

APPENDIX B – CASE STUDIES

B.1. CASE N°1: BI-DIRECTIONAL TUNNEL IN FRANCE

TUNNEL CHARACTERISTICS		
	before renovation	evolution after renovation
General description		
Location:	France	
Length (m):	1,752	1,752
Number of tubes:	1	1 + parallel evacuation gallery
Uni-directional or bi-directional traffic:	Bi-directional	
Urban:	Yes	
Traffic:		
annual average daily traffic volume:		
- per tube:	26,000	26,000
- per lane:	13,000	13,000
- indicate volume for peak hours:		
- risk of congestion (daily or seasonal):	Yes (daily)	
- presence and percentage of heavy goods vehicles:	no HGV, no Trucks	Vans in existing tunnel and Buses in parallel gallery
- presence, percentage and type of dangerous goods - traffic (% of HGV): - category according to EDR:		
Environment – operation:		
- particular geographical and meteorological environment:	urban tunnel in historical area - continental	
- characteristics of the access roads: numerous, close to the portals:	interchange at one portal	
- speed limit (km/h):	50	50
- permanent surveillance:	Yes	Yes
- strong influence of the emergency services:	Yes	Yes

RENOVATION CHARACTERISTICS		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Geometry: cross-section for a tube (join a scheme):		
- number of lanes:	2 x 2	2 x 2
- emergency lane and width:	No	
- width of slow and fast lane:	2.70 m and 2.55	
- separation space for bidirectional and width:	1.10 m – Yes	
- width of emergency walkways, easily accessible:	0.75 m – Yes	
- vertical alignment (slope):	close to zero	
- horizontal alignment: dangerous curves:		
Infrastructure measures:		
Emergency exits:		
- type (direct, cross connections: second tube or emergency gallery, shelters):	None	Evacuation gallery parallel to the existing tube with 11 cross passages
- inter distance:		150 m
- suitable for the use of emergency services.		Yes
- clear identification by the user:		Yes
Lays-bys:		
- presence:	None	None
- number:		
Drainage:		
- slots gutters:	Yes	Yes
- siphoids gullys:		
Ventilation system:		
- longitudinal:	No	Yo
- smoke exhaust shaft - number:	Yes - 5 shafts	Yes - 5 shafts
- semi -transverse:	Yes	No
- smoke extraction dampers - interdistance:	None	No
- longitudinal air flow control:	No	Yes
Safety equipment:		
Emergency stations:		
- interdistance:		
Water supply:		
- interdistance hydrants:	200 m	150 m
Lighting:		
- good lighting conditions:	Yes	Yes

RENOVATION CHARACTERISTICS (follow)		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Monitoring systems:		
- video:	Yes	Yes
- automatic incident detection:	No	Yes
- automatic fire detection:	No	Yes
Tunnel closing equipment (barriers):		
- outside tunnel:	Yes	Yes
- inside tunnel:	No	No
- signals:		
Communication:		
- radio:	Yes	Yes
- fire services broadcasting:	Yes	Yes
- loud speaker:	Yes	Yes
Operation issues:		
- personal training:	Yes	Yes
- emergency response plans:	Yes	Yes
- specific measures concerning DGV:		
- safety exercises:	Yes	Yes
- special traffic regulations (distances, etc.):	No	Yes

MAIN CONCLUSIONS	
Risk analysis of the current state	Key Improvements
<ul style="list-style-type: none"> • Main influence parameters: <ul style="list-style-type: none"> - Traffic flows - Urban constraints (works under operation) 	<ul style="list-style-type: none"> • Derogation (regarding local regulations)
<ul style="list-style-type: none"> • Main deficiencies pointed out: <ul style="list-style-type: none"> - No escape route except by the portals - Inefficient ventilation system performance regarding safety objectives 	<ul style="list-style-type: none"> • Additional - compensating measures: <ul style="list-style-type: none"> - Creation of a second tube for bus use only - Creation of an escape route at the same time • Innovative techniques: <ul style="list-style-type: none"> - Use of the safety tube for bus traffic as well as cyclist and pedestrian crossing - Reinforcement of the longitudinal ventilation system with control of the longitudinal air flow and extraction facilities

