

Association
mondiale
de la Route



World Road
Association



OECD/PIARC

ERS2 "TRANSPORT OF DANGEROUS GOODS THROUGH ROAD TUNNELS"

TECHNICAL REPORT OF

MISSION 2



DET NORSKE VERITAS

TECHNICAL REPORT — MISSION 2

DET NORSKE VERITAS AS
Division Nordic Countries

Abstract

This task was conducted by Det Norske Veritas (DNV) on behalf of the OECD and PIARC.

Veritasveien 1,
N-1322 HØVIK, Norway
Tel: +47 67 57 99 00
Fax: +47 67 57 74 74
<http://www.dnv.no>
Org. No: NO 945 748 931 MVA

The OECD and PIARC initiated in 1995 a joint research project on the transport of dangerous goods through road tunnels. The overall objectives of the research project were:

- to improve the overall safety of the transport of dangerous goods by road;
- to facilitate the management of such transport in order to prevent unnecessary costs and promote economic development.

The project was divided into four different tasks. The overall objectives of Task 1 (entitled "Review of Current National and International Regulations"), were to provide an overview of current regulations and evaluate their qualities and the problems they pose; to draw lessons on the needs and requirements for new regulations. Task 1 was divided into two "Missions" 1 and 2.

Mission 1 was undertaken by DNV in the period August to November 1996 with delivery of an interim report on 15 November 1996.

In Mission 2, complementary and more detailed information on existing road tunnels as well as rules, regulations and policies for the transport of dangerous goods was gathered for countries selected on the basis of the work performed in Mission 1. Furthermore, needs for improvements of existing regulations and requirements for new regulations were also identified. The results from the work performed in Mission 2 is documented in this report.

<i>Table of Contents</i>		<i>Page</i>
1	CONCLUSIVE SUMMARY	1
2	INTRODUCTION	4
2.1	Background and overall objectives of the ERS2 project	4
2.2	Main objectives	4
2.3	Work undertaken	4
3	CURRENT SITUATION IN THE INDIVIDUAL COUNTRIES.....	6
3.1	Austria	6
3.1.1	Austrian tunnels	6
3.1.2	Current rules and regulations	9
3.1.3	Decision process	11
3.1.4	Enforcement	11
3.1.5	Problems with existing rules and regulations	11
3.1.6	Plans for modifications and improvements of existing regulations	12
3.2	France	13
3.2.1	French tunnels	13
3.2.2	Current rules and regulations	15
3.2.2.1	Tunnels of the national road network	15
3.2.2.2	Tunnels outside the national road network	15
3.2.3	Decision process	16
3.2.4	Current situation	16
3.2.5	Enforcement	17
3.2.6	Contents of a typical tunnel regulation	17
3.2.7	Problems with existing regulations	17
3.2.8	Plans for modifications and improvements of existing regulations	18
3.2.8.1	Type of regulations to be considered for each tunnel	18
3.2.8.2	Decisions	18
3.2.8.3	Safety provisions and equipment in tunnels authorised to transport of dangerous goods	19
3.3	Germany	20
3.3.1	German road tunnels	20
3.3.2	Current rules and regulations	21
3.3.3	Decision process	21
3.3.4	Enforcement	22
3.3.5	Example of a local tunnel regulation	22
3.3.6	Problems with existing rules and regulations	22
3.3.7	Plans for modifications and improvements of existing regulations	23
3.4	The Netherlands	23
3.4.1	Dutch tunnels	23
3.4.2	Current rules and regulations	24

TECHNICAL REPORT — MISSION 2

3.4.2.1	Article 4 of the VLG	26
3.4.3	Decision process	27
3.4.4	Enforcement	27
3.4.5	Problems with existing rules and regulations	27
3.4.6	Plans for modifications and improvements of existing regulations	27
3.5	Japan	27
3.5.1	Japanese tunnels	27
3.5.2	Current rules and regulations	29
3.5.2.1	Road Law, general	30
3.5.2.2	Road Law, Enforcement Order	30
3.5.2.3	Road Law, Enforcement Regulations	32
3.5.3	Decision process	32
3.5.4	Enforcement	32
3.5.5	Problems imposed by the existing rules and regulations	33
3.5.6	Plans for modifications and improvements of existing regulations	33
3.6	Norway	33
3.6.1	Norwegian tunnels	33
3.6.2	Current rules and regulations	34
3.6.2.1	Basis	34
3.6.2.2	Enforcement	34
3.6.2.3	Problems imposed by the existing regulations	34
3.6.3	Contents of regulations	35
3.6.3.1	Tunnels in Oslo	35
3.6.3.2	“Aalesund-Valderoy” tunnel link	35
3.6.3.3	The Hvaler tunnel	36
3.6.4	Plans for modifications and improvements of existing regulations	36
3.7	Switzerland	36
3.7.1	Swiss road tunnels	36
3.7.2	Current rules and regulations	36
3.7.3	Decision process	38
3.7.4	Enforcement	38
3.7.5	Problems with existing regulations	38
3.7.6	Plans for modifications and improvements of existing regulations	38
3.8	United Kingdom	39
3.8.1	UK tunnels	39
3.8.2	Current rules and regulations	41
3.8.2.1	Toll tunnels	41
3.8.2.2	Non-toll tunnels	42
3.8.3	Decision process	42
3.8.4	Enforcement	42
3.8.5	Contents of a typical tunnel regulation	42
3.8.6	Problems with existing regulations	44
3.8.7	Plans for modifications and improvements of existing regulations and policies	44
3.8.7.1	Decisions	44

TECHNICAL REPORT — MISSION 2

3.8.7.2	Safety provisions	44
3.9	USA, State of California	45
3.9.1	State highway system tunnels	45
3.9.2	Current rules and regulations	47
3.9.3	Decision process	47
3.9.4	Contents of the Caldecott tunnel regulation and the preceding decision process	47
3.9.4.1	Background	47
3.9.4.2	The regulation	48
3.9.5	Enforcement	48
3.9.6	Problems with existing regulations	49
3.9.7	Plans for modifications and improvements of existing regulations	49
4	SUMMARY OF RECEIVED INFORMATION FOR TASK 2	50
4.1	France	50
4.1.1	Needs, requirements and expectations	50
4.1.2	General data available to help developing QRA/DSM methods and models	50
4.1.3	Potential users of the methods/models	50
4.2	The Netherlands	50
4.2.1	Needs, requirements and expectations	51
4.2.2	General data available to help developing QRA/DSM methods and models	51
4.2.3	Potential users of the methods/models	51
4.3	Norway	52
4.3.1	Needs requirements and expectations	52
4.3.2	General data available to help developing QRA/DSM methods and models	52
4.3.3	Potential users of the methods/models	52
4.4	United Kingdom	52
4.4.1	Needs, requirements and expectations	52
4.4.2	General data available to help developing QRA/DSM methods and models	53
4.4.3	Potential users of the methods/models	53
5	REFERENCES	53
Appendix A	French road tunnels with length > 500 m	
Appendix B	Swiss road tunnels	
Appendix C	Road signing, Germany	
Appendix D	Request for information	

1. SUMMARY

The OECD and PIARC initiated in 1995/96 a joint venture research project on the transport of dangerous goods through road tunnels. The aim of Task 1 of this project was to review current national and international regulations and provide an overview of these regulations, with an evaluation of their qualities and the problems they pose, and to draw lessons on needs and requirements for new regulations. Task 1 was divided into two “Missions”, 1 and 2, which were undertaken by DNV in the period August 1996 to June 1997.

Based on the work performed in Mission 1, Mission 2 was designed to gather complementary and more detailed information on existing road tunnels and rules, regulations and policies for transport of dangerous goods through those tunnels for the following countries: **Austria, France, Germany, The Netherlands, Japan, Norway, Switzerland, the United Kingdom, and the United States (state of California)**. Furthermore, problems arising from the existing regulations with respect to decision making, enforcement, operation and transport are identified, and needs for improvements of existing regulations and requirements for new regulations have been presented.

The information gathered throughout this study is very comprehensive and hence only extracts of this material are given in this report. Nevertheless, the information being available varies between the countries which subsequently affects the level of details in the presentation of the current situation in the various countries.

The findings of the study are as follows:

1. The rules and regulations for the transport of dangerous goods in road tunnels vary considerably among the countries analysed. This applies to the contents of the regulations, responsibilities, applications, decision process, etc. In most countries, the definition of the rules, the decisions to be taken, and the responsibility of enforcement are left to the local or provincial authorities and politicians, the tunnel owners, or “expert” opinions. This means that for most of the countries there are no general rules or regulations that are applicable to all road tunnels at the national level.
2. The decisions on whether a tunnel should have restrictions on the transport of dangerous goods, are in most countries *not* based on detailed Quantitative Risk Assessments (QRA) for comparison of risks. However, it is suggested to implement this approach in future regulations in a number of countries.
3. A great variety of restrictions are being imposed on the transport of hazardous materials in road tunnels. Among these are: inter-vehicle distance, speed limit, hourly/daily limitations, escorting requirements, mandatory notification of cargo, amount and type of substances, requirements in terms of vehicle and tunnel provisions, etc.
4. Problems arising from the existing regulations with respect to decision making, enforcement, operation and transport encountered in the selected countries are listed below.
 - The practice of authorising many tunnels for the transport of dangerous goods is in contradiction with the rules that prescribe the contrary as a principle.

- The new tendency to base decision making on risk studies is not planned for in present regulations.
 - The existing regulations only apply to state-owned tunnels; no regulations exist for tunnels owned by local communities.
 - Large variations in restrictions for the various tunnels causes problems for drivers since it is difficult to be aware of the current regulations of each and every tunnel on their route. Lack of advanced notification through proper information board or road signs for dangerous goods traffic is a problem in many countries.
 - There is no strict requirement to sign diversion routes, if a tunnel is banned/restricted for dangerous goods.
 - Some carriers or drivers, in particular from outside the country, are not familiar with restrictions in the tunnels. Information about current restrictions is not systematically submitted at the border crossings or found in Federal newsletters.
 - The restrictions cause heavy vehicles to use streets and roads that are not prepared for this kind of traffic.
5. Many of the problems identified in item 4 above could be dealt with by introducing proper and standardised (international) road signs for dangerous goods restrictions and for the available diversion routes (on the roads). In addition, the hauliers could be made aware of the various regulations through broad distribution of the information in official gazettes or newsletters. For foreign hauliers, relevant material should be handed over at the border crossings or at toll stations.
6. There is little or very limited information about the experience of how existing regulations are complied with, but infringements are known at least in tunnels with no permanent control. The level of control and attention from e.g. the police or fire brigades, is in most instances limited to spot checks (or none at all). The exception is the tunnels crossing borders where permanent controls are performed by customs personnel. The problem of infringements or evasions, however, is not considered as a serious problem in any of the countries considered.

Some countries have identified plans for improvements and modifications of their rules and regulations as follows:

- Transfer of responsibility with respect to decision making and enforcement from a federal to a local level.
- Introduction of stricter requirements for proper signing of current regulations at each tunnel and on possible diversion routes.
- Adjusting current regulations in such a way that they are not in conflict with the regulations for open roads.
- Decision on prohibition/restriction/authorisation of dangerous goods in tunnels should be based on a quantitative comparison of risks using QRA methodology.
- Introduction of more/new requirements in terms of safety provisions and equipment in tunnels which are to be authorised for the transport of hazardous substances.
- The regulations should be of a uniform character, e.g. throughout the country, region, county, etc.
- The soaring number and increasing complexity of products manufactured by the chemical industry make it more difficult to decide whether a material is covered by the restrictions or

not. This increases the work required for advising hauliers and manufacturers of chemicals and enforcing regulations.

2. INTRODUCTION

2.1 Background and overall objectives of the ERS2 project

The OECD and PIARC initiated in 1995/96 a joint venture research project on the transport of dangerous goods through road tunnels. The overall objectives of the joint project were:

- to improve the overall safety of the transport of dangerous goods by road;
- to facilitate the organisation of such transport in order to prevent unnecessary costs, and promote economic development.

The project was divided into four tasks:

Task 1: Review of current national and international regulations

Task 2: Methodologies relating to risk assessment and decision process

Task 3: Risk reducing measures

Task 4: Conclusions and recommendations

Task 1 was further divided into two missions, entitled:

- Mission 1: “Analysis of questionnaires”
- Mission 2: “Gathering of complementary information”

The overall objectives of Task 1 were to provide an overview of current regulations, with an evaluation of their qualities and the problems they pose; and to draw lessons on needs and requirements for new regulations.

Mission 1 was undertaken by DNV in the period August to November 1996 with delivery of an interim report on 15 November 1996 (ref. /1/).

In Mission 2, complementary and detailed information on rules, regulations and policies for the transport of dangerous goods in road tunnels were gathered for selected countries to supplement the work performed in Mission 1.

2.2 Main objectives

The main objectives for Mission2 are outlined below:

- to understand the background for the various policies that have led to the existing tunnel regulations in the country;
- to analyse differences or whether there is a uniform philosophy for the tunnel regulations in the country;
- to reveal any problems with the existing regulations in the country with regard to decisions, enforcement, operation, and transport;
- to give recommendations for new regulations and requirements for improvement.

2.3 Work undertaken

A request for information on a number of topics regarding the transport of hazardous materials in road tunnels was prepared (see Appendix D). This request was submitted to the contact persons

who had been responsible for completing the questionnaires in Mission 1, and it covered the following countries:

- Austria
- France
- Germany
- The Netherlands
- Japan
- Norway
- Switzerland
- United Kingdom
- United States (state of California)

The information received was supplemented by personal interviews, and a detailed description of the current situation in each of the above countries was prepared. This information is presented in Chapter 3 of this report. In addition, recommendations for new regulations and requirements for improvement are given.

Mission 2 also wanted to touch upon aspects related to Task 2 (see section 2.1 above): development of QRA (Quantitative Risk Assessment) / DSM (Decision Support Model) methods and models. The following information was requested from the above-mentioned countries:

- needs, requirements, and expectations (input/output data, software, etc.);
- general data available in the country to help developing QRA/DSM methods and models;
- potential users of the methods/models in the country.

The information received is systematised and documented in chapter 4.

Task 2 will be carried out during 1997/98 and the information will serve as a basis for generating a “user profile” for potential users.

3. CURRENT SITUATION IN THE INDIVIDUAL COUNTRIES

The contents of this chapter are based on information submitted by selected representatives for the various countries /organisations /authorities listed below, and direct personal interviews with some of them.

Country	Name	Company/Organisation/Authority
Austria	R. Hörhan	Bundesministerium für wirtschaftliche Angelegenheiten
Austria	G. Kafka	Bundesministerium für öffentliche Wirtschaft und Verkehr
France	D. Lacroix	CETU
Germany	Mr Rein	Bundesministerium für Verkehr
Germany	H.J. Bohm	Freie und Hansestadt Hamburg. Behörde für Inneres
The Netherlands	G.L. Tan	Ministerie van Verkeer en Waterstaat
Japan	H. Mashimo	Public Works Research Institute
Norway	E. Norstrøm	Vegdirektoratet (Public Roads Administration.)
Switzerland	D.M. Gilabert	Office fédéral de la police
Switzerland	A. Hofer	Office fédéral des routes
United Kingdom	J.M. Hart	UK Department of Transport, London
United States(state of California)	J.E. Roberts	California Department of Transportation
United States (state of California)	M. O'Mara	California Department of Transportation

3.1 Austria

3.1.1 Austrian tunnels

In this section, the road tunnels in Austria as per December 1996 are classified according to length and road type. Tunnels in this context comprise all underground excavated structures and all cut-and-covers with length > 100 m, 203 in total. The actual figures are given in Table 3.1.

Table 3.1 Austrian road tunnels per length class and type of road

Length class	Motorways		National roads		Local roads		All roads	
	No. of tunnels	Sum tunnel length (metres)	No. of tunnels	Sum tunnel length (metres)	No. of tunnels	Sum tunnel length (metres)	No. of tunnels	Sum tunnel length (metres)
< 0 - 200>	13	3 269	22	2 744	10	1 264	45	7 277
[200 - 600>	35	34 317	36	14 466	14	4 859	85	53 642
[600 - 1 000>	15	22 625	4	2 814	4	2 844	23	28 283
[1000 - 1400>	7	14 877	2	2 425	3	4 827	12	22 129
[1400 - 2000>	4	10 794	4	6 442	3	4 899	11	22 135
[2000 - 3000>	9	31 603	1	2 590	3	6 300	13	40 523
[3000 , ∞>	11	84 348	2	8 168	1	5 183	14	97 699
Total	94	201 833	71	39 649	38	30 206	203	271 688

Notes:

- The length class of a tunnel is determined by the length of its longest tube.
- Each tunnel structure is counted as 1 tunnel, irrespective of the number of tubes.

There are, in total, 36 road tunnels in Austria (of which 34 are longer than 1 000 m), which have restrictions with respect to the transport of dangerous goods, see section 3.1.2. Details of each of these tunnels are given in Table 3.2 on the following two pages.

Table 3.2 Austrian road tunnels with regulations, details

Name (county)	Location	Length (m)	AADT ¹	No. of tubes	No. of lanes ²	Road type ³	Owner
<i>Tunnels with special provisions (lengths between 1 000 and 5 000 m+ the two *-marked tunnels)</i>							
Oswaldiberg (Kärnten)	A10 Tauern Autobahn	4 297 4 307	24 713	2	2/2	M	Federal State
Wolfsberg* (Kärnten)	A10 Tauern Autobahn	950 675	16 042	2	2/2	M	Federal State
Hallstatt (Oberösterreich)	L 547 Hallstättersee Landesstraße	1 121 1 254	3 400	2	1/1	L	Federal Province
Ofenauer (Salzburg)	A10 Tauern Autobahn	1 385 1 320	32 282	2	2/2	M	Federal State
Hiefler (Salzburg)	A10 Tauern Autobahn	2 004 1 986	32 282	2	2/2	M	Federal State
Klamm (Salzburg)	B 167 Gasteiner Bundesstraße	1 600	5 939	1	2	N	Federal State
Herzogberg (Steiermark)	A2 Süd Autobahn	2 007	13 223	1	2	M	Federal State
Mitterberg (Steiermark)	A2 Süd Autobahn	1 142 1 134	12 601	2	2/2	M	Federal State

Name (county)	Location	Length (m)	AADT ¹	No. of tubes	No. of lanes ²	Road type ³	Owner
Selzthal (Steiermark)	A9 Pyhrn Autobahn	1 010	16 386	1	2	M	Federal State
Schartnerkogel (Steiermark)	A9 Pyhrn Autobahn	1 167 1 235	9 424	2	2/2	M	Federal State
Plabutsch (Steiermark)	A9 Pyhrn Autobahn	550 9 755	15 830	1	2/2	M	Federal State
Ganzstein (Steiermark)	S6 Semmering Schnellstraße	2 135	8 092	1	2	M	Federal State
Tanzenberg (Steiermark)	S6 Semmering Schnellstraße	2 446 2 384	16 950	2	2/2	M	Federal State
Brucker (Steiermark)	S6 Semmering Schnellstraße	1 228 1 208	13 923	2	2/2	M	Federal State
Niklasdorf (Steiermark)	S6 Semmering Schnellstraße	1 345 1 232	12 503	2	2/2	M	Federal State
Milser (Tirol)	A12 Inntal Autobahn	1 915 1 590	13 976	2	2/2	M	Federal State
Perjen (Tirol)	S16 Arlberg Schnellstraße	2 993	9 780	1	2	M	Federal State
Flirscher (Tirol)	S16 Arlberg Schnellstraße	1 518	8 841	1	3	M	Federal State
Lermooser (Tirol)	B314 Fernpaß Bundesstraße	3 168	7 811	1	2	M	Federal State
Harpfnerwand (Tirol)	B169 Zillertal Bundesstraße	2 590	N/A	1	1	M	Federal State
Ambergtunnel (Vorarlberg)	A14 Rheintal Autobahn	2 978	19 119	1	2	M	Federal State
City-tunnel (Vorarlberg)	A14 Rheintal Autobahn	1 311	14 086	1	2	M	Federal State
Dalaaser (Vorarlberg)	S16 Arlberg Schnellstraße	1 810	9 509	1	2	M	Federal State
Langener (Vorarlberg)	S16 Arlberg Schnellstraße	2 433 2 280	9 509	2	2/2	M	Federal State
Laaerberg* (Wien)	A23 Autobahn Südosttangente	270 270	103 369	2	3/3	M	Federal State
Lärmschutz- tunnel Kaisermühlen (Wien)	A22 (new construction)	approx. 2 150 m (each tube)	69 317	2	4/4 (incl. 1 emerging lane)	M	Federal State
Kalcherkogel (Kärnten und Steiermark)	A2 Süd Autobahn	1 993 1 968	12 601	2	2/2	M	Federal State
Tunnels with additional measures (lengths > 5 000 m)							
Gleinalm (Steiermark)	A9 Pyhrn Autobahn	8 320	9 673	1	2	M	Federal State
Tauern (Salzburg)	A10 Tauern Autobahn	6 401	12 136	1	2	M	Federal State

Name (county)	Location	Length (m)	AADT ¹	No. of tubes	No. of lanes ²	Road type ³	Owner
Roppener (Tirol)	A12 Inntal Autobahn	5 100	12 963	1	2	M	Federal State
Pfänder (Vorarlberg)	A14 Rheintal Autobahn	6 718	17 601	1	2	M	Federal State
Gräbern (Kärnten)	A2 Süd Autobahn	2 144	13 420	1	2	M	Federal State
Katschberg (Kärnten und Salzburg)	A10 Tauern Autobahn	5 439	11 059	1	2	M	Federal State
Felbertauern (Salzburg und Tirol)	Felbertauern Straße	5 183	3 300	1	2	P	Private company
Arlberg (Tirol und Vorarlberg)	S16 Arlberg Schnellstraße	13 972	6 303	1	2	M	Federal State
Bosruck (Steiermark und Oberösterreich)	A9 Pyhrn Autobahn	5 500	4 415	1	2	M	Federal State
Sum all tunnels:		117 709 ⁴	509 378				

Notes, Table 3.2:

- 1): AADT = Annual Average Daily Traffic, as per 31.12.95
- 2): Total number of lanes in the tunnel
- 3): Type of road
 - M : Motorway
 - N : National road
 - L : Local road
 - P : Private road
- 4): The length of the longest tube for 2-tube tunnels is used for the calculation

3.1.2 Current rules and regulations

There are no specific tunnel traffic regulations applicable to all road tunnels in Austria, but the transport of dangerous goods through 36 road tunnels (of which 34 are longer than 1 000 m) is regulated through the Road Tunnels Ordinance: “Verordnung des Bundesministers für öffentliche Wirtschaft und Verkehr vom 17 Juni 1987 über die Beförderung gefährlicher Güter auf bestimmten Straßenstrecken (*Straßentunnelverordnung*), BGBl. Nr. 270/1987 in der Fassung BGBl. Nr. 22/1990”, ref. /10/. In addition, there are specific rules for the transport of certain types of dangerous goods in tunnels longer than 5 000 m, by requiring escort vehicles to be used. All 36 tunnels which are subjected to this regulation are listed in the appendix of/10/.

