Firefighters: feeling the heat

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Preface

Most of us give little thought to firefighters' working conditions. The head-turning sights and sounds of "blues and twos" as scarlet engines rush high visibility-clad crews to fires tend to overshadow what they do before, during and after. The life-and-death nature of their job can result in the risks being trivialized and prevention ignored.

Firefighting is a risky business, and while some of the risks cannot be properly assessed in advance, firefighters' life and health can be better protected. The complex relation between an effective response and protecting workers' health is itself good reason for trade unions to be more involved. It is the only way to put firefighters' experience to better use. Their view as a work community can give the basis for improvements to working conditions which need not undermine effective responding if the financial, material and human resources are there.

This publication sets out to give an overview of firefighters' working conditions, and some thoughts on the priorities for better prevention. It is a cooperative venture between the European Federation of Public Service Unions (EPSU) and the European Trade Union Institute (ETUI). It is based on feedback from union reps from different countries brought together at two European conferences to take stock of their working conditions, supplemented by a review of existing literature and information gleaned from many union contacts in the EPSU firefighters network.

Hopefully, this report on the outcomes of this undertaking will help improve how the impact of working conditions on health is catered to at European sectoral level. For the ETUI, this is a new departure that will certainly lead on to other similar projects. For EPSU, it is an information and training tool that will also further develop its firefighters network. The high levels of union membership among firefighters (from 40 to 95%) in all European countries mean that the challenges can be met. The EPSU firefighters network is a key tool for lining up union strategies and experiences, and for developing a common European approach to improving firefighters' working conditions and the quality of fire services.

— *Carola Fischbach-Pyttel*
General Secretary of the European Federation of Public Service Unions

— *Laurent Vogel*
Director of the ETUI Working Conditions, Health and Safety Department

Part 1 Employment and working conditions in European fire services

The conditions in which both professional and voluntary firefighters work are largely shaped by the organization, structure and funding of their employing service, staffing levels, the recruitment and training and drilling methods, the tasks they are assigned to and the equipment they are supplied with. Before looking at the health and safety issues, a word needs to be said about these aspects and especially the wide differences between them across Europe.

How fire services work

The emergency response chain

To have an effective and appropriate response to a fire, road traffic accident or flood an "emergency response chain" made up of equally important links must be set in motion. The failure or deficiency of one will undermine the overall response with what may be catastrophic consequences. In a fire, for example, the delayed turnout of a fire engine may result in greater loss of property and/or life, just as not having the right equipment for the circumstances of the incident can also have tragic consequences.

What are the various links in the emergency response chain whose organization is so critical to ensuring an appropriate response in all circumstances?

— **The call:** The first link is the control room: this is where calls are received from witnesses - and/or if able - victims of a situation which the caller thinks requires firefighters' attendance. Using the information supplied by the caller, the control staff analyse and process the call and assign the incident to a category selected from a list. Through a standard procedure, the corresponding operational category and the human and material resources to be deployed (type of appliances, specific equipment, etc.) can be determined. The idea of this pre-operation processing is to standardize the response to typical operations (Boullier & Chevrier 2000:64). The control staff then take stock of appliance and crew availability. A "ticket" identifying the incident location and including a list of appliances and the number of firefighters required to "go on a shout"[1] is sent to the fire station[2] to set the second link in the chain in motion. The specially-trained control room staff will then advise the caller on immediate action to take (e.g., first aid, clearing the area, initial safety measures, etc.) until the firefighters reach the incident scene.

— **Coordination of appliances/crews and turnout:** The ticket received at the fire station specifies the number and type of engines to be dispatched to the incident. "This list of appliances is the backbone of the operation" (Boullier & Chevrier 2000: 64). To be properly "kitted out" each engine must have a certain manning level (Boullier & Chevrier 2000: 21; Graham 1992: 39). A crew is formed for each appliance by reference to the ranks and qualifications needed to man it[3]. On-duty crews are then alerted by the service's chosen means - siren, speaker, optical signal or personal pager. Crew members stop what they are doing to don their personal protective equipment (PPE) and take their place on the engine they are assigned to. Once fully-crewed, the engine sets off: the crew has a set time ("response time") to reach the incident scene. National regulations generally lay down a standard response time for each type of operation and each type of area (classified by risk level).

These practical aspects can vary widely between countries. For example, a turntable ladder turnout requires only a one-man crew in Finland, Italy and Norway, but at least two men in Germany, Belgium, Croatia, Denmark, Spain, Estonia, France, the Netherlands, Slovakia and Sweden. Similarly, a pump water tender[4] can turn out with a three-man crew in Norway, but requires double that in France and the Netherlands. The regulation response time also differs by country and even by region – e.g., in France, Spain and Finland – since it takes into account the area coverage and specific organization of fire services: e.g., a faster response is generally required from professional than volunteer or retained firefighters (e.g., Belgium) to the same type of call.

These practicalities can affect firefighters' safety. The presence of a ranking and experienced firefighter[5] to assess the risks and coordinate responders, a sufficient manning level to deal with the incident and a prompt arrival on the scene will all contribute to a successfully-run operation that provides maximum safety for firefighters.

1. "A shout" is the term commonly used for a call-out for one of the emergency services.
2. Control rooms may be local (e.g., in Croatia and Denmark and to a degree in Spain and Germany), regional, provincial or district (e.g., Belgium, France, Finland, Norway, the Netherlands and to a degree in Germany, Spain, Italy, Sweden, Slovakia) or national (e.g., in Estonia and to a degree in Italy, Slovakia and Sweden).
3. In several countries, an engine can only turn out with a crew leader on board who must at least hold the rank of corporal or sub-officer, as in Belgium, Croatia, Spain, France, Italy, Norway, the Netherlands and Sweden. In Slovakia, an emergency response vehicle can only turn out with an officer on board. This rule is not always kept to in practice.
4. A fire engine equipped with a fire pump driven by the vehicle engine, a water tank, hose reels and fire fighting equipment. The pump water tender resembles an oversize toolbox: as well as extinguishing equipment proper, it carries equipment for exploration (e.g., independent breathing apparatus stored in the crew cab), rescue (e.g., ladders, ropes and pulleys) and clearance (e.g., axes and sledgehammers) operations.
5. Command and control requires many qualities that cannot be guaranteed by rank alone. An operation may place extremely onerous responsibilities on the operation commander.

Table 1 **Differences in coordination of appliances/manning and response times in EU countries**

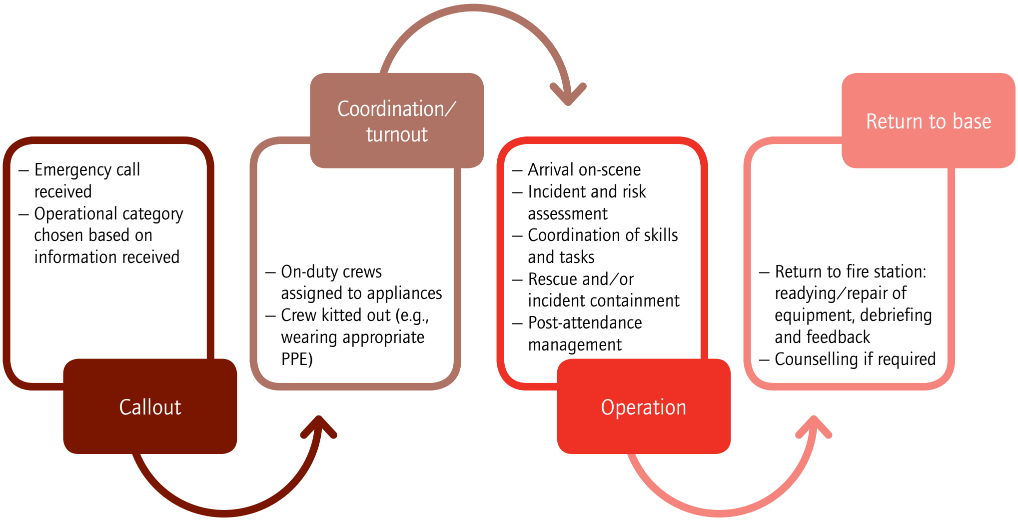
Country	Required manning level for turnout of a turntable ladder	Required manning level for turnout of a pump water tender	Response time for a fire in urban areas
Belgium	2	From 4 to 6	Turnout within the minute by professionals. Response time 8 to 15 minutes for professionals, and 13 to 20 for volunteers
Croatia	2	4 or 5	15 minutes
Denmark	2	6 in Copenhagen, 4 in smaller towns like Roskilde	Turnout must be within the minute of call acceptance. Response time is 15 minutes
Estonia	2	4	5 minutes in urban areas
Finland	1	4	By region: between 6 and 20 minutes
France	2 or 3	From 6 to 8	Depends on the *département*. Examples: Ain: 20 minutes; Nord: 15 minutes*.
Germany	2 or 3	4 or 5	8 minutes
Italy	1 or 2	5	Depends on the territorial area but must never exceed 20 minutes. In 2009, the response time averaged 15 minutes in central Italy and 13 minutes in the north and south**.
Netherlands	2	6	8 to 10 minutes
Norway	1 in small municipalities, two in towns and cities	At least 3	Turn-out must be within the minute of call acceptance. Response time should be 10 minutes at most in high risk urban areas; 20 minutes in low risk urban areas; and 30 minutes in rural areas.
Slovakia	2 or 3	At least 5	8 minutes
Spain	2 or 3	5 or 6	Varies by region
Sweden	2	5	11 1/2 minutes

* The prefects of *départements* tend to lengthen response times to avoid claims.
** Ministero dell'Interno. Dipartimento dei Vigili del fuoco del Soccorso Pubblico e della Difesa civile (2009) *Annuario statistico del corpo nazionale vigili del fuoco*, Roma, p. 54 (*Online*).
Source: ETUI – EPSU survey 2010 -2011

— **Operation:** The third link is the operation proper. On-scene, the incident commander analyses the incident and assesses the operational risks to determine the most appropriate operational strategy and issues orders to the different crew members. There is no room for hesitation or confusion in an emergency: a successful rescue operation requires coordinated actions and effort by the crew. Repeated drills have made each firefighter perfectly versed in what gear and equipment they need and what operational actions to carry out. While no two incidents are ever the same, the firefighters' operations run to a standard basic form. They follow a pattern and procedures that can be adapted to specific situations without having to improvise (Boullier & Chevrier 2000: 24, 58, 89-90). Once first response has been made, casualties evacuated and the fire contained, it remains to make the scene safe either by sanding a road, ensuring that the rubble conceals no smouldering embers that might reignite, or by marking out a safety perimeter.

