



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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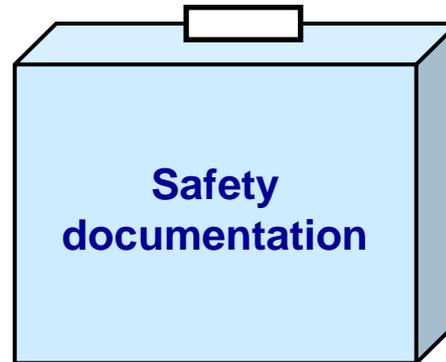
Presentation schedule

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

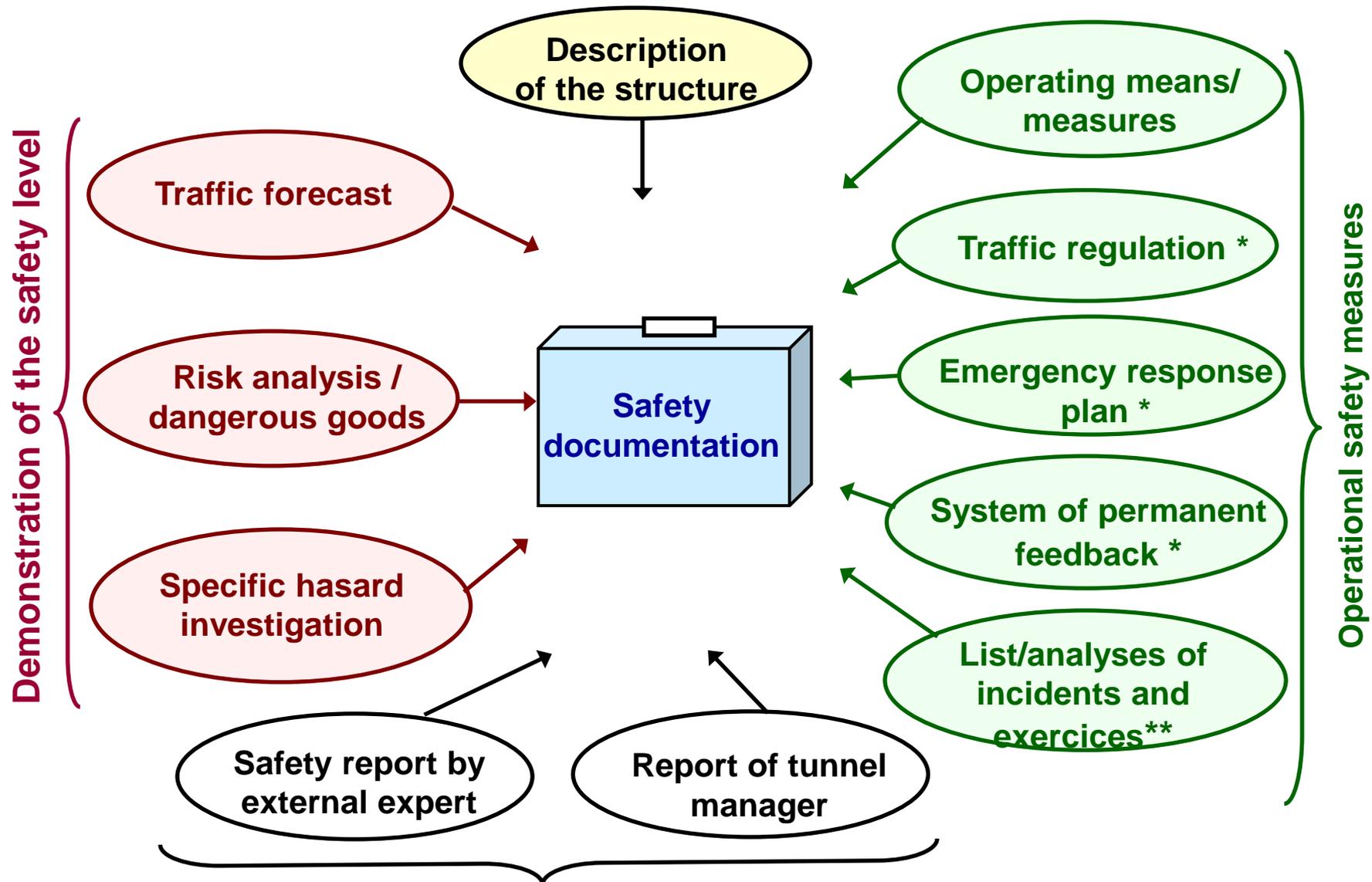
The context

For tunnels longer than 300 m

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



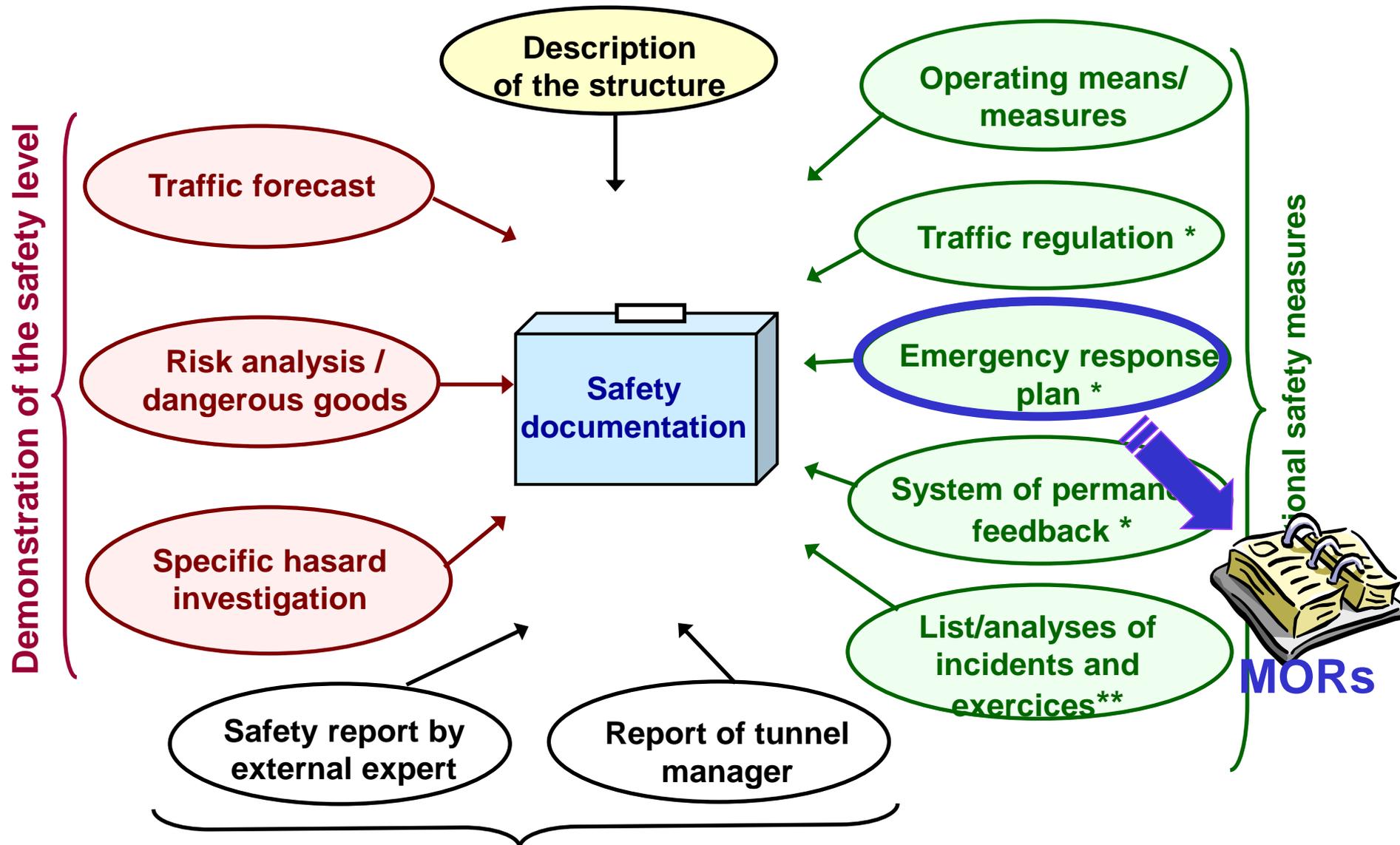
... in accordance with the European Directive