International carriage of dangerous goods performed by vehicles registered outside Austria is subject primarily to ADR (Accord européen relatif au transport international des marchandises Dangereuses par Route) whose provisions are (as far as possible) directly applicable. In addition to ADR, there are those provisions of the national Law on Carriage of Dangerous Goods by Road: “Bundesgesetz vom 23 Feber 1979 über die Beförderung gefährlicher Güter auf der Straße und über eine Änderung des Kraftfahrgesetzes 1967 und der Straßenverkehrsordnung 1960

(Gefahrgutbeförderungsgesetz-Straße - **GGSt**), BGBl. Nr 209/1979, idF BGBl. Nr 296/1987, BGBl. Nr 181/1988, BGBl. Nr 452/1992, BGBl. Nr 505/1994 und BGBl. Nr 430/1995”, ref. /15/ , which make reference to, implement and complement the ADR.

However, international carriage is not subject to any provisions of the national law that is in contradiction with the ADR. ADR always takes precedence. National law ruling matters not dealt with at all by ADR are not seen as contradictory to ADR. There are however restrictions in marg. 10599 of ADR. Ref. /10/ (the “Straßentunnelverordnung”), which is based on ref./15/ (the “GGSt”) and is not in contradiction with the ADR.

International carriage of dangerous goods performed by vehicles registered in Austria as well as domestic carriage of dangerous goods are also to a great extent subject to ADR whose provisions in this case are applicable by way of general and specific references to in the national "GGSt". Such carriage is, however, also subject to all the other provisions of national law, including those in contradiction with the ADR. Where there is a contradiction, national law takes precedence. ADR-special agreements also apply in that case.

Ref. /10/ addresses special provisions and measures for the transport of dangerous goods in the 36 identified Austrian road tunnels, which are outlined below. Note that this refers only to dangerous goods in quantities for which marking of the transport unit with orange plates according to marg. 10500 ADR is required (above certain limits per transport unit for "small quantities"). Transport of dangerous goods is fully authorised in all the Austrian road tunnels which are not listed in/10/. There are no Austrian tunnels that totally ban transport of dangerous goods. However, there are some tunnels that have introduced restrictions according to hours of the day or traffic level, e.g. prohibition during peak hours. Furthermore, there are no requirements as to what type of technical measures / provisions the tunnels should be equipped with to allow for the transport of dangerous goods.

Tunnels authorised with special provisions

The transport of dangerous goods in the 25 tunnels with lengths between 1 000 and 5 000 m (+ the Wolfsberg tunnel and the A23 Autobahn Südosttangente) is authorised under the following conditions:

- The transport units must be fitted with at least one amber flashing or rotating warning lamp that is visible in all directions. It must be switched on 200m before the portal and remain in operation throughout the tunnel;
- During their passage through the tunnel, these transport units must not overtake other vehicles and must keep a distance of at least 200m from other transport units which also have to bear orange plates according to marg. 10500 ADR.
- The speed limit is as on open road

Tunnels authorised with additional measures

The transport of dangerous goods in the 9 tunnels with lengths >5 000 m, is authorised under the following conditions (the two first ones are as for the 27 tunnels above):

- The transport units must be fitted with at least one amber flashing or rotating warning lamp that is visible in all directions. It must be switched on 200m before the portal and remain in operation throughout the tunnel;

- During their passage through the tunnel, these transport units must not overtake other vehicles and must keep a distance of at least 200m from other transport units which also bear orange plates according to marg. 10500 ADR.
- Transport units with orange plates bearing hazard identification numbers displaying "2" as the first digit (e.g. "20" or "23"), or two identical numbers (e.g. "33" or "44") or preceded by the letter "X" must be accompanied by at least one escort vehicle. If only one escort vehicle is used, this vehicle must travel less than 4seconds but at least 50 meters behind the escorted transport unit. During the tunnel passage, the escort vehicle must operate an amber warning light as well. The driver of the escort vehicle must be acquainted with the written instructions (marg. 10381 & 10385 ADR) carried by the escorted vehicle. The costs of such escorts are to be paid by the hauliers themselves.

Tunnels with mandatory notification

At some of the tunnels (including all toll tunnels) in the two above-mentioned categories, the driver is also required to notify the tunnel control of the ADR classification of the goods being carried, as contained in the transport document, together with the quantity.

3.1.3 Decision process

The decision on whether dangerous goods should be prohibited, restricted or fully authorised in tunnels on the national road network or on local roads, is taken by the federal provinces themselves. If any kind of restrictions are requested, an application has to be submitted to the Ministry which decides (on a tunnel-to-tunnel basis) whether the tunnels will be added to the existing list of tunnels in the appendix of the 'Strassentunnelverordnung'.

The decisions concerning the tunnels on the motorways or the express roads ("Schnellstrassen") are taken by the Ministry itself.

3.1.4 Enforcement

No regular controls of vehicles transporting dangerous goods are performed close to the tunnels, and hence there exist no statistics on the level of infringements or evasions. However, police or customs personnel do spot checks on the open road by bringing a mobile laboratory unit for checking the contents of the substances being transported. It is further thought that the very high sanctions for not following the current regulations contribute to prevent hauliers from doing so.

3.1.5 Problems with existing rules and regulations

Since the current regulations are not published internationally or handed over at the Austrian border, foreign hauliers may not be aware of possible restrictions on use of tunnels. The situation is also worsened since there are no signing at the tunnel entrances showing what type of materials and quantities are allowed/prohibited in the tunnel. In addition, the diversion routes are not properly signed.

The tunnels that require mandatory notification of the cargo being transported, as given in section 3.1.2, require large open spaces at the tunnel entrances. This is in order to make it possible for the vehicles to stop and to wait for escort, and to put up boards for relevant information to the hauliers. Construction of this kind of "provision" is costly and may pose a financial problem to the province in question.

3.1.6 Plans for modifications and improvements of existing regulations

A new Law on the Carriage of Dangerous Goods will be put into force in 1997: ‘Bundesgesetz über die Beförderung gefährlicher Güter und über eine Änderung des Kraftfahrzeuggesetzes 1967 und der Straßenverkehrsordnung 1960 (Gefahrgutbeförderungsgesetz - **GGBG**). Draft’, ref. /12/. This law will regulate the carriage of dangerous goods by all modes of transport.

For road transport, the following will apply:

- Carriage of dangerous goods by road within Austria as well as carriage between Austria and any member state of the EEA performed by any EEA member state registered vehicle, will be subject to the annexes A and B of the ADR Framework Directive: “Council Directive 94/55/EC of 21 November 1994 on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road”, ref. /13/;
- All other carriage will be subject to annexes A and B of the ADR;
- The provisions of the GGBG will apply as far as they are not in contradiction with the international provisions mentioned above.

Since Article 5/2 of /13/ states that rules imposed by an EEA member state on vehicles performing international carriage through its territory and authorised by marg.10599 of Annex B (this includes rules on restrictions concerning vehicles using tunnels) shall be limited in scope la the local level, the "Road Tunnels Ordinance" will not apply.

Existing or future restrictions may however be based on *individual ordinances* for each tunnel within the framework of the general Road Traffic Act: ‘Bundesgesetz vom 6 Juli 1960, mit dem Vorschriften über die Straßenpolizei erlassen werden (Straßenverkehrsordnung 1960 - StVO 1960), BGBl. Nr 159/1960 in der Fassung BGBl. Nr 201/1996’, ref. /14/. The competence for such legislation will depend on the character of the road concerned (e.g. motorways). Any such ordinance will not enter into force unless all conditions and consequences have been carefully examined by several authorities and road traffic experts. Such restrictions will be notified by the prohibition sign *'No entry for vehicles carrying dangerous goods'* with an additional plate. For this purpose the sign will explicitly refer to vehicles requiring orange plates according to marg. 10500 of the ADR as mentioned above.

The new regulations will require that all aspects relative to each tunnel have to be investigated individually. This will in turn lead to more relevant and practical solutions with respect to the transport of dangerous goods for each tunnel. However, it has been realised that there will still be some tunnels which will be subjected to the “old” regulations.

In the “Design Guidelines for Tunnel Ventilation”, issued in February 1997, a safety analysis for tunnels is defined, for the first time. The analysis is based on the danger potential of the tunnel that depends on:

- traffic volume;
- direction of traffic;
- additional points of conflict (merging lanes, intersections in the tunnel and in the portal area);
- permission and frequency of transport of dangerous goods.

For a determination of the danger potential, defined parameters and their weighting must be taken into account. On the basis of the value assessed for the potential, tunnels are divided into 4 danger classes.

3.2 France

3.2.1 French tunnels

In this section, the road tunnels in France as of February 1997 are classified according to length, road type and status. Tunnels in this context comprise all underground and excavated structures and all lit cut-and-covers. The latter implies that the shortest cut-and-covers are excluded. The actual figures are given in Table 3.3 and Table 3.4 below.

Table 3.3 French road tunnels per length class

Length class ¹ (metres)	No. of tunnels ²	No. of tubes	Σ tube length ³ (in metres)
< 0 - 200>	581	635	43 766
[200 - 600>	173	229	77 339
[600 - 1 000>	28	39	30 045
[1 000 - 1 400>	9	14	16 139
[1 400 - 2 000>	16	20	32 233
[2 000 - 3 000>	4	8	20 480
[3 000, ∞ >	7	9	42 079
Total	818	954	262 081

Notes

- 1): The length class of a tunnel is determined from the length of its longest tube
- 2): Each tunnel structure is counted as 1 tunnel, irrespective of the number of tubes
- 3): For tunnels with ≥ 2 tubes, the sum of the tube lengths is counted

Table 3.4 French road tunnels per type of road and status

Type of road	Owner status ¹	One-tube tunnels		Tunnels with ≥ 2 tubes		All tunnels	
		No. of tunnels ²	Σ tube length (metres)	No. of tunnels ²	Σ tube length ³ (metres)	No. of tunnels ²	Σ tube length ³ (metres)
Motorway	Private	2	1 994	42	57 317	44	59 311
	State	22	9 261	20	29 419	42	38 680
National road	Private	4	25 932	0	0	4	25 932
	State	142	29 494	14	12 444	156	41 938
Local road	Private	-	-	-	-	-	-
	Département	381	42 984	3	632	384	43 616
Forest road	Private	-	-	-	-	-	-
	State	7	478	-	-	7	478
City roads	Private	-	-	1	4 910	1	4 910
	City	127	26 613	52	19 503	179	46 116
Private road	-	1	1 100	-	-	1	1 100
Total	-	686	137 856	132	124 225	818	262 081

Notes:

- 1): "Private" indicates that the tunnel is owned and operated by a concessionaire company which "owns" the tunnel for a limited time (e.g. 30-70 years in general). In many cases, this company is not private, but rather semi-public, meaning that public authorities own a large part of the company.
- 2): Each tunnel structure is counted as 1 tunnel, irrespective of the number of tubes.
- 3): For tunnels with ≥ 2 tubes, the sum of the tube lengths is counted.

In *Appendix A*, a detailed list of 82 French road tunnels with length ≥ 500 m is given. However, a brief summary is given in (i) - (iii) below.

- (i) The tunnel tube lengths adds up to a total of 155 796 m, and the distribution with respect to tunnel length (in metres) is given below.

[500 , 600>	:	18
[600 , 1000>	:	28
[1000 , 1400>	:	9
[1400 , 2000>	:	16
[2000 , 3000>	:	4
[3000 , ∞ >	:	7

- (ii) The distribution of the tunnels according to authorisation/prohibition of dangerous goods is as follows:

A. Fully authorised

24. All transport of dangerous goods that are subject to signing is authorised in the tunnel without exception.

B. Authorised with special measures/provisions

17. All transport of dangerous goods that are subject to signing is authorised in the tunnel without exception. However, they are obliged to keep to a maximum speed of 50-60 km/h, and to comply with the minimum vehicle inter-distance of 100-200m. In some cases, hourly restrictions are defined.

C. Partly authorised

25. These are mainly tunnels in Paris or the Paris region. Transport of dangerous goods is authorised except for inflammable liquids, liquefied gas, combustible or not, and all explosive materials.

D. Special measures/provisions

2. The Mont Blanc and Fréjus tunnels. These tunnels have a complex and restricted list of substances authorised (A), restricted, i.e. display of the safety sheet is required in the case of an accident (B) or prohibited (C). The list is periodically updated by each tunnel's Italian/French Control Commission. These Commissions operate according to: (i) the existing rules in force in France and Italy; (ii) the ADR adopted in the ECE/UN; (iii) the Conventions in force between France and Italy for tunnel operations.

E. Prohibited

14. All transport of dangerous goods which are subject to signing are prohibited in the tunnel without exception.

Regarding the group A tunnels, the main reason for the decision taken is that the tunnels are located in rural areas. For the group B tunnels, the decisions are based on the following facts:

- The transport of dangerous goods is prohibited on the diversion route.

- The tunnels are located in rural areas.

With respect to the tunnels belonging to group E above, the decision is based on the fact that the tunnels are located in urban areas or that proper diversion routes exist.

(iii) 44 of the 82 tunnels are located in rural areas

3.2.2 Current rules and regulations

3.2.2.1 Tunnels of the national road network

The transport of dangerous goods through road tunnels of the French national network (i.e. national roads and concession/no concession motorways) is regulated by Circular No.76-44 “Circulaire N° 76-44 du 12 mars 1976 relative à la réglementation de la circulation dans les tunnels des véhicules routiers transportant des matières dangereuses” (ref./2/) of the French Equipment and Housing Ministry. This regulation applies to:

- all tunnels with length > 150 m;
- all tunnels with length between 50 and 150 m if the following aspects imply a certain risk of collision for vehicles carrying dangerous goods:
 - * Characteristics of the tunnel cross section;
 - * Available viewing distance for the users of the tunnel;
 - * Traffic volume;
 - * Actual speed limit.

The general rule is prohibition of transit of all vehicles carrying dangerous goods submitted to signing, i.e. mandatory two orange-coloured fixed plates on the vehicle. Exceptions to this rule exist for the following cases:

- Diversion route shows risks for safety (long urban centres and narrow crossings);
- Prohibition involves a long detour and therefore an unbearable constraint for the transport economy;
- No possible diversion is possible.

In particular, in the Mont Blanc and Fréjus tunnels, all vehicles’ loadings are permanently controlled and hence, a more complex distinction is possible between loadings which are authorised and loadings which are not.

When a tunnel is allowed for transit, the vehicles carrying dangerous goods are subject to the following conditions:

- Passage restricted to low traffic days and hours depending on the time of the year and the traffic direction of some one-way tunnels;
- Maximum speed limit permitted should be fixed between 40 and 60km/h;
- Distance between the vehicles should be kept at 200m;
- Escort may be required (in some two-way heavy traffic tunnels).

3.2.2.2 Tunnels outside the national road network

No general rules are applicable to tunnels not belonging to the national road network, i.e. *département* and city networks. The only exception to this concerns tunnels in Paris and areas around (*départements* of Hauts-de Seine, Seine St-Denis, and Val-de-Marne), where vehicles

carrying inflammable liquids, liquid gases, combustible or not (e.g. propane, butane, liquid oxygen, etc.), or any other material that may explode, are prohibited from entering tunnels.

3.2.3 Decision process

Normal practice leaves the decision as to whether the transport of dangerous goods is authorised or prohibited in a tunnel to the owner of the tunnel. If the owner is the State, its representative in the *département* (“le préfet”) takes the decision after having consulted the concerned services and communities. In addition, he may establish a Commission in charge of giving advice.

However, the recent trend is to develop a risk study method, which enables a comparison between the route including one or several tunnels and possible diversion routes in terms of probabilities and consequences.

3.2.4 Current situation

Although the Circular No. 76-44 bans, in principle, all transport of dangerous goods in tunnels of the national road network, there are many exceptions, some of which are listed below (note that the transport of dangerous goods is totally banned in only 14 out of the 82 tunnels longer than 500 m).

Tunnels in urban areas

In these tunnels, the transport of dangerous goods is banned almost without exception. The two main reasons for this are:

- Potential number of victims could be very high if an accident occurs in a congested tunnel;
- High economic consequences resulting from closing the tunnel for repair work during long periods following an accident.

Non-urban motorway tunnels

The transport of dangerous goods through these tunnels is authorised because:

- These tunnels are located in rural areas on roads provided with efficient operating means such as 24-hours control and supervision station, television supervision, patrol, intervention and safety plan;
- Diversion routes do not show the same level of safety and very often cross through towns, where the mayors generally decide to ban this type of transport through the town.

Non-urban and non-motorway tunnels

The transport of dangerous goods through these tunnels is most often authorised, with or without special measures or provisions. This is due to the fact that they show a low level of traffic (although they are two-way traffic tunnels), and that diversion routes are often difficult to plan for.

Regarding the Fréjus tunnel (France-Italy), there are special regulations. When opened in 1980, only goods that were considered as less hazardous (and in small quantities) were allowed through the tunnel (this is similar to the Mont Blanc tunnel). In 1985, the regulation was revised and transport of “moderately” dangerous goods was allowed with a double escort (convoy of 5 vehicles with escorting cars both in front and in back). Furthermore, complementary safety provisions were provided in the tunnel. However, the transport of goods defined to be the most dangerous was still prohibited. It is important to note that for the transit of Group B, speed is

limited to 60 km/h. Tunnel operation ordinance that is decided by the respective tunnel's Control Commission allows for simplifying requested transport documentation.

3.2.5 Enforcement

There is very little information about experience on how the existing regulation is complied with. Infringements are often mentioned in tunnels with no permanent control. At the portals of the Mont Blanc and Fréjus tunnels (Italian and French sides), some vehicles carrying dangerous goods are held at the control booth when the regulations prohibit them from passing. This arises mainly with foreign hauliers and is due to the fact that the rules are complex and that the users cannot be correctly informed by signboards. When a non-authorized vehicle comes to the control booth, it will have to make a U-turn and use another route.

3.2.6 Contents of a typical tunnel regulation

In this section, the main headlines of the current regulation for the Chamoise tunnel is given (ref. /4/). This tunnel is located on motorway A40 in a rural area consisting of two 3300 m tubes currently with one-way traffic in each. One tube was opened in 1986 (initially with two-way traffic) and the second one in 1995. The AADT (Average Annual Daily Traffic) as per 1995 is 17 000. The transport of dangerous goods is authorised under certain condition. The main contents of some of the “articles” of the regulation regarding the one-tube two-way traffic tunnel (from 1986 to 1995) are listed below. Note that only article 7 applies solely to dangerous goods vehicles.

- Speed limit is 90km/h maximum (art. 2);
- Vehicle inter-distance is 50m minimum (art.3);
- Overtaking is forbidden, except for police-, army-, and fire brigade vehicles (art4);
- Headlights should be on in the tunnel and use of the motor horn is forbidden (except if an immediate dangerous situation should occur) (art. 5.1 & 5.3);
- Voluntary stopping and parking is forbidden (art. 6.1);
- In the case of a vehicle breakdown, the driver should place the vehicle to the extreme right in the tunnel, check the lights, turn off the engine, and then call for help (art. 6.2a);
- In the case of tunnel (material) accidents not involving (or involving) the vehicles, the drivers should evacuate leaving their vehicles in the tunnel (art. 6.2b,c);
- The maximum speed limit is 50km/h for vehicles transporting dangerous goods and the minimum vehicle inter-distance is 200m (art. 7).