– **Return to base:** This is the final sequence in the operation: the return to the fire station to ready appliances, equipment and men for the next call-out. Fire engines are cleaned, checked, replenished (full fuel tank, full pump water tender tank, replenishment of emergency medical unit equipment, etc.). The equipment is checked and repaired or replaced as needed (e.g., fire hoses are unreeled, dried, inspected and rolled up). Soiled personal protective equipment is cleaned. Breathing apparatuses are cleaned and checked. This is also the time for debriefing and feedback from the operation: the crew reviews the conduct of operations to identify problems that need to be addressed for the next call-out. Finally, it is also – or should be – a time for counselling firefighters who have been involved in a traumatic operation.

Figure 1 The four links in the firefighters' emergency chain



Source: ETUI, 2011

In an emergency, each of these links must be able to swing into instant optimal action. In practice, this means that outside actual operations, each link must keep its component parts at all times in readiness to do its job in all circumstances, including the most critical. For the first link, that means the call acceptance and processing centres must have an updated picture of personnel strength and available appliances at all times. For the second link in the chain – turnout – it means readiness of appliances (i.e., maintenance), equipment (i.e., checking and/or replenishment) and the firefighters themselves (i.e., appropriate training and drilling, and regular physical exercise). Finally, because a successful operation requires theoretical and practical skills from firefighters, they must be trained beforehand (i.e., theoretical training) and their know-how must be regularly maintained (i.e., drills to rehearse the steps of coordinated procedures for specific operations and go through the technical motions).

The emergency response chain broadly outlined above is the lowest common denominator of the structured action of the different European fire services and so obviously may be much more complicated in some circumstances. Control rooms, for example, regularly have to send out several tickets to different fire stations at once to marshal the equipment and human resources needed by a given type of incident. The basic emergency response chain then has added to it the tasks of coordinating responders from different fire stations upstream (i.e., at call processing) and on-scene. Likewise, if fire stations are deemed under-manned for the needs of a particular incident, the emergency response chain is extended by mobilizing retained firefighters from outside these stations and by the travel time they need to join their fire station.

While this emergency response chain is structured broadly the same in all European countries, the practicalities of how it operates vary with a number of things: workforce management[6], financing, the scope of duties, etc.

Number and status

Firefighters fall into different employment categories. Public sector professional and volunteer firefighters make up the bulk of the workforce, although in widely varying proportions by country. Firefighting services are predominantly professional in Croatia, Spain, France and Italy, whereas volunteers outnumber professionals in Germany, Belgium, Denmark, Estonia, Finland, the Netherlands, Portugal and Slovakia. Then there are military firefighters, who may be professional (as in France) or volunteer (as in Belgium). Finally, there are also private sector firefighters employed mainly at sensitive sites like airports, chemical factories and nuclear power plants, as well as seasonal firefighters drafted in as reinforcements in Mediterranean countries when summer forest fires call for bigger numbers.

Trade union reps have voiced concerns about general under-manning in the sector, where numbers are too small to ensure a proper, quality service at all times. There is a worrying trend in Spain and France for retiring professional firefighters to be replaced by volunteer firefighters on temporary contracts. There are concerns about the aging of the sector workforce in Finland.

Table 2 Manning levels in the different European countries

Country	Public sector professional firefighters	Public sector volunteer fire-fighters	Military firefighters	Other categories
Belgium	approx. 5 000	12 000	Mainly volunteer (e.g., on Belgian military air bases). There are also military firefighters on NATO and SHAPE sites.	Commercial airports: with a fire service, mostly professional firefighters. Few professional firefighters employed in businesses, but there is a duty to have first response teams of volunteer workers. Many have a fire station and appliances, while others outsource to security firms. None of these have the employment status of professional firefighter.
Croatia	24 000	60 000 but only 5 000 operational	170	1 575 (including 1 000 seasonal firefighters, 500 industrial firefighters and 75 state firefighters)
Denmark	1 217	2 952	694	4 775 (comprising 3 221 employed by FALCK and 1 554 unpaid volunteers)

6. In the broad sense, including working time, the numbers and status of firefighters, training.

Estonia	1 600	100	0	0
Finland	2 940	19 400	50	600-700
France	39 200	197 800	12 000	No figures
Germany	35 000	Over 1 000 000	3 000	40 000 professional firefighters in business
Italy	Officially 31 000, in fact 26 000	approx. 7 000	/	No figures
Netherlands	4 000	21 000	500	1 000
Portugal	Officially: approx. 58 000. Union figures: fewer than 29 000. Only 3 000 are estimated to be professional firefighters	0	5000	
Slovakia	4 296	approx. 10 000	0	1 546
Spain	approx. 19 886	3 437	4 082	1 390 mainly in airports + 2 260 seasonal firefighters
Sweden	approx. 5 000	9 000	0	100 (at airports)

Source: ETUI - EPSU survey 2010 -2011

Firefighter recruitment is highly selective: their working conditions make high demands on physical and physiological fitness. But over the course of a working life, these abilities tend to decline partly with age and partly from occupational burnout. Firefighting is physically taxing work. Retirement ages are generally adapted to reflect that.

Table 3 Retirement ages in different European countries

Country	Legal retirement age
Belgium	60 for professionals, 55 for volunteers
Croatia	No later than 65. The age at which a firefighter qualifies for retirement is reduced by 1 year for every 5 years of service. So a firefighter with 30 years' service can retire at age 59.
Denmark	60
Estonia	65
Finland	Between 65 and 68
France	From age 57 depending on years of service. No later than age 67
Germany	60 to 62
Italy	Theoretically at age 53 with 38 years' service. Average: age 58
Netherlands	No later than age 59
Norway	Can retire from age 57. Official age: 60
Slovakia	After 15 years' service. In reality, after 25 years' service
Spain	60
Sweden	At age 58, or after 30 years' service

Source: ETUI - EPSU 2010 -2011.

Officially, women can now become firefighters. In fact, European fire services remain very male-dominated. Efforts in the United Kingdom and Sweden in particular to encourage women into the fire service notwithstanding, there remain very few women firefighters. In all European countries, women firefighters make up less than 4% of the professional workforce. While some of this lack of interest may be explained away by the working conditions and physical demands of the job, studies have pointed to an entrenched macho culture in the fire service that hinders women's entry into the profession (Caplen 2003; Pfefferkorn 2006: 203-230).

Working time

Under Article 17 of the EU's Working Time Directive (2003/88/EC), fire services like other activities where there is a need to ensure continuity of service (i.e., 24/24, 7/7), can exclude certain of the minimum requirements laid down by the Directive (e.g., daily rest (Article 3), weekly rest (Article 5) and duration of night work (Article 8). This is because continuity of service requires fire services to have sufficient staff to perform their duties at all times including nights and weekends. As a result, fire services generally operate on an "on-call" working time system whereby firefighters are on "stand-by" duty for a period in most cases equivalent to 24 hours. The Directive requires that this be immediately followed by an adequate compensatory rest period away from work.

The European Court of Justice (ECJ) has repeatedly held that the full on-call time spent in the workplace at the employer's disposal counts as working time[7]. Consequently, all on-call time, including non-working time, must be included in calculating a firefighter's weekly working hours.

Table 4 Maximum weekly working time in European fire services

Country	Weekly working time (hours)
Belgium	38*
Croatia	42
Denmark	48 but 42 in Copenhagen
Estonia	42
Finland	42
France	35 to 48 depending on the *département*
Germany	48 (since 2007)
Italy	36
Netherlands	36 or 48
Norway	42 but 38 in Oslo
Slovakia	37 1/2
Spain	42
Sweden	42

* With exceptions. The firefighters in some Belgian fire services work 42 or up to 52 hours but are paid only for 38 hours of work.
Source: ETUI - EPSU survey 2010-2011

7. i.e., the SIMAP, Jaeger and Pfeiffer judgements.

The Working Time Directive provides no specific exemption from the maximum weekly working time for fire service workers. As for other European workers, the average weekly working time for firefighters, including overtime, cannot exceed 48 hours (Article 6(b) of Directive 2003/88). This average must be calculated over a period of four months (Article 16(b) of the Directive) unless derogated from and extended by collective agreements or agreements between the two sides of industry (Articles 18, 19). So, the table 4 showing that the maximum weekly working time is observed in European fire services must be read subject to the fact that some countries (e.g., Belgium, Denmark, France and Slovakia) calculate the average over a twelve month reference period – the upper limit set for derogations from reference periods (Article 19 of the Directive)[8].

In reality, the maximum weekly working time seems to be far exceeded in countries like Germany and the Netherlands, where the firefighting sector tends to use the opt-out clause whereby workers are individually asked and agree to work more than the 48-hour weekly working time (article 22 of the Directive).

A number of European trade union reps have expressed doubts as to whether the working time arrangements generally that prevail in their countries' fire services are compliant, citing practices that improperly distort the calculation of working hours. Despite the ECJ rulings on on-call time, some countries still do not consider all the time spent at the employer's disposal as working time. If all the hours spent by firefighters at the workplace, at the employer's disposal, were recorded as they should be, then the maximum weekly working time would be exceeded in many cases, requiring an individual but no less wholesale opt-out by firefighters as already happens in some countries. But also, the calculations are systematically reduced by discounting the hours worked by retained firefighters on their "day job". Manpower shortages mean that firefighters also seem to be regularly denied the adequate compensatory rest their long working hours should entitle them to.

The adverse effects of long working hours, night work, shift work and rest deprivation on the health and safety of workers are now well documented. By laying down minimum standards for working time, Directive 2003/88/EC protects European workers from these effects[9]. The social partner consultation initiated by the Commission for a review of the Directive was an opportunity for the European Federation of Public Service Unions (EPSU) to reaffirm its commitment to this key piece of European health and safety at work legislation and come out firmly against the various purely financially-inspired proposed amendments to water the standards down[10]. In particular, EPSU opposed the proposed amendments to make the opt-out the default rule[11], to exclude non-working on-call time at a workplace at the disposal of the employer from the definition of working time and extend the reference period. In February 2011, the EPSU firefighters' network meeting agreed a joint statement in favour of the directive applying to all firefighters whatever their status (e.g., professional, volunteer, part-time)[12].

8. See EPSU, "EPSU European Firefighters' Network: Report on working time and retirement", July 2006, p. 2. On line: http://www.epsu.org/IMG/pdf/EN_Firefighters_Working_Time.pdf

9. Directive 2003/88/EC of the European Parliament and of the Council of 4 November 2003 concerning certain aspects of the organisation of working time.

10. EPSU has a webpage devoted to recent developments concerning the directive on working time. See http://www.epsu.org/r/152

11. The clause was originally only provisional.

12. View the summary report of the seminar held in Elewijt (Belgium) February 10 and 11, 2011. http://www.epsu.org/IMG/pdf/Minutes_FR-5.pdf

Training and practicing

European fire services require applicants to undergo a medical examination and pass certain physical tests. Once hired, their training starts.

