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FIRE FIGHTERS AND TRAFFIC SAFETY

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Abstract

Fire brigades have the task to realize public safety. Fire fighting and incident control proves to be one of the most visible and hazardous tasks. However, the transport back and forth to the accident sites proves to be very hazardous as well. In case of urgency, this transport task needs to be done in a quick and safe way. To this end, fire fighting vehicles have been legally acknowledged preferential regulatory arrangements, including driving with acoustic and optic signs. Despite these signs, traffic accidents involving fire-fighting vehicles occur. Consequences could be fatal for the persons involved in the accident itself, but could also be fatal for those people who were depending on for example for rescue activities of the fire fighters. The paper elaborates on a research project into the issue of traffic safety involving fire fighters vehicles on public roads in the Netherlands. It provides insights into the accident numbers, and qualitative insights in accident contributors. In addition, several recommendations are defined for improving traffic safety of fire-fighting teams.

Keywords: Fire fighting, traffic safety, urgent response

Introduction

Some years ago, several tragic accidents with fire fighting vehicles drew significant local public and media attention in the Netherlands:

3 December 2000:

> A fire commander turns out with urgency to a diving incident. In avoiding bicyclists and oncoming traffic, he deviated from his track on the dike road and collided with a tree. He did not survive the accident. Shortly afterwards the incident report was withdrawn.

12 November 2000, The Hague:

> During a turn out to a fire, the driver of a fire engine, supported by acoustic and visual signs, might have crossed a red traffic light. The fire engine and collided with a car containing 5 occupants. A young woman died, four young men got injured.

30 January 1999, Amsterdam:

> During a turn out, a traffic accident took place. The driver of the fire vehicle, supported by acoustic and visual signs, crossed a red light and collided with a car. The female driver of the vehicle was injured to such an extent that she had a miscarriage.

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2 July 1998, Wijk bij Duurstede:

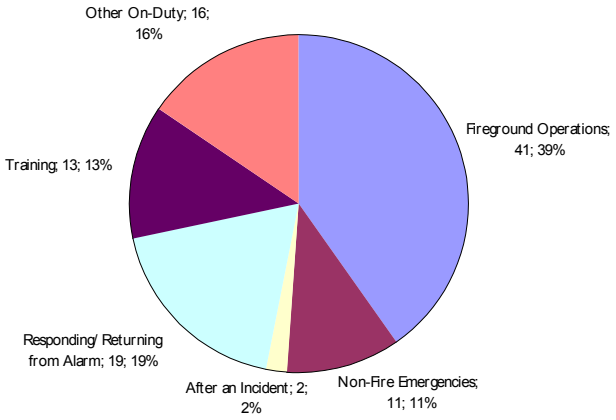
> The fire commander of a voluntary unit returns to his fire station after a fire report. In avoiding an oncoming car in a bend, his car ran into the soft shoulder of the dike road. He was thrown through the windshield and was partially crushed by his vehicle overturning on him. He died at the incident scene.

From these accidents, it can be seen that traffic victims occur within the fire brigades them selves as among other road users. The consequences of the delay for the fire fighter to arrive at the accident scene where they were initially heading for are unknown. In addition to the direct physical impacts of fire fighting traffic accident, indirect juridical impact may occur. In several cases, the drivers of fire fighting vehicles involved in accidents had to appear in court. These trials very much fuelled debate among the fire brigade community.

The above-described accidents are far more than ad hoc incidents. Despite the fact that for the Dutch situation a comprehensive fire fighting accident database is lacking (Duindam, 2001) American figures indicate the structural character of the traffic safety issue within the fire-fighting sector. It appears that in 2000, about 20% of the fatalities of the US fire fighters, died because of a traffic accident being on duty (based upon USFA: www.usfa.com) (See fig 1, category responding/returning from alarm).

For the Dutch situation, traffic risks for fire fighters seemed to be a forgotten issue in comparison with the occupational hazards (at the offices) and risks at the scene of a fire or other emergency. Despite the facts that traffic safety was mentioned in a survey concerning risks for fire-fighters (Helsloot and Van Duin, 1999), most attention was paid to the occupational safety aspects at that moment.

Figure 1: distribution among fire fighting activities of US fire fighter fatalities



The lack of attention to traffic safety and the ongoing flow of fire fighting traffic accidents did realize a fire fighting accident analysis group and the Dutch Institute for Fire Service and Disaster Management knowledge of the societal relevant subject was lacking. As a result, research after the issue of

traffic safety was initiated and has been elaborated in (Rosmuller et. al. 2001). This paper summarizes the most relevant findings. In chapter 2, the research framework is described, followed by a description of the relevant data (chapter 3): the accident numbers, causes and solution. Chapter 4 concludes this paper with the main lessons and recommendations.

