EuroTAP 2010 Tunnel Test

Methodology: This is how we tested

There's just no stopping ADAC and its 15 partner clubs in 14 European countries. This year, for the twelfth time in succession, the ADAC Tunnel Test was carried out within the scope of EuroTAP (European Tunnel Assessment Programme), the programme dedicated to greater safety in Europe's road tunnels. There is an unprecedented amount of construction work currently underway in tubes throughout Europe in order to bring the tunnels in line with the requirements of the EU Directive on road tunnel safety from 2004. We now wanted to find out just how far operators have come towards reaching the ambitious aim pursued by the Directive, i.e. making all of Europe's tunnels safer by 2019 at the latest. So, once again, the tunnel experts packed their cases and set out on a long journey. 26 tunnels in 13 countries were on the agenda: four in Spain, three in Germany, Italy, Austria and Switzerland, two in France and Norway, one in Belgium, Croatia, the Netherlands, Slovenia, the Czech Republic, and for the first time in the history of our test, in Iceland.

As always, the criteria for selecting the tunnels to be tested included tunnel length, location in the trans-European road network and importance for holiday traffic. Three of the tunnels had been tested before: Austria's Katschberg tunnel was rated Poor as a single-tube tunnel in 1999 and then, in 2002, received a rating of Acceptable following initial refurbishment. A rating of Acceptable also went to Tanzenberg tunnel, also in Austria, when it was tested in 2001, and the same rating went one year later to the French Maurice Lemaire tunnel.

As in previous years, ADAC commissioned DMT GmbH & Co. KG, an international, independent technology services company specialising in raw materials, safety and infrastructure with a staff of around 610, to carry out the test. With regard to tunnel construction, the company's services range widely from soil analysis to planning and safe operation of tunnel systems. One aspect of this work focuses on safety in complex systems, in particular, on protection against fire and explosion, as well as on ventilation and rescue services. DMT operates a state-of-the-art training centre for fire brigades where firemen are trained under realistic conditions to fight fires in tunnels and buildings.

DMT's experts carried out their on-site inspections of the 26 tunnels between 12 April and 20 May 2010. Following inspection of the respective tubes, the experts spoke with operators, clarified safety relevant issues and inspected the related documents. Prior to testing, operators were given a data list to record the most important technical tunnel parameters. This data was once again checked on site. Although the retrofitting and modification plans for some of the tunnels are noted in the criticisms of the individual tunnels, these were not included in the rating.

Checklist

A checklist, which is prepared by the traffic experts at ADAC and DMT and revised each year, serves as an objective foundation for testing. This checklist is based on the high standards that apply to road

tunnels in Germany, Austria, Switzerland, France and the UK, as well as on the EU Directive on minimum safety standards for tunnels in the Trans-European Transport Network.

The checklist is broken down into eight categories:

- **Tunnel system** **Weighting: 14 percent**
  - Number of tubes
  - Brightness of tunnel walls
  - Width and layout of traffic lanes
  - Geometry and layout of emergency lanes / lay-bys and emergency walkways
  - Additional measures: Portal design, road surface, tunnel route

- **Lighting and power supply** **Weighting: 7 percent**
  - Lighting throughout and adaptation zones
  - Power and emergency power supply

- **Traffic and traffic surveillance** **Weighting: 17 percent**
  - Congestion in the tunnel
  - Speed limits
  - Restrictions on and/or registration of vehicles carrying hazardous goods
  - Measures to close the tunnel: traffic lights, barriers, information displays
  - Traffic signs
  - Traffic management and control: traffic lights, variable traffic signs, signs
  - Visual guidance equipment
  - Video surveillance
  - Automatic traffic recording and detection of congestion and incidents
  - Tunnel control centre
  - Additional measures: for instance for heavy goods vehicles and automatic detection of hazardous goods transports, height checks, monitoring the distance between vehicles and speed

- **Communication** **Weighting: 11 percent**
  - Traffic radio
  - Loudspeakers
  - Emergency phones: distance, marking, insulation against traffic noise
  - Tunnel radio