Today, the tunnel consists of two tubes with one-way traffic. A draft regulation is available with the following changes compared to the one referred to above:

- For all vehicles, except for dangerous goods vehicles, maximum speed limit is 110km/h;
- Overtaking is forbidden for lorries;
- For dangerous goods vehicles, the maximum speed limit is 70km/h

3.2.7 Problems with existing regulations

There are many problems arising from the existing regulations with respect to decision making, enforcement, operation and transport. Some of these problems encountered in France throughout the years are listed below.

- The practice to authorise many tunnels for the transport of dangerous goods contradicts the rules which prescribe the contrary as a principle;
- The new tendency to base decision making on risk studies is not planned for in present regulations;
- The existing regulations only apply to state-owned tunnels. No regulations exist for tunnels owned by local communities;
- The situation varies significantly among the various tunnels, and this causes problems for the drivers carrying dangerous goods since it is difficult to be aware of the current regulations of the tunnel(s) on their route. It is often difficult to provide at each tunnel entrance the correct signing of its specific provisions, as no appropriate boards corresponding to the various situations are available;
- There is no strict requirement that diversion routes should be signed, if a tunnel is banned/restricted for dangerous goods. However, some French tunnels have this type of signing.

3.2.8 Plans for modifications and improvements of existing regulations

Circular No. 76-44 is in the process of being redrafted. This work is being done in co-operation with the administrations in charge of dangerous goods transport, roads, civil security, environment and competent technical services. Some of the proposals for the new text are given in the following sub-sections (still most provisional).

3.2.8.1 Type of regulations to be considered for each tunnel

It is important to offer proper information to the hauliers of dangerous goods about the existing regulations for the various tunnels. When restricted to the use of the existing regulatory traffic boards, only three regimes would be possible:

1. No restriction;
2. Access prohibited to all vehicles transporting dangerous goods submitted to signing;
3. Access prohibited only to vehicles transporting explosive or inflammable products. This is to be based on the “B18a”.

The case of the Mont Blanc or Fréjus tunnels, where permanent control is possible, will still be subject to a special regime.

Some further recommendations:

- Do not complicate signing by imposing vehicle inter-distance in tunnels that would be different from the one which applies on the open road;
- Do not complicate signing by imposing speed limits in tunnels that would be different from that apply on the open road;
- Do not require escort (except for the long toll tunnels, since the special means required are already in place);
- Introduce banning of the transport of dangerous goods through tunnels at peak hours.

3.2.8.2 Decisions

The decision to prohibit or to authorise the transport of dangerous goods through a tunnel should primarily be based on a comparison of risks for these two alternatives. If this exercise does not reveal any differences with respect to safety, other criteria should be considered such as cost of

equipment required in the tunnel if authorised, neighbourhood environment, and economic constraints related to using a diversion route.

In order to aid the above decision process, the following approach is proposed:

Define a Risk Indicator (RI), which should roughly represent an expected number of fatalities in a specific tunnel. The RI would be a function of traffic level, degree of dangerous goods traffic, tunnel length, and an one-/two-way traffic coefficient. Furthermore, risk levels denoted as S1 and S2 need to be defined. Having defined these three figures, the decision to be taken would depend on RI in relation to S1 and S2.

RI < S1: The transport can be authorised without any further studies.

S1 < RI < S2: A simple risk study should be performed first. This type of study is aimed at roughly comparing the risks on the route with one or several tunnels with the alternative route(s) without tunnels. If the study shows that the risks are more or less equivalent for the two routes or that the risk for the tunnel alternative route is higher than a level S3 (pre-defined), an exhaustive risk study must be performed.

RI > S2: The transport must be banned.

The contents and the methodology of both the simple and detailed risk studies referred to above are still to be defined. Furthermore, when considering situations when no diversion routes are available, the analytical approach has to be worked out.

3.2.8.3 Safety provisions and equipment in tunnels authorised for the transport of dangerous goods

The inter-ministerial Circular No. 81-109 “Circulaire N° 81-109 de décembre 1981 relative à la sécurité dans les tunnels routiers” (ref. /3/), defines the safety provisions and equipment and the operating measures to be planned for in national road network tunnels. This includes evacuation and rescue team intervention plans. With respect to the transport of dangerous goods, ref. /3/, article 5 only states that this type of transport may require complementary provisions so that the consequences of an accident involving a vehicle transporting dangerous goods are limited. The provisions referred to are not outlined in detail. Hence, it has been found necessary to issue a new Circular including an Annex with guidelines about safety provisions and equipment in road tunnels. In this Annex, one of the chapters addresses tunnels open to vehicles transporting dangerous goods. A number of specific provisions are planned in addition to the general provisions that are compulsory for all tunnels. The “headlines” are given below with examples:

- **Civil engineering provisions** (e.g. emergency lane, pavement transverse gradient, sewer system);
- **Equipment provisions** (e.g. smoke control, detection- and alarm systems, light markers, closing devices, water supply, anti-deflagrant material in recovery pits and electric rooms);
- **Resistance and reaction to fire** (primary and secondary structures’ resistance during a fire, power supply).

3.3 Germany

3.3.1 German road tunnels

As of 31 December 1995, there are 170 road tunnels (lengths > 80 m) on the road network in Germany.

In Table 3.5 below, the tunnel length categorisation is given.

Table 3.5 German road tunnels per length class

Length class ¹ (metres)	No. of tunnels ²	No. of tubes	Σtube length ³ (in metres)
< 0 - 200>	51	67	9 093
[200 - 600>	80	131	47 528
[600 - 1 000>	22	37	28 008
[1 000 - 1 400>	9	13	13 921
[1 400 - 2 000>	5	8	13 616
[2 000 - 3 000>	3	5	12 844
[3 000 , ∞>	0	0	0
Total	170	261	125 010

Notes

- 1): The length class of a tunnel is determined by the length of its longest tube. Ramps are excluded.
- 2): Each tunnel structure is counted as 1 tunnel, irrespective of the number of tubes.
- 3): For tunnels with ≥ 2 tubes, the sum of the tube lengths is counted.

The 170 tunnels, comprising 80 one-tube tunnels, 89 two-tube tunnels and one 3-tube tunnel, adds up to a total length of 78 062 metres, lengths ranging from 80 m to 2 653 m (Elbe tunnel, Hamburg). 41 tunnels are located on motorways (Autobahn), 77 on National roads (Bundesstraße), and the remaining 52 on county roads (Landesstraße) and cities (Ort-/Stadtstraße). None of the German road tunnels are owned or operated by private companies or entities.

In Table 3.6 below, the road tunnels are distributed according to current status of regulations regarding the transport of dangerous goods.

Table 3.6 German road tunnels, status of regulations

Status	Tunnels with 1 tube		Tunnels with >2 tubes	
	No. of	Total	No. of	Total
Fully authorised / free	48	17 149	69	29 684
Authorised with	7	4 211	5	6 307
Prohibition	3	2 942	9	3 837
Unknown	22	9 465	7	4 467
Sum all	80	33 767	90	44 295

- *) Restrictions with respect to:
- hours (transport restricted to off-peak periods)
 - type and quantity of substances
 - escorting
 - notification

3.3.2 Current rules and regulations

The transport of dangerous goods on roads in Germany is regulated through the “Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße (Gefahrgutverordnung Straße - GGVS)” of 12 December 1996 (ref. /15/). This document is based on the ADR convention and contains requirements and obligations for all parties involved in the transport of dangerous goods with respect to amount and type of dangerous substances, choice of routes, packaging, notification, and available documentation of contents of substances being transported. Appendix 1 of the GGVS lists the substances which are considered most dangerous, with the corresponding amounts that are not allowed to be transported by road. In these cases, railways or inland barges must be used. However, if this is not possible, specially dedicated routes on the roads should be followed (§ 7). Appendix 2 discusses the special cases for the transport of dangerous goods inside Germany for which the rules given in the ADR may be relaxed.

Appendix 3 relates to the transport of dangerous goods on certain motorways with tunnels, by vehicles with the international orange plate (kennzeichnungspflichtigen Beförderungseinheiten) according to the ADR margin 10500. The restrictions are summarised below.

- Berlin: Transport of dangerous goods is totally prohibited in the Rathenau and Innsbrucker Platz tunnels located on the Autobahn Stadtring (A 100).
- Hamburg: Transport of dangerous goods is prohibited in the Elbe tunnel (Autobahn A7) between 05:00 and 23:00 every day. In addition, there is a total ban of transporting a number of hazardous substances which are listed specifically in paragraph 2.2 and 2.3 of Appendix 3.
- Niedersachsen: The restrictions for the Emstunnel (Autobahn A28 / A31) are the same as for the Elbtunnel above.
- Nordrhein-Westfalen: Transport of dangerous goods on Autobahn A46 (between Bilk and Holthausen) is totally prohibited in both directions.

In addition to the above-mentioned GGVS, there exists a document which addresses how all German road tunnels should be equipped (technical provisions), operated and maintained, “Richtlinien für die Ausstattung und den Betrieb von Straßentunneln - RABT” issued in 1994 (ref. /20/). Chapter 4 of this document relates solely to the transport of dangerous goods.

3.3.3 Decision process

The development of the rules and regulations for individual tunnels is prepared by both the Federal Ministry of Transport and respective regional competent authorities. The GGVS and the RABT (refs. /15/ and /20/) serve as basis and support for the decisions to be made with respect to the transport of dangerous goods. Chapter 4 of the RABT specifically states: *“Authorisation or prohibition of transport of dangerous goods through a road tunnel depends on the comparison of the risk for accidents in the tunnel and on the diversion route(s). If transport of dangerous goods is restricted or prohibited in a tunnel, this requires clear signing of the actual restrictions and of the diversion route(s).”* However, there is not a mandatory requirement that a (quantified) risk analysis should be performed. Examples of signing are given in Appendix C.

Furthermore, the RABT details requirements with respect to technical provisions in the tunnels, i.e. lighting, ventilation, drainage, communication, fire alarms and fire extinguishing.

3.3.4 Enforcement

There is little information available on how the rules and regulations are complied with and enforced throughout Germany. Current rules and regulations are published in official gazettes (e.g. the “Bundesgesetzblatt”) and distributed within the various regions. Together with proper road signing (as described above), this reduces the probability of infringements or evasions, at least by national hauliers. Detailed topographical road maps showing the tunnels and their diversion routes in Germany are also available. In addition, regional maps are specially developed to show all the diversion routes in the area. Regarding international transport, there is no arrangement whatsoever to inform foreign hauliers about the current regulations in the road tunnels (e.g. at the German border, etc.)

Regarding the Elbe tunnel in Hamburg, in particular, the so-called “Water Police” do regular spot checks of vehicles (including dangerous goods vehicles) every two weeks on the Autobahn A7 leading to the tunnel or at the tunnel entrances. These controls normally take about 2-3 hours. Past experience with these controls reveals that the transport of dangerous goods in the Elbe tunnel is in most cases performed according to existing rules and regulations.

3.3.5 Example of a local tunnel regulation

The Hamburg Elbe motorway tunnel is part of the A7 Autobahn (which runs from Flensburg via Hamburg to Hanover) and was opened in January 1985. The tunnel structure consists of three tubes each with a total length of 2 653 m (3 325 m including ramps) and with two lanes and one-way traffic. This is the longest road tunnel ever built in Germany. The level of traffic in the tunnel in 1996 was reported to be 39 628 759 vehicles, giving an estimated AADT of 108 275. In 1992, the rate of vehicles carrying dangerous goods in the tunnel was approximately 550/day.

The main content of the current regulation for the Elbe tunnel (as per 1 January 1995) were outlined in the “Amtlicher Anzeiger” no. 61 of 27 March 1995 (the other roads and tunnels in Hamburg are also addressed in this paper). The basis for the latest update of the Elbe tunnel regulation is documented in the report “Überprüfung der Durchfahrtregelung für der Grundlage aktuellen Datenmaterials”.

The regulation governing the Elbe tunnel has been laid down in accordance with the following factors:

- traffic density and number of loads involving hazardous goods;
- length of the alternative route.

The regulation prohibits all transport of dangerous goods in the period 05:00- 23:00 (daily). In particular, all substances classified as “very dangerous” (e.g. explosives, pressurised gases) are totally prohibited (even at night). Transport of fuel oil and diesel products have free access in the tunnel. Vehicles carrying dangerous goods should use the right lane, have their headlights lit, and keep a maximum speed of 80km/h. At 5-10 km before the tunnel entrances, the diversion routes are signed.

3.3.6 Problems with existing rules and regulations

There is no indication of any problems posed by the regulations on the decision processes, enforcement, operation, or transport. However, two items relating to the Elbe tunnel should be mentioned:

- There are no stopping places close to the entrances of the tunnel where dangerous goods vehicles may be controlled. Hence, such controls have to be performed on the public resting places located beyond the tunnel. This strongly reduces the efficiency of these controls.
- The strict banning of transit with dangerous goods in the daytime leads to large administrative costs, since a high number of requests come from hauliers transporting special substances who want to know whether their goods may be transported through the tunnel.

3.3.7 Plans for modifications and improvements of existing regulations

There are no current plans for changes in the existing rules and regulations on a Federal level.

3.4 The Netherlands

3.4.1 Dutch tunnels

Information about the road tunnels in the Netherlands as of February 1997 are given in Table 3.7 and Table 3.8 below. All tunnels have at least two tubes (one tunnel has four) and with one-way-traffic in each tube.

Table 3.7 Information on Dutch tunnels, 1

Tunnel name	Tunnel length (m)		AADT	Type (no. of lanes)
	Excl. approach	Incl. approach		
Benelux	795	1 300	89 200	2 x 2
Botlek	539	1 181	95 000	2 x 3
Coen	587	1 300	92 700	2 x 2
Drecht (1)	569	823	120 000	4 x 2
Heinenoord	614	1 064	64 200	1 x 3 + 1 x (2+1) (4)
Schiphol	536	630	152 200	2 x 4
Ij	1 039	1 685	57 600	2 x 2
Kil	406	901	9 000	2 x (2+1) (5)
Margriet	77	938	27 300	2 x 2
Maas	1 070	1 373	81 900	2 x 2
Noord	543	1 270	75 000	2 x 3
Velser	768	1 644	84 400	2 x 2
Vlake	327	773	26 100	2 x 2
Zeeburger	580	940	92 800	2 x 3
Wijker	685	1 390	(2)	2 x 3
Piet Hein	1 265	1 900	(3)	2 x 2
Total	10 400	19 112	1 067 400 (6)	-

- (1) : 4 tubes
 (2) : Opened July 1996
 (3) : To be opened in April 1997
 (4) : One slow traffic lane in one tube (future: 2x3)
 (5) : One lane for slow traffic and bicycles in each tube
 (6) : Excl. the Wijker and Piet Hein tunnels

The tunnels are classified according to the type of restrictions (see column “Category” in Table 3.8): None, Category I and Category II. These classes are further defined in the next section.

Table 3.8 Information on Dutch tunnels, 2

Tunnel name	Location	Owner	Category	Crossing
Benelux	Highway	State	II (*)	River
Botlek	Highway	State	II	River
Coen	Highway	State	I	Canal
Drecht (I)	Highway	State	I	River
Heinenoord	Highway	State	II (*)	River
Schiphol	Highway	State	None	Runway
Ij	Urban	Municipality	II	River
Kil	Secondary	Province	II	River
Margriet	Highway	State	None	Canal
Maas	Urban	Municipality	II	River
Noord	Highway	State	I	River
Velser	Highway	State	II	Canal
Vlake	Highway	State	II (*)	Canal
Zeeburger	Highway	State	I	River
Wijker	Highway	State	I	Canal
Piet Hein	Urban	Municipality	II	Harbour

I: 4 tubes

(*) : Will be classified as Category I in the future

In addition to the tunnels listed above, there are four aqueducts (of which one is under construction), i.e. tunnels with length < 70 m. The Ij, Maas and Piet Hein tunnels are classified as category II since they are urban tunnels. Furthermore, in cities there are some 40 tunnels with lengths shorter than 200 m. In cities, the transport of dangerous goods is restricted to designated routes.

3.4.2 Current rules and regulations

The transport of dangerous goods in Dutch state road tunnels is regulated through the “Transport over land of dangerous goods” (VLG) which was first issued in 1984 with the latest revision in 1996. Article 4 of Appendix 2 - Chapter II of the VLG refers to tunnels, and the contents of this article can be found in section 3.4.2.1. below. In ref. /17/, the tunnels are categorised into three types according to the substances allowed to be transported through the tunnels:

- no restrictions;
- “Category I”: potentially explosive substances giving explosions >1 bar are not allowed, but most inflammable substances are allowed;
- “Category II”: only a few less dangerous substances are allowed (e.g. diesel oil).

The actual materials allowed to be transported through tunnels and defined either as category I or II, are listed in the regulation, and given in Table 3.9 below. In addition, the names of the tunnels in these categories are also given (see table above). All materials not allowed in the

tunnels have to be transported on defined and clearly signed diversion routes. Both category I and II tunnels are all signed using the international road sign for the transport of dangerous goods, with the given category added below. For each tunnel with any type of restrictions, a folder is prepared showing the diversion routes. These folders may be obtained at the Dutch embassy.

Table 3.9 Permitted materials for transport through tunnels (from the “VLG”, article 4) valid from 1-4-1997)

Class	Tunnels, category I	Tunnels, category II
1	Sub class 1.4, unlimited	Prohibited
2	Substances and objects recorded in the ADR list of substances only with the letter A (except 4A and 1858 Hexafluoropropylene) or O, unlimited Substances and objects recorded in the ADR list of substances with the letter 4A, T, TC, TO, TOC, F,TF or TFC, in units, unlimited 1858 Hexafluoropropylene in units, unlimited	Substances and objects recorded in the ADR list of substances only with the letter A (except 4A and 1858 Hexafluoropropylene) or O, unlimited Substances and objects recorded in the ADR list of substances with the letter 4A, T, TC, TO or TOC, in units, unlimited 1858 Hexafluoropropylene in units, unlimited
3	Substances number 1 - 12, unlimited Substances number 13 in units, unlimited Substances number 14 - 61c), unlimited	Substances number 31 - 34 and 61c), unlimited
4.1	All substances except the numbers 31b), 32b), 41b) and 42b), unlimited	All substances except the numbers 31b), 32b), 41b) and 42b), unlimited
4.2	Substances recorded in the ADR list of substances with the letter a) in units, unlimited Substances recorded in the ADR list of substances with the letter b) and c), unlimited	Prohibited
4.3	Substances in units, unlimited	Prohibited
5.1	All substances, unlimited	All substances, unlimited
5.2	Substances no. 3b-8b and 13b-18b in units, unlimited Substances 9b and 10b, , unlimited Substances number 13b) - 18b) in units, unlimited Substances number 19b) and 20b), unlimited	Prohibited
6.1	Substances number 1, 2, 3, 7, 8 and 10 in units, unlimited Substances number 4, 5, 6, 9 and 11 - 90, unlimited	Substances no. 11-90, unlimited
6.2	All substances, unlimited	All substances, unlimited
7	All substances, unlimited	All substances, unlimited
8	Substances number 6, 7a), 7b) - 14, in units, unlimited Substances number 1 - 5, 7c) - 13, 15 - 35b)1 and 35c) - 82, unlimited	Prohibited
9	All substances, unlimited	All substances, unlimited
	Empty uncleaned containers and tanks of the above-mentioned permitted substances	Empty uncleaned containers and tanks of the above-mentioned permitted substances

In general, the maximum speed limit for vehicles carrying dangerous goods through tunnels is 80 km/h, which is the same as for all types of lorries and heavy vehicles on the road network in general.

No tunnel has defined any hourly/daily/seasonal restrictions on the transport of dangerous goods, and escorting is not required at any tunnel.

The category I tunnels are required to have certain provisions such as:

- ceiling fire protection
- escape routes
- fire extinguishing systems
- ventilation systems

Allowing the transport of inflammable dangerous goods means that there is a small risk of explosion. This may happen when gas due to evaporation is ignited. Additional provisions are therefore required:

- good drainage systems
- gradient in carriageway
- explosion safe sump, etc.

It is important to note that there exist no special regulations for each Dutch road tunnel. The general rules set out in the VLG are valid for all tunnels concerned.

3.4.2.1 Article 4 of the VLG

Note that the references to tables and appendices given in the following relate to the VLG and not to this report.

§ 1 The transport of dangerous goods through tunnels as named in Table 3 is prohibited

§ 2 The prohibition mentioned in § 1 does not count for:

- a. the dangerous goods as stated in Table 4 of this chapter's mentioned quantities and units in each class and category;
- b. dangerous goods within the number 10.011 of appendix 1, to maximum quantity for that number;
- c. dangerous goods that belongs to the vehicle or trailer;
- d. dangerous goods that are transported in vehicles or trailers in packages to a maximum of 40 litres, as spare fuel of the vehicle.

§ 3 Tunnel sign

- The tunnels named in § 1 above are indicated with a sign corresponding to model number C22 of appendix I of the Regulation for traffic regulation and traffic signs of 1990.
- An undersign with a roman number mentioning the category of the tunnel, corresponding to Table 3 of this chapter, is placed under the sign above.

Table 3. Tunnel list with each category (corresponding to this report's Table 3.8).

Table 4. List of permitted materials through tunnels (corresponding to this report's Table 3.9).

3.4.3 Decision process

Every new highway tunnel being built in the Netherlands today should be constructed as a category I tunnel. The category II is only applied to older tunnels and tunnels in cities. The decision on whether transport of dangerous goods should be allowed through a tunnel, is based on a comparison of risks in the tunnel and on the diversion route. A non-computerised DSM tool is used for this purpose since 1984, and the results are then presented to the Ministry of Transport which subsequently makes the final decision.