2. Research framework

Three principal research questions were raised:
- To what *extend* are fire fighting vehicles involved in traffic accidents?
- Which *causes* and *conditions* can be identified for these traffic accidents?
- Which categories of *solutions* may contribute to improving traffic safety? (for the road user in general and fire fighting community in particular).

The research consisted of a questionnaire, an expert group session and several workshops.

Questionnaire

To indicate the extent of the traffic safety problem, a questionnaire was developed. It was not possible to search existing accident databases for traffic accidents involving fire fighting vehicles. Until 1997, the Dutch organization for statistical research maintained a traffic accident database in which emergence vehicles accidents were labelled. After 1997, this label was removed for political reasons and database searches after it were not facilitated anymore. In addition fire brigades themselves do not file their accidents and near misses in databases.

In the questionnaire, quantitative questions were formulated regarding traffic accident over the 5-yearperiod 1995-1999 and the average number of transport activities throughout these years.
Traffic activities where discriminated into three principle phases:
- the call out phase: transport in a private car from the homes/work towards the fire-station
- the turn out phase: transport in a fire fighting vehicle towards the accident scene
- the turn in phase: transport in a fire fighting vehicle from the accident scene towards the fire station.

The goal of the questionnaire was to realize a first approximation of the number of accidents per trip during the call out, turn out and turn in phases. Most relevant questions for all categories of fire brigade organizations:
- the number of urgent call outs and turn outs per year
- the number of accidents over a 5 year period during all phases, discriminating fatalities, injuries and material damage only.
- The number of near-misses during all phases of the traffic participation over a 5 year period

In the questionnaire a distinction was made between questions for management and drivers within the fire brigades regarding the overall accident frequency versus personal experience with accident involvement. Questions to drivers also regarded the number of years they had experience as a driver. Volunteers were also asked for the number of years experience as a fire brigade member and the distance between their homes and the fire station. Both drivers and staff where asked for the accident numbers. In this way, it was possible to cross check the generated accident numbers.

Expert group session
To provide insight in the accident causes, a group session with drivers and driving experts was organized. This session was meant to clarify the processes that a fire fighter encounters from the moment (s)he receives a distress call. The discussion was structured according to the phases encompassing the overall transport activity:

- Reporting: the alarm to fire fighters
- call out: the trip in a private car from a volunteer from his home/work to the fire station
- preparation at the fire-station: getting ready for leaving the fire station
- turn out: the trip in a fire fighting vehicle from the fire station to the incident scene
- turn in: the trip in a fire fighting vehicle from the incident scene to the fire station.

Experts and drivers were asked about their motivation for and nature of their decisions and operational dilemma's they encountered in each of these phase. Meanwhile, drivers and experts were stimulated to interact and react on issues that where brought forward.

Workshops
After making an inventory of factors contributing to possible accident, a series of workshops was organized to explore the professional judgment of drivers on these factors. In addition, the social support for possible solutions was discussed in these workshops. Four parallel workshops where held twice at an occupational safety congress in June 2000 at the Dutch Institute for Fire Service and Disaster Management. Attendants of this congress were for the bigger part fire fighters, affiliated both with public and private fire brigades. The almost 200 attendees came for the broader subject of occupational safety with respect to fire fighting. Traffic safety is just one of particular subject of this broad subject. During the morning, time was reserved for plenary presentations. After the lunch, attendees were randomly distributed among for parallel session, each having a chairman who was active in fire fighting accident analysis group. The subject in the first round was to address causes for traffic safety problems regard fire fighting vehicles. The second round, most effort was put on making an inventory of solution directions.

3. Data
Data was gathered with regard to the number of accidents, accident causes and solutions.

<u>The numbers</u>
The questionnaire was distributed to 25private fire brigades, 50 voluntary fire brigades as well as professional public organizations. A total of 404 questionnaires were distributed (75 to management, 200 to drivers and 129 to volunteers). The response to the questionnaire differed between the categories, varying from management (66.7%), to drivers (59.5%) and volunteers (49.6%). Approximately 70% of all turn outs proved to be preceded by call outs of volunteers. Discriminated towards the three phases and related to the actual number of trips per year a clear distinction between the phases was shown.

Table 1: accidents per transport phase.

	Accidents/yr	Trips/yr	Acc.%/trip
Call out	18	24792	0.07
Turn out	110.4	35803	0.31
Turn in	9.2	35803	0.03

As we can see by this table, accidents during turn out occur 4 times as frequent as accidents during call out and approximately 10 times more than during turn in.