The content of firefighter training is normally specified by the fire service authority: it can be uniform for all firefighters in a country or vary by region. Spain has no nationally-prescribed training standards, whereas Italy does, for example. Training in France is governed by national guidelines but also by *département* regulations. The trade unions consider the training comparatively satisfactory and generally adapted to the risks of the job. Some, however, feel the practical component – i.e., situation scenarios for learning to get things done – is too weak. Some union reps have stressed that safety aspects overshadow health aspects, which is clearly not apt to promote a "health culture" in European fire services.

Nor is the duration of firefighters' basic training harmonized across Europe. Some countries calculate it in hours, as in Belgium where it has recently been increased to 150 training hours. Elsewhere (e.g., Slovakia and Italy) it takes place over several months. In most countries, firefighters undergo continuing professional training and modules for skills maintenance or training in new risks are provided for active staff. The fire services themselves hold drills to practice the coordinated techniques involved in the different types of operation. Officially, these are held daily, but staff shortages mean they not uncommonly have to be cancelled in order to attend incidents.

Training may vary with the firefighter status. In some countries, professional and volunteer firefighters undergo the same training and must meet the same requirements, whereas in others – France and Italy for example – the content and length of training differs for professionals and volunteers. Given that the duties performed by both groups are identical and carry the same risks, it is questionable why this should be so, especially where volunteer firefighters receive less practice since their on-duty time – when drills and operations are carried out – is much less than that of the professionals.

Financing

Who pays for fire services?

Broadly, there are three sources of financing for fire services: central government, regional and/or local authorities, and the private sector. These funding sources are not mutually exclusive and fire services in most countries are funded from a combination of two or more. In many cases, fire service running costs (i.e., salaries, cost of operations, etc.) are paid for by local authorities from earmarked local or regional taxes, while training provision, part of the equipment (especially fire appliances) and large-scale rescue operations are subsidized by the relevant national ministries. Such mixed public funding is found in Belgium, Croatia, Denmark, the Czech Republic, the Netherlands, Portugal and Great Britain amongst others. It is not, however, found in Spain, where decentralization has transferred all such powers to regional and local authorities. In Estonia, by contrast, fire services are wholly state-financed. Where they fall under central government, fire services are generally the responsibility of the Interior Ministry, but may also come under the Ministry of Defence – as in Croatia and Finland - or the Justice Ministry as in Denmark and Sweden (Nuessler 1999, Graham *et al.* 1992: 14, 17)[13].

It should be noted at this point that local authorities in some countries can within their local boundaries outsource to a private fire service. This is particularly widespread in Denmark, where over 50% of municipal authorities use the services of Falck[14], Europe's biggest private firefighting and rescue operations company. Outsourcing, which authorizes the transfer of public funds to private providers and paves the way for the privatization of fire services, remains relatively marginal as yet in the EU (Lethbridge 2009: 5).

While most fire services in Europe are publicly-funded, private firms operating in high-risk sectors (e.g., the oil, gas and nuclear industries, and airports), are generally required – or strongly encouraged – to operate their own on-site fire service. Some countries have statutory requirements for undertakings whose activities pose a threat to public health to have such brigades[15]. These are known as industrial brigades and are quite common in many European countries. They are to be found in Finland, Germany, Portugal, Belgium, Spain, the Netherlands as well as Slovakia and the Czech Republic. Conversely, there are few in Britain (Graham 1992: 31). Not surprisingly, the Falck company's services are more commonly used in the private than in the public sector.

The cost of fire services varies widely by country, being dictated by a wide range of factors (e.g., total wage bill[16], predominantly a volunteer or professional service, organizational structure, scope of responsibilities and duties assigned to the fire service, organization of working time, whether there are industrial brigades[17], the geographical and environmental characteristics of the area covered, etc.). The diversity that characterizes European fire services makes it difficult not to say unsafe to venture international comparisons from the overall national cost of fire services. Where national statistics do exist, they commonly calculate the relative costs, i.e., the *per capita* cost of the public service. This measure, which some see as an indicator of the relative efficiency of fire services, must nevertheless be approached with the utmost caution.

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13. The French case is somewhat of a hybrid from this standpoint. The Paris and Marseille firefighters are military. Administratively, they fall under the Defence Ministry but in practice they are placed at the disposal of the Interior Ministry (Demory 1997).

14. However, while Danish municipalities can outsource the services, they cannot outsource their responsibility in this area. They remain accountable for the application of national operating standards and fire service performance, even if contracted-out. As a result, the Falck fire brigades are always commanded by an officer employed by the local authority (Graham *et al.* 1992: 15-16).

15. The Netherlands, for example, in Section 13 of the Fire Services Act 1985. The country has no fewer than 1 000 industrial brigades (Graham *et al.* 1992: 12; Nuessler 1999).

16. Personnel costs are estimated to account for 60 to 80 percent of the cost of fire services (Graham *et al.* 1992: 22).

17. The existence of industrial brigades helps reduce public expenditure on fire services (Graham *et al.* 1992: 2).

Equipment: from old-style to cutting-edge

Firefighters need a wide range of equipment to carry out the different types of task successfully while preserving their health and safety. Fire stations are equipped with a wide range of tools and materials generally connected with specific response vehicles. The employer also has a duty to carry out a risk assessment of his work activity and provide workers with personal protection equipment (PPE) appropriate to the risks he has identified and assessed for each activity. For example, for a firefighting task, the firefighter must be protected from head to toe, and must therefore have at the very least a helmet, fire hood, protective clothing (i.e., turnout coat and turnout trousers), breathing apparatus, a pair of gloves, a pair of boots, belt with fall arrest lanyard lifeline and a safety harness for work at heights[18]. Similarly, an operation that does or may involve exposure to chemicals will require a chemical suit and boots.

The standard of equipment in Europe is seen to vary widely between but also within countries where paid for other than by central government (e.g., *départements* in France) or for different categories of personnel (e.g., between professional or mixed and volunteer fire services in Belgium). While some European fire services are equipped with the best money can buy on the market, others struggle to replace defective equipment and failing personal protective equipment (e.g., clothing that is no longer liquid tight or smokeproof, etc.).

Table 5 Current state of equipment and level of satisfaction at European level

Country	Current state of equipment generally	Level of satisfaction
Belgium	Fairly up-to-date for professionals; aging in some volunteer brigades	Moderately
Croatia	Fairly up-to-date	Reasonably
Denmark	Very up-to-date	Completely
Estonia	Very up-to-date	Completely
Finland	Very up-to-date	Completely
France	Very up-to-date or fairly up-to-date, according to *département* financing	Differs by *département*
Germany	Very up-to-date	Reasonably satisfied
Italy	Fairly up-to-date	Reasonably
Netherlands	Fairly up-to-date	Completely
Norway	Very up-to-date	Reasonably
Slovakia	Fairly up-to-date	Completely
Spain	Very up-to-date	Reasonably
Sweden	Very up-to-date	Reasonably

Source: ETUI-EPSU, 2011

Equipment selection and procurement bodies differ by country: they may be fire service personnel, as in Denmark, the national ministry or local authorities. In most European countries, procurement procedures are subject to consultation with staff reps. In Germany, Belgium, Spain and Finland, however, such consultation does not always take place in all cases. This is unfortunate in that it is the workers with their daily front-line experience who

18. Personal protective equipment for firefighting is discussed in detail in Part 3 of this brochure.

are clearly best placed to assess their own needs, and the good and bad points of the different equipment. They can identify the problems with handling a particular tool or premature loss of leak-tightness or penetration-resistance of turnout gear in use. They, too, can show that by overprotecting them, the performance of the new generation of fire protective clothing prevents them from perceiving danger in time. In short, firefighters are the ones who are able to specify the requirements for equipment in normal daily use but also in cases of reasonably foreseeable misuse that must form part of the risk assessment. Ensuring the safety and health of fire service personnel is a costly investment which would very likely be more profitable were it based on consultation with first responders themselves.

Table 6 Equipment selection and procurement across the EU

Country	Equipment selection and procurement body	Consultation of workers' reps on equipment procurement
Belgium	Municipalities, provinces or the Interior Ministry depending on what is purchased. Where the Ministry is involved, procurement is by group purchasing and it finances 75% of the actual acquisition cost	Consultation requirement laid down by royal decree (regulations). In fact, firefighters are not always consulted on drawing up the technical specifications of orders made by the Interior Ministry
Croatia	Municipalities, provinces or the Interior Ministry depending on what is purchased	Yes
Denmark	The personnel of each service	Yes
Estonia	Fire service	Yes
Finland	Local authorities	No
France	*Département* (i.e., administrative division)	Yes. Consultation required. Joint industrial committees give an opinion.
Germany	The municipal authorities	No
Italy	Municipalities, regions or the Ministry depending on what is purchased	Yes. There is a scientific committee that includes union representatives
Netherlands	The head of the fire service	Yes, the service personnel are consulted
Norway	Fire service	Yes
Slovakia	The national ministry	Yes, but only for helmets and clothing
Spain	Municipalities or regions	Half
Sweden	Local authorities	Yes. Selection is done by joint industrial committees

Source: ETUI-EPSU survey, 2011

Equipment for firefighters can be improved at an earlier stage by participating in the European standardization process. This is a proactive strategy that trade unions can use and is developed further in Part III of this booklet where recommendations and "good practices" on compatibility and cleaning of personal protection equipment (PPE) are also set out. The main focus is on specific firefighting PPE, but a similar approach could easily be applied to other equipment.

Tasks: more diverse everywhere

The popular image of the firefighter is of the heroic soldier-like figure wielding an attack hose-line or perched atop an aerial ladder bringing out victims from a raging inferno. Like all stereotypes, this over-simplifies things. For decades now, emerging challenges and successive fire service reforms have everywhere added to the range of jobs firefighters are tasked with. Traditional firefighting is now only one among many of the things European firefighters do. In France for example, fire suppression now accounts for only 10% of fire service call-outs (Boullier & Chevrier 2000: 11). This means that firefighting is now just one part of a broader mission that firefighters have: that of protecting people, animals and the environment. It is a mission that can take the form of a wide range of operations: emergency medical assistance, surface search and rescue, void search, debris and rubble removal, etc. The idea of the "warrior of fire" now seems to be giving way to that of "hazard engineer" (Boullier & Chevrier 2000: 11).

While all European fire services have seen their responsibilities expanded, firefighters' duties still vary between countries (see table 7).