3.4.4 Enforcement

There is no information to document to what degree the existing regulations are being obeyed. Police only make spot checks, and their experience is that there are very few infringements or evasions.

3.4.5 Problems with existing rules and regulations

There is no experience that existing rules and regulations pose any problems to the decision process, tunnel operations and management, or to transport. This is due to the following:

- hauliers, police, and fire brigades have regular meetings with the Ministries of Public Works and Internal Affairs at which all aspects of the transport of dangerous goods are openly discussed;
- the current regulations are widely made available through Federal Newsletters

From the hauliers' point of view, the introduction of category I tunnels on certain parts of the road network has enabled smoother transport of dangerous goods than before, because there were only category II tunnels and all transport had to use the diversion routes.

3.4.6 Plans for modifications and improvements of existing regulations

In the Netherlands, a discussion has been initiated on how to handle toxicants in the future. Today, most toxicants are authorised in all Dutch tunnels.

Studies are being made on the effects of risk-reducing measures.

3.5 Japan

3.5.1 Japanese tunnels

The road tunnels in Japan, as of April 1997, are classified according to length as shown in the table below.

Table 3.10 Japanese road tunnels per length class

Length class (metres)	No. of tunnels
< 0 - 200>	4 196
[200 - 600>	1 977
[600 - 1 000>	444
[1 000 - 1 400>	206
[1 400 - 2 000>	126
[2 000 - 3 000>	62
[3 000 - ∞>	39
Total	7 050

There are rules and regulations with respect to the transport of dangerous goods attached to 22 of the 7 050 tunnels in Japan. Some details of these tunnels are presented in Table 3.11 below. These 22 tunnels add up to a total length of approximately 65 000 m, with a total AADT of 1 028 000.

Table 3.11 Japanese road tunnels with rules and regulations, details

Tunnel Jurisdiction and Name	Length (m)	Construction type ¹	Location ²	No. of tubes /lanes	Traffic type	AADT (per tube)	Design (regulatory speed limit, km/h)
<u>Ministry of Construction:</u> Kuko-kita	1 487	I	U	2/3	1-way	12 000	80 (60)
<u>Metropolitan Expressway</u>							
Haneda	688	I	U	2/2	1-way	58 000	60 (60)
Chiyoda	1 900	CC	S	2/2	1-way	40 000	40,50,60 ³ (40)
Yaesu	1 400	CC	U	2/2	1-way	13 000	40 (40)
Tokyo-kou	1 325	I	U	2/3	1-way	76 000	80 (70)
Sakuragi-cho	339	CC	U	2/2	1-way	51 000	60 (50)
Kuko-kita	1 353	CC	U	2/3	1-way	27 000	80 (80)
Tamagawa	2 170	I	U	2/3	1-way	26 000	80 (80)
Kawasaki-koro	1 954	I	U	2/3	1-way	28 000	80 (80)
<u>Japan Highway</u>							
Kanmon	3 461	M	U	1/2	2-way	33 000	40 (40)
Enasan (up)	8 649	M	M	1/2	1-way	13 000	80 (70)
Enasan (down)	8 649	M	M	1/2	1-way	13 000	80 (70)
Kan-etsu (up)	11 055	M	M	1/2	1-way	10 000	80 (70)
Kan-etsu (down)	10 926	M	M	1/2	1-way	10 000	80 (70)
Higo	6 340	M	M	1/2	2-way	23 000	80 (60)
Meito	185	CC	U	2/2	1-way	19 000	60 (60)
Moriyama	230	CC	U	2/2	1-way	19 000	60 (60)
Sumiyokegawa	55	CC	U	2/2	1-way	24 000	60 (60)
Shirasawagawa	65	CC	U	2/2	1-way	23 000	60 (60)
Kakutoh	6 255	M	M	1/2	2-way	20 000	80 (70)
<u>Aichi Prefecture</u>							
Kinu-ura	986	I	U	1/2	2-way	6 000	70 (40)
<u>Kobe City</u>							
Shin-Kobe	6 910	M	M	2/2	1-way	10 000	60 (60)
Daini-Shin-Kobe	7 175	M	M	2/2	1-way	10 000	60 (60)
<u>Kawasaki City</u>							
Kawasaki-kou-kaitei	1 160	I	U	2/2	1-way	14 000	80 (50)
Total	65 142	-	-	-	-	578 000	-

(1): Construction type

CC : Cut and cover
I : Immersed
M : Mountain

(2): Location

M : Mountain
S : Shoreline
U : Underwater

(3): The Chiyoda tunnel is a group of three tunnels. Each design speed is different.

3.5.2 Current rules and regulations

Japan has no general rules applying to the transport of dangerous goods through all the tunnels in the country. However, specific rules restricting such transport exist for underwater (or similar) tunnels, tunnels under water level, and tunnels longer than 5000 m (defined by the Ministry of Construction). This is because an accident such as an explosion of hazardous materials inside an underwater tunnel or waterside tunnel under water level, would inflict irreparable damage to the structure of the tunnel. Furthermore, if an explosion of hazardous materials should occur in an

extremely long tunnel, the longer the tunnel is the more difficult it would be to evacuate the tunnel and carry out rescue operations. Tunnels with a maximum length of 5km were considered to guarantee that it would always be possible to perform an acceptable rescue operation.

In the following, selected articles from the Japanese “Road Law” are presented, describing different aspects related to how road administrators handle the transport of dangerous goods through the tunnels, i.e. prohibiting or restricting this type of transport and notification of the actual situation at each tunnel.

3.5.2.1 Road Law, general

Article 46-3

A road administrator (or operator) shall, in order to preserve the structure of an underwater (or similar) tunnel or to prevent danger to traffic, be in a position to prohibit or to restrict the use of the tunnel by motor vehicles carrying explosive or flammable material or other hazardous materials as given by the Cabinet Order.

3.5.2.2 Road Law, Enforcement Order

The following articles 19-12, 19-13, 19-14, and 19-15 relating to underwater tunnels are found in the “Enforcement Order” of the Road Law.

Article 19-12 (Prohibition of the passage of motor vehicles)

A road administrator shall be in a position to prohibit the passage through an underwater tunnel of motor vehicles carrying the following types of hazardous materials:

- 1) Explosives [as defined in Article 2 of the “Explosives Control Act Law” (No. 149 of 1950)], comprising:
 - mercury fulminate, lead azide, other priming powders
 - nitro-glycerine, nitro-glycol, other nitric esters used as explosives
 - fireworks (not toy fireworks)
- 2) Copper acetylide, diazomethane, and other products with explosive properties
- 3) Toxicants and deleterious substances (as defined in Article 2 of the “Toxicants and Deleterious Substances Control Act Law” (No. 303 of 1950), §’s 1 and 2, respectively), comprising:
 - hydrogen cyanide
 - cyanogen chloride
 - tetraalkyl lead
 - phosgene
 - chloropicrin
- 4) Thiphosgene, and other products with toxicity equal to or greater than the defined toxicants
- 5) Additional materials
 - hazardous materials defined in Article 2, § 7 of the “Fire Services Law” (No. 186 of 1948)

- acetylene chloride, disilane, or other products with explosive properties equal to or greater than the preceding ones when acted upon by water or air

Article 19-13 (Restrictions on the passage of motor vehicles)

A road administrator shall be in a position to restrict the carriage of the hazardous materials given below through an underwater tunnel, when performed by motor vehicles belonging to categories designated by the administrator, and satisfying necessary conditions defined by the administrator (see Article 19-14 below) with regard to:

- the containers holding the hazardous materials
- the way the material is placed inside the containers
- the outside packing
- the number of containers carried on each vehicle
- the way the containers are loaded on the vehicle

Furthermore, the administrator is also in the position of limiting the time periods for these vehicles.

The following categories of materials are restricted:

- 1) Explosives (defined in Art. 19-12)
- 2) High pressure gas as defined in Article 2 of the High Pressure Gas Control Law (No. 204 of 1951)
- 3) Toxicants and deleterious substances (defined in Art. 19-12)
- 4) chloroacetophenone, monochloroacetone, and other products with toxicity equal to or greater than the defined toxicants and deleterious substances
- 5) hazardous materials defined as “Category 4” in Article 2, § 7 of the “Fire Services Law” (No. 186 of 1948)
- 6) Silicon tetrachloride, phosphorus oxychloride, and other products with corrosive properties equal or greater than the two former materials

In addition, the items 2 and 5 given in Article 19-12 above are also included here.

Article 19-14

With reference to the above-mentioned article, a road administrator shall establish conditions related to (i) categories of vehicles, (ii) containers and packaging, (iii) number of containers, (iv) way of loading and (v) the time period allowed for passage.

- (i): The vehicle shall be constructed so that even when carrying dangerous goods, there should be no possibility of vibration, shock, exhaust, etc., inducing any activity of the hazardous materials.
- (ii): The container and packaging shall be such that there is no possibility of any action of the materials occurring within the container/packaging, nor any possibility of the material leaking out of the container/packaging.
- (iii): The quantity loaded on a single vehicle shall be such that there is little possibility that the action of all the material could pose any threat to the structure of the tunnel or to the

safety of the traffic within the tunnel.

- (iv): The loading method shall be such that there is no possibility of the materials being subjected to friction, shaking, impact, falling or overturning.
- (v): The time periods when such transport is permitted shall not be periods when (as a consequence of traffic conditions) there is a high probability of collisions between vehicles.

Article 19-15 (public notice of the prohibition/restriction of passage of vehicles)

When a road administrator intends to prohibit or restrict passage of vehicles in a tunnel in accordance with the provisions of Articles 19-12/13, he shall issue a public notice of this fact in accordance with the order of the Ministry of Construction.

3.5.2.3 Road Law, Enforcement Regulations

Article 4-10 below addresses tunnels similar to underwater tunnels and is found in the “Enforcement Regulations” of the Road Law.

Article 4-10

A public notice of the prohibition/restriction of the passage of motor vehicles carrying dangerous substances in accordance with the provisions of Article 19-15 above shall be prepared and published in an official gazette containing the following items:

- 1): The name and location of the tunnel where the transport of hazardous materials is prohibited or restricted.
- 2): If transport of hazardous materials through the tunnel is prohibited, the names of the materials in question should be listed.
- 3): If transport of hazardous materials through the tunnel is restricted, the following information should be given:
 - names of materials in question
 - categories of vehicles which are permitted to carry the materials in question
 - essential conditions regarding containers and packaging, amount loaded on each vehicle, and loading method
 - the time period for which passage is allowed (if applicable)

3.5.3 Decision process

The decisions on the type of restrictions that should be introduced for the transport of dangerous goods (if any) concerning specific tunnels, are comprehensive judgements reached in the light of the opinions of scholars and other experts. Quantitative judgements reached through analysis are not used.

3.5.4 Enforcement

Signs indicating restrictions on the transport of dangerous goods are posted at the entrances to expressways and at the portals of restricted tunnels to alert drivers to the restrictions.

Furthermore, road management personnel conduct patrols to enforce the restrictions, and police and fire service officers and officials of other concerned organisations work co-operatively to enforce the restrictions at the expressways entrances and at the portals of restricted tunnels.

3.5.5 Problems posed by the existing rules and regulations

The following problems with enforcement, decision, operation, etc., induced by the current regulations are identified:

- Goods whose transport is prohibited or restricted do not conform to risk evaluations stipulated in the UN "Recommendations on Transport of Dangerous Goods", etc.
- The soaring number and increasing complexity of products manufactured by the chemical industry make it more difficult to decide if a material is (or is not) covered by the restrictions. This increases the time required for the tasks of advising chemical makers and enforcing regulations.
- It is difficult to tell if a truck is (or is not) carrying hazardous materials simply from its external appearance.

3.5.6 Plans for modifications and improvements of existing regulations

There are no such plans for the time being.

3.6 Norway

3.6.1 Norwegian tunnels

Information regarding Norwegian road tunnels are outlined in this section through the following table.

Table 3.12 Norwegian road tunnels subject to regulations

Name	Road no.	Location	Length (m)	AADT ²	No. of tubes	No. of lanes ⁴	Traffic
Oslo	EV18	Urban	1 800	74 000	2	6	1-way
Vaalereng	RV190	Urban	831	40 000	2	5	1-way
Hammersborg	RV162	Urban	225	16 500	2	4	1-way
Vaterland	RV162	Urban	337	16 500	1	2	2-way
Ellingsøey ¹	RV658	Subsea	3 520	2 700	1	3	2-way
Valderøey ¹	RV658	Subsea	4 222	2 250	1	3	2-way
Hvaler	RV108	Subsea	3 751	1 100 ³	1	2	2-way

1: These two tunnels forms the "Aalesund-Valderøey Link"

2: AADT = Annual Average Daily Traffic

3: The traffic during summer is heavier

4: Total number of lanes in the tunnel

The seven tunnels in the table above are owned by the Norwegian state. They add up to a total tube length of 17 317 m.

Information in the following two tables, Table 3.13 and Table 3.14, were obtained from the Norwegian Public Roads Administration in April 1997 (ref. /5/). Note that the tables comprise road tunnels on both national roads (677 tunnels) and county roads (142 tunnels). None of the county road tunnels has restrictions with respect to the transport of dangerous goods

Table 3.13 All Norwegian road tunnels

	Tunnels with 1 tube		Tunnels with ≥ 2 tubes	
	No. of tunnels	Total length (m)	No. of tunnels	Total length (m)
Tunnels <i>with</i> regulations	4	11 830	3	2 856
Tunnels <i>without</i> regulations	790	597 021	22	22 347

Table 3.14 Norwegian road tunnels per length class

Length class (metres)	No. of tunnels	No. of tubes	Σ tube length (in metres)
< 0 - 200>	288	295	30 061
[200 - 600>	242	253	91 626
[600 - 1 000>	108	112	85 009
[1 000 - 1 400>	58	59	70 363
[1 400 - 2 000>	42	43	71 069
[2 000 - 3 000>	40	41	102 116
[3 000 - ∞ >	41	43	210 275
Total	819	846	660 519

These 819 tunnels add up to a total length of 634 054 metres. Further it should be noted that nine of the tunnels are 6 000 metres and longer, the longest being 11 428 m.

3.6.2 Current rules and regulations

3.6.2.1 Basis

The development of rules and regulations for the transport of dangerous goods in Norwegian road tunnels is based on a global estimate of the risks arising from this transport. The availability of alternative routes and the risks associated with general traffic are also taken into account. General experience has normally been the basis for selecting safety measures, but risk assessment is coming into use for the design and implementation of technical, organisational, and emergency preparedness measures. In particular, a risk analysis has been carried out for the Oslo and Vaalereng tunnels, but current regulations for these two tunnels are not directly related to the conclusions of that analysis.

3.6.2.2 Enforcement

Enforcement is carried out by the police on a spot check basis. Experience has shown that infringements do not represent a problem; hence, the police have no plans to give this more attention in the future.

3.6.2.3 Problems posed by the existing regulations

The most important problem appears to be that some carriers, particular from foreign countries, are not familiar with the restrictions in the tunnels. Information about current restrictions is not systematically presented at border crossings. This is due to the fact that the current transport of dangerous goods is only slightly affected by the restrictions. Furthermore, hauliers doing this type of transport on a regular basis are familiar with the restrictions.

Moreover, the restrictions cause heavy vehicles to use streets and roads that are not prepared for this kind of traffic.

There is no signing or other information given at the tunnel entrances about the existing regulations in the tunnel.

3.6.3 Contents of regulations

In the following sub-sections, the current regulations for the tunnels in the Oslo area, the “Aalesund-Valderoey” tunnel link and the Hvaler tunnel, are outlined.

3.6.3.1 Tunnels in Oslo

This regulation comprises the Oslo, Vaalereng, Hammersborg and the Vaterland tunnels.

The transport of dangerous goods specified in a) to c) below is prohibited at the following hours and days of the week:

- Monday - Friday at 07:00 - 09:00
- Monday - Friday at 14:00 - 18:00

- a) Explosive substances and articles, ADR Class1, division 1.1, in quantities > 50 kg on a transport unit
- b) The following gases, ADR Class2, when carried in tanks or tank containers with a total capacity > 3 000 litres on a transport unit:
 - ammonia, chlorine, and sulphur dioxide of item3 (at)
 - flammable and chemically unstable gases classified under the letter(b), (bt), (c), and (ct) of the various items
- c) Flammable liquids, ADR Class3, classified under the letter (a) of the various items, when carried in tanks or tank containers with a total capacity > 3 000 litres on a transport unit

Note: * The regulation also applies to empty, uncleaned tanks.

* The Directorate of Public Roads may exempt from the regulation in special cases.

3.6.3.2 “Aalesund-Valderoey” tunnel link

The transport of dangerous goods specified in a) - c) below is prohibited on the RV between Aalesund and Valderoey every day of the week between 06:00 - 24:00.

- a) Flammable liquids of categoryA (flash point 23° C or less) in quantities > 3 000 litres on a transport unit
- b) Gases, compressed or liquefied, when the individual transport consists of >200 kg
- c) Explosive substances and articles, ADR Class1, division 1.1, in quantities > 25 kg on a transport unit

Note that the Chief County Roads Officer of Moere & Romsdal may exempt from the regulation in special cases.

3.6.3.3 The Hvaler tunnel

The transport of dangerous goods is prohibited when there are other vehicles in the tunnel. Transit must be arranged with the person in charge of the toll station. Exceptions are the transport of fuel oil, kerosene, and formic acid.

3.6.4 Plans for modifications and improvements of existing regulations

A general policy is envisaged of not imposing special restrictions on transport of dangerous goods, except in cases where probable significant gain in safety can be clearly demonstrated. The overall risk associated with transporting dangerous goods from point A to point B should be considered, and the possible adverse effects on the overall safety caused by the restrictions should be identified. It is further envisaged that the regulations should be of a uniform character, based on the current regulation for the Oslo tunnel given above.

3.7 Switzerland

3.7.1 Swiss road tunnels

As of 31 December 1995, there are 162 road tunnels on the national road network in Switzerland. In addition, there are several tunnels on the local cantonal road network. Further details of these 162 tunnels are given in Appendix B.

In Table 3.15 below, the tunnel length categorisation is given.

Table 3.15 Swiss National road tunnels per length class

Length class (metres)	No. of tunnels	No. of tubes	$\Sigma_{\text{tube length}}$ (in metres)
< 0 - 200>	46	60	7 471
[200 - 600>	68	107	40 441
[600 - 1000>	18	29	22 136
[1000 - 1400>	10	16	19 389
[1400 - 2000>	9	16	25 448
[2000 - 3000>	4	5	12 352
[3000 - ∞ >	7	10	63 998
Total	162	243	191 235

The 162 tunnels add up to a total length of 129 178 metres, with lengths ranging from 20m to 16 918 m (St. Gotthard tunnel). 81 tunnels are one-tube tunnels (total length 67 121 m) and 81 are two-tube tunnels (total length 62 057 m).

3.7.2 Current rules and regulations

There are general road traffic regulations specific to national and local “cantonal” road tunnels which are detailed in:

- (i) Road Traffic Regulation of 13 November 1962 (“RS 741.11”), article 45
- (ii) Federal law on Road Traffic of 19 December 1958

Furthermore, there are specific rules for transporting dangerous goods through road tunnels given in “Regulation of Road Transport of Dangerous Goods” (SDR) of 1 January 1997, Appendix 2

(Article 23) entitled “*Liste de tronçons de route pour lesquels sont prescrites des limitations de passage avec certaines marchandises dangereuses*”. This regulation is developed from the latest version of the ADR convention. Margin280 150 lists the types and corresponding quantities of substances which are fully authorised for transport through the tunnels, authorised with special restrictions, and totally prohibited. Margin280 100 of the article lists the tunnels which are subject to Margin 280 150.

Table 3.16 below is based on Margin280 100 and completed with additional tunnel information from other sources.