Documents provided with the safety file

* From commissioning stage

** Once tunnel in operation



Documents provided with the safety file

* From commissioning stage

** Once tunnel in operation

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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

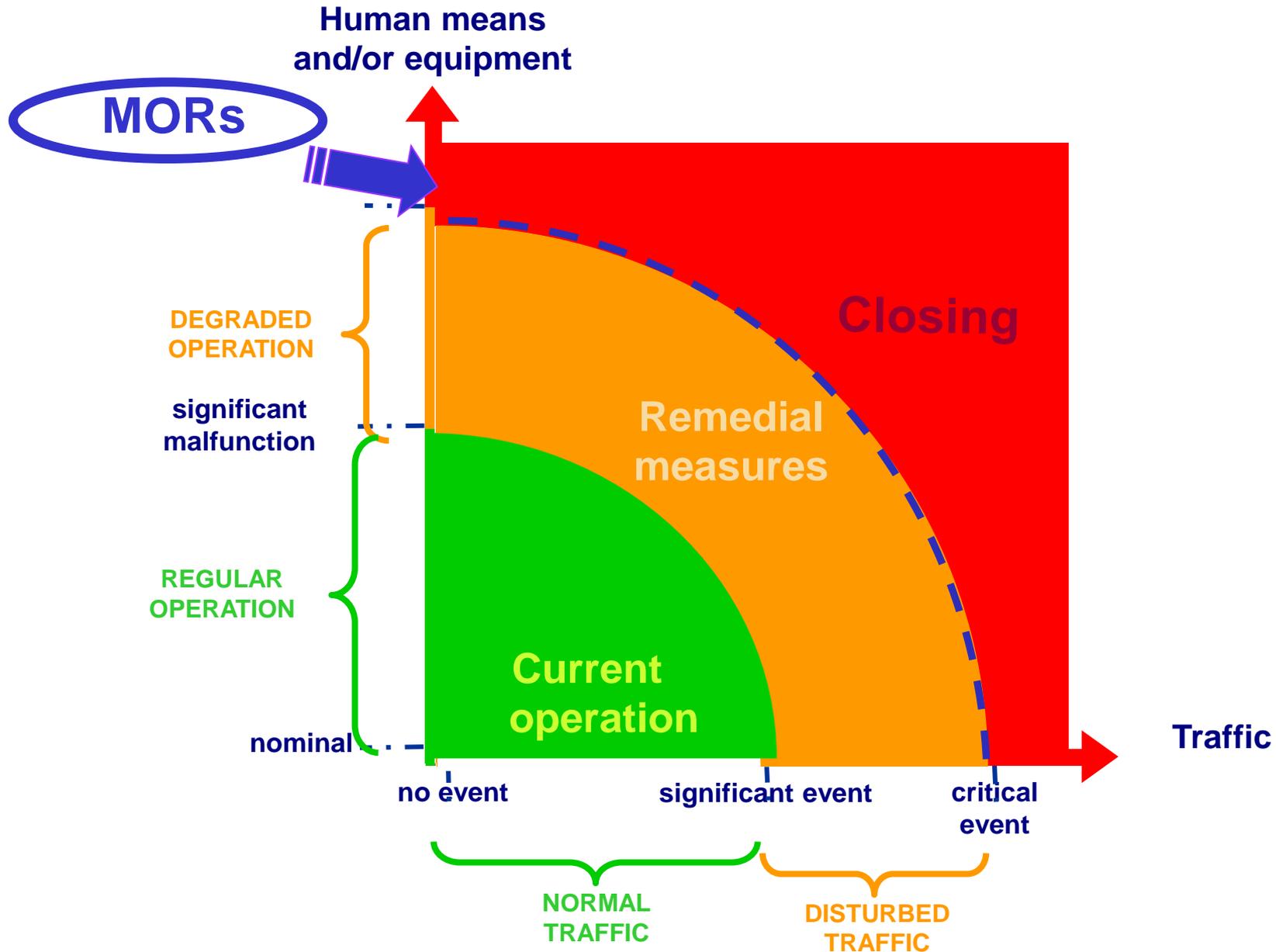
- Relative to the available operating means ...
(equipments – staff)