B.2. CASE N°2: BI-DIRECTIONAL TUNNEL IN AUSTRIA

TUNNEL CHARACTERISTICS		
	before renovation	evolution after renovation
General description:		
Location:	Austria	
Length (m):	1,311	1,311
Number of tubes:	1	1
Uni-directional or bi-directional traffic:	Bi-directional	Bi-directional
Urban:	Yes	Yes
Traffic:		
annual average daily traffic volume:		
- per tube:	13,614	15,225
- per lane:	6,807	7,613
- indicate volume for peak hours:		
- risk of congestion (daily or seasonal):	daily	daily
- presence and percentage of heavy goods vehicles:	Yes (6%)	Yes (6%)
- presence, percentage and type of dangerous goods		
- traffic (% of HGV):	0.33 % of heavy good vehicles	0.33 % of heavy good vehicles
- category according to EDR:	A	A
Environment – operation:		
- particular geographical and meteorological environment:		
- characteristics of the access roads: numerous, close to the portals:		
speed limit (km/h):	80	80
permanent surveillance:	Yes	Yes
strong influence of the emergency services:	Yes	Yes

RENOVATION CHARACTERISTICS		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Geometry: cross-section for a tube (join a scheme):		
- number of lanes:	2	2
- emergency lane and width:	No	No
- width of slow and fast lane:	3.75	3.75
- separation space for bidirectional and width:	No	No
- width of emergency walkways, easily accessible:	width:1.00 m – Yes	width:1.00 m – Yes
- vertical alignment (slope):	1.2%	1.2%
- horizontal alignment: dangerous curves:	No	No
Infrastructure measures:		
Emergency exits:	Yes	Yes
- type (direct, cross connections: second tube or emergency gallery, shelters)	1 emergency exit	1 emergency exit
- inter distance:	495 m/818 m	495 m/818 m
- suitable for the use of emergency services.	No	No
- clear identification by the user:	Yes	Yes
Lays-bys:		
- presence:	Yes	Yes
- number:	2	2
Drainage:		
- slots gutters:	Yes	Yes
- siphoids gullys:	No	No
Ventilation system:		
- longitudinal:	Yes	Yes
- smoke exhaust shaft - number:	No	No
- semi -transverse:	No	No
- smoke extraction dampers - interdistance:	No	No
- longitudinal air flow control:	Yes	Yes
Safety equipment:		
Emergency stations:	7	7
- interdistance:	178-255 m	178-255 m
Water supply:		
- interdistance hydrants:	<250 m	<250 m
Lighting:		
- good lighting conditions:	Yes	Yes (higher luminance level)

RENOVATION CHARACTERISTICS (follow)		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Monitoring systems:		
- video:	Yes	Yes
- automatic incident detection:	No	Yes
- automatic fire detection:	Yes	Yes
Tunnel closing equipment (barriers):	CO and visibility sensors	CO and visibility sensors
- outside tunnel:		
- inside tunnel:	No	No
- signals:	No	No
Communication:	Yes	Yes
- radio:		
- fire services broadcasting:	Yes	Yes
- loud speaker:	Yes	Y
Operation issues:	Yes (in lays bys and portals)	Yes (in lays bys and portals)
- personal training:		
- emergency response plans:	Yes	Yes
- specific measures concerning DGV:	Yes	Yes
- safety exercises:	No	No
- special traffic regulations (distances, etc.):	Yes	Yes

