Uli Barth and Adrian Ridder *et al* from the Faculty of Safety Engineering at the University of Wuppertal discuss their insights into the risk management of major incidents involving CBRNE in German railway tunnels

Tunnel vision

Following the terrorist attacks of 9/11 in New York and Washington and the so called "new threat level" that was proclaimed for the Federal Republic of Germany afterwards, the German Federal Office of Civil Protection and Disaster Assistance (BBK) initiated a programme for the protection of critical infrastructures (KRITIS) in 2004. One part of this programme was the scientific analysis of the "Transportation and Transport" sector. A major focus of this sector was the evaluation of the CBRNE threat and the controllability of major incidents involving them in conjunction with dangerous goods transports in German railway tunnels. This paper describes a study that was conducted as part of a co-operative research project by BBK and the University of Wuppertal (BUW) in 2005, as well as the insights that were derived thereof.

Just as this paper was being prepared, a cargo train derailed near the city of Schwedt in Germany, spilling approximately 80,000 litres of gasoline. More than 30 dwellings had to be evacuated and a nearby highway had to be closed. Major incidents due to the transportation of dangerous goods, like the one in Schwedt, prove there is a particular risk that must be assessed and observed.

Traffic infrastructure is of particular importance for industry and society in the Federal Republic of Germany, as both are dependent on the reliable supply of goods. A large part of the overall transportation of cargo takes place by railway, and dangerous goods make up a high percentage of the overall goods transported by rail. Because of those connections, the question arises over the extent to which the transportation system could be disturbed or even destroyed by multiple incidents involving CBRNE in railway tunnels. Depending on that criterion, it should be determined if railway tunnels meet the requirements of being part of the "critical infrastructure" (KRITIS). BSI/BBK define critical infrastructure as: "Organisations and facilities of major importance to the community whose failure or impairment would cause a sustained shortage of supplies, significant disruptions to public order or other dramatic consequences."

To investigate this problem from the perspective of safety requirements, the BBK funded a research project that was conducted by BUW and BBK. BBK held the project management and established an interdisciplinary advisory committee to which the research project was presented and with which the findings were extensively discussed. The following passages sum up the essential parts of research which were compiled by BUW during the 11-month preliminary phase of the project until December 2005.

The preliminary project focused on the analysis and evaluation of: the risk of exposure of dangerous goods transports; databases of certain dangerous goods transported by railway; the identification of railway tunnels in vulnerable locations; and the risk of exposure of humans to CBRNE materials. The main project was planned to deal with: the creation of possible incident scenarios; assessment of the possible effects on passengers, railway personnel and the emergency services; assessment of the possible effects of single or multiple incidents on the neighbouring population; assessment of the effects on the sector; and an overall assessment in regard to KRITIS.

The risk exposure of dangerous goods transports is made clear by the quantity

Darkness, long access routes and potentially large areas make life difficult for rescuers ©Fire Department Landeck

Tunnel vision

transported: roughly 110,000 tonnes of dangerous goods roll on German railways every day. Approximately 95 per cent are tank wagons with liquid petroleum products, chemical products and liquefied petroleum gas (LPG). The amount of dangerous goods transported by and for the German Army and allied forces is not as big as the total commercial amount (approximately five million tonnes per year).

Transportation is regulated by laws and regulations which specify nine different classes of dangerous goods. With the revised ADR/RID 2005, an effort was made to take into consideration the changed threat levels by implementing so called "high consequence dangerous goods (HCDG)" for which a series of measures are required. Those measures extend traditional transportation safety to include additional measures of "safeguarding against malpractice".

Predicting the effects

CBRNE events can harm individuals in various ways. They can affect both train passengers and the civilian population (for instance in densely populated areas), as well as responding emergency services personnel. The dangers that emanate from a substance depend on various substance-specific characteristics, such as concentration, toxicity, etc. The danger to individuals stemming from the release of a substance therefore depends on that substance's characteristics, as well as other conditions such as the exposure period, release behaviour, the number of exposed persons, etc.

What makes dealing with those hazards more complicated is the fact that, for some threats such as biological substances, their characteristics aren't sufficiently well known (eg detailed spread models). Risks are therefore hard to calculate and are dynamic depending on the number of persons affected as well as regional and temporal changes.

At least 14 databases offer information on the dangerous goods transported on the German railway system. That information is accessible by experts as well as interested citizens. These databases contain, among other things, information on serious accidents and incidents, means of identification of the specific agents based on their names, lists of synonyms and UN-Numbers, substance-specific safety characteristics, advices on dangers and dangerous effects on humans and the environment, safety measures, emergency measures, access to supporting companies and corresponding legislative provisions.

With regard to the cardinal question whether or not railway tunnels must be considered as critical infrastructure, it became obvious that this could not be answered on a case-by-case basis, due to limited project resources, the large number of railway tunnels and the different basic conditions, such as structural design, periphery, etc.). The decision was made to develop a screening process which could assist in "filtering" the most relevant sites and therefore reduce the quantity which would have to be investigated in further detail. The criteria of critical infrastructure should be the foundation of the detailed analysis.

Seven hundred tunnels have been evaluated by means of the screening procedure. The information on those tunnels was taken from the "Eisenbahnatlas Deutschland 2005/2006" (German Railway Atlas 2005/2006), in which the entire German railway system is listed. That set of data has been supplemented by data of the digital landscape model 250 (DLM250) from the topographical information system (ATKIS). Publicly available resources like the Railway Atlas have been purposely chosen to work with data that can be obtained by everyone and to be independent from assistance by the railway operator.

The screening procedure relied on both qualitative and quantitative data. The aim of the preliminary project was to create a collection of data that could be handled during the main project. Therefore the number of possibly vulnerable locations had to be reduced in order to meet the limitations of available time and money. Specific tunnels should be filtered out of the entity of German tunnels. Those specific tunnels were selected based on their potential to be considered part of the critical infrastructure. Therefore only tunnels which seemed suited for a more detailed case study were selected.

Inoperative track sections were eliminated in the first stage of screening. Roughly 70 inoperative track sections could be filtered out in this way, leaving approximately 650 tunnels of various lengths for further investigation. The next step was to filter from the remaining tunnels the ones which were shorter than 1,000 metres. The remaining tunnels are so called "long tunnels" (1,000 metres to 15.000 metres) and "very long tunnels" (more than 15,000 metres). Those denominations are legal terms taken from the Tunnel Directive of the German Federal Railway Authority (EBA – Eisenbahnbundesamt).

This quantitative criterion implies a series of aspects, such as the probability of detection of manipulation, the ability of passengers to rescue themselves without external help (Point 2.2 EBA Tunnel Directive), the development of an incident, incident tactics and possibilities for external help, as well as the required means of effective help by first responder agencies. By concentrating on tunnels longer than 1,000 metres, about 100 locations were left.

In the third stage of screening, locations without densely populated areas and/or important infrastructure in the proximity were eliminated. Part of that stage of screening was the application of the safety science concept of overlapping danger or hazard areas (SKIBA 2000). To achieve this, the area around every tunnel was divided into radiuses of 1, 2.5 and 5km, measured from the entrance and exit of the tunnel. In addition to that, information on the number of people living nearby and other aspects such as the proximity of industry, highways, water bodies, were gathered and summed up in a preliminary "tunnel passport" for every tunnel.

The definition of the maximum radius of 5,000 metres was based on the findings of the guideline "*Recommendations for separation distances between establishments under the major accidents ordinance and areas requiring protection within the framework of Land-Use Planning – Implementation of 50 Federal Pollution Protection Law*" (BImSchG) issued by