



Statens vegvesen
Region vest
Bergen distrikt

Report

Fire in the Fløyfjell tunnel on the 10th of November 2003



Preface

The report is based on the data in a log from the VTS (Traffic control centre), information from the fire brigade of Bergen and Hordaland Police Precinct, in addition to data from Statens Vegvesen's emergency plans and general instructions.

The report is written by Gunnar Gjæringen who deals with the service, maintenance and security of road tunnels in the western region, and is also in charge of fire protection in the tunnels of the Bergen district.

If more information is needed, please do not hesitate to contact the undersigned.

Bergen, the 21st of December 2003

Gunnar Gjæringen

Chief of fire protection

Translation of frequently used names and terms

VTS (Vegtrafikksentralen) = Traffic control centre

Statens Vegvesen = The Norwegian public road administration

Fløyfjells tunnel = A major tunnel tangent to the centre of Bergen, connecting the northern and southern main approaches.

Hordaland = County in western Norway, with Bergen as the largest town and administrative centre.

Mesta = Major private contractor deriving from the privatization of Statens Vegvesen's contracting operations.

Contents

Preface.....	chapter 1
Contents.....	chapter 2
Introduction.....	chapter 3
Conclusion.....	chapter 4
Description of the Fløyfjells tunnel.....	chapter 5
The accident.....	chapter 6
Course of events.....	chapter 7
Clearance work.....	chapter 8
Damages and repairs.....	chapter 9
What did we learn?.....	chapter 10
Tunnel drawing.....	chapter 11

Introduction

The Fløyfjells tunnel has 2 parallel passages (effectively two tunnels, one southbound and one northbound), being 3195 meters and 3825 meters respectively. The tunnels have two lanes each, and approximately 17.000 cars pass through each of them every day.

The tunnel is currently subject to an upgrade in order to comply with the relevant standards for technical outfitting found in handbook o21.

The tunnel is equipped with stop signals outside each mouth and on the onramps. There are also emergency telephones and fire extinguishers for every 350 meters. There is longitudinal ventilation and a vertical shaft 500 meters from each mouth.

There are crosswise escape passages with fireproof door-closers between the tunnels for every 350 meters. Two of them are wide enough to take a car, and the others are accessible by foot only.

The tunnel is divided into 11 zones of sprinkler systems. Each nozzle is activated when a sprinkler head melts at 59 ° C. One of the zones is equipped with a water-fogging system where the entire system (i.e. all the nozzles of that zone) sprays the tunnel with a dense, small-particle fog when heat (defined as 59 ° C) is detected in a heat-detecting cable.

The sprinkler and water fogging systems are dry systems, in that the pipes in the tunnel vaults are empty until the water is turned on at the melting of a head or detection of heat in the detection cable.



Conclusion

An accident with a tragic outcome where a person dies, is naturally an event that our department would wish had not happened. But it did, and from this we must try to gain any knowledge that can help us avoid such accidents in the future, or at least reduce the extent of them.

These points worked according to the plans

- Warning signals from the open-door sensor in the emergency cabinets.
- Warning signals from the sensor detecting a removed fire extinguisher.
- Warning signals from the off-hook sensor on the emergency telephone.
- Warning signal from the sprinkler system activation.
- The sprinkler system
- Alarm call from the VTS to the rescue departments (Police, Fire and Ambulance)
- Activation of closing procedures.
- Ventilation
- Activation of fireproof door-closers in emergency passages.
- All emergency installation worked as they should.
- Communication between the rescue teams and personnel from Statens Vegvesen.
- Commuters and other present civilians helped in any way they could, and acted with exemplariness.

These points did not work according to the plans

- The fireproof doors in the emergency passages were difficult to open.
- There were too few fire extinguishers (after the upgrade to be completed by spring 2004 there will be two extinguishers for every 60 meters).
- Journalists created dangerous situations by their badly parked cars, and by their general behaviour around the scene of the accident.
- Heavy traffic created problems for the rescue teams and slowed their progress.
- The parallel (northbound) passage was not utilized for rescue purposes.
- The means of internal alarm notifications within Statens Vegvesen must be further discussed.
- Break-in messages to the commuters on radio frequencies (not yet ready)



As this report is written, the report from the Police is not yet ready. Consequently, it is too soon to conclude on the reason for the accident.