Table 7 Tasks performed by firefighters in fourteen European countries

Tasks	Belgium	Croatia	Denmark	Estonia	Finland	France	Germany	Italy	Netherlands	Norway	Portugal	Slovakia	Spain	Sweden
Firefighting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prevention through education and awareness	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	By region	Yes
Prevention through compliance and inspection measures	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	By region	Yes
Emergency medical assistance	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	By region	Yes
Rescue of road traffic accident victims	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environmental protection / environmental disasters	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	±	Yes	Yes	Yes	No	Yes
Emergency and technical assistance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crisis management	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Hazardous chemical incident management	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Air search and rescue	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Handling floods and natural disasters	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Sea search and rescue	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Management of biological, bacteriological, chemical and nuclear accidents	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Yes No By region

Sources: Nuessler 1999 and ETUI - EPSU survey, 2010 -2011

Part 2
Health and safety risks of firefighting

Fire suppression, freeing casualties from crashed vehicles, air-sea rescue, etc.: prevention activities aside, none of the tasks that fire services carry out are on the face of it without risk to firefighters' health and safety. Generally, what firefighters both professional and volunteer do can unhesitatingly be classed as a "high risk" activity. The on-duty fatality figures speak for themselves. In France, for example, an average twenty firefighters died in the line of duty each year between 1992 and 2002 (Pourny 2003a: 2). In Britain, official figures report an average of one on-duty firefighter death every quarter since 1978 (Labour Research Department / Fire Brigade Union 2008b: 21). To this grim roll-call must be added the figures for on-duty accidents and occupational diseases, which are hard to pin down and on which recommendations are made in the third part of this brochure.

Because the kind of risks are specific to the type of operation, the expansion of fire service tasks in recent decades puts a comprehensive consideration of all the risks of the job far outside the scope of this brochure. A choice had therefore to be made as to which fire service tasks were looked at. Fire suppression was chosen for a number of reasons. First, while it may no longer occupy so much of firefighters' time as competing tasks have been added, it still remains the emblematic activity that sets them apart from other emergency services. Then, firefighting is relevant to the largest number: unlike other tasks, it is common to all European fire services and requires no specialization or special status. Finally, the choice is also justified by the wide variety of risks[19] to which it

19. Despite the many risks involved in firefighting, they do not represent all the risks to which firefighters are exposed in the course of their job. Further studies need to be done on other risks not considered in this brochure, such as exposure to noise, biological agents and the manual handling of heavy loads (ISTAS 2004).

exposes firefighters, the severity of the accidents associated with it and the illnesses that it contributes to causing.

According to a British report published in 2008 (Labour Research Department / Fire Brigade Union 2008b: 21), there is no evidence to suggest that firefighters' health and safety in fire suppression operations has improved in recent years. So, while firefighting operations significantly decreased between 1996 and 2006, on-duty deaths in the same period continued to rise.

What fire risks are firefighters exposed to? For ease of discussion, the main firefighting risks are classified into four groups: those related to heat, smoke, the physical characteristics of the fireground, and finally, the psychosocial load of the activity. Some of these risks – e.g., most of the risks from heat exposure – are peculiar to firefighting, while others – like psychosocial risks – also occur in other types of task.

Heat risks

Two main types of risk are associated with the heat from a blaze. One is that the heat generated by a fire in a confined or semi-enclosed space can produce hostile fire events (sometimes called "thermal phenomena") that are particularly hazardous to firefighters. But also, even without hostile fire events, working in a high temperature environment poses a big risk to firefighters' health and safety from the specific – and potentially severe – disorders it entails.

Hostile fire events

Two hostile fire events ("thermal phenomena") are particularly dangerous for firefighters. The first is known as backdraft. This is a smoke explosion. Among its other properties, smoke is flammable and explosive. Backdraft occurs when air is suddenly re-introduced into an overheated, oxygen-starved environment. This happens, for example, where the fire is confined to a room which is well-insulated or sealed-off from the outside, so there is little or no combustion agent (i.e., the oxygen content of the air). As a result, combustion is incomplete: the fire smoulders, no longer produces flames and contains a lot of soot particles. Even so, significant amounts of uncombusted gases are given off, producing excess pressure inside the room. As the temperature rises, the gases expand and this excess pressure increases. In these conditions, sufficient combustion agent can be introduced by ventilating the room – e.g., opening a door – to cause a very rapid oxygen enrichment of the combustible hot smoke and uncombusted gases, producing an explosive effect. Opening a door or breaking a window can feed oxygen to the fire area and thus cause an explosion.

While characterized by an explosion, backdraft is also accompanied by a shock and heat wave. Exposed individuals are likely to suffer a range of organ damage known as "blast". Primary blast consists of internal injuries caused by the direct action of the shock wave in the body (e.g., pneumothorax, acute lung injury [or adult respiratory distress syndrome], ruptured eardrum, subarachnoid haemorrhage, myocardial infarction, peritonitis, etc.). Secondary blast comprises injuries resulting from the high-speed projection of explosion debris. Casualties may suffer superficial or deep multiple lesions. Tertiary blast injuries are caused by the victim being projected within the fire room (e.g., fall, impact). Finally, quaternary blast comprises burn injuries, smoke inhalation injuries and injuries from being buried under collapsing debris. The severity of the injury depends on the intensity of the explosion, the conditions of propagation of the shock wave (e.g., a compartment explosion is accompanied by haze heat and reverberations) as well as individual factors (e.g., the position and weight of the exposed person) (Naudin & Oualim). Needless to say that exposure to a backdraft can be fatal.

The second hostile fire event, which is no less dangerous, is that of flashover – a near simultaneous ignition of all flammable gases which have built up across the ceiling of an adequately ventilated compartment. This can happen when a fire develops in a semi-open space. Initially, the fire has sufficient air supply to grow. It produces smoke. The smoke, heated by the point of origin of the fire, produces a rise in temperature resulting in pyrolysis of all the combustible materials in the room (e.g., partition walls, furniture, decorations, etc.). The unburned gases distilled by the combustible materials in the environment will mix with the smoke and create a "gas layer" in the upper part of the room. At this point, the seat of the fire situated in the lower part of the room is still being supplied with oxygen and so the temperature continues to rise. It is then enough for the "gas layer" to reach its ignition temperature (i.e., autoignition temperature) or come into contact with burning materials transferred by the point of origin for the fire to spread across to all the distilled smoke and gases present in the fire room. This is flashover.

Exposure to a flashover is invariably fatal because it causes a surge in temperature to above 1,000 degrees Celsius.

Given the severity of these phenomena which can develop during any fire in an enclosed or semi-open space, any firefighting operation must necessarily be preceded by a risk assessment done from outside by the incident commander. He must first determine whether the indicators of these fire events are there (e.g., is the window glass blackened or opaque? Is the smoke being pushed out by existing ventilation or the roof? Are the flames visible?, etc.) and whether steps need to be taken to make the fireground safe (e.g., establishing a safety perimeter). Based on the risk assessment, the incident commander will determine the most appropriate fire attack technique (i.e., offensive *vs.* defensive). If rescue or reconnaissance personnel need to be committed, the incident commander will take different prevention and protection measures to ensure their safety. These will include at least ensuring that they wear full personal protective equipment, that there is an escape route if the way in/out has become unsafe, a "two-out" standby team is ready to go in at the slightest sign of danger, and that a sufficient number of charged water appliances are on hand.

It is vital for the tactical actions carried out by the different crew members to be coordinated by the incident commander and for there to be efficient communication between the "two-in" attack team and the outside. In conditions that can produce fire events, a lack of communication and coordination can have tragic consequences. For example, if a firefighter working outside a burning structure freelances independently of both incident command and the deployed entry team by venting the structure (e.g., by opening a door, breaking a window or by positive pressure ventilation), his action may in some circumstances improve matters, but can also make things worse by causing a backdraft or flashover that will put his entry team colleagues' lives in danger.

Face with these incipient fire events, it is vital that attack firefighters should be able to respond appropriately, quickly and calmly. That means that they must be able to fully read a fire, including understanding the specific indicators.

Table 8 Conditions and indicators for backdraft and flashover

Hostile event	Conditions	Some indicators
Backdraft	– Confined space (no ventilation) – Fire smouldering, no visible flames (just glowing embers)	– Doors and/or door handles are hot – indicating a high energy charge inside – Windows are vibrating slightly – Windows appear brown or black – Noise and sounds are muffled – Smoke seems to exit in puffs through gaps, especially under doors (escapes then seems to be sucked back in) – Smoke is dense and usually coloured
Flashover	– Space is ventilated – There are flames and a thick "gas layer" that can spread through corridors, stairwells and other spaces	– Signs of pyrolysis of flammable gases away from seat of fire gas emission (usually white smoke resembling steam) – High heat radiation in the upper part of the compartment – hard to stay upright – Flames rolling across the ceiling (*rollover*) indicates it is about to occur – Sudden drop in the "gas layer" indicates a change in ventilation and/or gas density – flashover may be about to occur

Source: Persoglio *et al.* 2003: 103-111

All fire and rescue service personnel must know these signs, which can partly be taught in classroom training. But for it to be usable on-scene, responders must still be able to recognize and identify these indicators when they see them. Practical training is essential. Purpose-built shipping container simulators exist for training firefighters to look for and recognize the typical indictors of fire events and for drilling them in the right way to deal with them (e.g., door opening techniques, covering jet and attack jet, pulsed jets, spray angle, flow control, water spray for immediate mitigation, venting techniques, etc.). Despite the high probability of these fire events occurring during fire suppression and the severity of their consequences, it is clear that there is no such training provision in many European countries. It must also be pointed out that tools and technologies exist that can significantly reduce responders' exposure to these fire events, but European fire services are for the moment tight-lipped about acquiring them.

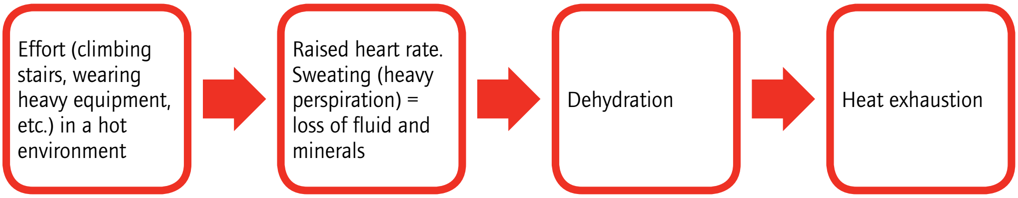
Heat stressors: health implications

It seems self-evident that firefighters would be at risk of severe burns. Even air and smoke when heated by a seat of fire may cause such injuries by radiated heat. The development of protective clothing made of synthetic fibres with high heat stability and high temperature, combustion and thermal radiation resistance has surely helped to give fire and rescue service personnel more protection from this kind of injury.

