A translation of the

Final Report
Live Fire Training inside the A 8 High-Way-Tunnel Sachseln (CH) 14. May 1997

made by

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1. Preparation

1.1 General situation

With the opening of the A 8 High-Way section Sarnen south - Ewil and the tunnel Sachseln with a length of 5,2 km all rescue services and in particular the fire services will be confronted with new and unpredictable situations.
In order to familiarize the members of the Sarnen fire department (voluntary fire services) with the pecularities of a fire in a road tunnel it was decided to conduct a training under live fire conditions.

1.2 Characteristic of the training

Realistic fire combat training under clearly stipulated conditions.

1.3 Command

Officer in charge: - August Husner, Chief AZSF, Fire sevice inspector

Participants:
- Otto Läubli, Fire Chief Sarnen
- Walter von Weissenfluh, Construction Office Sachseln
- Jörg Stauber, Construction Dep. OW
- Karl Rohrer, Construction Dep. OW
- Josef Burch, Roads Inspectorate OW
- Stefan Küchler, Chief Traffic Police OW
- Various representatives of companies involved in the tunnel project
- Messrs. VOGT AG, Fire Equipment and Fire Service Vehicles, Oberdiessbach.

1.4 Objective and purpose of the training

⇒ Familiarisation of the members of the volintary fire dep. Sarnen with fire and smoke inside the tunnel by means of a controlled exercise

⇒ Practical and realistic test of the ventilation system installed in the tunnel

⇒ Demonstrating the possibility of a solution to the problem by means of mobile equipment in cases where the capacity of the fixed ventilation system is insufficient or when a full system failure occurs.

2. Realization

2.1 Scenario

Frontal collision between a car and a small bus at km 72.200 (approx. 2000 m distant from northern entry/exit). Both of the vehicles instantly burst in flames. No rescue required.

2.2 Schedule

Time	Action
18.45 h	Collision and fire scenario readily prepared
18.45 h	Introduction into the exercise - Officer in charge - other participants in the exercise - command group of exercise - visitors and guests
19.00 h	Visual inspection of the site
19.15 h	All persons without breathing equipment proceed for the northern entry/exit
19.26 h	Communication check
19.30 - approx. 20.00 h	FD Sarnen ready to respond. Video ready. Exercise phase I fire, ventilation by fix installed system
20.00 h	Re-establishment, preparation for phase II
20.15 - approx. 20.45 h	Exercise phase II fire,MVU
approx. 21.00 h	End of exercise, briefing

3. Valuation

3.1 Fire service response

The protective outfit of the members of the Sarnen FD has proved suitable as in particular the wim cylinder Dräger breathing apparatus PA 94. The concept born in view of a response to a Tunnel fire to equip the pumper-tanker with two rapid intervention handlines water/fram with 60 m length of hose each, forward sweep nozzle, BA-units readily installed inside the crew compartment has proven to be very effective and suiting the purpose. Both fires with pre-burn of 5 minutes were extinguished within a few minutes.
During phase I Fire the vision was temporarily less than 50 cm which added to the precariousness thus heavily increasing the psychological pressure on the firemen. Transport capacity provided by the available vehicles of approx. 18 persons is considered to be barely sufficient.

3.2. Infrastructure on site

Water supply inside the tunnel by means of pillar hydrants spaced every 150 m apart was sufficient to allow to combat the fire and at the same time to provide extra water for the two stand-by resp. cooling water lines. In both vehicles the fire was ignited inside the passengers compartment resulting in adequate production of smoke. The intensity of smoke developed by the fire was such that withdrawing of smoke by suction from the ventilation system was insufficient resulting in severe obscuration of vision, at times to a value of no vision at all. (Refer to appendix 1 and 2).

4. Realization

4.1. Cognitions

Combatting the fire was not problematic for the FD Sarnen, because of:

- availability of appropriate equipment
- situation and site were recognized prior to start of fire and therefore known
- fire fighters and their equipment ready to combat the fire were positioned at 10 - 15 m distance to the site prior to ignition of the fire.

Visibility was obscured by smoke arizing from the fire to such an extent that:

- approach to the site by vehicles is considered heavily impeded, and if at all possible only at sacrifice of time and by using breathing equipment.
- there appears to be no chance to rescue other persons from vehicles that may also be involved in the collision

Correctness of this statement is clearly documented by the video tape taken of phase I. Photos were only taken from phase II.

During the exercise phase II with the MVU positioned in front of the entrance of the tunnel the following was observed:

- within a few minutes from starting the MVU the ffect was noticed at the site (2000 m distant from MVU-position). (refer to append.)
- the MVU created an air movement at a velosity of 7 km/h in the south direction
- the approach road for vehicles was clear from smoke
- visibility at the site was fairly good (refer to append. 3). The fire men were able to advance under almost "normal" conditions

4.2 Lessons drawn

When combatting a fire or rescuing persons it is a must, that vehicles and equipment are available in the immediate vicinity of the incident for what reason it is a vital requirement that the vehicles of the FD will reach the site under any circumstances. Condition of clear visibility provides a prerequisite for the approach of the firemen where as bad visibility will add to their physical and psychological pressure.