The complete costs relating to expended materials and clearance work in the tunnel (not covering the work of the rescue departments) has been estimated to NOK 200.000,- (approx. USD 30.000,-).

Description of the Fløyfjells tunnel

The tunnel is made out of two parallel passages (i.e. separate tunnels for each direction). Each passage has two lanes of traffic.

Length of southbound tunnel	:	3.195 km (accident)
Length of northbound tunnel	:	3.825 km
Tunnel class	:	E
Opening year	:	1987
Cars per day – southbound	:	18000
Cars per day - northbound	:	18000
Crosswise emergency passages	:	10 for every 300 meters 2 of which are driveable

Watertighting by PE-foam mats:

Southbound :	approx. 29.400 m ²
Northbound :	approx. 32.500 m ²

Means of securing the tunnels:

- Emergency break-in message to commuters via the radio frequencies on the national radio channels "NRK P1", "P4", and "Radio 1".
- Emergency telephones in the tunnel (Currently being upgraded).
- Longitudinal mobile telephone aerial in the tunnel vault
- Communication trunk to the rescue departments, channels 1, 2 and 3 and emergency rescue channel.
- Red stop signals for closing the tunnel.
- Gates for closing the tunnel.
- 10 emergency passages to the opposite tunnel.
- 2 larger emergency passages for evacuation of vehicles to the opposite tunnel.
- Signs identifying emergency exits.
- Fire extinguishers (currently subject to upgrade / extension).
- Fire protection of PE-foam. Current sprinkler system has been installed since the opening year. A water-fogging system is installed in one zone for testing.
- Powerful ventilation system installed since opening year. Longitudinal ventilation with shafts in each end.
- Water supply at each emergency passage.
- The tunnel is connected to the VTS.
- Emergency control cabinet near the tunnel mouth.
- Emergency plan with a risk analysis and an action plan for the Fire brigade.

Fire protection of the Fløyfjells tunnel is a part of the upgrade programme that the Fire brigade of Bergen has imposed on Statens Vegvesen for all the tunnels in the Bergen area. The goal of the programme is to make the tunnels comply with the standards in handbook o21 for road tunnels. The upgrade of the Fløyfjells tunnel is currently in progress and is expected to be completed in the course of 2004.

The predefined action plan for the fire brigade in the event of a fire in the tunnel is that firemen from Sandviken fire station (i.e. the precinct to the north of the tunnels) drive to the southbound passage, while firemen from the main fire station (in the town centre) drive to the northbound passage. This ensures that the fire brigade reaches the scene of the accident as soon as possible.

The accident

The car was an old Opel Ascona (aka Vauxhall) with one driver and no passengers. It drove down the southbound tunnel and hit the left wall, then the right wall before it hit the left wall again with a powerful impact. The accident happened about 2.1 km inside the 3.195 km long tunnel, a short distance after the southernmost of the wide, driveable emergency crosswise passages.

There were no other cars near the accident car when it hit the walls. The driver was stuck inside the car.

The car caught fire after the collision, and other motorists tried in vain to put out the fire with the extinguishers found in the tunnel and inside stopping trucks. The fire was already beyond control when the firemen arrived and the driver of the car was dead on arrival. The cause of death will be stated in the report from the Police's post-mortem examination.

The fire spread to the PE-foam mats on the tunnel wall and about 3-4 square meters of this material had caught fire. The automatic sprinkler system started at an early stage and suppressed the car fire itself as well as the fire in the PE-foam mats.

The accident occurred during rush-hours at around 16.20 and a large part of the southbound tunnel was rapidly filled with cars. The fire truck from Sandviken fire station drove 300 meters into the tunnel before it met a congestion of cars that had stopped because of the accident. Hence, the around 1.700 meters long tie-up of cars in both lanes must have contained about 500 vehicles in total.