Table 3.16 Swiss road tunnels subjected to Margin 280 150 of the SDR

Tunnel name (road no ¹ ., distance, canton)	Length (m)	No. of tubes	AADT ³	Traffic
Seelisberg ² (N2 Stans-Flüelen, NW-UR)	9 280	2	18 742	2-way (each tube)
Costoni di Feud ² (N2 Col du St. Gotthard-Airolo, TI)	810	1	3 334	2-way
Kerenzerberg ² (N3 Wesen-Murg, GL)	5 760	1	24 170	2-way
St. Gotthard (N2 Göschenen-Airolo, UR-TI)	16 918	1	17 260	2-way
Rongellen II (N13 Thusis-San Bernardino, GR)	625	1	77 15?	2-way
Via Mala (N13 Thusis-San Bernardino, GR)	742	1	7 715	2-way
Bärenburg (N13 Thusis-San Bernardino, GR)	998	1	7 715	2-way
Rofla (N13 Thusis-San Bernardino, GR)	995	1	7 715	2-way
San Bernardino (N13 Thusis-Tessin, GR)	6 600	1	5 610	2-way
Great St. Bernard (RC Martigny-Aoste, VS, Switzerland-Italy)	N/A	N/A	1 521	N/A
Solis (RC Thusis-Tiefencastel, GR)	N/A	N/A	N/A	N/A
Alvaschein (RC Thusis-Tiefencastel, GR)	N/A	N/A	N/A	N/A
Landwasser (RC Tiefencastel-Davos, GR)	N/A	N/A	N/A	N/A
Mappo/Morettina (RC Bellinzona-Brissago, TI)	N/A	N/A	N/A	N/A

1: N = national road, RC = cantonal road

2: It is forbidden to transport the quantities of dangerous goods exceeding the ones indicated in the last column (entitled "Interdit en quantité supérieure à") of table 280 150 of the Swiss regulations on transport of dangerous goods (SDR) on the following days:

* Saturdays and Sundays

* Holidays mentioned in SR 741.11 "Rules for Road Traffic" (OCR), regulation of 13 November 1962 article 91, § 1

* Monday-Friday 17:00-07:00

3: AADT = Annual Average Daily Traffic

Margin 280 200 of the SDR addresses the procedure for authorisation of the transport of dangerous goods that is indicated in Margin280 150 in three paragraphs:

1. Authorisation of transport of substances exceeding the limits for free passage according to Margin 280 150 will be decided by the competent cantonal authorities. In these cases, it is mandatory to complete a specific form which is given in Margin280 250 and to submit it to the tunnel operators beforehand, and the decision will be based on this form. This

procedure is required for the transport through the following road tunnels: St. Gotthard, Great St. Bernard, San Bernadino, Rofla, Bärenburg, Via Mala, RongellenII, Solis, Alvaschein, Landwasser, and Mappo/Morettina. In addition, it is possible to complete the above-mentioned form when arriving at most of the above tunnels, except for the St. Gotthard and the Mappo/Morettina tunnels. The important addresses are given in a separate table in the SDR.

2. When the competent authorities have evaluated the safety of a given transport, authorisation will be given when the transit is kept under surveillance (escort, television) through the whole passage of the tunnel.
3. The driver of the vehicle must keep the form through the passage of the tunnel.

3.7.3 Decision process

If a canton wants to have one (or more) of their tunnels included in the list of tunnels given in margin 280 100, an application has to be submitted to the “Eidgenössischen Justiz-und Policedepartement - Chief of Police”, who will make the final decision based on:

- existing technical provisions/installations in the tunnel ensuring proper ventilation and drainage
- availability of escape routes

3.7.4 Enforcement

The responsibility of enforcing the current rules and regulations for the transport of dangerous goods in road tunnels remains with the Police in each canton. They are also responsible for proper signing of the current restrictions at each tunnel and of the possible diversion routes. Only spot checks are being performed to ensure that regulations are complied with.

Infringements/evasions are not considered to be a great problem, at least among national hauliers, since the current regulations are widely distributed to the cantons. No organised international distribution is planned and the availability of such information at the Swiss border is limited.

3.7.5 Problems with existing regulations

No information provided.

3.7.6 Plans for modifications and improvements of existing regulations

In the future, Quantitative Risk Assessments may be used as an important tool for decisions.

3.8 United Kingdom

3.8.1 UK tunnels

There are 31 road tunnels in the United Kingdom as of February 1997 for a total length of about 23 000 m. Restrictions on the transport of dangerous goods are given in ten of the tunnels (4 one-tube and 6 two-tube tunnels, total length of 14 300 m), while the remaining 21 have no restrictions (5 one-tube and 16 two-tube tunnels, total length of 8 700 m). The following two tables document the number of tunnels and tubes per length class and details on each of the tunnels.

Table 3.17 UK road tunnels per length class

Length class ¹ (metres)	No. of tunnels ²	No. of tubes	$\Sigma_{\text{tube length}}$ ³ (in metres)
< 0 - 200>	5	10	1 780
[200 - 600>	13	21	7 574
[600 - 1000>	5	9	6 245
[1000 - 1400>	3	6	7 204
[1400 - 2000>	3	4	6 000
[2000 - 3000>	1	2	4 966
[3000 - ∞ >	1	1	3 237
Total	31	53	37 006

- 1: The length class of a tunnel is determined by the length of its longest tube
- 2: Each tunnel structure is counted as 1 tunnel, irrespective of the number of tubes
- 3: For tunnels with ≥ 2 tubes, the sum of the tube lengths is counted

Table 3.18 UK road tunnels, details

Name	Location	Length (m)	AADT ¹	No. of tubes	No. of lanes ²	Road type ³	Owner	Regulations
Bell Common M25	Rural	450	46 500	2	6	T	The Crown	No restrictions
Blackwall, A102, London	Urban		66 000			NT	The Crown	By-laws
Tube 1		1 362		1	2			
Tube 2		1 174		1	2			
Cargo tunnel (Heathrow A.port)	Urban	885	-	1	2	NT	BAA	BAA
Clyde, Glasgow	Urban	760	38 000	2	4	NT	Local auth.	By-laws
Conwy, A55	Rural	1 090	15 000	2	4	NT	The Crown	No restrictions
Crindau, M4	Rural	362	50 250	2	4	M	The Crown	No restrictions
Cuilfail, A26, Lewes	Urban	420	-	1	2	NT	Local auth.	No restrictions
Dartford, A282	Urban		45 000			T	The Crown	Dangerous goods are conveyed
Tube 1		1 429		1	2			
Tube 2		1 436		1	2			
Fort Regent, Jersey	Rural	253	-	1	2	NT	State of Jersey	Unknown
Gibraltar Hill, A40, Monmouth	Rural	185	-	2	4	T	The Crown	No restrictions
Hanger Lane, A40, London	Urban	241	-	2	2	T	The Crown	No restrictions
Hatfield, A1(M)	Urban	1 150	63 000	2	6	T	The Crown	No restrictions

Name	Location	Length (m)	AADT ¹	No. of tubes	No. of lanes ²	Road type ³	Owner	Regulations
Heathrow A.port, Main access	Urban	628	67 700	2	2	NT	BAA	BAA
Holmesdale, M25	Urban	650	46 500	2	6	M	The Crown	No restrictions
Lancaster Circus, A34, Birmingham	Urban	197	-	2	4	NT	Local auth.	No restrictions
Manchester A.port, A538	Urban	400	-	2	4	NT	Manchester A.port auth.	Manchester A.port auth.
Matthew Murray, Leeds	Urban	160	-	2	4	NT	Local auth.	No restrictions
Mersey Kingsway, Liverpool	Urban	2 483	29 250	2	4	T	Local auth.	Dangerous goods are convoyed
Mersey Queensway, Liverpool	Urban	3 237	25 500	1	6	T	Local auth.	No vehicles over 7.5 tonnes, and no dangerous goods
Park Lane Underpass, London	Urban	306/314	-	2	4	NT	Local auth.	No restrictions
Penmaenbach, A55, Gwynedd	Urban		7 500			T	The Crown	No restrictions
Tube 1		642		1	2			
Tube 2		170		1	2			
Queensway, A38, Birmingham	Urban	548	-	2	4	NT	Local auth.	No restrictions
Rotherhithe, London	Urban	1 483	18 000	1	2	NT	Local auth.	By-laws
Saltash, A38	Urban	400	4 000	1	3	T	The Crown	No restrictions
St. Chads Circus, A38, Birmingham	Urban	192	-	2	4	NT	Local auth.	No restrictions
Strand Underpass		365	-	1	1	NT	Local auth.	No restrictions
Tyne, Newcastle	Urban	1 645	-	1	2	NT	Local auth.	Dangerous goods are convoyed
Victoria Av., A658, Leeds/Bradford A.port	Urban	237	-	2	4	NT	Local auth.	No restrictions
Well Hall Underpass, A2, Rochester Way	Urban	156	-	2	4	T	The Crown	No restrictions
Westgate, A58(M), Inner Ring Road, Leeds	Urban	367	-	2	4	T	The Crown	No restrictions
Woodpecker, A58(M), Inner Ring Road, Leeds	Urban	298	-	1	2	T	The Crown	No restrictions

1: AADT = Annual Average Daily Traffic

2: Total number of lanes in the tunnel

3:

M : Motorway

NT : Non-trunk road

T : Trunk road

An important source of information for the sections below is a paper of MrRodney Jones, General Manager of the Dartford River Crossing Ltd., “Transport of Dangerous Goods through the Dartford Tunnel”, presented at the École Nationale des Ponts et Chaussées, Paris, France, 15-16 Nov. 1993.

3.8.2 Current rules and regulations

The wide variety of road tunnel constructions in the United Kingdom has led to a number of different operational procedures being developed and implemented, both related to traffic control and transport of dangerous goods. Hence, no general rules or regulations are developed for the transport of dangerous goods in UK road tunnels. However, specific regulations are introduced for the major, sub-estuarial toll tunnels Dartford, Mersey and Tyne, and for the Blackwall, Rotherhithe and Clyde non-toll tunnels.

3.8.2.1 Toll tunnels

The Dartford tunnels (opened in 1963 and 1980, respectively) form part of the Dartford River Crossing which is the most easterly crossing of the River Thames, situated some 10km from central London. The road through the crossing is the A282 trunk road which joins the easterly sections of the M25 and connects the main routes to the Channel ports and Eurotunnel to the Midlands and North of England. The tunnel is operated by the private company Dartford River Crossing Limited.

The Mersey tunnels (Mersey Kingsway and Mersey Queensway) link the city of Liverpool with the Wirral peninsular. These tunnels are operated by the local Merseyside Passenger Transport Authority.

The Tyne tunnel carries the A19 to the east of Newcastle. The tunnel is operated by the local Wallsend - Tyne & Wear.

Although these tunnels are situated in different parts of the United Kingdom and controlled by separate operators, they are nevertheless similar in many respects and have comparable operating regimes. The three operators have a shared policy with regard to the transport of dangerous goods through their tunnels.

The restrictions for all three tunnels are given in the booklet “British Toll Tunnels - Dangerous Traffic - List of Restrictions; 8th Edition, July 1995” (ref. /6/). This document restricts products (from the UN classification) on the basis of their “Packing Group” and quantity. The toll tunnels retain the services of a consultant scientist (chemist) to advise on the restrictions applied to individual substances. The book is issued to petrochemical and haulage industries and police forces, fire brigades and similar organisations. Many types of tank transport are not permitted in these tunnels or are required to be escorted. Typical delays while waiting for escorts is 15 minutes. Additional tolls are not charged for dangerous goods movements.

In Appendix A of ref. /6/, additional regulations for the Mersey tunnels are given:

Vehicles conveying goods shown in this booklet as requiring to be escorted through the tunnels are excluded from the tunnels during the periods 8.15a.m. to 10.15 a.m. and 4.15 p.m. to 6.15 p.m. on Mondays to Fridays inclusive. Tank wagons conveying flammable liquids having a flash point less than 21°C and empty tank wagons which have contained such flammable liquids, are excluded from the Mersey tunnels except between the hours of 10 p.m. to 6 a.m. daily. Refrigerated vehicles whose refrigeration system is run under LPG and which have not more than 2 LPG cylinders of 40kg capacity each are permitted to pass through the Kingsway tunnel provided that the cylinders are shut off, the vehicles are escorted and the passage takes place in off peak hours.

3.8.2.2 Non-toll tunnels

To most of the non-toll tunnels there are no restrictions with respect to the transport of dangerous goods. However, restrictions are applied to the Blackwall, Rotherhithe and Clyde non-toll tunnels, and the actual restrictions are fully outlined and documented in so-called “By-laws” for each tunnel. These regulations are less detailed than to those for the toll tunnels. Regarding the Blackwall tunnel, the restrictions principally concern explosives, flammables and organic peroxides. In the Clyde tunnel, transport of the most dangerous goods is prohibited.

3.8.3 Decision process

The decision process for applying rules on the transport of dangerous goods is, in part, dependent on the body owning and operating the tunnel and on the type of tunnel. The owner/operator is free to determine the restriction, or not, of dangerous goods as it chooses. Part of the decision will depend on the age and type of tunnel construction, for example, whether facilities exist for conveying vehicles, and part on considerations other than safety, e.g. loss of toll revenue in the event of tunnel closure.

Assessments may be made on the basis of a detailed Quantified Risk Assessment or simply on the basis of perceived risk or commercial consideration. No overall policy guidelines are available.

3.8.4 Enforcement

The success of a policy ultimately depends upon rigorous enforcement of the current restrictions and the provision of an efficient operating regime that provides a level of service that is acceptable to users and does not therefore encourage evasion. This implies quite high costs that are compensated by toll charges or escort charges. The wide distribution of the booklet (ref./6/) has reduced problems of enforcement in the toll tunnels. However, some irregular users may not be familiar with the restrictions, and attempts to evade the regulation may also occur. It is therefore essential that the operating systems contain safeguards to ensure, as far as possible, that evaders are prevented from entering the tunnel.

In particular for the Dartford tunnels, the escort system has been refined over the years to reflect the substantial increase in traffic using the crossing and the number of dangerous goods vehicles in the flow. This policy has minimised the risks to the general traffic while at the same time allowing transport of dangerous materials.

3.8.5 Contents of a typical tunnel regulation

In this section, the main headlines of the current regulation for the Blackwall tunnel is given (ref. /9/). This is a subsea tunnel located on motorway A102 consisting of two tubes with respective lengths of 1 362 and 1 174 m with one-way traffic in each. The total AADT (Average Annual Daily Traffic) is 66000. Transport of dangerous goods is authorised with certain constraints. The main contents of the regulation are listed below.

Extract of the “Blackwall Tunnel By-laws 1968”:

* *Traffic management*

- Minimum speed is 16km/h (item 2);
- No person shall drive into the tunnel any vehicle which is not provided with sufficient petrol or power to ensure that it maintains the minimum speed (item3);

- If vehicle has to stop in the tunnel, engine should be turned off (item 4);
- Refuelling of any vehicle is prohibited (item 5);
- Repairs to any vehicle are prohibited except when (item 6):
 - permission is given by a police officer
 - repairs is done to prevent danger from fire or explosion
 - changing tyre/wheel

*** Carriage of dangerous substances (item 8)**

No person shall take into the tunnel:

- any loaded firearm or any explosive within the meaning of the Explosives Act 1875;
- any empty tank wagon if its immediately preceding load included an inflammable gas or liquid giving off an inflammable vapour at temperatures $< 130^{\circ}\text{F}$;
- any cylinder containing acetylene;
- any spontaneously inflammable substance;
- any organic peroxide.

Furthermore, Table 3.19 below specifies under which conditions the substances in classes A through E are allowed through the tunnel, provided that:

- no such article/substance is carried on the tailboard, sideboard or loading platform of a vehicle;
- the package or vessel containing any such article/substance is securely closed and the outside case or receptacle enclosing such article/substance is plainly marked to show the nature of its contents.

Table 3.19 Dangerous substances: class and conditions

Substance class	Special conditions
A <i>[substances having flash point $< 73^{\circ}\text{F}$]</i>	Containers of ≤ 1 kg properly packed and protected in packages containing ≤ 30 kg each
B <i>[substances having flash point $< 130^{\circ}\text{F}$, excepting those in Class A]</i>	Containers of ≤ 2 kg properly packed and protected in packages containing ≤ 30 kg each, except that there shall be no restriction between the hours of midnight and 5 a.m.
C <i>[(a) liquefied refrigerated gases, (b) cylinders and containers under pressure]</i>	The load is to comprise only inert gases and net load ≤ 10 kg in containers of a capacity ≤ 2 kg
D <i>[(a) substances excepting those of classes A, B and C which give off inflammable gases when exposed to air or water, (b) substances excepting those of classes A, B and C which, when exposed to air or water, give off toxic gases or vapours which are likely to be dangerous under the circumstances of the tunnel (c) chlorinated hydrocarbons]</i>	(a) & (b): Net load \leq kg in separately packed containers ≤ 1 kg (c): Properly packed and protected in Winchester quarts or containers of similar construction and no larger capacity
E <i>[concentrated acids excepting those acids classified under class D]</i>	Properly packed and protected in Winchester quarts or containers of similar construction and no larger capacity up to a total maximum load of 10 Winchester quarts or 10 containers of similar construction and no larger capacity

3.8.6 Problems with existing regulations

Since there is no consistent UK policy with regard to restrictions on the transport of dangerous goods through tunnels, this may lead to confusion for hauliers who do not regularly use the tunnels having restrictions. Another important issue is the problem of accurate signing. The fact that the current restrictions vary considerably among the tunnels causes problems for the drivers carrying dangerous goods, since it is difficult to be aware of the restrictions for the tunnel. This problem would to a large degree be solved by accurately signing the tunnel restrictions before each tunnel entrance, but no standard ways of doing this exists at the present time.

3.8.7 Plans for modifications and improvements of existing regulations and policies

Reports and articles have been prepared to assist with the process of deriving a uniform policy for the transport of dangerous goods through UK road tunnels, addressing use of QRA techniques, introduction of special safety provisions, etc. An important reference document in this matter is a report prepared by W.S. Atkins for the UK Department of Transport in July 1993 “The Transport of Dangerous Goods through Road Tunnels in the United Kingdom”(ref. /7/). The report proposes a method for assessing whether certain classes of goods should be accepted for transport through road tunnels, having regard for the accepted classification of such materials and the relevant parameters/attributes of the tunnels (e.g. traffic volume, mix, and speed, tunnel length, alignment, and cross section, available incident detection systems, presence and manning of a tunnel operations centre, etc.).

3.8.7.1 Decisions

When considering the nature of possible restrictions to be placed on the transport of dangerous goods through a tunnel, the consequences of those restrictions must be fully evaluated. If a vehicle is prevented from travelling through a tunnel it will have to re-route using the all-purpose road network. This will introduce other risks which must be taken into account.

3.8.7.2 Safety provisions

In tunnels with free access, effective administration of restrictions is difficult as the levels of traffic with dangerous goods rise. In such circumstances, there are several means to ensure safe passage of dangerous materials where the consequences of an accident are unacceptable due to the density of the traffic or the time of day. One may be the convoy / escort arrangement at Dartford, and another may be continuous speed limit control with displays on a roadside panel to warn the driver. Furthermore, modern surveillance systems could be employed to select tankers carrying dangerous goods for a convoy. A camera by the roadside or on a gantry that is linked to a database and a display reads the orange dangerous substances label on the vehicle. If the cargo is one that needs to be escorted, the appropriate message could warn the driver to stop at the convoy assembly point for safe passage through the tunnel.

Fixed overhead signs are being used on the approach to the Channel tunnel terminal to separate all vehicles bearing an orange plate from the general heavy goods vehicle traffic.

3.9 State of California, United States

3.9.1 State highway system tunnels

The following table is obtained from the “Structures Maintenance System - TU4”. If the table comprises information on 59 tunnels (out of 60) on the State highway system carrying either mainline highway or ramp connectors, adding up to a total length of about 15km. Tunnel structures under the highways are not included in the table.

Table 3.20 Road tunnels on the state highway system, California

Tunnel name	Area/ location	Length (m)	AADT	No.of tubes	No of lanes	Bore type
Collier	Rural	575	2 700	1	2	Concrete Arch.
Grizzly Dome	Rural	119	1 800	1	2	Bored
Elephant Butte	Rural	362	1 800	1	2	Bored
Route 271	Rural	55	400	1	2	RC box girder
Arch Rock	Rural	80	1 700	1	2	Bored
Donner CR UP	Rural	23	17 200	1	2	Concrete Arch.
SR 37 Off-ramp	Urban	58	70 000	1	2	Concrete Arch.
Waldo (bore 1)	Urban	305	55 650	1	2	Concrete Arch.
Waldo (bore 2)	Urban	305	55 650	1	4	Concrete Arch.
Caldecott (bore 2)	Urban	1 100	150 300	1	2	Concrete Arch.
Caldecott (bore 1-1)	Urban	1 027	75 150	1	2	Concrete Arch.
Caldecott (bore 1-2)	Urban	1 102	75 150	1	2	Concrete Arch.
Webster Street tube	Urban	1 021	30 000	1	2	Concrete pipe (underwater)
Posey tube	Urban	1 081	30 000	1	2	Concrete pipe (underwater)
N580-San Joaquin Av. Off.	Urban	79	6 200	1	2	RC box girder
Yerba Buena	Urban	165	204 900	1	10 ¹	Concrete Arch. (2-level)
Presido	Urban	396	67 000	1	4	Concrete Arch.
Branch East UC	Urban	144	151 700	1	2	RC box girder
Rte 280	Urban	219	102 450	1	2	RC box girder
S. Connector UC	Urban	274	11 000	1	2	RC box girder
N17-N85 Connector ramp	Urban	91	0 ²	1	2	RC box girder
S17-S85 Connector ramp	Urban	87	10 001	1	2	RC box girder
W58-N99 Connector ramp	Urban	73	12 500	1	2	RC box girder
Gaviota Gorge	Rural	128	10 650	1	2	Concrete Arch.
South Matilja	Rural	62	900	1	2	Steel arch.
Middle Matilja	Rural	40	900	1	2	Concrete Arch.
N. Matilja	Rural	52	900	1	2	Steel arch.
N101-N1 Connector ramp	Urban	110	2 200	1	1	Concrete slab
Route 1	Urban	122	56 700	1	4	Concrete Arch.
Figuroa St. (1)	Urban	230	85 200	1	4	Concrete Arch.
Figuroa St. (2)	Urban	141	85 200	1	4	Concrete Arch.
Figuroa St. (3)	Urban	40	85 200	1	4	Concrete Arch.
Figuroa St. (4)	Urban	123	85 200	1	4	Concrete Arch.
Route 101 NB	Urban	73	64 500	1	2	Concrete slab

Tunnel name	Area/ location	Length (m)	AADT	No.of tubes	No of lanes	Bore type
E2-N5 & W2-S5 Connector ramps	Urban	149	51 000	1	4	Concrete slab
International Airport OC	Urban	582	63 000	2	6	Concrete slab
Angeles Crest #1	Rural	196	300	1	2	Concrete Arch.
Angeles Crest #2	Rural	145	300	1	2	Concrete Arch.
Stewart St. on-ramp UC	Urban	65	3 100	1	1	Concrete slab
Route 405 NB	Urban	132	97 600	1	3	RC box girder
E. Connector UC	Urban	72	31 500	1	2	Concrete slab
W. Connector UC	Urban	66	222 000	1	2	Concrete slab
Long Beach Airport OC	Urban	307	38 400	2	6	Concrete slab
E60-N57 Connector ramp	Urban	171	134 400	1	3	RC box girder
WB134-WB2 Connect.ramp	Urban	112	172 100	1	2	RC box girder
Sbnd. I5 Truck rte.	Urban	166	136 000	1	2	RC box girder
Sbnd. I5 Truck rte.	Urban	161	195 400	1	2	RC box girder
Route 210	Urban	199	100 900	2	11 ³	RC box girder
E2-W210 Connector ramp	Urban	123	27 400	1	3	RC box girder
S405-Devonshire St. Offrp.	Urban	75	4 203	1	1	RC box girder
Ebnd. 210 Direct Conn.	Urban	229	244 800	1	2	RC box girder
Conn. WB I210-SBSR7	Urban	171	106 700	1	3	RC box girder
Outer N. Conn. UC	Urban	173	106 700	1	2	RC box girder
E105-S405 Connector ramp	Urban	113	7 000	1	1	RC box girder
E105-N405 Connector ramp	Urban	411	3 000	1	2	RC box girder
W105-S405 Connector ramp	Urban	543	7 200	1	2	RC box girder
E22-N405 Connector ramp	Urban	65	1 680	1	1	Concrete slab
S605-S405 Connector ramp	Urban	116	15 000	1	2	RC box girder
Centre City Pkwy-S15 rmp.	Urban	168	11 500	1	2	RC box girder

- 1: 5 lanes in each level
 2: The structure this connects to is not completed
 3: 5+6 lanes

The only tunnel with regulations regarding transport of dangerous goods is the Caldecott tunnel.