Working in heat, even where there is no skin damage, poses major risks to firefighters' health. In a fireground, firefighters are operating in an environment where temperatures can far exceed human body temperature, which normally ranges between 36.5 and 37.5 degrees Celsius. Two major disorders of varying severity can result from such exposure to extreme heat. One is heat exhaustion. It can be broadly described as follows.

There are many symptoms of heat exhaustion: raised heart rate, headaches, nausea, dizziness or light-headedness, vomiting and even fainting. There is no rise in body temperature. Treatment is rest in a cool environment and replacing fluid loss with water.

Figure 2 Stages leading to heat exhaustion



Source: ETUI, 2011

The other illness is much more serious. It is heat stress or heat stroke. This occurs when after prolonged exposure to extreme heat, the body's heat regulation system stops working properly. Sweat cannot be dissipated fast enough so the body temperature rises. The first signs of heat stroke are very hot skin without sweating, confusion, irrational behaviour, loss of consciousness. At this point, emergency medical treatment is needed. The central nervous system, kidneys and heart can suffer irreversible damage. The body must be cooled down by any means possible to halt the rise in temperature otherwise heat stroke will result in death (OSHA 2005: 2; Raffel 2011).

During a protracted operation, firefighters must be able to replace fluid loss when leaving the incident site, e.g., to replace their breathing apparatus[20]. Before and after any hot environment operation, firefighters must be able to rehydrate. In summer, when outside temperatures are high, it is important that they should have access to a cool space to bring down their body temperature (e.g., compartment of a vehicle fitted with air conditioning). Any unusual behaviour or sign of weakness observed in a first responder after operating in a hot environment should be considered as a possible sign of heat exhaustion or even heat stroke. Medical treatment facilities must always be available at the scene of the operation.

The risks of smoke

In a fire, combustion or pyrolysis[21] of materials tends to produce a large amount of smoke which is particularly hazardous to both victims and firefighters, being toxic, radiant heat-emitting, opaque, mobile, flammable and even explosive[22].

Toxicity and radiated heat hazards of smoke

Smoke produced by combustion or pyrolysis is composed of solid particles, gases and aerosols. Their chemical composition depends on the materials involved in the combustion, the state of combustion (i.e., complete vs. incomplete) and the oxygen concentration (Brandt-Rauf *et al.* 1988: 606).

Smoke released from house fires can contain 200 or more toxic gases. The most common are carbon monoxide (CO), carbon dioxide (CO_2), hydrogen chloride (HCl), hydrogen

20. Average air cylinder duration is half an hour. It is not wise to replace a cylinder more than once without taking an hour's rest in a cool place before returning to operations.
21. Pyrolysis is the process by which a solid material subjected to a significant rise in temperature will give off distilled gases (vapor) (Persoglio et al.2003: 44).
22. This latter characteristics of smoke is dealt with the next section on thermal phenomena.

cyanide (HCN), nitrogen oxides (NO_x) and soot particles. Not uncommonly, it may also contain benzene, toluene, sulphur dioxide (SO_2), aldehydes, acrolein, trichloroethylene, and others. The effects of contact with or inhalation of these gases and particles obviously depend on their concentration in the air and the exposure time.

Table 9 Characteristics and symptoms associated with gases and particles

Toxin	Characteristics and symptoms
Carbon monoxide	– Always released in a fire (product of incomplete combustion) – Highly asphyxiating gas because CO binds to haemoglobin and impedes oxygen transport – Incapacitating because CO binds to muscle myoglobin, impeding movement and thus escape – Symptoms: neurological disturbances like headache, dizziness, nausea, fatigue, loss of consciousness, coma – Prolonged exposure and/or exposure to high concentrations of CO results in death
Carbon dioxide (carbonic acid gas)	– A product of complete combustion – Asphyxiating gas – CO_2 has a specific toxic effect (narcosis) but also acts as an "asphyxiation catalyst", i.e., its presence leads to an increase in respiration rate (breathing frequency) which makes it easier for other toxins to penetrate into the airways – Symptoms: neurological disturbances (headache, dizziness, unconsciousness, coma) and cardiovascular disturbances
Hydrogen chloride	– Produced by combustion of common plastics like PVC (polyvinyl chloride) – Irritant, toxic and corrosive – Effects: irritation of mucous membranes – Exposure to high levels (1000 to 2000 ppm) can cause death by acute pulmonary oedema
Hydrogen cyanide	– Highly toxic gas produced by the combustion of natural (e.g., silk, wool) or nitrogen-containing synthetic (e.g., polyurethanes, polyamides) polymers – Acts by blocking cellular respiration – Symptoms: death (lethal concentration is from 100 ppm) – Poisoning is reversible if the antidote is administered promptly
Nitrogen oxide	– Symptoms: in low concentrations (20 to 50 ppm), it causes irritation. In higher concentrations (90 ppm), it can lead to pulmonary oedema. From concentrations of 250 ppm upwards, it causes death within minutes
Soot	– Carbon-rich solid particles given off by incomplete combustion of fossil and biomass fuels – Soot sticks to cell walls, obstructing the bronchial tree (trachea) – When hot, they can cause burn injuries to the airways – They have a caustic effect: they attack body tissues – Symptoms: change in voice, respiratory distress, asphyxia
Benzene	– Monocyclic aromatic hydrocarbon – Solvent used for the chemical synthesis of plastics – Irritant to eyes and skin – Carcinogen – May be fatal if it penetrates into the airways
Toluene	– Aromatic hydrocarbon used as a solvent – Harmful, ecotoxic and reprotoxic (i.e., toxic to reproduction) – Irritating to skin, eyes and respiratory system – If inhaled at high doses, can be fatal or cause permanent brain damage
Sulphur dioxide	– Highly toxic gas – Causes severe skin burns and eye damage – Causes irreversible damage to the pulmonary vesicles
Acrolein	– Liquid produced from combustion of plastic, rotting fruit, decomposing fat – Extremely toxic if inhaled or ingested – Causes burns – Causes death by suffocation

Acetal-dehyde	– Colourless, volatile liquid, soluble in water and all organic solvents – Causes severe eye irritation – Suffocating in high concentrations – Suspected carcinogen
Trichloro-ethylene	– Organic compound, solvent – Causes severe skin burns and eye damage – May cause genetic defects and may cause cancer – Toxic to the central nervous system: can produce coma or death within minutes – Under certain conditions, the vapours may form explosive mixtures with air (Institut national de recherche et de sécurité 2011: 2)

Sources: Hansen 1990: 805; Cuttelod 2004: 17

The effects of exposure to some chemicals may not appear until much later on because diseases like cancer have long development periods. Medical surveillance throughout but also after the end of working life is vital for firefighters.

The smoke that firefighters are exposed to if not wearing a self-contained breathing apparatus (SCBA) contains different toxins and irritants, typically resulting in multiple poisoning. A self-contained breathing apparatus can prevent these toxins being inhaled. Wearing them should be compulsory where there is visible smoke, but also during fire scene overhaul, because residual embers give off large quantities of what may be invisible and odourless carbon monoxide and other toxic gases.

The temperature of smoke adds to its toxicity. Hot smoke gives off radiant heat which at certain temperatures can ignite combustible materials. They can cause serious injury to human beings. Entering the airways at a temperature below that which causes fatal burns, hot smoke destroys the lungs' innate defence system, heightens the action of the toxins it contains and passes into the bloodstream (Cuttelod 2004: 17).

Smoke opacity

Fire smoke can be more or less opaque depending on the concentration of solid particles and aerosols. Dense, thick smoke forms a screen that reduces visibility – sometimes to zero – and especially deadens sound waves. Sounds and voices are muffled. That makes it hard to judge distances. In smoke, all visual and sound bearings are lost (or missing). Firefighters are effectively having to find their way around rooms they are normally unfamiliar with as if they were partially sighted or blind, hearing impaired or deaf. Moving forward through or reconnoitring the scene in such circumstances carries clear high risks: firefighters may lose their sense of direction and head back to the seat of the fire when they think they are exiting - a mistake that may cost lives if the self-contained breathing apparatus (SCBA) cylinder's reserves are too low to turn back or if a fire event is developing. They may also sustain injury tripping over objects or losing their teammate who is close by because they can no longer locate or hear his calls. Smoke puts firefighter safety particularly at risk and renders on-scene rescue personnel operations very difficult.

Physical hazards

Fire control exposes firefighters to a wide range of physical and structural hazards, largely determined by the characteristics of the fireground. First, moving forward through a compartment whose boundaries, size and height differences are hidden by opaque smoke can result in falls, slips and collisions with objects. Also, a structure fire (e.g., house, shed, etc.)

increases the risk of collapse because combustion or prolonged exposure to heat alters and reduces the structural strength of materials. Given the potential severity of collapse injuries to fireground personnel, the risk assessment prior to any operation must marshal all available knowledge about the yield points of the structural materials used and their loss-of-strength behaviour in fire. Finally, firefighting operations involve risks from energy sources in the structure – electricity, gas, etc. – which do not mix with water or fire and involve potentially fatal risks of electrocution and explosion. Before committing entry teams, the risk assessment must identify the energy sources present in order to cut off the supply (Persoglio 2003: 121-122). A word must be said here about new risks emerging in firefighting. The solar panels equipping increasing numbers of house roofs in recent years are a source of growing concern to fire and rescue service personnel because they remain powered even when the mains power is off, leaving the risk of electrocution (Thill & Gouzou 2010).

Emergency travel to fire stations or call-outs to incident sites is also responsible for many accidents. The emergency services' road traffic accident record is a source of growing concern. It could be brought down by improvements to vehicle markings. Specific emergency vehicle driver training modules for difficult or dangerous conditions would also be a good idea.

Psychosocial risks

The risks considered above and the macho culture prevalent in many fire services of suppressing emotions and feelings often mean that scant attention is paid to the psychosocial risks of firefighting missions.

Stress: a firefighter's daily bill of fare

The conditions that firefighters work in are a breeding ground for stress. Various stressors can be identified both in the work itself and in how it is organized. Emergencies that mean working against the clock are obviously highly stressful. The alarm shatters the fire station routine: all activities, including sleep in a night-time callout, are summarily interrupted (Guidotti 2002: 95.7; De Soir 1997: 43). The on-call firefighters stop what they are doing and prepare to turn out. The clock starts ticking, as it were, from the pre-operations phase and the pressure of an emergency response will ease only once the operation is finished. On top of the time pressures are those of the kind of operation and its procedures. Particularly gruelling working conditions in terms of the physical, physiological and/or emotional demands, an awareness of the risks run and the stakes, are all – especially when added together – apt to generate stress among on-scene personnel. Organizational and relational aspects of firefighters' work may also be stressful. A lack of strong, reassuring leadership or communication breakdowns on-scene, for example, may be particularly anxiety-producing. On the organizational front, union representatives point to employers' disregard of various components of fire service work organization (i.e., working time, work/life balance, personnel and skills management, workload allocation, communication between firefighters of different grades and statuses, social recognition, etc.) as being particularly damaging to firefighters' psychosocial well-being.