Course of events

On the 10th of November 2003 an accident occurred in the southbound passage of the Fløyfjells tunnel going towards the centre of Bergen.

The course of events has been outlined in an extract from the log made by the VTS:

- 16.21: Alarm on OS 32 indicating that a fire extinguisher had been removed and an indication that a door on an emergency telephone booth had been opened at locations 1103, 1104 and 1113. An indication that the sprinkler system had been activated was also seen. All these alarms went off at the same time.
- 16.22: The fireman on duty calls and asks that the tunnel is closed as there is a fire in the tunnel close to the exit near the town centre.
- 16.23: Closed the tunnel.
- 16.24: The traffic lights in the town centre were set in a mode reflecting the change of traffic patterns when the tunnels are closed.
- 16.31: The fans were set to manual override and switched to level 3 towards the town centre in the southbound tunnel as requested by the fire brigade.
- 16.31: A message was recorded in "Evita" that the tunnel had been closed in both directions and posted on list B.
- 16.32: Head of the district road administration Olav Finne was notified about the event. He received consecutive updates the next hours.
- 16.48: The person on duty for emergency stand-by was notified.
- 16.42: The chief fireman on duty asked for the fans to be switched to level 3 in the northbound tunnel, as there was smoke in the tunnel vault. The fans in the southbound tunnel were turned on.
- 16.45: The northbound tunnel was opened. The left lane remained closed while the right lane was open with the speed limit reduced to 60 km/h. The traffic lights were changed according to the action plan.
- 16.57: The smoke was cleared from the tunnel and the Police requested that the fans be reset to automatic in the southbound tunnel.
- 17.09: The left lane of the northbound tunnel was reopened and the fans set to automatic. The speed limit was still 60 km/h.

- 17.11: Note in "Evita" that the northbound tunnel was opened and posted on list B.
- 17.15: Gjæringen asks that Mesta is called out to clear the accident scene.
- 18.29: The fans were set to automatic towards the shafts.
- 18.59: The light was set to "day 1" in the entire southbound tunnel.
- 19.00: The clearance team was asked to wait until the victim had been removed from the car.
- 19.34: The speed set to normal (80 km/h) after having conferred with the police.
- 19.55: Message from Gjæringen and the Police that clearance team may be on the site in an hour. The message was passed on to the standby workers and the electrician on duty.
- 23.45: The Police asked to know when the tunnel may be opened. The electrician reported that it could reopen at 02.00. The Police and the Lærdal office were notified.
- 05.00: The tunnel was opened – posted on "Evita". The Police and the Lærdal office were notified.

Clearance work

The fire was put out shortly after the fire brigade arrived at the scene of the accident. The rescue team quickly concluded that the person in the car was dead, and the car was covered.

People from the press were allowed to take pictures on the scene.

After this, the clearance work could start.

- Present in the tunnel was people from the Police, the fire brigade, Statens Vegvesen, a forensic team, a funeral agent and an emergency car rescue company.
- The Police made the necessary investigations on the in order to secure evidence that could point towards a conclusion on the cause of the accident. This work was extensive.
- The fire brigade commenced with the process of removing the victim from the car. The car was stretched and parts of it were cut away. The victim was removed and transported to *Gades* forensics institute.
- The wreck was removed from the scene.
- The road surface was hosed and cleaned.
- *Mesta*, as the contractor for tunnel maintenance, performed the remaining clearance work, dismantling and preparation of the sprinkler system, replacement of damaged air-hose, refitting of the electrical equipment and refitting of the control system and cables.
- The tunnel was closed for 12,5 hours from 16.20 to 05.00.

Damages and repairs

- One emergency cabinet with a fire extinguisher and an emergency telephone and a distribution box for 4 other emergency cabinets were destroyed as a result of the impact.
- As a cause of the fire, 2-3 m² of the watertight sealing material – PE – was damaged.
- The air hose for the sprinkler system was damaged and had to be replaced for 20 meters.
- 10 sprinkler heads were used (melted) and had to be replaced.
- The sprinkler system was dismantled and prepared for reinstallation.
- The tunnel was cleaned.
- Estimated total expenses for repairs was NOK 200.000,-



What did we learn?