MAIN CONCLUSIONS	
Risk analysis of the current state	Key Improvements
<ul style="list-style-type: none"> • Main influence parameters: <ul style="list-style-type: none"> - Ventilation in case of fire 	<ul style="list-style-type: none"> • Derogation (regarding local regulations) <ul style="list-style-type: none"> - new ventilation system with new regulation - renewing the traffic control and traffic supervision - renewing of the tunnel lighting - new emergency call system - evaluation of the fire response plan (first step) - LED on both hard shoulders
<ul style="list-style-type: none"> • Main deficiencies pointed out: <ul style="list-style-type: none"> - emergency exit spacing too great - structural fire protection (apartment buildings are over the tunnel) 	<ul style="list-style-type: none"> • Additional - compensating measures: <ul style="list-style-type: none"> - installation of a water mist system (ordered by an official notification based on a risk analysis) - reducing the distance between the emergency exits (ordered by an official notification)

B.3. CASE N°3: BI-DIRECTIONAL TUNNEL IN AUSTRIA

TUNNEL CHARACTERISTICS		
	before renovation	evolution after renovation
General description:		
Location:	Austria	
Length (m):	2,135	Length of each tube: 2,135 (right - existing) and 2,102(left – new))
Number of tubes:	1	2
Uni-directional or bi-directional traffic:	Bi-directional	Uni-directional
Urban:	No	No
Traffic:		
annual average daily traffic volume:		
- per tube:	12,255	12,586
- per lane:	6,128	3,147
- indicate volume for peak hours:		
- risk of congestion (daily or seasonal):	congestion only on specific weekends, especially on winter time	No in general and practically
- presence and percentage of heavy goods vehicles:	Yes (17%)	Yes (21%)
- presence, percentage and type of dangerous goods - traffic (% of HGV): - category according to EDR:	2.2 % of heavy good vehicles A	2.2 % of heavy good vehicles A
Environment – operation:		
- particular geographical and meteorological environment:		
- characteristics of the access roads: numerous, close to the portals:		
speed limit (km/h):	80	100
permanent surveillance:	Yes	Yes
strong influence of the emergency services:	Yes	Yes

RENOVATION CHARACTERISTICS		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Geometry: cross-section for a tube (join a scheme):		
- number of lanes:	1x2	2x2
- emergency lane and width:	No	No
- width of slow and fast lane:	4.25	4.25/3.75
- separation space for bidirectional and width:	No	
- width of emergency walkways, easily accessible:	width:1.00 m – Yes	width:1.00 m – Yes
- vertical alignment (slope):	Maximum 1.41%	Maximum 1.41%
- horizontal alignment: dangerous curves:	Yes	Yes
Infrastructure measures:		
Emergency exits:	Yes (1)	Yes
- type (direct, cross connections, second tube or emergency gallery, shelters):		5 cross connections and 1 emergency exit
- inter distance:		330 - 365 m
- suitable for the use of emergency services.		Yes
- clear identification by the user:	Yes	Yes
Lays-bys:		
- presence:	Yes	Yes
- number:	1	1 and 2 in the new tube
Drainage:	No Separate system for road surface liquids	There is separate system with siphons
- slots gutters:	Yes	No
- siphoids gullys:	No	Yes
Ventilation system:		
- longitudinal:	injector ventilation	Yes
- smoke exhaust shaft - number:	No	No
- semi -transverse:	No	No
- smoke extraction dampers - interdistance:	No	No
- longitudinal air flow control:	Yes	Yes (3 per tube)
Safety equipment:		
Emergency stations:	11	11 and 19 (new tube)
- interdistance:	212 m	For the new tube interdistance 96 -127 m
Water supply:		
- interdistance hydrants:	Maximum 212 m	For the new tube interdistance 96 -127 m