In Table 3.21 below, the 60 tunnels on the state highway system are distributed according to length and area/location.

Table 3.21 Road tunnels on the state highway system, California, per length class

Length class (metres)	No. of tunnels in urban areas	No. of tunnels in rural areas	Total
< 0 - 200>	9	33	42
[200 - 600>	2	11	13
[600 - 1 000>	-	-	-
[1 000 - 1 400>	-	5	5
Total	11	49	60

3.9.2 Current rules and regulations

The only tunnel which has a state law regulation on the transport of dangerous goods, is the Caldecott tunnel. However, there are other tunnels in the state which are posted or regulated by ordinances (laws) of other government bodies, such as county or district.

These regulations, in some instances, impose restrictions on the routing of transport of hazardous materials for highway structures as bridges, subways, viaducts, tubes, and tunnels. All such regulations within local or state statutes require that signs giving notice of any restrictions be posted on any approach to the highway structure.

3.9.3 Decision process

The federal government requires states to evaluate risk before designating or closing roads to the transport of hazardous materials.

When evaluating and designating routes for transport, or for closure of routes to the transport of hazardous materials, the **California Highway Patrol (CHP)** utilises a risk analysis computer-modelling programme called HazTrans, developed by Abkowitz & Associates (AAI) from Nashville, Tennessee. The programme is used to rank hazards, calculate exposures, identify operations requiring priority risk management attention and assess the risk reduction potential of alternative actions. The programme includes an integrated system of databases, maps, analysis modules and management reporting which helps solve the most complex risk analysis situations. It utilises the accident rate, travel times, population and potential for release from an accident in evaluating risk to the population from transport of hazardous materials. The output from the programme may be applied to identify an (eventual) appreciable reduction in risk using the alternative route.

3.9.4 Contents of the Caldecott tunnel regulation and the preceding decision process

In this section, the restrictions for the Caldecott tunnel are outlined [ref. Section 31301, Chapter 5, Article 1, of the “California Vehicle Code” (1990), CVC]. This tunnel is located on State Highway, Route 24, near the Alameda-Contra Costa County boundary, connecting Oakland with Contra Costa County in the East Bay area. The tunnel consists of three, 2-lane bores with lengths ranging from 1027 to 1 102 metres. The initial bore of the tunnel is really two bores with common portals, each with AADT = 75 150.

Later a parallel bore was constructed (AADT = 150 300), and from this time one side of the original is used as reversible lanes for rush hour traffic.

3.9.4.1 Background

The development of the regulations for the Caldecott tunnel was triggered by the accident of 7 April 1982. In this accident, a gasoline truck, carrying a full load in the north bore of the tunnel, caught fire as a result of being side-swiped by a speeding bus that was trying to avoid a parked automobile. The tank shell breached from the forces of the collision. Almost all of the 33 308 l (8 800 gallons) of gasoline in the tanker burned. Seven lives were lost and many were injured. The tunnel sustained extensive damage.

On 3 May 1983, the National Transportation Safety Board (NTSB) asked the California Department of Transportation (Caltrans) to ban the movement of hazardous materials through vehicular tunnels where the relative risks of the tunnel route are higher than alternate routes. The

incident caught the attention of local and state governments and led to legislative actions. The California Legislature enacted statutes that severely limited the permitted time of day for the passage of flammable liquid cargoes through the Caldecott tunnel. Also, they granted Caltrans the authority to regulate when tank vehicles may travel through tunnels on state highways. This legislation also gave the CHP the authority to prohibit or restrict the movement of hazardous materials through tunnels after consultation with Caltrans. Funds then became available for Caltrans to initiate and administer a consultant study to compare the relative risks of transporting flammable liquid cargoes through State highway tunnels, versus the risks of using alternative state highway route(s) on 35 specific tunnels using Quantitative Risk Assessment (QRA) methods and the Decision Support Model (DSM). The study was completed by Arthur D. Little Inc. in September 1991.

The focus of the study was to determine if those tunnels pose a higher risk to public safety than their corresponding alternative routes. To complete this study Caltrans worked in conjunction with the CHP using HazTrans software (ref. section 3.9.3 above).

3.9.4.2 The regulation

Chapter 5, article 1, section 31301 (effective 20 September 1982) of the CVC addresses the restrictions on transport of hazardous materials in the Caldecott tunnel:

- *No person shall transport any explosive substance, flammable liquid, liquefied petroleum gas or poisonous gas in tank truck, trailer, or semi-trailer through the tunnel at any time other than between the hours of 3 a.m. to 5 a.m. [subdivision (a)];*
- *The Department of Transportation may, in compliance with the requirements of Article 1 of Division 11, determine and declare a reduced speed limit, lower than the maximum speed of 55 miles per hour (88 km/h), found most appropriate for traffic safety between the hours of 3 a.m. to 5 a.m. [subdivision (b)];*
- *Nothing in this section shall be construed as a limitation or restriction on the power of the Dept. of Transportation, conferred by any other provision of law, to adopt regulations with regard to the movement of vehicles, including, but not limited to, tank truck vehicles transporting any cargo specified under subdivision (a) through the tunnel. If, pursuant to any such other law, the Dept. of Transportation adopts or amends regulations after the effective date of this section, which adopted or amended regulations governing the movement of vehicles subject to subdivision (a), then on the operative date of those regulations, this section shall no longer be operative [subdivision (c)].*

3.9.5 Enforcement

The CVC section 31201 is an authoritative section, not punitive, and is not cited directly. Hence, a haulier in violation of that section could be cited with failure to obey regulatory signs (posted before the tunnel) or for being off a designated route.

The transport of Hazardous Materials in California is governed not only by the CVC but also by the regulations that are adopted pursuant to the VC and adopted in Title 13, California Code of Regulation (13 CCR). California adopts, by reference, most of the federal regulations regarding the transport of hazardous material (Title 49, Code of Federal Regulations). In addition, California requires transporters of commodities that require placards to obtain a Hazardous Material Transporter licence from the CHP. Enforcement of the hazardous materials regulations takes place through the use of fixed inspection facilities, mobile commercial enforcement officers,

and a programme that inspects truck terminal operations within the state. Commercial drivers who want to transport hazardous materials are required to pass a test in order to obtain a driver's license endorsement for the transport of hazardous materials.

The CHP provides copies of regulations pertinent to the transport of hazardous materials to anyone who requests them.

In addition to the general hazardous materials statute and regulations, California has adopted specific regulations and prohibitions for the transport of certain commodities. Specifically, transport of explosives (Division 1.1, 1.2, and 1.3), bulk quantity shipments of materials that are poisonous by inhalation, and Highway Route Controlled Quantity Shipments of Radioactive Materials must stay on designated routes for through transport. These materials may leave a designated route in order to make a local pick up or delivery.

3.9.6 Problems with existing regulations

No information provided.

3.9.7 Plans for modifications and improvements of existing regulations

There are no plans that Caltrans is aware of, to modify the existing laws and regulations, since they appear to be working satisfactorily.

4. SUMMARY OF INFORMATION RECEIVED FOR TASK 2

Mission 2 also wanted to touch upon aspects related to Task 2 (see section 2.1 above): development of QRA (Quantitative Risk Assessment) / DSM (Decision Support Model) methods and models. The following information was sought from the countries considered in this study:

- needs, requirements, and expectations (input/output data, software, etc.);
- general data available in the country to help develop QRA/DSM methods and models;
- potential users of the methods/models in the country.

Task 2 will be carried out during 1997/98 and the information will serve as a basis for generating a “user profile” for potential users.

This chapter summarises the information provided by the various countries.

Unfortunately, Austria, Germany, Japan, Switzerland and the US State of California did not (or were unable to) provide information on these subjects.

4.1 France

4.1.1 Needs, requirements and expectations

The following aspects have been identified:

- The elaboration of a simplified method which could be applied with a restricted amount of data would be very useful in the various steps taken in studies;
- In difficult cases, at the level of detailed studies, it will always be necessary to proceed with a detailed risk study, and the methodology should also be worked out;
- Defining the permissible risk levels would allow for resolving some cases;
- The study of public opinion sensitivity to the disaster effect would deserve some development;
- A facility with automatic identification of dangerous goods by means of “tagging” would be welcomed;
- The provisions and equipment to be planned for tunnels which permit the transport of dangerous goods should be detailed.

4.1.2 General data available to help developing QRA/DSM methods and models

All dangerous goods incidents and accidents on roads are recorded and published annually in France. However, to date, no incidents or accidents of this type have occurred in tunnels since these records have been kept.

A risk study, performed to compare a route with a 2 km two-way tunnel and tunnel-free route through the suburbs of a city, could be used during the development of the QRA model as one of the test cases.

4.1.3 Potential users of the methods/models

The simplified methods can be applied by the technical services of administrations in charge of a project. Regarding detailed studies, it will be necessary to subcontract these to specialised

consultants after tendering. Especially, it will be necessary to follow up the work performed for validity checks.

4.2 The Netherlands

4.2.1 Needs, requirements and expectations

For the QRA and DSM models it is important to make a distinction between:

- Internal safety (safety of the people who use the roads)
- External safety (safety of the people and the environment close to the roads)

Furthermore, it is important to make a distinction between:

- Accidents involving dangerous goods (people killed by the release of the goods); and
- Accidents not involving dangerous goods (people killed or injured, material damage)

The risk parameters that are best suited for internal safety are the expected value and the societal risk.

The risk parameters that are best suited for external safety are the individual risk and the societal risk. The societal risk curve can be calculated per kilometre and can be summed up for a whole route. In this way, it is possible to compare risks for alternative routes.

The internal and external safety is to be treated separately.

The QRA/DSM is to be used for several types of problems:

- Allowing or prohibiting some types of dangerous goods
- Comparing alternative routes or different designs for the tunnel
- Comparing several types of measures
- Comparing the risk parameters with the standard, which is different in each country. (Several countries do not have a standard.)

The QRA/DSM should have several levels of calculation:

1. Global level (hand calculation of risk by use of tables or simple computer programmes)
2. Detailed level (calculation of risk by advanced computer programmes)

4.2.2 General data available to help developing QRA/DSM methods and models

The following data are available:

- Accidents having occurred over several years are recorded in a database operated by the government
- TNO has a large database in which detailed information about several accidents is recorded.

4.2.3 Potential users of the methods/models

The methods and models will be used by:

- Policy makers or decision makers of the government (including road owners)
- Risk analysts working in government, consultants, engineering agencies
- The present DSM model of TNO

The way the QRA and DSM models work must be explained to government policy/decision makers. In particular, the DSM model must document how it arrives at the specific conclusions. Finally, it is important that the risk analysts are able to calculate the risks in a simple way.

4.3 Norway

4.3.1 Needs, requirements and expectations

The software should be used with the following types of input data:

- Tunnel [length, AADT for heavy goods vehicles, geometrical data (horizontal and vertical curvature, number of tubes, etc.)]
- Traffic (general or specific data on dangerous goods)
- Detours (general layout of roads for detours)
- Population (number of people living along detour routes)

4.3.2 General data available to help developing QRA/DSM methods and models

Norway has good statistics on all accidents resulting in injury to persons as well as on dangerous goods accidents. In February 1997, there was an ongoing study on traffic accidents in tunnels. Data from three QRA studies of tunnels in Norway were also available. In addition, a QRA model has been developed for dangerous goods transport with ferries.

4.3.3 Potential users of the methods/models

It is most likely that the model will be used by the Public Roads Administration and some relevant consulting companies.

4.4 United Kingdom

4.4.1 Needs, requirements and expectations

The UK needs, requirements and expectations are well described in the UK discussion document “Development of a QRA Model for Transport of Dangerous Goods through Road Tunnels” (ref. /8/). A summary of the document is given below:

The overall objective of the project is to develop a generic risk assessment model for deciding what dangerous substances can be transported safely through a road tunnel. Specific constraints on the scale of the project are proposed with respect to tunnel characteristics/types, road traffic through the tunnel, location of tunnel, and types of substances. Then it has to be decided which parameters to apply to the outputs. The parameters on which final decisions are made may be based upon:

- Safety: number of fatalities and serious injuries
- Commerce: tunnel damage, loss of revenue, costs of congestion and delays, insurance claims and compensation, availability of alternative routes
- Pollution: environmental damage, contamination

Furthermore, the model should be able to take into account control or mitigation features provided in some tunnels, e.g. separation of dangerous goods by distance and time (convoys), surveillance, ventilation, and drainage.

It is further recognised that while QRA will identify a level of risk, it is very time-consuming, resource intensive, and expensive. In addition, the problem remains as to what to do with the input, i.e. QRA will not provide all the answers.

4.4.2 General data available to help developing QRA/DSM methods and models

Reference is made to the Health and Safety Executive's Advisory Committee on Dangerous Substances report *Major Hazards aspects on the transport of dangerous substances* ISBN 0-11-8885676-6.

4.4.3 Potential users of the methods/models

The future users of the methods and models in the United Kingdom would be the Department of Transport, Welsh Office, Scottish Office, Health and Safety Executive, individual tunnel operators and tunnel insurers.

5. REFERENCES

- /1/ “ERS2-Transport of dangerous goods through road tunnels. Task 1 - Mission 1”. DNV Report No. 96-3566
- /2/ “Circulaire N° 76-44 du 12 mars 1976 relative à la réglementation de la circulation dans les tunnels des véhicules routiers transportant des matières dangereuses”
- /3/ “Circulaire N° 81-109 de décembre 1981 relative à la sécurité dans les tunnels routiers”
- /4/ “Arrêté du 11 décembre 1986 relatif à la réglementation de la circulation à l’intérieur du tunnel Chamoise sur l’autoroute A 40”
- /5/ Excel spreadsheet programs developed by the Norwegian Public Roads Administration, April 1997
- /6/ “British Toll Tunnels - Dangerous Traffic - List of Restrictions”. 8th Edition, July 1995”
- /7/ “The Transport of Dangerous Goods through Road Tunnels in the United Kingdom”. WS Atkins Consultants Limited, July 1993
- /8/ “Development of a QRA Model for Transport of Dangerous Goods through Road Tunnels”. UK discussion document.
- /9/ “Blackwall Tunnel - By-Laws 1968”. Greater London Council
- /10/ Verordnung des Österreichische Bundesministers für öffentliche Wirtschaft und Verkehr vom 17 Juni 1987 über die Beförderung gefährlicher Güter auf bestimmten Straßenstrecken (Straßentunnelverordnung), BGBl. Nr 270/1987 in der Fassung BGBl. Nr 22/1990
- /11/ Bundesgesetz vom 23 Feber 1979 über die Beförderung gefährlicher Güter auf der Straße und über eine Änderung des Kraftfahrzeuggesetzes 1967 und der Straßenverkehrsordnung 1960 (Gefahrgutbeförderungsgesetz-Straße - GGSt), BGBl. Nr 209/1979, idF BGBl. Nr 296/1987, BGBl. Nr 181/1988, BGBl. Nr 452/1992, BGBl. Nr 505/1994 und BGBl. Nr 430/1995.
- /12/ Bundesgesetz über die Beförderung gefährlicher Güter und über eine Änderung des Kraftfahrzeuggesetzes 1967 und der Straßenverkehrsordnung 1960 (Gefahrgutbeförderungsgesetz - GGBG). Draft.
- /13/ Council Directive 94/55/EC of 21 November 1994 on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road, OJ No. L 319, 12.12.1994, p.7.

- /14/ Bundesgesetz vom 6 Juli 1960, mit dem Vorschriften über die Straßenpolizei erlassen werden (Straßenverkehrsordnung 1960 - StVO 1960), BGBl. Nr 159/1960 in der Fassung BGBl. Nr 201/1996
- /15/ Verordnung über die innerstaatliche und gränzüberschreitende Beförderung gefährlicher Güter auf der Straße (Gefahrgutverordnung Straße – GGVS), 12 December 1996.
- /16/ Richtlinien für die Ausstattung und den Betrieb von Straßentunneln - RABT”, Bundesministerium für Verkehr StB 27/38.75.50/20 Va 94; Allgemeines Rundschreiben Straßenbau Nr. 18/1994.
- /17/ First International Conference on Safety in Road and Rail tunnels (SIRRT), Basel 23-25 November 1992, pp. 199-211

- o0o -

APPENDIX A

APPENDIX

A

FRENCH ROAD TUNNELS WITH LENGTH > 500 M

- o0o -

APPENDIX A

Table 1 presents general characteristics of 82 French road tunnels with length exceeding 500m. Below are given the various notations used in that table.

Location (column 3):

U : Urban areas
R : Rural areas

Traffic (column 4):

U : Uni-directional (one-way)
B : Bi-directional (two-way)

Type (column 12):

V : Horseshoe-shaped
R : Cut & cover (rectangular)
I : Submerged
C : Circular

Ventilation (column 13):

N : Natural
LA : Longitudinal
ST : Semi-transverse
TP : Partial transverse
T : Transverse

Lighting/illumination (column 14):

Y : Tunnel is illuminated. If the level of illumination is known, the Lux value is given (omitting the Y code in these cases)
N : Tunnel has no lighting
? : No information available

AADT (column 15):

AADT is the abbreviation of Annual Average Daily Traffic. The year for which the figure given is obtained is given in brackets after the AADT figure. A “?” is used if no information is available.

APPENDIX A

Name of tunnel (Town)	Road no.	Loca-tion	Traf-fic	No.of tubes	Tube no. 1			Tube no. 2			Type	Ventil-ation	Light-ing	AADT(year)
					No.of lanes	Length (m)	Year opened	No.of lanes	Length (m)	Year opened				
Mont Blanc	RN205	R	B	1	2	7 640	1965	-	-	-	TP	130	5 390 (93)	
Maurice Lemaire	RN159	R	B	1	2	6 872	76	-	-	-	TP	40	2 523 (91)	
Frejus	RN566	R	B	1	2	6 580	80	-	-	-	TP	50	3 078 (93)	
Puymorens	RN20	R	B	1	2	4 840	94	-	-	-	T	Y	1 200 (94)	
Roux	RD160	R	B	1	2	3 336	30	-	-	-	N	N	800 (87)	
Chamoise	A40	R	U	2	2	3 300	86	2	3 300	95	TP	Y	16 500 (93)	
Epine	A43	R	U	2	2	3 117	74	2	3 094	91	TP	120	23 027 (93)	
Foret de St. Germain	A14	U	U	2	2	2 810	96	2	2 810	96	LA	Y	?	
Defence-Epad 3 (Puteaux)	A14	U	U	2	3	2 750	96	3	2 750	96	TP	Y	?	
Prado-Carenage (Marseille)	V.C.	U	U	2	2	2 455	93	2	2 455	93	T	Y	24 698 (94)	
Tranchee Couverte de Nogent	A86	U	U	2	3	2 260	87	3	2 190	87	TP	Y	115 000 (92)	
Montets	RN506	R	U	1	1	1 882	85	-	-	-	N	40	?	
Fourviere (Lyon)	A6	U	U	2	2	1 853	71	2	1 836	71	C	100	100 115 (92)	
Defence-Epad 1 (Puteaux)	A14	U	U	1	4	1 850	84	-	-	-	R	Y	?	
Defence-Epad 2;doubling (Puteaux)	A14	U	U	1	4	1 850	93	-	-	-	ST	Y	?	
Aragnouet-Bielsa	RD173	R	B	1	2	1 766	76	-	-	-	N	N	676 (93)	
Croix Rousse	V.C.	U	B	1	4	1 753	52	-	-	-	T	100	78 440 (93)	
Bretelle de Monaco	A800	R	B	1	3	1 590	92	-	-	-	TP	90	22 136 (93)	
Foret de St. Germain	A14	U	U	2	2	1 550	96	2	1 550	96	R	LA	?	
La Grand-Mare (Rouen)	RN28	U	U	2	2	1 533	92	2	1 511	92	V	LA	30 000 (94)	
Siaix	RN90	R	B	1	3	1 500	90	-	-	-	V	ST	11 044 (91)	
Chat	RN504	R	B	1	2	1 488	31	-	-	-	V	LA	8 230 (91)	
Col de Tende	RN204	R	B	1	2	1 487	1882	-	-	-	V	LA	2 669 (91)	
Forum Central (Semah, Paris)	V.C.	U	U	1	2	1 470	79	-	-	-	R	TP	19 000 (83)	

Reference to part of this report which may lead to misinterpretation is not permissible.