As demonstrated by the next table, discriminated to the kind of organization, professional organizations suffer the most accidents per turn out. The least accidents occur with mixed organizations (of voluntary and professional fire fighters), while the percentage of accidents per turn out of public fire brigades is almost 3 times as low as compared to private fire brigades. An explanation for this difference cannot be supplied due to the ambiguity of registration in the various organizations.

Table 2: Accident among types of fire brigades.

	Acc./yr.	Turn out/yr.	Acc./turn out
Voluntary	1.6	403	0.40%
Mixed	44.2	24389	0.18%
Professional	54.2	9950	0.55%
Overall public	100.2	34742	0.29%
Private	10.2	1061	0.96%

A relation with the number of years in service shows a two to three times higher accident frequency during the first 5 years compared to drivers with longer working experience. A slight increase in traffic accidents also appeared for drivers having over 20 to 25 years in service.

A distinction occurs between professionals and volunteers, with a clear peak in accident frequency for volunteers with about 15 to 20 years of experience. While the other categories have a percentage of about 0.20% to 0.30%, volunteers score about 0.94%. Again, we were not able to find a plausible explanation for this difference.

The results of the questionnaire provide a preliminary picture of the accident frequency per year across various categories of the fire fighting field and phases of the traffic process:

Table 3: Accident consequences per type of fire brigade per phase.

	volunteer	**professional**	**Private**	**Overall**
		Call out		
Fatal	0	-	-	-
Injury	3.65	-	-	-
Material	6.6	-	-	-
		Turn out		
Fatal	0	0	0	0
Injury	0	0.001	0	0.001

	volunteer	professional	Private	Overall
Material	0.18	0.03	0.09	0.30
		Turn in		
Fatal	0	0	0	0
Injury	0	0	0	0
Material	0.07	0.01	0.04	0.12

Rearranged to the number of accident per number of trips the traffic safety of fire brigade vehicles can be stated as:
Call out: one accident per 1400 trips
Turn out: one accident per 300 trips
Turn in: one accident per 3300 trips.

During the most risky trip phase –the turn out-, the number of accidents per trip over the types of fire brigades is:
Volunteers: one accident per 250 trips
Professionals: one accident per 200 trips
Mixed: one accident per 550 trips.

The severity of the accidents as an average over a 5-year period showed 0.4 accidents with fatalities and injuries per year and 127.2 accidents with material damage only.

Above-presented figures are just indications, a statistically representative judgement is not yet possible. Ambiguity on data collection procedures and collection rate, differences across registration systems and limited distribution of the questionnaire may obscure the image

Based on the data collected by the questionnaire, some preliminary conclusions can be drawn.
1. the inventory indicates a justification for paying attention to the traffic safety of fire brigade vehicles. During callout, turn out as well as turn in, accidents do frequently occur, sometimes with serious consequences
2. Differences across phases exist, as turn out prevails over the other phases. However, the call out of volunteers deserves additional attention.
3. Differences across organizations exist. Private and professional organizations have accident rates compared to mixed organizations.
4. A relation between accident rate and years in service and age exists. Novice drivers, very experienced drivers and volunteers with a long career history score relatively high on being involved in traffic accidents.

3.2 Contributors and causes

The preliminary findings do provide some indications of the extend, nature and severity of traffic accidents involving fire-fighting vehicles. They do not yet however provide understanding of contributing factors or give a satisfactory explanation of the accidents.

Contributing factors

The results of the group session are presented according to the phases encompassing the whole transport activity: reporting, call out, preparation at the fire-station, turn out and turn in.

During *reporting*, distress calls may be received in three different manners:

- alert without notification. The dilemma for the supervisor is the lack of information, in the decision whether this call is of an urgent nature or not and what the nature of the response should be.
- Alert with notification. A dilemma is the assessment of the information, since urgent calls do require a timely response.
- Alert with verbal notification. By listening to the tone and agitation of the voice an indication can be received of the nature and urgency of the call.

During *call out*, only the role of volunteers, leaving their homes/work is the matter. Professionals are already present in their fire stations. Factors and conditions that may contribute to accident causation are:

- stress. After receiving a notification, the fire fighter has to decide whether or not to respond to the message implying that work/family are left behind at once. In practice hardly any denial takes place.
- The 'first vehicle' effect. Volunteers are eager to participate in a turn out. Since fire are relatively rare events and the first vehicle to arrive has control over the situation at the scene, any volunteer tries to get on this vehicle. Only 6 volunteers can take part, so a mismatch between supply and demand occurs. In the call out phase, volunteers speed to the fire stations with their private cars and cannot be recognized by other traffic participants as drivers with urgent tasks.