- **Escape and rescue routes** **Weighting: 14 percent**
  - Evacuation lighting and escape route signs in the tunnel
  - Distance between emergency exits and marking
  - Preventing smoke from penetrating external escape routes, fire resistant doors

◊ External access and access for rescue services
◊ Additional measures: special lighting for emergency exits, signs showing what to do, barrier-free emergency exits

♦ **Fire protection** **Weighting: 18 percent**

◊ Fire protection of the tunnel structure
◊ Fire resistant cables
◊ Drainage system for draining flammable and toxic liquids
◊ Fire alarm systems: automatic/manual
◊ Extinguishing systems: arrangement, signs, function
◊ Fire brigade training, equipment, time needed to reach the tunnel
◊ Capacity and efficiency of automatic extinguishing systems

♦ **Ventilation** **Weighting: 11 percent**

◊ Normal mode to thin out vehicle emissions
◊ Control of the longitudinal flow in the tunnel and consideration of this in ventilation control
◊ Temperature stability of facilities and equipment
◊ Special fire programmes
◊ Proof of correct functioning in fire trials and by flow measurements
◊ Longitudinal ventilation: airflow speed, length of the ventilation section, airflow in the direction of traffic, reversible fans.
◊ Transverse / semi-transverse ventilation: extraction volume flow, longitudinal flow control, opening / closing the exhaust air outlets can be controlled

♦ **Incident management** **Weighting: 8 percent**

◊ Regular training for tunnel control centre staff
◊ Maintenance plan
◊ Emergency response plans
◊ Automatic linking of emergency systems
◊ Measures in the case of an accident or fire
◊ Regular emergency drills

Safety potential

Each of the items of the checklist also has sub-items. All in all, the catalogue covers far more than 200 criteria. Each criterion is evaluated and awarded a certain number of points. The sum of these points is the result achieved for the so-called safety potential of a tunnel. It describes all the structural and organisational measures which are designed to prevent emergencies or limit their severity.

Risk potential

In addition to the above, the so-called risk potential is also calculated. This indicates not only the probability of incidents occurring, but also the possible extent of the damage. In other words, it serves as a parameter for the risk of becoming involved in an accident while driving through the respective tunnel and for the seriousness of the consequences which must then be expected. This is based on the following considerations:

- The longer the tunnel, the more vehicles and hence the more people may be present in the tube. However, as the length of a tunnel increases, the fewer accidents occur.
- The higher the number of HGVs, the greater the likelihood of a major fire breaking out.
- If a hazardous material catches fire, this can be disastrous due to high temperatures and extremely toxic gases. This means that the unrestricted transport of hazardous goods significantly increases the risk of a major fire.
- The type of traffic (unidirectional / bi-directional traffic), traffic volume and traffic conditions (slow-moving traffic / congestion) influence the correct assessment of escape and rescue possibilities, as well as the choice of a suitable ventilation system. With unidirectional traffic and no congestion, longitudinal ventilation systems permit vehicles ahead of the fire zone to leave the tunnel safely. The vehicles downstream from the fire zone can be protected by extracting smoke in a single direction. In the case of bi-directional traffic or unidirectional traffic with congestion, vehicles may be located at both sides of the fire zone and may have difficulties leaving the tunnel. This places high demands on the ventilation system (suitable smoke extraction) and the design of escape routes. Furthermore, the risk of more serious accidents, e.g. head-on collisions, is greater in the case of bi-directional traffic, like the accidents that took place in 2001, for example, in the Gleinalm tunnel and the Amberg tunnel in Austria.
- The longitudinal gradient of a tunnel influences smoke spread. The steeper the gradient, the stronger the thermal lift and hence the greater the zone in which smoke can spread. Furthermore, longer tunnel stretches with gradients can lead to brakes and engines overheating, particularly in the case of HGVs, and this also increases the likelihood of fire.

The risk potential is evaluated both in terms of quantity and quality. This is based on the respective analyses carried out by DMT and on the experience gained in previous ADAC tunnel tests.