RENOVATION CHARACTERISTICS (follow)		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Lighting:		
- good lighting conditions:	Yes	Yes (higher luminance level)
Monitoring systems:		
- video:	Yes	Yes (new, distance of the cameras 106 – 115 m)
- automatic incident detection:	No	Yes
- automatic fire detection:	Yes	Yes
Tunnel closing equipment (barriers):	CO and visibility sensors	CO and visibility sensors
- outside tunnel:		
- inside tunnel:	No	No
- signals:	No	No
Communication:	Yes	Yes
- radio:		
- fire services broadcasting:	Yes	Yes
- loud speaker:	Yes	Yes
Operation issues:	Yes (in lays bys, cross connections and portals)	Yes (in lays bys, cross connections and portals)
- personal training:		
- emergency response plans:	Yes	Yes
- specific measures concerning DGV:	Yes	Yes
- safety exercises:	No	No
- special traffic regulations (distances, etc.):	Yes	Yes

MAIN CONCLUSIONS	
Risk analysis of the current state	Key Improvements
<ul style="list-style-type: none"> • Main influence parameters: <ul style="list-style-type: none"> - high percentage of heavy goods vehicles 	<ul style="list-style-type: none"> • Derogation (regarding local regulations) <ul style="list-style-type: none"> - new ventilation system with better regulation - new fire detection system - new drainage system - new emergency call system - new lighting system - information panels
<ul style="list-style-type: none"> • Main deficiencies pointed out: <ul style="list-style-type: none"> - low luminance level - no fire protection of the structure 	<ul style="list-style-type: none"> • Additional - compensating measures: <ul style="list-style-type: none"> - LED on both hard shoulders - new emergency call system - new radio system - new lighting system - information panels

B.4. CASE N°4: UNI-DIRECTIONAL TUNNEL IN SPAIN

TUNNEL CHARACTERISTICS		
	before renovation	evolution after renovation
General description:		
Location:	Spain	
Length (m):	940 (tube I) and 560 (tube II)	940 (tube I) and 560 (tube II)
Number of tubes:	2	2
Number of lanes per tube	2	2
Uni-directional or bi-directional traffic:	Uni-directional	Uni-directional
Urban:	No	No
Traffic:		
annual average daily traffic volume:		
- per tube:	16,500	16,500
- per lane:	8,250	8,250
- indicate volume for peak hours:	1,075 veh/h per tube	1,075 veh/h per tube
- risk of congestion (daily or seasonal):	Yes	Yes
- presence and percentage of heavy goods vehicles:	18.9%	18.9%
- presence, percentage and type of dangerous goods traffic (% of HGV):	Yes 0.53%	Yes 0.53%
category according to EDR:		
Environment – operation:		
- particular geographical and meteorological environment:	interurban tunnel, dry warm Mediterranean	interurban tunnel, dry warm Mediterranean
- characteristics of the access roads: numerous, close to the portals:		interchange at both portals
speed limit (km/h):	80	100
permanent surveillance:	No	Yes
strong influence of the emergency services:	No	No

RENOVATION CHARACTERISTICS		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Geometry: cross-section for a tube:		
- number of lanes:	2 x 2	2 x 2
- emergency lane and width:	No	No
- width of slow and fast lane:	3.5 m and 3.5 m	3.5 m and 3.5 m
- separation space for bidirectional and width:	No	No
- width of emergency walkways, easily accessible:	0.75m – Yes	0.75m – Yes
- vertical alignment (slope):	average 2%	average 2%
- horizontal alignment: dangerous curves:	No	No
Infrastructure measures:		
Emergency exits:		
- type (direct, cross connections, second tube or emergency gallery, shelters):	No	Yes - one cross connection, one emergency gallery
- inter distance:		400 m
- suitable for the use of emergency services.		Yes
- clear identification by the user:		Yes
Lays-bys:		
- presence:	No	No
- number:		
Drainage:		
- slots gutters:	No	continuous slot
- siphoids gullys:	No	every 100 m
Ventilation system:		
- longitudinal:	Yes	Yes (four additional jets in tunnel II)
- smoke exhaust shaft - number:	No	No
- semi -transverse:	No	No
- smoke extraction dampers - interdistance:	No	No
- longitudinal air flow control:	No	Yes
Safety equipment:		
Emergency stations:		
- interdistance:	Yes - 180 m	Yes - 180 m (upgraded)
Water supply:		
- Presence:	No	Yes
- interdistance hydrants:		50 m