During *preparation* at the fire stations, a stressful situation occurs in getting dressed and equipped for the turn out. Volunteers arriving relatively late in responding to a call out, may encounter fire fighters and vehicles already leaving the premises. Crossing vehicles may jeopardize the traffic safety at the fire station. This hazard is less prominent for professional and corporate fire fighting organizations since all personnel is already present at the fire station.

During *turn out* a number of risk contributing factors have been identified which may have a negative influence on driving behaviour and concentration. These factors are:

- experience. The more experienced, the less stress occurs due to familiarization and decreasing responses at older age, an increased accident proneness may occur.
- Coaching. During the trip, the on-scene commander coaches the driver through the traffic by anticipating on traffic bottlenecks and route diversions. The fire engines have to comply with established time arrival criteria. Commanders in a voluntary organization may not have driving experience themselves, which may reduce their drivers coaching capability.
- Distracting factors. Drivers overhear a lot of incoming information during the trip, which may be relevant for their routing and driving decisions. Also the commander has to assess the information. This assessment task may interfere with the driving task.
- Accessibility. Urban environments have specific problems due to limited access of the scenes, traffic jams, unloading vehicles, etc. To avoid a gridlock situation, in many cases fire fighting vehicles approach the scene from two different directions. In case of an emergency, fire fighting vehicles may 'force' their way into the scene by accepting small material damages to other vehicles or the environment.
- Personal attitude. Stress and private circumstances may have such a dominant influence on the driver's behaviour that another driver will be asked to take over the driving task.

During *turn in* a number of risk contributing factors are identified which may contribute to accident causation:

- aggravating circumstances on the scene of the incident. Often, the fire fighters have been active for many hours at a stretch. Fatigue, filth, cold, heat and climatic circumstances may influence the driving ability of the drivers. Leaving the scene requires careful attention to others, equipment and bystanders. Sometimes the window shields are steamed, reducing visibility for the drivers.
- 'Heading for home'. Within professional organizations there is a tendency to leave for the fire stations individually, causing a sense of urgency which may possibly interfere with other activities still present on the scene. Volunteers however, tend to leave the scene together, followed by an evaluation of the event after returning to the fire stations.

Causes

The following categories of accident causation factors were identified as of a more systematic and structural nature:

- regulation for fire fighting vehicle drivers deals with interpretation problems regarding the acoustical and optical signs regulation. The definition of a 'urgent task' leaves room for interpretation[3]. Vehicles with urgent task do not have a right of way, and consequently cannot *claim* this right, but other vehicles do have the *obligation to give* them right of way.
- The knowledge of other traffic participants is almost absent regarding the 'right of way regulations' for vehicles with urgent tasks. This is demonstrated in practice by the wide variety of responses to such vehicles.
- The ratio in courses between training and operational practice leaves little room for practicing. The responsibility for practicing is delegated to local organizations.
- Quality control of driver performance and proficiency within the fire fighting organizations is not tuned to the needs of operational crews.

Ranked to their perceived importance, the group session participants identified the most important accident causation conditions as:

- Allocation of money. The manner in which policy institutions deal with available money does not comply with the needs of fire fighting vehicle drivers: speed bumps reduce speed but increase driving times, high demands are put on the skills of drivers, but inexperienced volunteers without detailed legal knowledge are recruited.
- Discipline of fellow road users. There is a sense that other road users are not any longer so much willing to respect the needs of vehicles with urgent tasks. There seems to be a decreasing willingness to clear the roads for these vehicles.
- Training of drivers. The substantial contribution of theoretical knowledge in the training modules deprives the drivers from the need to have practical knowledge of vehicle control and traffic situations.
- Driver's attitude. Drivers of fire fighting vehicles are just human beings; they also suffer from a fading discipline and loss of tolerance in modern traffic.

[3] In July 2002, the Dutch Government presented a 'Guideline for optical and acoustic signs for the fire fighting sector' (BZK, 2001). Police and medicals services will follow. The fire fighting guideline is implemented by holding presentations in each of the fire fighting regions in the Netherlands.

3.3 Solutions

In view of the above mentioned conditions a wide variety of strategies and solutions for safety improvements are available. Due to the complexity and involvement of many actors, a number of these solutions will only be possible on the long term. Fortunately, short-term options are available as well. Indications for solutions and opportunities to improve the traffic safety of fire fighting vehicles on a short term have emerged from the workshops and group session and were discussed during a working conference (Nibra 2000). The solutions can be ranked in compliance with the phases of the traffic process.