regular operation

degraded operation

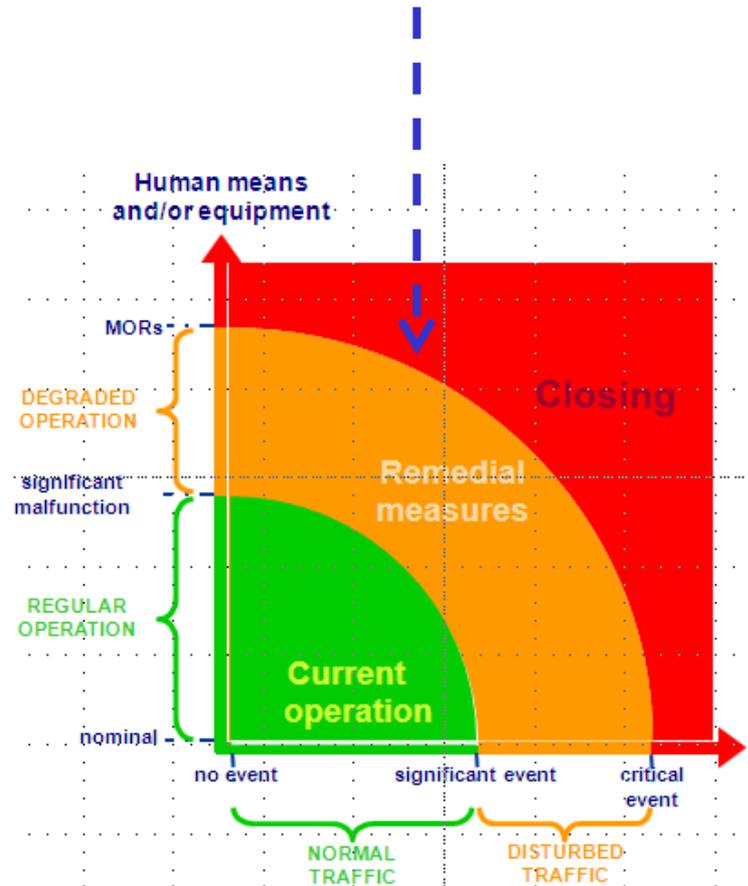
critical operation

How to define the MORs ?



How to define the MORs ?

- We have to define the border between
 - the **orange area**
 - the **red area**

