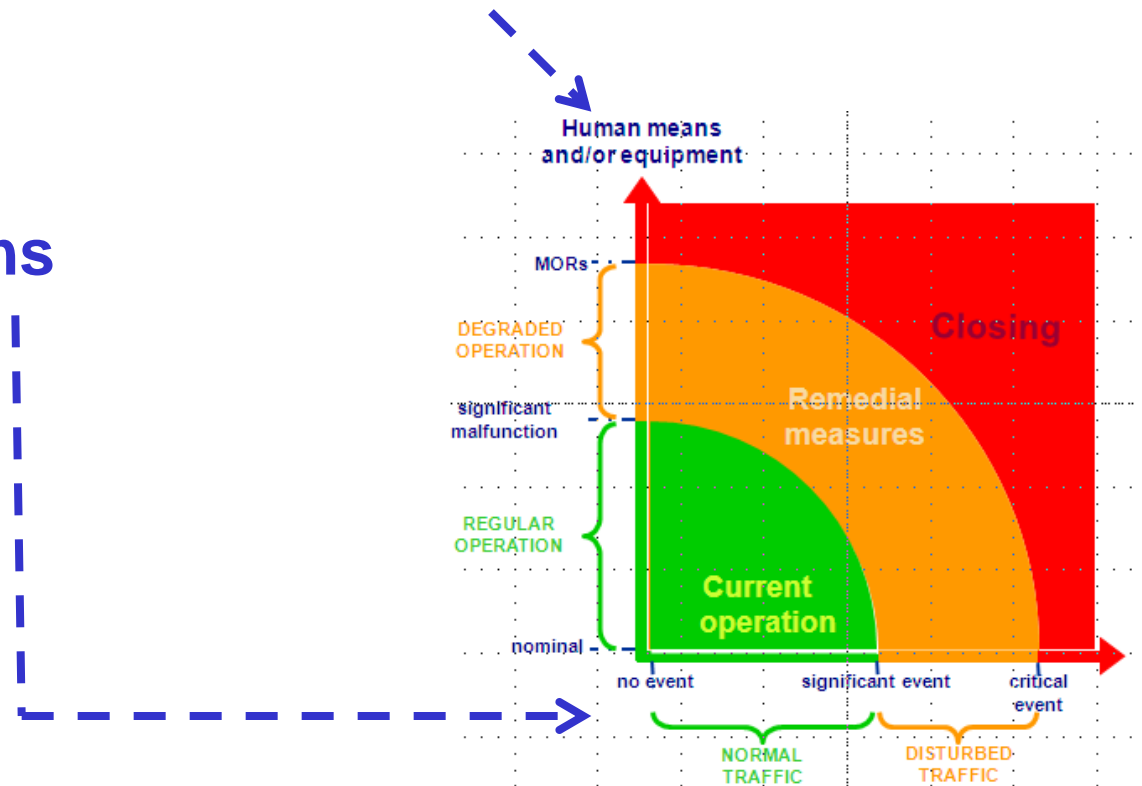


How to define the MORs ?

Not too complicated if we consider only one axe :

➤ the **Human means or equipment**

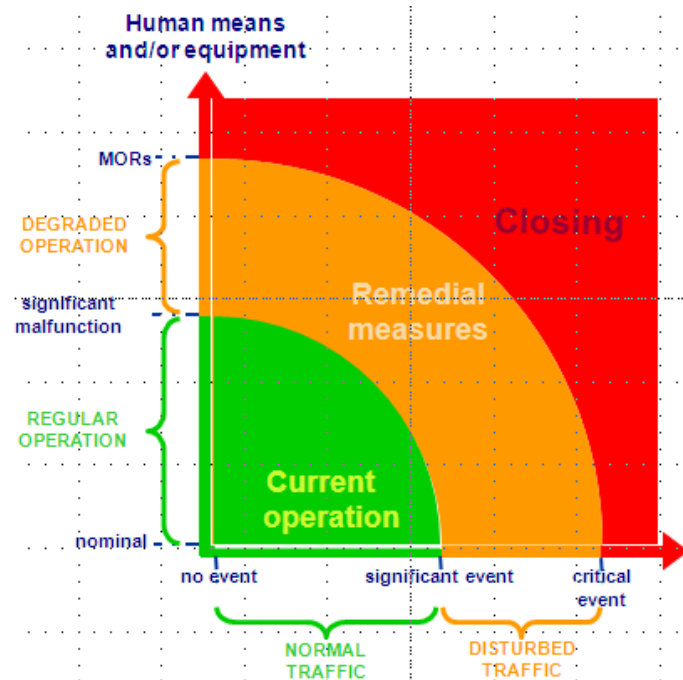
➤ the **traffic conditions**



How to define the MORs ?

More complicated if we consider :

- Two axes
- Human means and one piece of equipment
- Several pieces of equipment
- Human means and several piece of equipment



How to define the MORs

One possibility is to use :

The safety functions

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Safety functions

Five Safety functions have been defined :

- F1 : Preventing incidents/accidents
- F2 : Detection
- F3 : Alerts and information given
- F4 : Limiting the consequences of the incident
- F5 : Ensuring a return to normal

Detailed safety functions

F1 Preventing incidents / accidents
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
F 2 Detection
F 2.1 Detecting an incident / accident
F 2.2 Classifying the incident / the accident
F 3 Alerts and information given by the tunnel operating body
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
F 4 Limiting the consequences of the incident
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
F 5 Ensuring a return to normal
Checking the condition of the tunnel and carrying out any necessary emergency work to restore traffic flows

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> <div>Safety functions →</div> <div>Resources ↓</div> </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													

Presentation schedule

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Using safety functions :

Resources		Safety functions	
			F1-1 Monitoring the tunnel, its equipment and the traffic in it
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	
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	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	

One safety function is reached by several pieces of equipment :
Function F1.1

By associating several resources, the safety function can be fulfilled

Using safety functions :

One equipment is involved in all the safety functions (power supply)

<div> <div>Safety functions →</div> <div>← Resources</div> </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	F1-2	F1-3	F1-4	F2-1	F2-2	F3-1	F3-2	F3-3	F4-1	F4-2	F4-3	F4-4	
M1: Civil engineering	M1-1 Roadway and emergency stopping lanes														
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	M3-2 Power substations / low voltage master distribution panel														
	M3-3 Uninterruptible emergency power supply														
	M3-4 Water supply														



We need redundancy

Thank you for your attention