APPENDIX A

Name of tunnel (Town)	Road no.	Loca-tion	Traf-fic	No.of tubes	Tube no. 1			Tube no. 2			Type	Ventil-ation	Light-ing	AADT(year)
					No.of lanes	Length (m)	Year opened	No.of lanes	Length (m)	Year opened				
Dullin	A43	R	U	2	2	1 460	1974	2	1 460	74	V	LA	120	20 087 (91)
Vuache	A40	R	U	2	2	1 430	82	2	1 390	82	V	LA	79	13 024 (92)
Lioran (Lavessiere)	RN122	R	B	1	2	1 414	1847	-	-	-	V	LA	Y	4 700 (93)
Ponserand	RN90	R	U	1	2	1 300	1989	-	-	-	V	LA	Y	8 020 (90)
St. Germain de Joux	A40	R	U	2	2	1 200	89	2	1 200	89	V	LA	Y	17 100 (93)
Hurtieres	A43	R	U	2	2	1 198	97	2	1 160	97	V	LA	Y	?
Rainier 3	RN7	U	U	1	2	1 180	94	-	-	-	V	LA	150	?
L'Arme	A8	R	U	2	2	1 112	89	3	1 105	79	V	LA	70	8 329 (92)
Las Planas	A8	R	U	2	3	1 108	76	2	1 072	83	V	LA	70	24 197 (92)
Cap Sicie	V.P.	R	B	1	1	1 100	93	-	-	-	V	N	Y	?
La Mescla 2	RN202	R	U	1	2	1 014	91	-	-	-	V	LA	Y	?
Les Chavants	RN205	R	U	1	2	1 000	90	-	-	-	V	LA	Y	8 200 (90)
Puech Mergou	RD172	R	B	1	2	963	18	-	-	-	V	N	Y	1 098 (84)
Aiguebelle	A43	R	U	2	2	921	97	2	898	97	V	LA	Y	?
Tranchee Remise de Verrou	A4	U	U	2	4	880	76	4	850	76	R	ST	Y	150 000 (92)
Les Monts (Chambery)	RN201	U	U	2	3	862	82	3	842	82	V	LA	150	50 000 (90)
Quai des Tuileries (Paris)	V.C.	U	U	1	2	861	67	-	-	-	R	TP	180	35 053 (87)
La Gatine (Angouleme)	V.C	U	B	1	2	859	80	-	-	-	R-V	LA	Y	12 530 (90)
Epad (Puteaux)	A14	U	U	1	3	850	84	-	-	-	R	TP	200	30 000 (87)
Pas de l'Escalette	A75	R	B	2	2	845	95	2	728	94	V	N	Y	?
St. Cloud (St. Cloud)	A13	U	U	2	4	832	45	3	909	76	V	LA	200	170 000 (93)
Ambroise Pare (Boulogne)	A13	U	U	2	3	828	74	3	828	74	R	ST	200	103 889 (82)
Front de Mer (Bastia)	RN193	U	B	1	2	822	83	-	-	-	V-R-I	ST	Y	32 000 (90)
La Coupiere	A8	R	U	2	2	814	70	2	803	70	V	N	70	22 196 (93)

Reference to part of this report which may lead to misinterpretation is not permissible.

APPENDIX A

Name of tunnel (Town)	Road no.	Loca-tion	Traf-fic	No.of tubes	Tube no. 1			Tube no. 2			Type	Ventil-ation	Light-ing	AADT(year)
					No.of lanes	Length (m)	Year opened	No.of lanes	Length (m)	Year opened				
Trou au Renard-Guy Moq	A86	U	U	2	2	800	1990	2	800	90	LA	Y	110 000 (92)	
Col de Rousset	RD518	R	B	1	2	769	79	-	-	-	N	30	1 135 (92)	
Grand Chambion	RN91	R	B	1	2	753	35	-	-	-	N	Y	2 600 (90)	
Castillon	RD2566	R	U	1	1	750	88	-	-	-	N	?	4 078 (90)	
Castillon 2	RD2566	R	U	1	1	750	92	-	-	-	N	Y	?	
FFF	A86	U	U	2	2	750	90	2	750	90	LA	Y	?	
Chatillon	A40	R	U	2	2	720	89	2	720	89	N	Y	16 518 (92)	
Rive Gauche du Paillon (Nice)	V.C.	U	U	1	2	676	83	-	-	-	LA	Y	14 500 (90)	
Nanterre	RN186	U	U	2	2	660	96	2	660	96	LA	Y	?	
Pte Pantin 1	V.C.	U	U	1	2	655	66	-	-	-	N	Y	?	
Cap Estel	RN98	R	B	1	2	620	93	-	-	-	N	Y	?	
Canta Galet	A8	R	U	2	2	615	83	3	515	76	LA	70	24 197 (92)	
Vieuxport (Marseille)	V.C.	U	U	2	2	602	67	2	597	67	ST	100	45 908 (90)	
Pessicart	A8	R	U	2	3	600	76	2	599	83	LA	70	21 497 (92)	
Voie de Desserte Int. (Courbevoie)	V.C.	U	U	1	2	600	83	-	-	-	TP	Y	?	
Voie de Desserte Int. (Puteaux)	V.C.	U	U	1	2	600	84	-	-	-	TP	Y	?	
Ardoisieres	RN91	R	B	1	2	590	1858	-	-	-	N	40	2 298 (90)	
Antony (Antony)	A86	U	B	1	4	590	94	-	-	-	N	Y	?	
Jenner (Le Havre)	V.C.	U	U	2	2	585	56	2	585	56	V	40	50 000 (90)	
Parc des Princes (Paris)	V.C.	U	U	2	4	580	71	4	580	71	ST	160	226 400 (87)	
Lac Superieur (Paris)	V.C.	U	U	2	4	580	71	4	574	71	ST	160	226 400 (87)	
Castellar	A8	R	U	2	2	575	70	2	568	70	N	70	14 120 (92)	
En Raxat	RN114	R	B	1	2	550	94	-	-	-	N	Y	?	
Orly 1 (Orly)	RN7	U	B	1	4	550	59	-	-	-	ST	120	62 700 (90)	

Reference to part of this report which may lead to misinterpretation is not permissible.

APPENDIX A

Name of tunnel (Town)	Road no.	Location	Traffic	No. of tubes	Tube no. 1			Tube no. 2			Type	Ventilation	Lighting	AADT(year)
					No. of lanes	Length (m)	Year opened	No. of lanes	Length (m)	Year opened				
La Baume	A51	U	U	2	546	1990	2	465	90	V	N	Y	7 034 (92)	
Roissy en France 4 (Roissy e F.)	A1	U	U	2	536	70	3	536	70	R	N	Y	79 562 (90)	
Roissy en France 4 (Roissy e F.)	RD212	U	B	1	536	70	3	-	-	R	N	Y	?	
Malleval	RD22	R	B	1	530	-	2	-	-	V	N	?	?	
Reine Bl.-Grandchamps(Kremlin B.)	A6B	U	B	1	530	70	4	-	-	R	ST	150	100 000 (82)	
Parpaillon	RD39T	R	B	1	512	1890	1	-	-	V	N	?	?	
Dame Jouette (Marseille)	V.C.	U	U	1	508	94	2	-	-	R	LA	Y	?	
Mortier	RD218	R	B	1	502	68	2	-	-	V	N	Y	200 (86)	
St. Pancrasse (St. Pancrasse)	RD30	R	B	1	501	54	2	-	-	V	N	Y	1 800 (86)	
Rocher Chabrand	RD3	R	B	1	500	-	2	-	-	V	N	?	?	
Total					113 106				42 690					

Reference to part of this report which may lead to misinterpretation is not permissible.

APPENDIX A

Table 2 given on the following pages presents information relative to the transport of dangerous goods through 82 French road tunnels with length exceeding 500m. Below are given the various notations used in that table.

Conditions (column 2):

For each tunnel the conditions for the transport of dangerous goods through the tunnel are given:

- P:** Prohibited (banned). [All transport of dangerous goods that are subject to signing are prohibited in the tunnel without exception] .
- AP:** Partial authorisation. [This is valid for the tunnels in Paris-75 and in the Paris region (i.e. départements of Hauts de Seine - 92, Seine Saint Denis - 93, and Seine et Marne - 94) where transport of dangerous goods is authorised except for inflammable liquids, liquefied gas combustible or not, and all explosive materials].
- AR:** Authorisation given, but with certain specific measures/provisions. [All transport of dangerous goods that are subject to signing are authorised in the tunnel without exception. However, they are obliged to keep a maximum speed of 50-60 km/h, and to comply with the minimum vehicle inter-distance of 100-200m. In some cases, hourly restrictions are defined] .
- A:** Fully authorised with no restrictions [All transport of dangerous goods that are subject to signing are authorised in the tunnel without exception] .

Decision basis (column 3):

This gives the background for the decision taken and distinguishes between two cases, (i) and(ii):

(i) Transport of dangerous goods authorised with or without special measures/provisions

- A:** Transport of dangerous goods on diversion route is banned
- I:** No diversion route exists
- N:** Tunnel is located in rural areas
- P:** Tunnel is located in Paris or Paris region

(ii) Transport of dangerous goods prohibited

- D:** A diversion route exists
- S:** Tunnel is of a private character
- U:** Tunnel is located in urban areas

Responsibility (column 4):

This indicates which type of road the tunnel is part of (which determines the responsibility of operation, enforcement, etc):

- C:** Community road
- D:** Departmental road
- N:** National road (State)
- P:** Private road

APPENDIX A

Name of tunnel (Town)	Conditions	Decision basis	Responsibility
Mont Blanc	AP ⁽¹⁾	A	N
Maurice Lemaire	AR ⁽²⁾	N	N
Frejus	AR ⁽³⁾	A	N
Puymorens	P	D	N
Roux	P	D	D
Chamoise	AR	I	N
Epine	AR ⁽⁴⁾	N	N
Foret de St. Germain	AP	P	N
Defence-Epad 3 (Puteaux)	AP	P	N
Prado-Carenage (Marseille)	P	U	C
Tranchee Couverte de Nogent	AP	P	N
Montets	P	D	N
Fourviere (Lyon)	P	U	N
Defense-Epad 1 (Puteaux)	AP	P	N
Defence-Epad 2;doubling (Puteaux)	AP	P	N
Aragnouet-Bielsa	A	N	D
Croix Rousse	P	U	C
Bretelle de Monaco	P	U	N
Foret de St. Germain	AP	P	N
La Grand-Mare (Rouen)	AR ⁽⁵⁾	I	N
Siaix	A	N	N
Chat	AR ⁽⁴⁾	N	N
Col de Tende	A	N	N
Forum Central (Semah, Paris)	AP	P	C
Dullin	AR ⁽⁴⁾	N	N
Vuache	AR	I	N
Lioran (Lavessiere)	AR ⁽⁴⁾	N	N
Ponserand	A	N	N
St. Germain de Joux	AR	N	N
Hurtieres	A	N	N
Rainier 3	P	U	N
L'Arme	AR	I	N
Las Planas	AR	I	N
Cap Sicie	P	S	P
La Mescla 2	A	N	N
Les Chavants	A	N	N
Puech Mergou	A	N	D
Aiguebelle	A	N	N
Tranchee Remise de Verrou	AP	N	N
Les Monts (Chambery)	AR	I	N
Quai des Tuileries (Paris)	AP	P	C
La Gatine (Angouleme)	AP	U	C
Epad (Puteaux)	AP	P	N

APPENDIX A

Name of tunnel (Town)	Conditions	Decision basis	Responsibility
Pas de l'Escalette	AR	N	N
St. Cloud (St. Cloud)	AP	P	N
Ambroise Pare (Bolougne)	AP	P	N
Front de Mer (Bastia)	P	I ????	N
La Coupriere	AR	I	N
Trou au Renard-Guy Moq	AP	P	N
Col de Rousset	A	N	D
Grand Chambion	A	N	N
Castillon	A	N	D
Castillon 2	A	N	D
FFF	AP	P	N
Chatillon	AR	N	N
Rive Gauche du Paillon (Nice)	P	U	C
Nanterre	AP	P	N
Pte Pantin 1	AP	P	C
Cap Estel	A	N	N
Canta Galet	AR	I	N
Vieuxport (Marseille)	P	U	C
Pessicart	AR	I	N
Voie de Desserte Int. (Courbevoie)	AP	P	C
Voie de Desserte Int. (Puteaux)	AP	P	C
Ardoisieres	A	N	N
Antony (Antony)	AP	P	N
Jenner (Le Havre)	P	U	C
Parc des Princes (Paris)	AP	P	C
Lac Superieur (Paris)	AP	P	C
Castellar	AR	I	N
En Raxat	A	N	N
Orly 1 (Orly)	AP	P	N
La Baume	A	I	N
Roissy en France 4 (Roissy e F.)	A	P	N
Roissy en France 4 (Roissy e F.)	A	P	D
Malleval	A	N	D
Reine Bl.-Grandchamps(Kremlin B.)	AP	P	N
Parpaillon	A	N	D
Dame Jouette (Marseille)	A	U	C
Mortier	A	N	D
St. Pancrasse (St. Pancrasse)	A	N	D
Rocher Chabrand	A	N	D

1. The tunnel has developed very special regulations (e.g. a complex list of substances authorised or prohibited)
2. Prohibited for transport of extremely dangerous substances
3. Escort is required
4. Additional hourly restrictions defined
5. Prohibited for transport of LPG

APPENDIX A

By matching Tables 1 and 2, the following table is obtained. It shows the number of tunnels per length class (m) and conditions for the transport of dangerous goods.

Length class (m)	Conditions					Total
	Authorised	Authorised with restrictions	Authorised with very special restrictions	Partly Authorised	Prohibited	
[500 - 750>	13	4	-	10	4	31
[750 - 1 000>	5	3	-	7	1	16
[1 000 - 2 000>	6	8	-	4	6	24
[2 000 - 3 000>	-	-	-	3	1	4
[3 000 - 4 000>	-	2	-	-	1	3
[4 000 ->	-	1	1	1	1	4
Total	24	18	1	25	14	82

APPENDIX B

APPENDIX

B
SWISS ROAD TUNNELS

- o0o -

APPENDIX B

Tunnels der schweizerischen Nationalstrassen
Tunnels des routes nationales suisses
at end 1995

Kantone	Objekte	1 Röhre Tube	2 Röhren Tubes	Spurenzahl Nombre de voies	Lüftungs- system Système de ventilation	Querschnitt Coupe	In Betrieb
Cantons	Ouvrage	(m)	(m)		(1)	(2)	En service
	N 1						
SG	Rosenberg, St. Gallen (SN)		1,435	2+2	Q	K	01.07.87
SG	Stephanshorn, St. Gallen		570	2+2	L	H	01.07.87
SG*	Schorentunnel inkl. Kreuzbleiche, SG (SN)		(1,100)	2+2	L	K	01.07.87
ZH	Tagelswangen		128	3+3	-	R	11.12.74
ZH	Winterthurstrasse (TB)		350	2+2	L	R	20.08.80
ZH	Rasterzwischenstück (TB)		140	2+2	-	R	20.08.80
ZH	Schwamendingerstrasse (TB)		220	2+2	L	R	20.08.80
ZH	Milchbuck, 1. Etappe (SN)	1,910		2	Q	H	02.07.85
ZH	Unterführung 1.92 unter der N20 (TB)	90		2	-	R	01.09.81
AG	Baregg		1,080	2+2	H	H	07.10.70
BE	Brünnen (TB)		510	2+2	L	H	22.12.82
Total 10 = 6,433 m (*1 = 1,100 m)		2,000	4,433				
	N 1a (N10)						
GE	Canada, Vernier		1,900	2+2	L	H	26.06.93
GE	Chèvres (TB)		400	2+2	-	H	26.06.93
GE	Confignon		1,240	2+2	L	H	26.06.93
Total 3 = 3,540 m			3,540				
	N 1c (N20)						
ZH	Gubrist		3,230	2+2	L+Q	K	21.06.85
ZH	Stelzen (TB)		375	2+2	-	R	21.06.85
ZH	Niederurdorf (TB)		450	2+2	-	R	18.08.87
Total 3 = 4,055 m			4,055				
	N 2						
BS	Schwarzwaldallee (SN) (TB)		560	3+3	L	R	22.08.74
BS	Prattelerstrasse (SN) (TB)	148		2	-	R	25.10.78
BS	Singer I (SN) (TB)	150		2	-	R	05.12.85
BS	Singer II (SN) (TB)	320		2	-	R	05.12.85
BL*	Schänzli (TB) (Zubringer)		(510)	2+2	L	R	25.10.78
BL	Arisdorf		1,360	2+2	H	H	23.12.70
BL	Ebenrain		350	2+2	-	H	23.12.70
BL	Oberburg		180	2+2	-	H	23.12.70
BL/SO	Belchen		3,180	2+2	Q	H	23.10.70
LU	Mariazell (TB)		230	2+2	-	H	02.07.81
LU	Eich (TB)		910	2+2	L	H	02.07.81
LU	Reussport, Luzern (SN)		600	3+3	L	H	11.11.74
LU	Sonnenburg, Luzern		1,540	2+2	Q	K	26.10.76
NW	Acheregg Nord	281		2	-	H	11.12.65
NW	Acheregg Süd	753		2	H	H	11.12.65
NW	Acheregg Ost, (Abfahrt Brünig)	78		2	-	H	11.12.65
NW/UR	Seelisberg		9,280	2+2	Q	K+H	12.12.80
UR	Fischlauri (TB)		105	2+2	-	R	12.12.80
UR	Taubach, Erstfeld (TB)		260	2+2	-	R	05.07.79
UR	Platti		440	2+2	-	H	23.06.72
UR	Intschi I		130	2+2	-	H	23.06.72
UR	Intschi II		100	2+2	-	H	23.06.72
UR	Langlauri		350	2+2	-	H	23.06.72
UR	Ried		260	2+2	-	H	23.06.72
UR	Teifal		520	2+2	-	H	23.06.72
UR	Naxberg		290	2+3	-	H	05.09.80
UR	Schöllenen	50		2	-	H	1956
UR	Umerloch	65		2	-	H	1956
UR	Hospental	25		2	-	H	1956
UR/TI	Gotthard (inkl. Vortunnel)	16,918		2	Q	H	05.09.80
TI	Banchi	70		2	-	H	14.07.67
TI	Castoni di Fieud	810		2	L	H	14.07.67
TI	Stalvedro		318	2+2	-	H	24.06.77
TI	Quinto (TB)		293	2+2	L	R	03.06.80
TI	Monte Piottino		720	2+3	L	H	15.06.83
TI	Pardorea		600	2+3	L	H	15.06.83
TI	Caseletto		192	2+3	-	H	15.06.83
TI	Piumogna		1,538	2+3	L	H	15.06.83
TI	Gribiasca (TB)		160	2+2	-	R	20.11.84
TI	Biaschina		515	2+3	L	H	20.11.84