So firefighters are not immune to work-related stress (Murphy *et al.* 1999: 179-196), which may be somatic (e.g., heart disease, high blood pressure), psychosomatic or psychological (e.g., depression, burn-out). The problem of alcohol and other kinds of substance abuse (e.g., anxiety-relievers, drugs) that some studies have helped highlight in the fire services should prompt thought about prevention and be at least partly considered as a behavioural response to chronic stress. The European framework agreement on work-related stress (2004)[23] requires employers to take steps to prevent, eliminate or reduce work-related stress for firefighters. Exposing them to inordinate stress on the grounds that it is inherent to firefighting tasks is unacceptable. While nothing can be done about the characteristics of incidents that are in themselves acutely stressful, they can perfectly well be factored into the pre-operational risk assessment so as to adapt operations accordingly. However, many stressors are related to the organizational and inter-personal aspects of work. While nothing can be done about stressful organizational arrangements derived from the obligation to ensure a continuous service (e.g., night work), a wide range of specific, especially collectively-agreed measures exist that can be used to act on many sources of organizational and inter-personal stress.

Employers in some countries seem to recognize the extent of the problem of stress among firefighters and some are seeking to tackle it by offering their staff training in stress management. This kind of individual-centric measure may help to cope with stressors that cannot easily be acted on. But they are no magic bullet.

A collective, preventive approach (i.e., directed at eliminating stress at source) will surely yield more conclusive results.

Post-traumatic stress

Firefighters are used to difficult operations. Their operational commitment – i.e., knowing what to do and how to do it on arrival on-scene - usually allows them to focus on the work, keep a healthy distance from the suffering of any victims (Boullier & Chevrier 2000: 59) and avoid developing negative feelings (e.g., powerlessness, anxiety, insecurity, guilt). Some events, however, can break down this vital psychological barrier - incidents where lives are at stake, for example, especially of children or acquaintances. Likewise on-scene injuries or deaths of colleagues – such incidents face firefighters with a major emotional shock or trauma that can cause *post-traumatic stress disorder*.

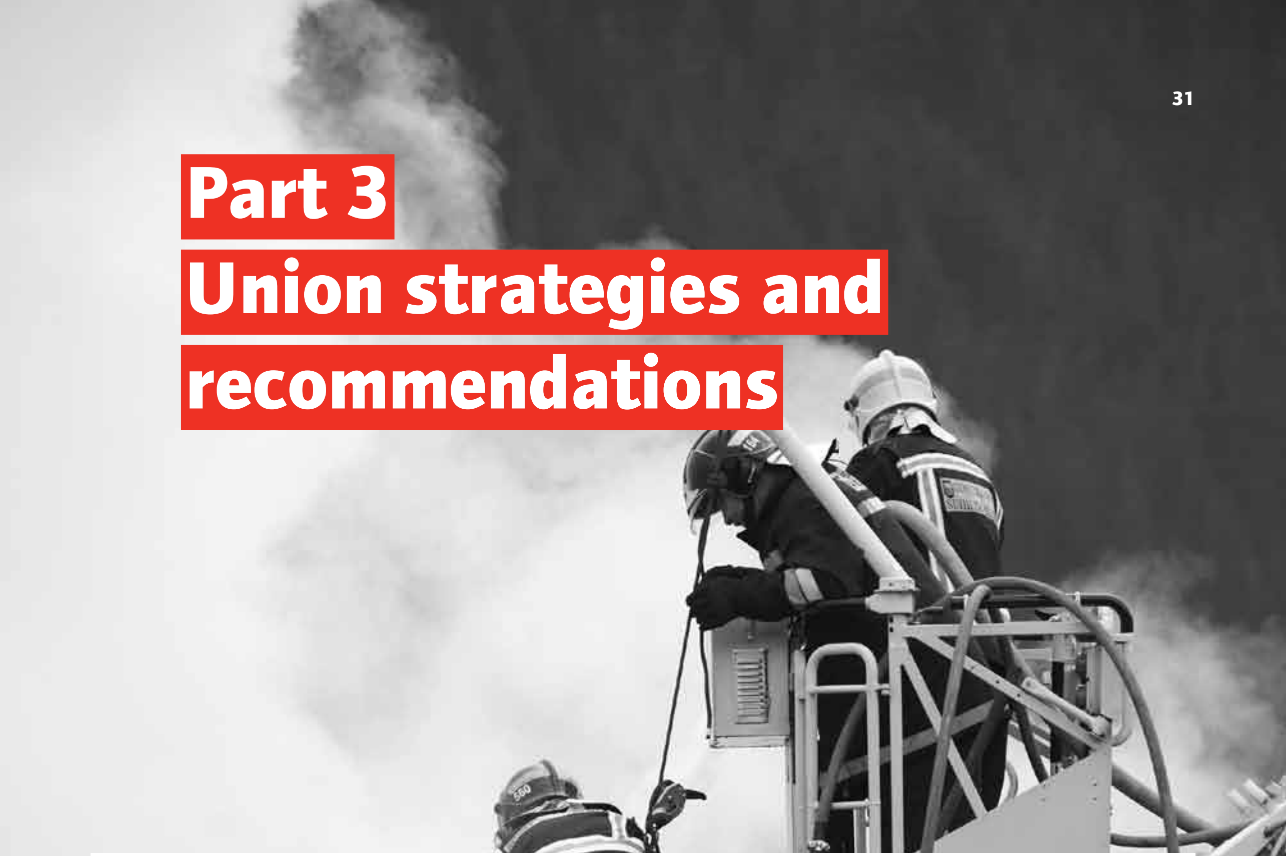
This syndrome is now well documented (e.g., De Soir 1992: 139-152; Bryant *et al.* 1996: 51-62), and the symptoms associated with it are well-established. The serious mental and physical toll it can take on workers suffering from it requires specific support. Like the help provided to physically injured firefighters, those confronted with a traumatic or potentially traumatic event need appropriate psychological help. Specific psychological counselling techniques (e.g., defusing, debriefing) have been developed by psychologists to prevent the syndrome developing among emergency services personnel. To be effective, counselling must be available immediately after exposure (i.e., on-scene support). It has also been shown that successful counselling for firefighters depends on compliance with the social comparison principle (De Soir 1999: 28, 32). These requirements and findings are behind the creation in some European countries like Belgium of Firefighters Emergency Stress Teams (FiST) – teams of firefighters specially trained in the prevention and management of post-traumatic stress. They are rapid response teams distributed more or less nationwide, and work to the social comparison principle by providing peer support.

23. See http://www.etui.org/Topics/Health-Safety/Stress-harassment-and-violence.

Attacks on firefighters

A comparatively new phenomenon has surfaced in some European countries: attacks on firefighters. It has been seen in France, for example, most often in connection with inner-city rioting. But it has also occurred in the United Kingdom (Labour Research Department/ Fire Brigade Union 2008a), and similar problems are reported in Italy, Finland and Sweden. Whatever the causes – the most commonly cited being equating firefighters with the police – the attacks are endangering the physical safety and mental health of firefighters. They can also give rise to post-traumatic stress disorder, and cause firefighters to question their motivation and undermine their vocation – their sense of purpose in what they do.

In 2007, the European social partners signed a framework agreement on harassment and violence at work which recognizes that workplace violence can come from third parties, and confirms that employers have a duty to protect their workers from such systematic assaults. Secondary prevention is crucial here. The risk must be planned for by making good use of all information about the social and environmental context of the operation in order to take appropriate protective measures. Also, where fire and rescue personnel have been attacked, it is vital for the employer to implement a tertiary prevention system (e.g., defusing or debriefing) to limit the psychological impacts on attacked workers and, especially to prevent posttraumatic stress reactions appearing (Pourny 2003d: 297-309).



Part 3
Union strategies and recommendations

Risk assessment and management: ways to make operations safer

Risk assessment and command

Firefighters' missions demand a singular commitment: voluntarily intervening in situations that by nature put their own safety at risk. This commitment by professionals and volunteers is remarkable. To do their job of saving lives, firefighters voluntarily endanger their own – they go into it accepting a high level of risk.

As in any other job, that risk must be assessed in order to be avoided or at least reduced. For firefighters, that assessment is done in several stages following the sequence of the emergency response chain. Immediately the call is received, a pre-assessment is done based on the information gathered from witnesses to the incident to determine the human and material resources needed to respond. Properly matching the incident and the resources needed to get it under control is crucial inasmuch as an operation that is under-manned or lacking the right equipment can increase the risk to on-scene personnel. But only once on-scene can an appropriate assessment of the potential and actual risks of the incident be made so as to determine the preventive measures and strategy to be adopted .

The nature of the firefighters' mission means that the results of the risk assessment alone cannot determine the operational tactics. Along with the risk assessment, the incident commander must also consider what is at stake in the operation. Are lives or only property endangered? How certain of that can we be? Not uncommonly – in certain conditions – where human lives are at risk, what is at stake outweighs the results of the risk assessment and leads to a considered choice of a higher-risk strategy for firefighter safety – e.g., an offensive action involving entry into the burning building – over a defensive action from outside it. This is a singular feature of the profession: the risk to workers is apt to be outweighed by what is at stake. A high risk may be deemed "acceptable" if considered proportional to what is at stake, in other words where it is judged that the presumed benefit of the intervention outweighs its cost – i.e., exposure to the risk (Grimwood 2008: 8-15; Perret 2009: 4).

This difficult trade-off, often based on a risk assessment and weighing-up of the stakes done in very short order, is performed by the incident commander who will then be accountable for all its consequences. The trade-off results in an action strategy being chosen which will dictate the measures that must be implemented to protect the deployed crew (e.g., readying a two-out team to intervene in support of the two-in team). It is then down to the incident commander to coordinate and adapt the response to changing circumstances and risks. The responsibilities and complexity of incident command tasks mean that the importance of stringent selection and training of incident commanders cannot be overstressed. A knowledge of structural stability and strength of materials, fire (behaviour and dynamics), operational risks and techniques, analytical skills, ability to prioritize, decision-making, communication and leadership skills in critical situations, etc. – the position requires a solid body of theoretical, practical and human relationship skills (Grimwood 2008: 29). Often, this key post is open only to officers. In many countries, however, as various participants in seminars organized by ETUI and EPSU on the health and safety of European firefighters have remarked, graduates are fast-tracked into officer posts with no prior on-scene experience to draw on or the human skills required to handle all the incident commander responsibilities. But in an operation where men know they are risking life and limb, trust and respect in the incident commander's capabilities are vital. If leadership appears weak, not there or simply lacking credibility to the very people who are putting their safety and health in his hands, firefighters may try and make up for management's purported or actual failings by freelancing as they see fit which, in the absence of overall coordination, can have disastrous outcomes.