During call out:
- Improve the driving behaviour by discussing risk awareness among volunteers, propagate seat belt use, social responsibilities and apply sanctions if necessary.
- Adapt the picket schedule and regulations by matching supply and demand and readjustment of the need for urgent calls[4].
- Evaluate risk adaptation of routing and tracks in public space and fire stations.
- Apply standardization of calls and phraseology.

During turn out:
- define an unambiguous definition of urgent tasks in regulations, allocate responsibilities to define the urgency of a task and supply guidelines for call out on urgent tasks
- Supply a classification and coding of the information to enable clarity and a uniform interpretation of the information[5].
- explore the possibility to store trip data in 'black boxes' for each vehicle in order to facilitate detailed analysis of events and trips.
- Supply information and education for the fire fighting organizations as well as by driver training modules

During turn in: for the turn in phase no recommendations were made.

The suggestions were categorized along the lines of driver's behaviour, organization and technical means.

Behaviour:
- educating road users. Drivers of fire fighting vehicles expect positive results in educating and instructing other traffic participants in order to gain a better anticipation towards vehicles with urgent tasks. Such education should be incorporated in regular driver training courses.
- Coaching fire fighting vehicle drivers. Less experienced drivers will benefit from allocating a coach to their vehicle who supports them in evaluating their performance.
- Driving simulators. Simulated training could support gaining experience and safe driving behaviour in realistic training environments that cannot be trained in real life situations. Specific scenarios can be practiced in learning how to anticipate in relation to other road users.

Organization:

[4] This is realized in the guideline for optic and acoustic signs for fire fighting (BZK, 2001).
[5] This is realize in the guideline for optic and acoustic signs for fire fighting (BZK, 2001).

- Geographic Information Systems (GIS). GIS may indicate roadblocks, detours that may prevent drivers from taking wrong directions and facilitate on-line actualisation of routing by pre-structured driving plans. The information overload during driving may also be reduced.
- Training. Training that is focussed on practical exercises may be provided to experienced as well as inexperienced drivers to contribute to vehicle control, traffic oversight and motivation.

Technical means:
- Registration of trip data. Registration of incident and accident data may provide a basis for learning: what and where did it go wrong, which causes contributed and what could have been done to prevent the event. Such a technical approach could be put in a wider perspective of technological innovation in the Dutch fire fighting community (Stoop and Van Dooren 2000).

4. Conclusions and recommendations

Based upon the above described research activities several conclusions and recommendations were formulated.

4.1 Conclusions

From the exploratory survey into the safety of fire fighting vehicle performance, a number of general conclusions may be drawn.
These conclusions are:
- the information collected and analysed, based on the questionnaire, workshops and group session, justifies closer attention to traffic safety for fire fighting vehicles. To highlight causes, conditions and priorities, a distinction could be made between type of organization, age and experience, training and distance to the homes of the volunteers.
- The performance of urgent tasks is under pressure of deteriorating conditions including workload, stress, reduced accessibility of sites, high traffic densities and diminishing tolerance of other road users.
- The performance of urgent tasks is increasingly under pressure of balancing smooth versus safe operational practice. The threat of legal steps has increased in case of involvement in an accident. Reconsideration might be necessary with respect to the available rights and duties as well as considerations in the acceptability of the risks involved.
- Deficiencies in operational practices, organization, regulations, technical means and training are revealed due to the increased demands in driving a fire-fighting vehicle under changing conditions. Such deficiencies should be addressed in order to improve the safety levels of the performance of urgent tasks.
- A wide variety of solution categories are available, varying from behavioural, organizational to a technical nature. These solutions can be specific allocated to several phases of the driving process.

4.2 Recommendations

Accident analysis can be developed along two lines of reasoning. On the one hand, accident analysis may blame allocation and liability and explains the accident as an unwanted deviation from a behavioural norm. On the other hand, establishing deficiencies in the traffic system and working conditions and drawing up of recommendations is advocated. This project favoured the second option to enhance the safety of the fire fighting tasks. Due to the

limitations in the data availability and the preliminary nature of the findings, recommendations are formulated to continue the research.

In particular the conditions and context of specific fire fighting traffic accidents have hardly been analysed. The performance of urgent tasks is broader than fire fighting: police and ambulance vehicles are also involved in such tasks and may consequently suffer from a similar risk exposure. The development of a Branch Guideline for all vehicles with acoustic and optic signs and improving the driver training courses may enhance traffic safety more in general. Both issues contain elements of regulation, organization, and safety culture and management responsibilities.

The issue of urban development, local spatial planning and road traffic design should be taken into account, in particular from a point of view of accessibility of densely inhabited areas and timely access of emergency services to such areas.

Last but not least, technological innovation could be advocated with respect to dedicated ICT applications for the fire brigade and other emergency services.

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