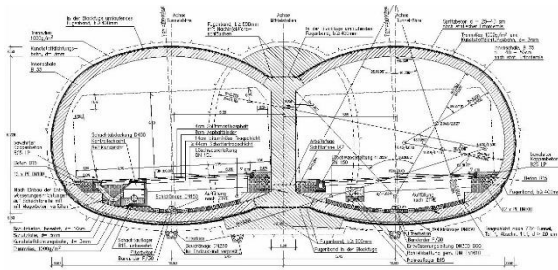




East portal of the Leutenbach tunnel



Standard cross-section of the Leutenbach tunnel

Category	Restriction
A	No restriction for dangerous goods (UN 2919 and 3331; see ADR, section 8.6.3.1)
B	Restrictions for dangerous goods that can cause: - a very large explosion
C	Restrictions for dangerous goods that can cause: - a very large explosion - a large explosion - a substantial release of toxic substances
D	Restrictions for dangerous goods that can cause: - a very large explosion - a large explosion - a substantial release of toxic substances - a large fire
E	Restriction for all dangerous goods except UN numbers 2919, 3291, 3331, 3359 and 3373

Tunnel categories according to ADR 2007

No.	Representative scenario
1	Truck, 20 MW fire
2	Truck, 100 MW fire
3	Liquid gas explosion (BLEVE) of a 50 kg liquid gas (LPG) cylinder
4	Motor spirit pool fire, 28 t
5	Explosion of a fuel vapor cloud (VCE, vapor cloud explosion), 28 t
6	Release of liquid chlorine from a 20 t tank
7	Liquid gas explosion (BLEVE) of an 18 t liquid gas tank
8	Explosion of a vapor cloud (VCE, vapor cloud explosion) from an 18 t liquid gas tank
9	Jet flame from an 18 t liquid gas tank
10	Release of ammonia from an 18 t tank
11	Release of acrolein from a 25 t tank
12	Release of acrolein from a 100 l cylinder
13	CO <sub>2</sub> liquid gas explosion (cold BLEVE) from a 20 t tank
BLEVE	Boiling liquid expanding vapor explosion – Container explosion
Hot BLEVE	Liquid gas under pressure exploding due to the effects of heat, followed by a fireball
Cold BLEVE	Liquefied, non-flammable gas under pressure exploding due to the effects of heat
VCE	Vapor cloud explosion – Gas/air mixture exploding after ignition

Event scenarios of the QRAM model

## Description

The Leutenbach tunnel is part of the B14 highway in Winnenden, Germany and comprises two sections measuring 1,080 meters in the east-west directions. Vehicles travel in a single direction in two lanes per side at a speed of 80 km/h. The tunnel has a gradient of -4.0 percent and +3.9 percent when moving from west to east and features longitudinal ventilation with 12 fans on each side. The Leutenbach tunnel also includes 4 emergency exits in the form of escape doors that lead to the adjacent side.

## Services

The procedure for categorizing dangerous goods transports as per ADR 2007 requirements subdivides into two parts.

Part 1 includes subpart 1a – rough selection via a basic parameter process. If parameters are exceeded, anticipated risk values are calculated in part 1b using the OECD/PIARC QRA model for a variety of dangerous goods accident scenarios.

If the defined limit values are exceeded, the detailed investigations outlined in part 2 must be conducted. Subpart 2a involves quantifying the risk in greater detail by way of defined scenarios. A standardized risk assessment is subsequently made and plotted on a frequency/magnitude chart for categorization purposes in order to identify and prohibit specific groups of dangerous goods from being transported through tunnels. In subpart 2b, this exclusion leads to investigating the risk inherent with traveling on the bypass route.

HBI Haerter Consulting Engineers leveraged the QRAM model in part 1b of the procedure to analyze the Leutenbach tunnel. The “default” event trees in the model were chosen as scenarios based on the type and scope of the risk calculations, and frequencies and parameters were varied to reflect the extent of the damage.

The results were reported as anticipated damage in fatalities/annual km). The values calculated in the scenarios were assigned to five different types of effect and compared against defined limit values. As all limit values were under-shot, category A could be assigned.