A new operational function: incident safety officer

Among the recommendations made by industry experts to improve the safety and also the physical and mental health of on-scene firefighters, creating a new operational function specifically focused on these aspects has attracted a broad consensus. The idea is to have the incident commander assisted by a technical advisor the incident safety officer – tasked with looking at the operation purely from the crew's safety and health angle. At first response, he will input his "deployed crew safety" expertise to the risk vs. stakes trade-off done by the incident commander. During the operation, the safety officer will be responsible for implementing all the prevention and protection measures for "safe" engagement by firefighters. He will also ensure that after each engagement, each firefighter receives the necessary medical, physical and/or psychological support. Finally, he will conduct a critical analysis of the operation and produce the feedback from which lessons for future operations can be developed (Grimwood 2008: 20; Pourny 2003b: 6, 9, 13).

Personal protective equipment and other equipment

Standardization: getting a trade union say

Under the 1989 Framework Directive on the safety and health of workers, the employer must evaluate occupational risks and provide workers with personal protective equipment (PPE) appropriate to the occupational risks he has identified and assessed. Where firefighting is concerned, the thermal, chemical and physical risks described above mean that the risk assessment generally results in the employer supplying firefighters with at the very least:
— a helmet with a lamp and hood;
— a self-contained breathing apparatus (SCBA);
— protective clothing (turnout coat and overtrousers);
— gloves;
— boots;
— a belt with restraint and work positioning lanyard;
— a safety harness for work at heights.

Having assessed the risks, the employer will look to the market to purchase this equipment to minimize the risks identified and assessed. But what does the market offer?

The EU regulates the design and manufacture of PPE through a Directive[24] which lays down the essential safety requirements that PPE must meet in order to be placed on the European internal market. This "New Approach"-type Directive offers manufacturers a simplified procedure for ensuring compliance of their products: if they satisfy the so-called harmonized standards, they are presumed to comply with the Directive. As a result, the quality of PPE – and therefore part of firefighters' working conditions (levels of stress, comfort and protection) – are directly dictated by the quality of these harmonized standards. These standards are drawn up by technical committees and working groups set up by the European Committee for Standardization (CEN). While there is no doubting the conscientiousness of most manufacturers of PPE for firefighters, one crucial question must be asked: as there are generally no representatives of firefighters in the bodies mandated to develop harmonized standards, is there not a risk that they may be inappropriate, inadequate and/or ineffective by failing to take into account the actual conditions in which firefighters use their PPE? Is this not tantamount to a missed opportunity to incorporate the real demands of work, especially ergonomic factors, into equipment to improve health and safety in day-to-day work?

Take the case of helmets for fire fighting in buildings and other structures, for example. These helmets are designed to Standard EN 443 developed by Technical Committee CEN TC 158 "Head Protection". No firefighters' representative sits on this committee, so the question is whether this might not be harmful to firefighters who are unable to input everything they know about the normal use and reasonably foreseeable misuse – which they are undoubtedly best placed to know - into the development of the standard. As a result, firefighters are less than wholly satisfied with the fire helmet supplied to them. When asked, firefighters are quick to complain about its comfort, strength and the protection it provides in actual conditions of use.

Similar complaints are levelled against other personal protective equipment. The same kind of question can therefore be asked about all PPE covered by harmonized standards (see table 10).

24. Council Directive 89/686/EEC of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment.

Table 10 Main PPE specific to firefighting: harmonized standards, technical committees and most common complaints

PPE	Standard	Committee	Examples of complaints
Helmet (optional neck curtain*) and lamp	EN 443: 2008	CEN TC 158	– Does not sufficiently withstand high temperatures (including the internal frontal impact protection – components are crushable) – Some new models greatly reduce hearing capability
Helmet face shield and visor	EN 14458: 2004	CEN TC 85	– No anti-radiant heat visor on some new helmet models
SCBA**	EN 137: 2006 (Open circuit)	CEN TC 79	– Too heavy if cylinders are in steel rather than composite – Insufficient heat-resistance, especially the straps attaching the backplate – Compatibility issue with the helmet
	EN 145: 1997 (Closed circuit)	CEN TC 79	– Air cooling system inefficient – Issue with fogging in the mask (except for models fitted with a central wiper) – Bulkiness, wearer mobility, comfort and ergonomics vary with the model – Too heavy (around 15 kg)
Hood	EN 13911: 2004	CEN TC 162	
Clothing	EN 469: 2005 EN 15614: 2007	CEN TC 162	– Overprotection, which: • Reduces sensory perceptions by too much (essential for firefighters to assess their own safety) • Interferes with mobility, freedom of movement – Clothing unsuitable for use of a full body harness (used for outside work at heights over 2 metres) – Too heavy (turnout clothes regularly weigh over 4.5 kg) – Visibility issues with some models
High visibility vests with retro-reflective strips	EN 471: 2003 + A1 2007	CEN TC 162	
Gloves	EN 659: 2003 + A1: 2008	CEN TC 162	– Poor water penetration resistance (especially leather gloves) – Loss of heat protection when wet (risk of burns) – Restricted hand/finger movements
Shoes	EN 15090: 2006	CEN TC 161	– General lack of flexibility – Not impervious – Too heavy when wet
Belt with restraint and work positioning lanyards	EN 358: 1999 EN 354: 2010	CEN TC 160	
Safety harness (for working at heights) with fall arrest	EN 361: 2002 EN 353-1: 2002 EN 353-2: 2002	CEN TC 160	– Cannot be used with long jackets

*A neck curtain is a removable covering attached to the back of the helmet to protect the firefighter's neck.
** There are two variants of SCBA in use by firefighters: open circuit and closed circuit. Open circuit sets are by far the most common. Closed circuit sets are used only when a longer-duration supply of breathing gas is needed (e.g., fires in tunnels, multistorey car parks, underground stations, long-duration reconnaissance in a smoke-filled environment). Most closed-circuit SCBAs on the market offer a theoretical working duration of around 4 hours. Given the constraints of their use, closed circuit SCBAs are worn only by specially trained and drilled crew.
Source: ETUI - EPSU survey 2010-2011

CEN Committee TC 162 "Protective clothing" does, however, include one representative each of the Norwegian firefighters' union and Dutch firefighters.

The same kind of question can be asked about harmonized standards that regulate the design of other equipment vital to firefighters' work, like aerial rescue and escape carrying appliances or hose and water appliances. Like PPE, such equipment is regulated by a "New Approach"-type Directive, meaning that the quality of their design is dictated by that of various harmonized standards. Take the example of firefighting and rescue vehicles[25]: no firefighters' representatives are involved in developing the harmonized standards for this equipment, so the question arises whether that lack of input into developing standards for equipment so fundamental to firefighters' work might not result in the requirements not only for daily normal use but also the reasonably foreseeable misuse which only firefighters with their experience realistically know about being overlooked?

Standardization may be about technical expertise, but it is also a very effective way for improving workers' health and safety by ensuring that the quality of products and equipment placed on the market are up to the demands of fireground work. Trade unions must be involved in this standards development process. The ETUI is committed to supporting firefighters' unions that want to go further down this road. If required, the ETUI is willing to facilitate an active presence by worker representatives in the technical committees considered as priority for the sector.

A bigger focus must be put on standardization as an opportunity to act on workers' health and safety. A reference to it in the seventh section[26] of the EPSU Firefighters' Charter could certainly help that.

Compatibility of PPE

Firefighters must have PPE that meets harmonized standards. But for them to be fully protective in a fireground, the different elements of the PPE ensemble must be compatible with one another. For example: to protect the forearms from radiated heat that can cause severe burns, the sleeves of the protective jacket must be adapted to the wristlet (gauntlet) of the gloves. Or again, firefighters often have to perform firefighting or rescue operations at height, especially when working from the rescue cage of an aerial appliance. To ensure their safety and health in such circumstances, firefighters have two separate PPE: a safety-belt with lanyard and safety harness with fall arrest system[27]. However, many firefighters report that their harnesses do not fit easily over their turnout coat (which reaches down to mid-thigh) and significantly restrict and interfere with their movements[28].

While compatibility may seem a self-evident requirement, it often seems to take second place to financial and managerial considerations. A further example: the Belgian Interior Ministry placed a bulk order for next generation protective helmets to get the keenest prices from an equipment supplier. Despite meeting both harmonized standards and

25. Whose design specifications are drawn up by CEN Technical Committee TC 192 "Fire service equipment" and codified in Standards EN 1846-1 - 2 and -3.

26. Concerned specifically with training and equipment. The Firefighters' Charter is available in several languages on the EPSU website: http://www.eps4

27. The belt is mainly used as a work positioning system and tool carrier. It is not recommended for working at heights as in the event of a fall, it may cause significant damage to the wearer's back, kidneys and spleen. A harness is best worn for working at heights, because in the event of a fall, it spreads the acceleration over the whole body.

28. There is, however, a solution to this compatibility issue: a turnout coat with built-in harness system, offered by some manufacturers, but supplied to very few European firefighters.

contract specifications, the introduction of the new helmets in many Belgian fire services was soon followed by problems.

Before using the open circuit self-contained breathing apparatus (SCBA), the firefighter runs a check on its functions, including the cylinder pressure gauge which must give a reading at least equivalent to 280 bars to ensure 20 to 40 minutes' operating duration depending on the wearer and degree of effort. Problems with SCBA use were reported from the very first operations using the new helmet: a sharp fall in remaining air causing the low pressure warning signal[29] to activate after less than a third of the normal usable time. In fact, the problem was not an SCBA malfunction. On closer inspection, the firefighters realized that the side arms of the SCBA's face piece (or facemask) were not fully compatible with the fasteners fitted to the newly acquired helmets, resulting in a loss of seal (e.g., leakages). But a firefighter caught unawares by a supply of air too low to retrace his steps and evacuate a structure fire may be fatally trapped. Conversely, there are also reports that some Belgian fire services acquired new SCBA facemasks fitted with the new-style side arms without introducing the new generation helmet at the same time. In this case, it was found that in the event of impact, the incompatibility of the two PPE could result in nothing less than the SCBA face piece being ripped off sideways. The potential tragic consequences of an incompatibility of that order are clear to see!

Hopefully, this finding will lead to an early review of the compatibility between helmets and SCBAs in Belgium's fire services. If finances do not permit firefighters to be supplied with helmets and SCBAs of the same generation at the same time, then the helmet securing straps or SCBA side arms should be replaced to ensure that these PPE critical to firefighters' health and safety in a fireground are compatible.