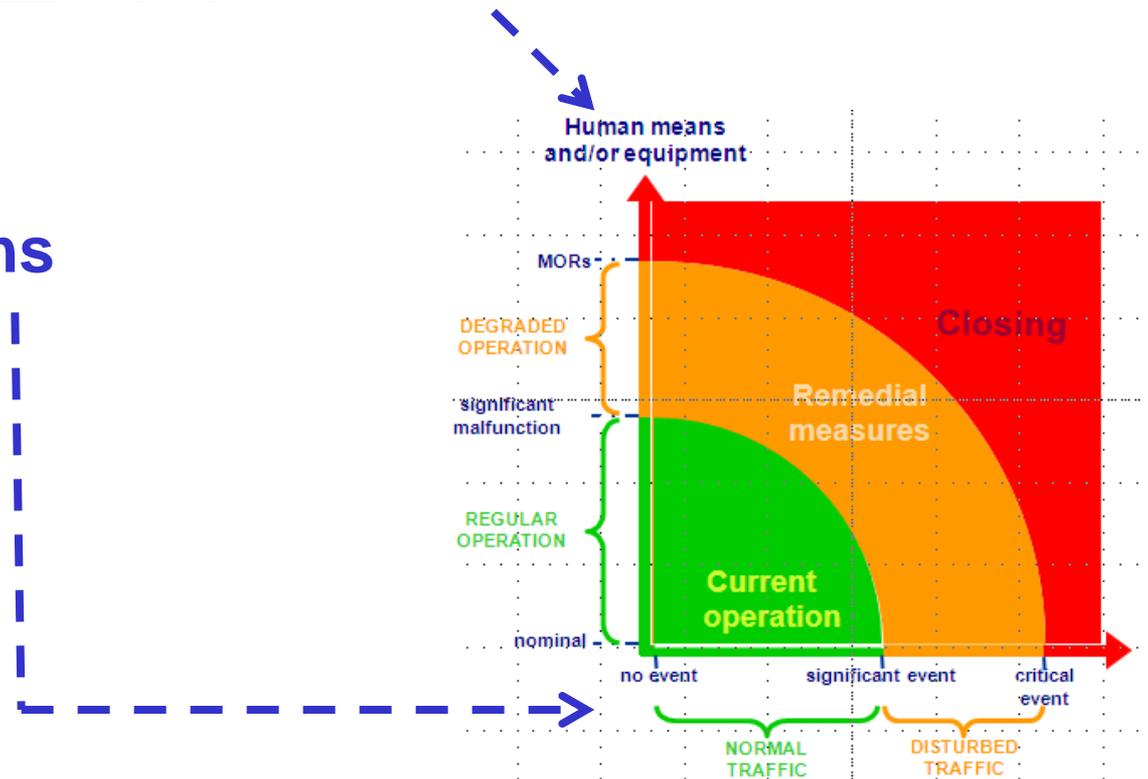


How to define the MORs ?

Not too complicated if we consider only one axe :

➤ the **Human means or equipment**

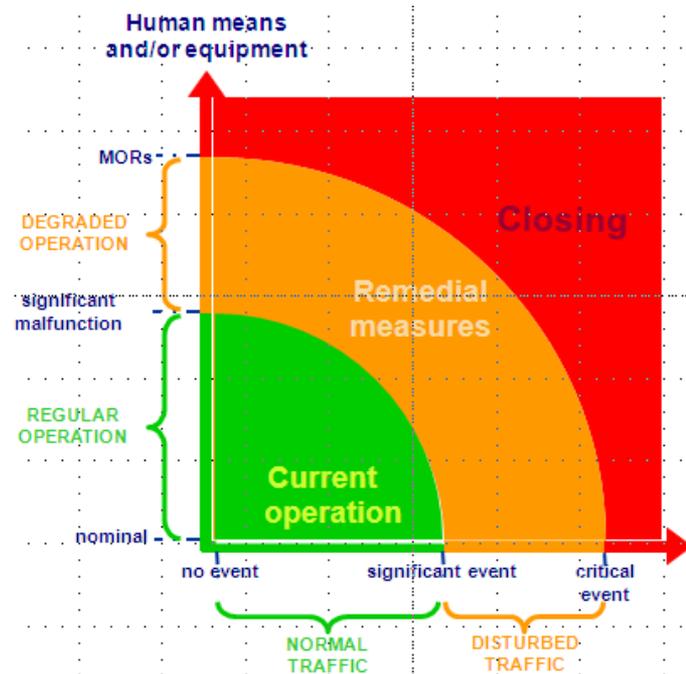
➤ the **traffic conditions**



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 style="text-align: center;"> <p>Safety functions →</p> <p>↓ Resources</p> </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	
		Monitoring the tunnel, its equipment and the traffic in it	Monitoring weather conditions, traffic and the external environment	Ensuring safe, comfortable driving conditions	Keeping users informed about traffic conditions	Detecting an incident/accident	Classifying the incident/accident	Alerting the emergency services	Alerting users in the tunnels and at tunnel portals	Informing users on the network outside the tunnel	Minimising the number of users in the tunnel and avoiding further accidents	Limiting escalation of the incident while waiting for the emergency services to arrive	Aiding evacuation, getting users to safety (self-evacuation)	Aiding and supporting access and action by emergency services	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													

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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 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		

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 style="border: 1px solid black; padding: 10px; width: fit-content;"> <p>Safety functions →</p> <p>Resources ↓</p> </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
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We need redundancy

Thank you for your attention