4.3 Conclusions

Measures should be initiated to reduce the problem of smoke removal to an extent as depicted under 4.2.
The MVU as was employed during phase II of the exercise clearly demonstrated, how such targets can be met.

The problem of low transport capacity for the personell of the FD as well as for the remoral of persons (civilians) from the endangered area should be further examined.

5. File of application

Procurement of such a unit (MVU) is to be initiated at the earliest possible.

6. Appreciation

As the officer in charge I should like to express my sincere thanks to all people involved in permitting such an exercise, and all participants in the exercise. Special thanks are addressed to the Director of the military and police department, Mrs. Elisabeth Gander, who with interest observed the exercise on site.

Measuring results of phase I, south of site

Ventilationtest 14.05.97 in Highwaytunnel Sarnen-Sachseln				
Measureing instruments engaged at 19.17 h				
Location of instruments: approx. 20 m south of fire place at 0,5 m; 1,6 m and 4 m above ground + "on man"				
The following details refer to "on man"				
Time	"Wind"; km/h	"Wind"; Direc..	CO-Concentr..	Remarks/Observation on smoke
1935	< 1	to North	- 9	prior to ignition
1945	< 1	to South	0	justantly after ignition
1946	< 1	to South	0	already significant generation of smoke and flames visible in PW
1948	< 1	to South	0	smoke under ceiling spread 50 m south-wards
1950	< 1	to North	-1	intensive fire; up to approx. 10 m southward thick smoke
1952	< 1	to South	8	Sight from south towardsfire through steam developed from water < 20 m
1953	< 1	to North	16	dense smoke/steam
1956	< 1	to North	6	dense smoke/steam
1958	< 1	to North	9	fire object beoming sightly visible again
1959	< 1	to South	7	visibility up to vehicle parked opposite (50 m) "good"

Measuring results of phase I, north of site

Ventilationtest 14.05.97 in Highwaytunnel Sarnen-Sachseln				
Measureing instruments engaged at 19.17 h				
Location of instruments: approx. 20 m north of fire place at 0,5 m; 1,6 m and 4 m above ground + "on man"				
The following details refer to "on man"				
Time	"Wind"; km/h	"Wind"; Direc..	CO-Concentr..	Remarks/Observation on smoke
1940	< 1	to South	1	prior to ignition
1944	< 1	to South	17	justantly after ignition (=> 1943)
1949	< 1	to South	16	no smoke visible
1949	< 1	to South	22	smoke visible
1949	< 1	to South	42	dense smoke
1949	< 1	to South	77	
1950	< 1	to South	116	
1950	< 1	to South	122	
1953	1	to South	79	smoke less dense
1953	< 1	to South	42	
1954	< 1	to South	39	
1955	< 1	to South	24	visibility good again
1959	< 1	to South	20	

Measuring results of phase II, south of site

Ventilationtest 14.05.97 in Highwaytunnel Sarnen-Sachseln				
Measureing instruments engaged at 19.17 h				
Location of instruments: approx. 20 m north of fire place at 0,5 m; 1,6 m and 4 m above ground + "on man"				
The following details refer to "on man"				
Time	"Wind"; km/h	"Wind"; Direc..	CO-Concentr..	Remarks/Observation on smoke
2040	< 1	to South	-9	prior to ignition
2051	ca. 3	to South	-6	inpantly after ignition (=>2050; flames visible in PW)
2053	ca. 3	to South	-3	spares development of smoke, but reading the ceiling above the fire
2056	> 4	to South	-8	black smoke under ceiling travels south
2057	ca. 7	to South	-6	black smoke under ceiling travels further south. Vision to fire site unobserved.
2059	ca. 7	to South	0	black smoke/steam also at ground; visibility to the north difficult
2100	ca. 7	to South	-4	visibility too the north "clear", to the south smoke/steam exeaping
2103	ca. 7	to South	-4	visibility to north clear; to the southalready clear up to 200 m

Measuring results of phase II, north of site

Ventilationtest 14.05.97 in Highwaytunnel Sarnen-Sachseln				
Measureing instruments engaged at 19.17 h				
Location of instruments: approx. 20 m north of fire place at 0,5 m; 1,6 m and 4 m above ground + "on man"				
The following details refer to "on man"				
Time	"Wind"; km/h	"Wind"; Direc..	CO-Concentr..	Remarks/Observation on smoke
2040	< 1	to South	1	prior to ignition
2049	ca. 3	to South	1	prior to ignition
2051	ca. 5	to South	1	intently after ignition (=> 2050; flames visible in PW)
2054	ca. 4	to South	1	smoke up to as far as PW
2058	ca. 6	to South	15	smoke further than PW