A fire in a tunnel will have disastrous consequences, especially if it takes more than 5 minutes from the fire breaks out until the rescue teams arrive at the scene. On this occasion, it took 6 minutes from the moment when the operators were notified until the rescue party arrived.

The indication of time must be synchronised between the VTS and the fire brigade's emergency operator.

It is crucial that a message is sent from the scene of the accident immediately after the incident. This will improve the chances of a positive outcome.

Tunnel closing procedures must work, as they did here.

The use of driveable emergency crosswise passages is important both for rescue and evacuation purposes. On this occasion, all smaller vehicles were guided through these passages and into the opposite tunnel.

Ventilation must be responsive and efficient, like it was in this situation.

It is crucial that the sprinkler system is activated and functional immediately, like it was here.

The emergency equipment worked as a first means of support like it should.

The efforts of civilian motorists can be vital for the outcome of an accident.

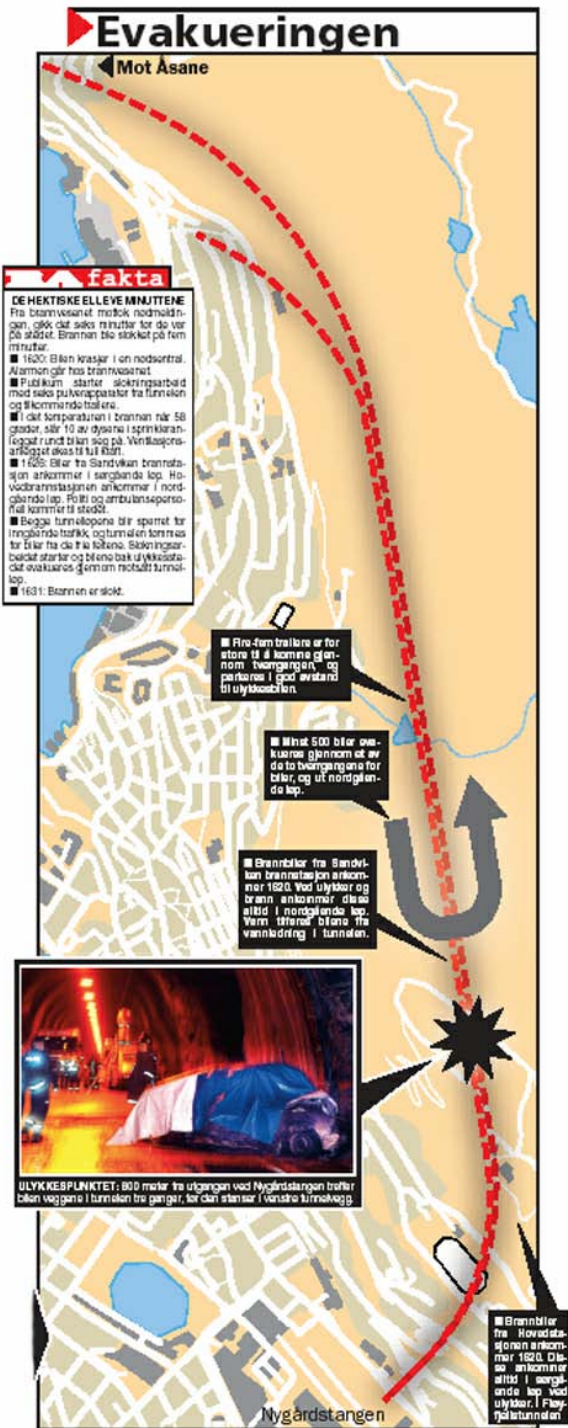
Proper routines for operation and maintenance are of crucial importance for all the equipment to work at all times. The documentation of routines and schedules is very important.

Sufficient access for the fire brigade is of significant importance.

The use of the crosswise emergency passages is important for the accessibility for the rescue parties.

If the tunnel had been designed in accordance with T-9,5 as Hb. 021 requires today, the rescue teams would probably have reached the scene of the accident at an earlier stage.

Tunnel drawing



Copyright – Bergensavisen AS