RENOVATION CHARACTERISTICS (follow)		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Lighting:		
- good lighting conditions:	No	Yes - Lighting control units and emergency lighting
Monitoring systems:		
- video:	Yes	fixed cameras, fibre optic
- automatic incident detection:	No	Yes
- automatic fire detection:	No	Y
Tunnel closing equipment (barriers):		
- outside tunnel:	No	Yes
- inside tunnel:	No	No
- signals:	Yes	Yes
Communication:		
- radio:	Yes (out of service)	Yes
- fire services broadcasting:	Yes (out of service)	Yes
- loud speaker:	No	Yes
Operation issues:		
- personal training:	Yes	Yes
- emergency response plans:	Yes	Yes (improved)
- specific measures concerning DGV:	No	No
- safety exercises:	No	Yes
- special traffic regulations (distances, etc.):	No overtaking	Security distance: 70 m

MAIN CONCLUSIONS	
Risk analysis of the current state	Key Improvements
<ul style="list-style-type: none"> • Main influence parameters: <ul style="list-style-type: none"> - Emergency exits - Ventilation control - Heavy goods vehicles traffic volume 	<ul style="list-style-type: none"> • Derogation (regarding local regulations)
<ul style="list-style-type: none"> • Main deficiencies pointed out: <ul style="list-style-type: none"> - Insufficient Lighting - Emergency Lighting - Radio Signal not available in the whole tunnel - Emergency phones out of service - No established emergency routes - Toxic waste drainage inexistent - No safety exercises - No fire alarm 	<ul style="list-style-type: none"> • Additional - compensating measures: <ul style="list-style-type: none"> - Cross connections - Emergency radio service

B.5 CASE N°5: BI-DIRECTIONAL TUNNEL IN GREECE

TUNNEL CHARACTERISTICS		
	before renovation	evolution after renovation
General description:		
Location:	Greece	
Length (m):	1,399	Length of each tube: 1,399 (right - existing) and 1,403 (left - new))
Number of tubes:	1	2
Uni-directional or bi-directional traffic:	Bi-directional	Uni-directional
Urban:	No	No
Traffic:		
annual average daily traffic volume:		
- per tube:	12,800	7,150
- per lane:	6,400	3,575
- indicate volume for peak hours:	1,580 (16 and 23 August 2009)	
- risk of congestion (daily or seasonal):	No in general (congestion only on specific 4 or 5 days e.g. holy Thursday and good Friday, Monday and Tuesday after Easter, the fifteenth of August)	No in general and practically (congestion provided only a running lane (for whatever reason) only on specific 4 or 5 days e.g. as next and some other holidays))
- presence and percentage of heavy goods vehicles:	Yes	Yes (5%)
- presence, percentage and type of dangerous goods	No DGV	Yes for the new tube, No for the existing old (renovated) tube, for the present Note: For the existing tube, the decision is mainly influenced by the presence of loads with liquid fuels DGV tanks (unlike the new tube where there are mostly empty DGV tanks) and the absence of flame traps of the separate drainage system for road surface liquids. As risk analysis concludes, after implementation of flame traps DGV will be allowed without restrictions, and the tunnel will be ADR category A for renovated tube.