(1) L = Längs / Longitudinal

(2) H = Hufeisen / Fer à cheval

(TB) = Tunnel im Tagbau erstellt / Tunnel en tranchée couverte

Q = Quer / Transversal

K = Kreis / Cercle

(*) = Nicht auf der Stammlinie / N'est pas sur le tracé

H = Halbbauer / Semi-Transversal

R = Rechteck / Rectangule

APPENDIX B

Tunnels der schweizerischen Nationalstrassen

Tunnels des routes nationales suisses

Stand Ende 1995 / Etat fin 1995

Kantone	Objekte	1	2	Spurenzahl	Lüftungs-	Querschnitt	In Betrieb
Cantons	Ouvrage	Röhre	Röhren	Nombre	system	Coupe	En service
		Tube	Tubes	de	Système	(2)	
		(m)	(m)	voies	de		
				ventilation	de		
				(1)	ventilation		
				(2)			
TI	Ceneri		1,425	2+3	L	H	15.11.84
TI	Taverne/Torricella		320	2+2	-	H	26.05.73
TI	Pambio/Gentilino		580	2+2	-	H	05.12.68
TI	Grancia		1,730	2+2	Q	H	05.12.68
TI	Maroggia		590	2+2	-	H	24.11.67
Total 44 = 49,294 m (1* = 510 m)		19,668	29,626				
N 3							
SZ	Blatt, Wollerau		510	2+2	-	H	11.12.68
SZ*	Buchberg (Zubringer)		(500)	2+2	-	H	04.10.77
GL	Ofenegg	370		2	-	H	11.07.64
GL	Weisswand	460		2	-	H	11.07.64
GL	Kerenzerberg (3.+ 4. Spur / Voie)	5,760		2	H+Q	K+H	09.04.86
GL	Standenhorn	230		2	-	H	11.07.64
GL	Glattwand	100		2	-	H	11.07.64
GL	Mühlehorn	260		2	-	H	11.07.64
GL	Stutz	144		2	-	H	11.07.64
SG	Murg und Börtli		1,420	2+2	L	H	27.11.87
SG	Quarten und Annaberg		1,040	2+2	L	H	27.11.87
SG	Fratten		320	2+2	-	H	27.11.87
SG	Hof		560	2+2	L	H	27.11.87
SG	Raischibe		800	2+2	L	H	27.11.87
Total 13 = 11,974 m (1* = 500 m)		7,324	4,650				
N 4							
SZ	Engiberg		263	2+2	-	H	03.05.78
SZ	Schöneegg		197	2+2	-	H	03.05.78
SZ	Mosi	1,080		2	L	H	04.06.65
SZ	Oelberg	350		2	L	H	16.10.92
SZ	Hinter Wasi Nord	40		2	-	H	...
SZ	Hinter Wasi Süd	40		2	-	H	...
SZ	Schiferenegg	135		2	-	H	...
SZ	Dorni	20		2	-	H	...
UR	Kleine Galerie	162		2	-	H	20.12.82
UR	Buggital	113		2	-	H	11.04.82
UR	Stutzegg	320		2	-	H	10.12.86
UR	Tellsplatte	234		2	-	H	13.07.90
UR	Axen (neu)	390		2	-	H	...
UR	Zingel	354		2	-	H	1977
UR	Gumpisch	100		2	-	H	07.87
Total 15 = 3,798 m		3,338	460				
N 5							
NE	Tunnel Est, Neuchâtel		2,610	2+2	Q	H	18.06.93
NE	Tunnel Ouest, Neuchâtel		745	2+2	L	H	18.06.93
NE	Tranchée Falaises Ouest (TB)		272	2+2	-	R	18.06.93
NE	Tranchée Monruz (TB)		404	2+2	-	R	19.12.95
NE	Tranchée Hauterive (TB)		580	2+2	-	R	19.12.95
NE	Tranchée St-Blaise Ouest (TB)		300	2+2	-	R	19.12.95
NE	Tranchée du Vignier (TB)		340	2+2	-	R	19.12.95
BE	Ligerz	2,483		2	H+Q	H	07.05.91
NE	Tranchée d'Auvernier (TB)		180	2+2	-	R	29.11.75
NE	Prébarreau	119		3	-	H	21.12.84
Total 10 = 8,033 m		2,602	5,431				
N 6							
BE	Allmend, Thun (TB)		960	2+2	L	H	13.06.71
Total 1 = 960 m			960				
N 7							
TG	Asp Holz (TB)		140	2+2			27.11.92
TG	Fuchswies (TB)		200	2+2			27.11.92
Total 2 = 340 m			340				

(1) L = Längs / Longitudinal

(2) H = Hufeisen / Fer à cheval

(TB) = Tunnel im Tagbau erstellt / Tunnel en tranchée couverte

Q = Quer / Transversal

K = Kreis / Cercle

(*) = Nicht auf der Stammlinie / N'est pas sur le tracé

H = Halbquer / Semi-Transversal

R = Rechteck / Rectangle

APPENDIX B

Tunneln der schweizerischen Nationalstrassen

Tunneln des routes nationales suisses

Stand Ende 1995 / Etat fin 1995

Kantone	Objekte	1	2	Spurenzahl	Lüftungs-	Querschnitt	In Betrieb
Cantons	Ouvrage	Röhre	Röhren	Nombre	system	Coupe	En service
		Tube	Tubes	de	Système		
		(m)	(m)	voies	de	(2)	
					ventilation		
					(1)		
	N 8						
BE	Leimeren, Hondrich	250		2	-	H	20.09.73
BE	Leissigen	2,200		2	L	H	23/06/94
BE	Rugen		780	2+2	L	H	03.12.79
BE	Lütschinen (TB)	545		2	-	R	18.05.88
BE	Sengg	823		2	L	H	18.05.88
BE	Chüebalm	1,339		2	L	H	18.05.88
BE	Giessbach	3,340		2	H+Q	H	18.05.88
BE	Soliwald, Brienzwiler	555		2	-	H	06.07.95
OW	Sachseln	5,213			L		24.09.97
OW	Z'matt (TB)	102		2	-	R	19.12.79
NW/OW	Lopper 1. Etappe	1,562		2	H+Q	H	07.12.84
NW*	Verbindung N 8 / N 2 (Lopper)	(346)		1	L	H	07.12.84
Total 10 = 11,496 m (1* = 346 m)		10,716	780				
	N 9						
VD	Belmont		296	2+2	-	H	31.10.74
VD	Chauderon		165	2+2	-	H	30.10.74
VD	Criblette		233	2+2	-	H	30.10.74
VD	Flonzaley		690	2+2	L	H	30.10.74
VD	Glion		1,345	2+2	H	H	10.11.70
VD	L'Arzillier, St-Maurice		420	2+2	-	H	06.06.88
VS	Condémines, St-Maurice (TB)		1,300	2+2	L	R	06.06.88
VS	Champsec, Sion (TB)		710	2+2	-	R	16.12.91
VS	Gesterna	110		2	-	H	06.11.75
VS	Anschluss Vispताल (Zubringer)	3,250			L		04.02.97
VS	Bächwald	120		2	-	H	06.11.75
VS	Schallberg	465		2	-	H	06.11.75
VS	Kap I, Simplon	30		2	-	H	1970
VS	Kap II, Simplon	140		2	-	H	1970
VS	Kulm, Simplon	400		2	-	H	1970
VS	Gabi	70		2	-	H	1970
VS	Casermetta	300		2	-	H	1970
VS	Gstipf	215		2	-	H	07.05.86
VS	Wechselkehr (TB)	123		2	-	H	01.09.93
VS*	Mont Chemin (Zubringer)	(1,800)		2	L	H	
Total 18 = 7,132 m (1* = 346 m)		1,973	5,159				
	N 12						
BE	Thörishaus (TB)		110	2+2	-	R	10.12.76
FR	d'Avry (TB)		170	2+2	-	H	23.11.81
FR	Gumefens (TB)		340	2+2	-	R	23.11.81
Total 3 = 620 m			620				
	N 13						
GR	Plazzas, 1. Etappe	252		2	-	H	11.11.83
GR	Isla Bella, 1. Etappe	2,449		2	H+Q	H	11.11.83
GR	Crapteig	2,171			L		24.10.96
GR	Rongellen I	206		2	-	H	1958
GR	Rongellen II	625		2	L	H	1958
GR	Rongellen III	135		2	-	H	1958
GR	Viamala	742		2	L	H	01.12.67
GR	Bargias	416		2	-	H	01.12.67
GR	Wegerhaus (Inkl. Galerie)	228		2	-	H	01.12.67
GR	Bärenburg	998		2	L	H	24.11.70
GR	Rofla	995		2	L	H	24.11.70
GR	Traversa	375		2	-	H	24.11.70
GR	Casanwald (TB)	1,230		2	L	H	04.11.86
GR	San Bernardino	6,600		2	Q	H	01.12.67
GR	Gei	418		2	-	H	01.12.67
GR	Landrüfe (TB)	213		2	L	R	30.10.72
GR	Brusei	560		2	L	H	30.10.72
GR	Cresta	100		2	-	H	30.10.72
GR	Benabbia, Mesocco	150		2	-	H	20.11.75
GR	Gorda, Mesocco	130		2	-	H	20.11.75
Total 19 = 16,822 m		16,822					

(1) L = Längs / Longitudinal

(2) H = Hufeisen / Fer à cheval

(TB) = Tunnel im Tagbau erstellt / Tunnel en tranchée couverte

Q = Quer / Transversal

K = Kreis / Cercle

(*) = Nicht auf der Stammlinie / N'est pas sur le tracé

H = Halbquer / Semi-Transversal

R = Rechteck / Rectangle

APPENDIX B

Tunnels der schweizerischen Nationalstrassen

Tunnels des routes nationales suisses

Stand Ende 1995 / Etat fin 1995

Kantone	Objekte	1 Röhre Tube	2 Röhren Tubes	Spurenzahl Nombre de voies	Lüftungs- system Système de ventilation (1)	Querschnitt Coupe (2)	In Betrieb En service
Cantons	Ouvrage	(m)	(m)		(1)	(2)	
LU	N 14 Rathausen (TB)		680	2+2	L	H	18.09.86
Total 1 = 680 m			680				
BE	N 16 La Heutte (TB)		315	2+2	-	R	10.11.95
BE	Métairie de Nidau (TB)		553	2+2	-	H	10.11.95
BE	Tunnel Nr. 8 (Taubenloch)	1,010		2	L	H	1980
BE	Tunnel Nr. 6 (Taubenloch)	480		2	-	H	1978
BE	Tunnel Nr. 5 (Taubenloch)	570		2	-	H	1978
BE	Rondchâtel (Taubenloch)	180		2	-	H	1965
BE	Tunnel Nr. 4 (Taubenloch)	115		2	-	H	1970
BE	Tunnel Nr. 3 (Taubenloch)	123		2	-	H	1970
BE	Tunnel Nr. 2 (Taubenloch)	200		2	-	H	1970
BE	Tunnel Nr. 1a + 1b (Bözingen)		455	2+2	-	H	1970
Total 10 = 4,001 m		2,678	1,323				

(1) L = Längs / Longitudinal

(2) H = Hufeisen / Fer à cheval

(TB) = Tunnel im Tagbau erstellt / Tunnel en tranchée couverte

Q = Quer / Transversal

K = Kreis / Cercle

(*) = Nicht auf der Stammlinie / N'est pas sur le tracé

H = Halbquer / Semi-Transversal

R = Rechteck / Rectangle

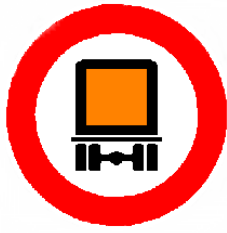
APPENDIX C

APPENDIX

C
ROAD SIGNING, GERMANY

- o0o -

APPENDIX C



Vz 261 StVO



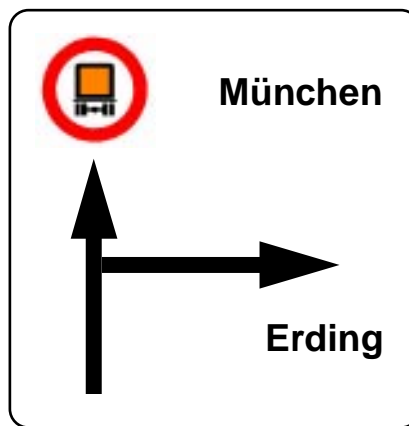
Vz 269 StVO

150 m

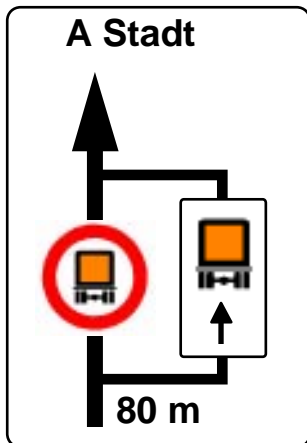
Vz 741 StVO

150 m

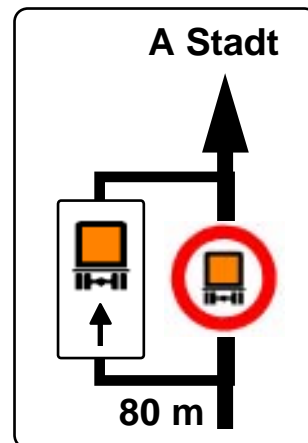
Vz 741 StVO



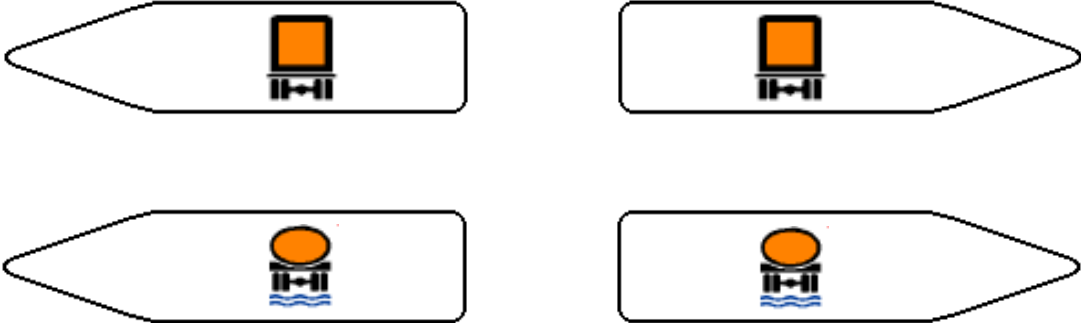
Vz 438 StVO



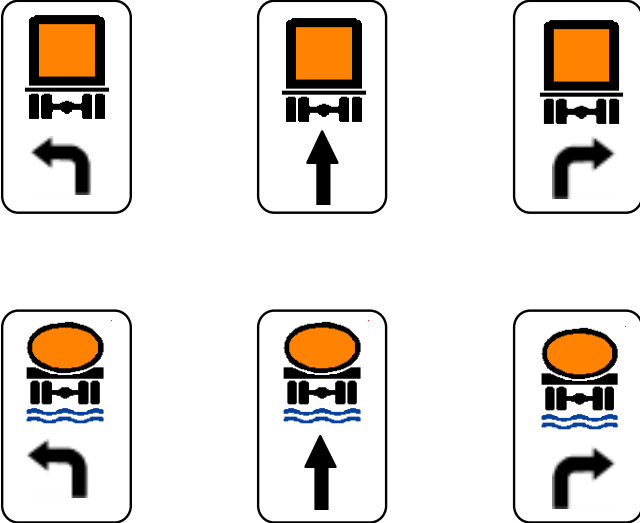
Vz 459 StVO



APPENDIX C



Vz 421 StVO



Vz 442 StVO

APPENDIX D

APPENDIX

D
REQUEST FOR INFORMATION

APPENDIX D

OECD RESEARCH PROJECT ERS2; TASK 1 - MISSION 2

REQUEST FOR INFORMATION

1. Introduction and Background

OECD and PIARC initiated in 1995/96 a joint venture research project on the transport of dangerous goods through road tunnels. The overall objectives of the joint project were:

- to improve the overall safety of the transport of dangerous goods by road
- to facilitate the organisation of such a transport in order to prevent unnecessary costs, and promote economic development

The project was divided into four tasks:

- Task 1: Review of current national and international regulations
- Task 2: Methodologies relating to risk assessment and decision process
- Task 3: Risk reducing measures
- Task 4: Conclusions and recommendations

Task 1 was further divided into two missions, entitled:

- Mission 1: “Analysis of questionnaires”
- Mission 2: “Gathering of complementary information”

The overall objectives of Task 1 were to provide an overview of current regulations, with an evaluation of their qualities and the problems they pose; to draw lessons on needs and requirements for new regulations.

Mission 1 was undertaken by DNV in the period August to November 1996 with delivery of an interim report 15 November 1996.

In Mission 2, it is planned to gather complementary and detailed information on rules, regulations and policies for transport of dangerous goods in road tunnels based on the work performed in Mission 1. Furthermore, following an in-depth analysis of the gathered material, to conclude on needs for improvements of existing regulations and requirements for new regulations.

2. Objectives, Task 1 – Mission 2

The main objectives for Mission 2 are outlined below:

- understand the background for the various policies that have led to the existing tunnel regulations in the country
- analyse differences or whether there is a uniform philosophy for the tunnel regulations in the country
- reveal any problems with the existing regulations in the country with regard to. decisions, enforcement, operation, and transport
- give recommendations for new regulations and requirements for improvement

APPENDIX D

3. Specification of requested Information

In order to fulfil the objectives given above, we are in need of having a comprehensive material as a basis for analysis regarding your country. The type of information we are seeking is outlined below.

- (i) For each tunnel with rules/regulations or in general for groups of tunnels in your country, obtain information that illustrate or document the following aspects:
 - Criteria and studies as a basis for decisions for regulations and policies (e.g. risk analyses, country codes, normal practice, etc.);
 - Standard, quality, and success/experience of enforcement (how rules are respected);
 - Problems with existing regulations with respect to:
 - * decisions;
 - * enforcement;
 - * operation;
 - * transport
 - Plans for modifications and improvements of regulations (if any).

- (ii) Give an example of the contents of a typical local tunnel regulation.

- (iii) For each of the tunnels with rules/regulations, obtain the following information:
 - Tunnel identification (name, distance from-to, etc.)
 - Number of tubes
 - Indication of whether 1-way or 2-way traffic
 - Length (m)
 - AADT (Annual Average Daily Traffic)
 - Type of road (road status)
 - Location (through urban or rural areas, mountains, under navigable waters, etc.)
 - Ownership (state, municipality/county, etc.)
 - Main contents of (incl.. reason/background for) the rules/regulations/policies which apply

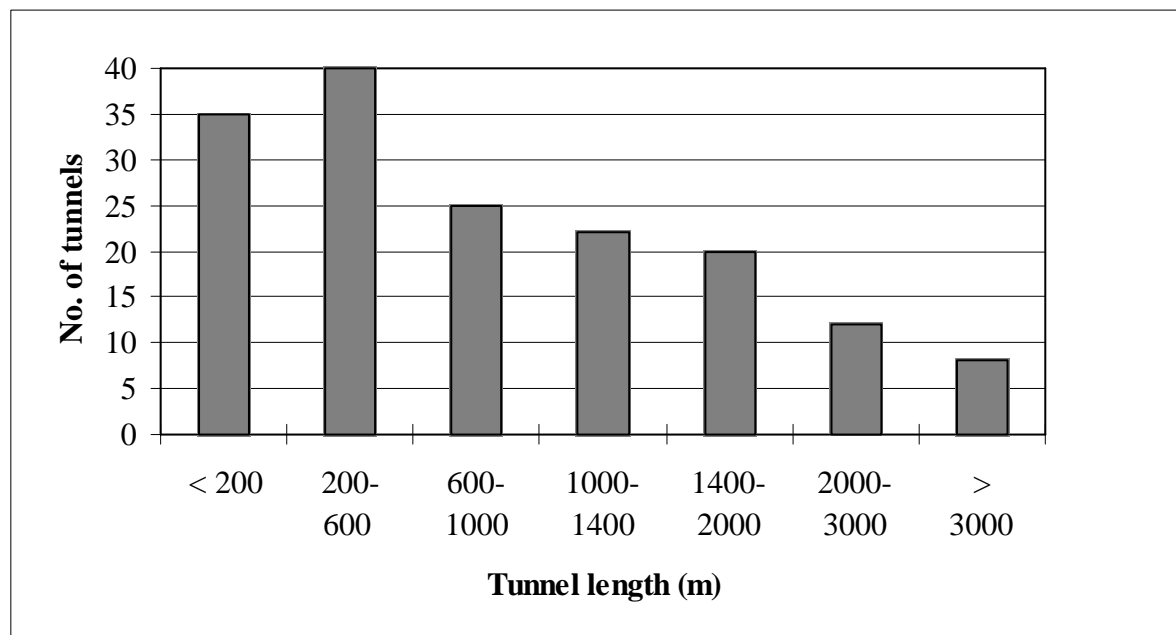
If readily available or may be made available with a smaller amount of efforts, please consider points (iv) and (v) below:

(iv) Obtain information about all existing road tunnels in your country according to the following format:

	Group 1: Tunnels <u>with</u> rules/regulations		Group 2: Tunnels <u>without</u> rules/regulations	
	1-tube tunnels	2-tube tunnels	1-tube tunnels	2-tube tunnels
Total no. of tunnels				
Total length (km)				

APPENDIX D

(v) For all existing road tunnels in your country, obtain the distribution of tunnel lengths according to the format given in the figure below (or obtain information material such that such a graph may be made):



4. Task 2

Mission 2 also want to touch upon aspects related to Task 2; development of QRA (Quantitative Risk Assessment) / DSM (Decision Support Model) methods and models. The following information is sought for:

- What are your needs, requirements, and expectations (input/output data, software, etc.)?
- What general data is available in your country to help developing QRA/DSM methods and models? (e.g. existing specifications/recommendations on risk studies for dangerous goods in road tunnels or on roads in general; existing data, databases, or research results that can help evaluating the probabilities/frequencies and/or consequences of accidents involving dangerous goods incidents in road tunnels and on roads in open air; statistics on dangerous goods incidents and accidents in road tunnels and roads in open air, etc.)
- Who will apply/use the methods/models in your country? (e.g. consultants, hauliers, governmental bodies, authorities, etc.)

Task 2 will be carried out during 1997/98 and the information we are seeking here will serve as a basis for generating a “user profile” for potential users.

5. Summary from the Report for Mission 1

The Interim Report for Mission 1 contained a section with a summary of our perception of the conditions in each country based on the submitted questionnaires and supplementary information. The summary for your country is given below. We would very much appreciate your comments upon the given description.