The following parameters are considered for risk evaluation:

- Tunnel length — 1 to 6 points
- Traffic volume, depending on traffic routing
  Unidirectional or bi-directional traffic — 1 to 10 points
- Percentage of HGVs — 8 points max.
- Transport of hazardous goods — 5 points max.
- Traffic density (vehicles per day and lane): — 5 points max.
- Maximum gradient of the tunnel — 3 points max.
- Additional risks, such as entrances and exits,

intersections in the tunnel or in the downstream area,
long gradients in front of the tunnel,
risk of flooding: 3 points max.

The risk points thus awarded are added together and their total is classified as follows:

- Very low risk 2 to 9 points
- Low risk 10 to 14 points
- Medium risk 15 to 21 points
- High risk 22 to 28 points
- Very high risk 29 points and higher

Evaluation

The safety and risk potential are brought together to rate a tunnel. The safety potential is multiplied by the tunnel-specific risk factor which is derived from the risk potential calculated. This means that it is very well possible for tunnels to be awarded a bonus, depending on their risk potential, that could significantly improve the result from the safety potential. Tunnels with a medium to low risk potential hence do not have to fulfil the same high safety requirements (safety potential) as tunnels with a very high risk potential. This complies with the EU Directive on minimum safety standards for tunnels in the Trans-European Transport Network (2004/54/EC) which makes certain safety measures contingent upon existing risk parameters.

Knock-out criteria

The categories: Tunnel system, Lighting and power supply as well as Traffic and traffic surveillance are primarily preventive measures; the categories: Escape and rescue routes and Ventilation are self-rescue and rescue measures whilst the categories: Fire protection, Emergency management and Communication are measures that are needed in order gain control of an emergency.

The safety measures in the individual categories can supplement each other or compensate for each other, but can also be more or less independent of each other as, for instance, in the area of prevention. But the picture is completely different when it comes to measures for identifying and mastering certain events: Depending on the possibilities which exist to detect and report an incident, safety systems are activated either automatically or manually, adequate monitoring and control measures are taken, external services, such as the fire brigade, rescue services, police etc. can be involved. The strongest links, however, exist within and between the Escape and rescue routes and Ventilation categories. The traffic situation, i.e. unidirectional or bi-directional traffic, is very important when it comes to choosing the ventilation system, the control and monitoring of smoke extraction and the layout of emergency exits. This applies especially to single-tube tunnels without emergency exits or with long distances between emergency exits. This generally means, for instance, that serious shortcomings cannot be compensated for by other measures. For instance, missing emergency exits cannot be offset by very good lighting or a stable power supply.

In the tunnel test, this means that if a tunnel is given an overall positive rating, then ideally all eight safety potential categories must have a positive result, and at least none of them should be found to be very poor. Otherwise, the so-called knock-out criterion is used to lower the overall rating according to a precisely defined scheme.

The EU Directive

The EU Directive on minimum safety standards for tunnels in the Trans-European Transport Network (2004/54/EC) was adopted in April 2004. Since then, the related requirements have been integrated into the EuroTAP rating scheme. The requirements of the test were compared to those of the Directive. One difficulty here was that although the EU Directive sets forth requirements for tunnel safety, it frequently fails to specify these in greater detail. For instance, reference is made to emergency walkways, but there are no specific details concerning the minimum width and layout of such walkways (on one/both side(s)). The Directive makes no reference whatsoever to important basic criteria, such as intact road surfaces or markings, clean light fixtures or properly working emergency phones. In order to fill these gaps in the rating scheme of this test, the national laws of the most important tunnel countries in Europe were referred to.

However, the EuroTAP assessment ensures that tunnels with a medium or lower risk, which only fulfil the minimum requirements of the EU Directive, still achieve a rating of Acceptable. Since these are minimum requirements that have at times already been replaced by stricter regulations in a number of EU countries, there are still no clear limits to the performance range, and this is expressed in test ratings of Good and Very good. Tunnels with a higher risk usually have a standard of safety that is higher than the minimum requirements defined in the Directive which is why these tunnels always receive positive ratings.

On the whole, the ADAC ratings of Very good, Good and Acceptable are in the positive range whilst Poor and Very poor are in the negative range.