TUNNEL CHARACTERISTICS (follow)		
	before renovation	evolution after renovation
- traffic (% of HGV):		
- category according to EDR:	E	A (new tube) and E (existing renovated tube) Note: After implementation of flame traps both tubes will be in category A.
- particular geographical and meteorological environment:	Rural tunnel – continental Mediterranean	
characteristics of the access roads: numerous, close to the portals:		
speed limit (km/h):	60	80
permanent surveillance:	Yes	Yes
strong influence of the emergency services:	Yes	Yes

RENOVATION CHARACTERISTICS		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Geometry: cross-section for a tube:		
- number of lanes:	1x2	2x2
- emergency lane and width:	No	No
- width of slow and fast lane:	3.75	3.75
- separation space for bidirectional and width:	No	
- width of emergency walkways, easily accessible:	width:1.08 m – Yes	width:1.08 m – Yes
- vertical alignment (slope):	Maximum 0.94%	Maximum 0.94%
- horizontal alignment: dangerous curves:	No	No
Infrastructure measures:		
Emergency exits:	No	Yes
- type (direct, cross connections, second tube or emergency gallery, shelters):		cross connections second tube (3 cross connections)
- inter distance:		380 m maximum
- suitable for the use of emergency services.		The mid cross connection is suitable for the use of emergency services.
- clear identification by the user:	Yes	Yes
Lays-bys:		
- presence:	Yes	Yes
- number:	1	1 for each tube
Drainage:	Separate system for road surface liquids but no flame traps	There is separate system with flame traps (siphons) , which prevents the spread of fire, for the new tube. Separate system, no flame traps for the old (renovated) tube. For this renovated tube there is provision for construction of flame traps in distances every 50 m in the near future (after peak traffic of summer months).
- slots gutters:	Yes	Yes
- siphoids gullys:	No	Yes for the new tube

RENOVATION CHARACTERISTICS (follow)		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Ventilation system:		
- longitudinal:	Yes	Yes
- smoke exhaust shaft - number:	No	No
- semi -transverse:	No	No
- smoke extraction dampers - interdistance:	No	No
- longitudinal air flow control:	No	Yes
Safety equipment:		
Emergency stations:		
- interdistance:	Maximum 200 m	For the new (left) tube interdistance 50 m, for the existing (right) tube maximum interdistance 200 m
Water supply:		
- interdistance hydrants:	Maximum 200 m	For the new (left) tube interdistance hydrants 50 m, for the existing (right) tube maximum interdistance hydrants 200 m
Lighting:		
- good lighting conditions:	No	Yes
Monitoring systems:		
- video:	Yes	Yes
- automatic incident detection:	No	Yes
- automatic fire detection:	Yes (conventional analogic detectors distributed in 7 zones)	Yes [linear heat sensor (optic fibre cable)]
- air quality control:	CO and visibility sensors	CO, NO _x , and visibility sensors, system for measurement of direction and velocity of the air
Tunnel closing equipment (barriers):		
- outside tunnel:	No	No
- inside tunnel:	No	No
- signals:	Yes	Yes
Communication:		
- radio:	No	No
- fire services broadcasting:	No	Yes
- loud speaker:	No	Only into cross connections

RENOVATION CHARACTERISTICS (follow)		
Equipment	State of the tunnel	
	before renovation	evolution after renovation
Operation issues:		
- personal training:	Yes	Yes
- emergency response plans:	Yes	Yes
- specific measures concerning DGV:	No DGV	No
- safety exercises:	Yes	Yes
- special traffic regulations (distances, etc.):	No	interdistance for cars 45 m, for HGV 90 m

MAIN CONCLUSIONS	
Risk analysis of the current state	Key Improvements
<ul style="list-style-type: none"> • Main influence parameters: <ul style="list-style-type: none"> - Composition of traffic load (for renovated tube, presence of loads with liquid fuels DGV tanks (unlike the new tube where there are mostly empty DGV tanks) and the possibility of spreading the fire from liquid spillage) 	<ul style="list-style-type: none"> • Derogation (regarding local regulations) <ul style="list-style-type: none"> - There are not any derogations regarding local regulations and requirements of European directive 2004/54/EC
<ul style="list-style-type: none"> • Main deficiencies pointed out: 	<ul style="list-style-type: none"> • Additional - compensating measures: <ul style="list-style-type: none"> - Tunnel control centre is not mandatory but required on the basis of results of risk analysis for transport of DGs

B.6. CASE N°6: UNI-DIRECTIONAL TUNNEL IN ITALY

TUNNEL CHARACTERISTICS		
	before renovation	evolution after renovation
General description:		
Location:	Italy	
Length (m):	1,669	
Number of tubes:	2	
Uni-directional or bi-directional traffic:	Uni-directional	
Urban:	No	
Traffic:		
annual average daily traffic volume:		
- per tube:	50,000	
- per lane:	12,500	
- indicate volume for peak hours:	5,000	
- risk of congestion (daily or seasonal):	Yes (daily)	
- presence and percentage of heavy goods vehicles:	Yes	
- presence, percentage and type of dangerous goods	Yes	
- traffic (% of HGV):	20%	
- category according to EDR:	A	
Environment – operation:		
- particular geographical and meteorological environment:	urban tunnel	
- characteristics of the access roads: numerous, close to the portals:		
speed limit (km/h):	130	50
permanent surveillance:	No	Yes
strong influence of the emergency services:	No	No

RENOVATION CHARACTERISTICS		
Equipment:	State of the tunnel	
	before renovation	evolution after renovation
Geometry: cross-section for a tube:		
- number of lanes:	2 x 2	2 x 2
- emergency lane and width:	No	
- width of slow and fast lane:	3.75 m	3.75 m
- separation space for bidirectional and width:	No	
- width of emergency walkways, easily accessible:	0.75m – Yes	
- vertical alignment (slope):	1.5%	
- horizontal alignment: dangerous curves:		
Infrastructure measures:		
Emergency exits:		
- type (direct, cross connections, second tube or emergency gallery, shelters):	None	Cross connections
- inter distance:		300 m
- suitable for the use of emergency services.		Yes
- clear identification by the user:		Yes
Lays-bys:		
- presence:	No	No
- number:		
Drainage:		
- slots gutters:	No	No
- siphoids gullys:	No	No
Ventilation system:		
- longitudinal:	No	Yes
- smoke exhaust shaft - number:	No	No
- semi -transverse:	No	No
- smoke extraction dampers - interdistance:	No	No
- longitudinal air flow control:	No	Yes
Safety equipment:		
Emergency stations:		
- interdistance:		150 m
Water supply:		
- interdistance hydrants:		150 m
Lighting:		
- good lighting conditions:	No	Yes

RENOVATION CHARACTERISTICS		
Equipment:	State of the tunnel	
	before renovation	evolution after renovation
Monitoring systems:		
- video:	No	Yes
- automatic incident detection:	No	Yes
- automatic fire detection:	No	Yes
Tunnel closing equipment (barriers):		
- outside tunnel:	No	No
- inside tunnel:	No	No
- signals:	No	Yes
Communication:		
- radio:	Yes	Yes
- fire services broadcasting:	No	Yes
- loud speaker:	No	Yes
Operation issues:		
- personal training:	Yes	Yes
- emergency response plans:	No	Yes
- specific measures concerning DGV:	No	Yes
- safety exercises:	No	Yes
- special traffic regulations (distances, etc.):	No	Yes

MAIN CONCLUSIONS	
Risk analysis of the current state	Key Improvements
<ul style="list-style-type: none"> • Main influence parameters: <ul style="list-style-type: none"> - Traffic Volume - HGV percentage 	<ul style="list-style-type: none"> • Derogation (regarding local regulations)
<ul style="list-style-type: none"> • Main deficiencies pointed out: <ul style="list-style-type: none"> - Open cross connections - Ventilation - Lighting 	<ul style="list-style-type: none"> • Additional - compensating measures: <ul style="list-style-type: none"> - Compartmentalization and ventilation of cross connections - Longitudinal ventilation with air velocity control - LED ordinary and evacuation lighting - innovative techniques: <ul style="list-style-type: none"> - LED Visual guide for lighting and signalling - Prefabricated intelligent cross connection module (Ventilation, Lighting, signalling, communications, PLC)