There is a more general need to promote the development of standards for compatibility between SCBAs and other PPE they are regularly used with and on which the seal integrity depends (e.g., helmet, hood). There are no such standards at the present time, notwithstanding the requirement in Article 4.2 of individual Directive 89/656/EEC on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace that, "where the presence of more than one risk makes it necessary for a worker to wear simultaneously more than one item of personal protective equipment, such equipment must be compatible and continue to be effective against the risk or risks in question".

Maintaining and cleaning personal protective equipment: taking care of health

In a fire, firefighters are exposed to gases and smoke released from burning materials. The toxicity of these gases and smoke means that SCBAs must be worn not only during fire suppression activities but also – although they tend not to be – during overhaul activities. Is that enough to keep firefighters' healthy?

The incidence of ill health (cancer, infertility, etc.) among firefighting personnel led firefighters from the city of Skellefteå in Sweden to look into the problem of more indirect exposure to toxic substances resulting from firefighting activities. They realized that while SCBAs protect the airways in fireground operations, their fabric protective clothing and boots were saturated with small particulates (e.g., soot, cyanide derivatives, sulphur

29. The signal sounds when the air supply falls to 50-60 bars. The firefighter then knows he still has 5-6 minutes to evacuate the area where the SCBA is needed.

Self-contained breathing apparatus must be worn during overhaul operations

Firefighters' on-scene activities do not end with extinguishing the fire. Attack operations are followed by overhaul and surveillance of the fireground. For a period which may take longer than fire suppression proper, firefighters overhaul the charred debris – using a thermal imaging device if available – to find and extinguish any hotspots that might reignite the fire.

While SCBAs must be worn during the attack phase of firefighting, especially in an offensive operation, they are much less systematically worn during overhaul activities and regularly left to the discretion of crew members. Barring gas and volatile organic compound detection devices*, the only way firefighters often can determine whether an SCBA is needed in this phase of operations is by sight. The complete or significant dissipation of smoke combined with the discomfort of wearing SCBAs leads many firefighters to overhaul fire scenes without respiratory protection (IARC 2007: 441 - 443).

From measurements taken at various stages of development of a fire in a variety of structures, American researchers have shown that production of ultrafine particles   by definition invisible to the naked eye – not only continued after the fire was extinguished, but actually increased. As a result, not wearing SCBAs during overhaul operations would expose firefighters to particularly critical levels of ultrafine particles which the study's authors argue to be a contributory factor for the prevalence of coronary heart disease among firefighters (Baxter *et al.* 2010: 791-796). Other researchers have shown that direct exposure to combustion products during overhaul may adversely affect the results of respiratory function tests – i.e., the breathing capacity of the lungs   and reduce lung permeability (Brandt-Rauf *et al.* 1989: 209-211; Burgess *et al.* 2001: 467-473).

The large number of cases of respiratory diseases and failures (Banauch *et al.* 2006: 313-319; Reibman *et al.* 2009: 534-541; Aldrich *et al.* 2010: 1263-1272) and cancers (Moline *et al.* 2009: 896-902; Goldenberg & Edelman 2001) seen among firefighters who worked without respiratory protection (Buisson 2010) on the protracted overhaul of Ground Zero in New York are no less unsettling. Exceptionally protracted and large-scale as these operations were, their tragic consequences for the health of fire and rescue personnel militate for SCBAs to be worn as a precaution in all overhaul operations.

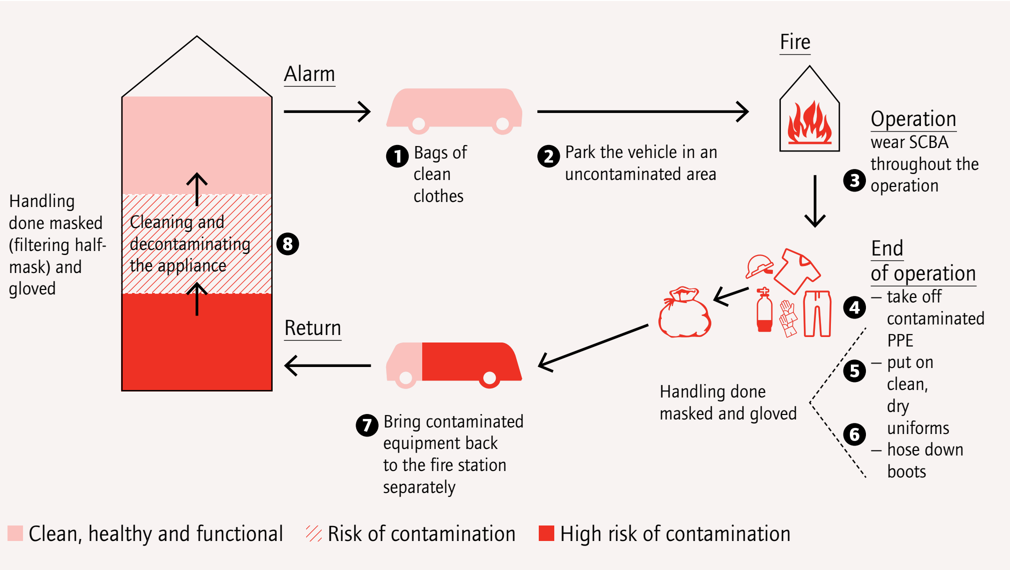
* Although existing devices cannot detect the full range of particles and gases that may be emitted from fireground debris and rubble.

compounds, etc.) that contaminate the gas and smoke, and that the routine use and handling of these clothes resulted in an indirect exposure which needed to be addressed. By breaking down the post-attendance routines into individual steps, they realized that their dirty clothes were handled and brought back into the appliance cab and fire station with no precautions, resulting in wider contamination. Working with their employers[30], they developed a new procedure for post-attendance management and maintenance of personal protective and other equipment. This procedure, now known as the Skellefteå Model, received the accolade of a European Good Practice Award from the Bilbao Agency in April 2011 (European Agency for Safety and Health at Work 2011: 12).

What practical steps does the model recommend to reduce firefighters' post-attendance exposure to potentially toxic substances and contamination? In the diagram below, the figures show the sequences that the Skellefteå model adds to the normal firefighting operation routine. Sequences 3 and 8 denote operations that are not unusual but that the model systematizes for each cycle of operation.

30. The model is supported and cooperated on by the two firefighters' unions (Kommunal and Brandmännens Riskförbund) and the employers (the Swedish Association of Local and Regional Authorities).

Figure 3 The Skellefteå model: proper equipment maintenance to prevent post-incident contamination



Firefighters normally respond to a callout wearing their protective clothing (turnout jacket and trousers). ❶ Now, they also turn out equipped with a bag of clean clothes. ❷ On arrival on-scene, they park the vehicle in an area uncontaminated by smoke and gases. ❸ Throughout the entire operation, including during overhaul operations, they wear their SCBA. Once the operation is completed, ❹ they remove their protective clothing (turnout jacket and trousers) to ❺ don clean and dry outerwear and ❻ hose down their boots. ❼ The protective clothing contaminated by fire gases and smoke along with the SCBA are put in plastic bags that are now stored at the rear of the vehicle rather than in the cab with the crew. The key idea is that the return to the fire station must be done in a healthy and uncontaminated environment. ❽ Back at the fire station, the plastic bags containing the contaminated clothes and SCBAs are taken directly to depressurized rooms for decontamination[31]. The clothes are washed in a washing machine kept for the purpose, then dried[32]. The Skellefteå firefighters have adapted an industrial dishwasher to clean the SCBAs, which are tested and reconditioned after cleaning. Once clean, all these PPE can go back into the operational circuit, ready for use again with no risk to health. The firefighting vehicles and equipment also undergo a thorough cleaning. If hoses and nozzles cannot be cleaned directly, they are immersed in containers of water to prevent the solid residues of burning from drying and becoming volatile. Note also that all operations involving the handling of contaminated equipment (❹❻❼❽) are done wearing gloves and a particle filtration half-mask[33].

The model's developers have worked hard to promote it to Sweden's fire services where it is now widely applied, but also more recently in other European countries where it

31. The cleaning rooms are put under negative pressure (i.e., ambient air is extracted to the outside via a ventilation system) so that the toxic particulates from the firefighting operation cannot escape from the chamber and spread throughout the rest of the fire station.
32. The frequency of cleaning means that the protective clothing has to be cleaned quickly and all at the same time, so the washing machines and tumble dryers must have large capacity drums.
33. To Standard EN 149: 2001.

has generated much interest[34]. The issue of firefighter exposure to toxic substances apart, the Skellefteå model is valuable in raising fire service awareness of the issue of health and safety in holistic terms. Using it encourages consistency: there is little point in additional – sometimes burdensome – preventive measures to reduce exposure to toxins if at the same time firefighters are wantonly exposing themselves to other occupational hazards. Where the model has been implemented, a change of mindset has been observed: crew tend to be more proactive and positive in identifying potential risks and developing counter-measures. This suggests that implementing the Skellefteå model has allowed firefighters to be openly concerned about all aspects of their health and safety.

The Skellefteå model is also valuable for calling attention to two other big and clearly inherently linked aspects of PPE use – maintenance and replacement.

The new generation of firefighting protective clothing has forsaken leather for technical textiles (e.g., Kevlar©, Nomex© III, Kermel©, Gore-Tex©, Protex©, FiTek) made from synthetic fibres with valuable properties for firefighting operations: high thermal stability, good temperature, combustion and radiant heat resistance, good torsion strength, good sweat absorption capacity, good impermeability, comfort of wear, etc. Some of these properties result from the chemical finishes given in the initial treatment of the fibres. But these finishes tend to degrade with cleaning (e.g., loss of impermeability). The textiles lose some of their special properties, reducing the protection afforded by the PPE of which they are made. How and how often should they be cleaned? When should they be replaced?

The cheapest answer many fire services find to this is to put off cleaning their bunker gear indefinitely, thus extending the benefit of the protective properties of their clothing and delaying the moment of replacement. But this cannot stand as the cure-all for firefighters' health because in seeking to improve on-scene protection it underestimates the impact of post-incident contamination highlighted by the Skellefteå model.

It is clearly not relevant to set a hard-and-fast frequency for cleaning bunker gear in this regard – that can only be set in the light of use and exposures. Nevertheless, the deterioration in textiles' protective properties can be "estimated" by strictly following the manufacturers' recommendations. The Personal Protective Equipment Directive[35] requires the designers of PPE that are subject to aging to provide information on recommended cleaning (i.e., products, programmes and temperatures, etc.) and to indicate the maximum number of cleaning operations that can be carried out before it needs to be inspected or replaced. Furthermore, the Use by Workers of Personal Protective Equipment Directive[36] provides that the necessary maintenance, cleaning and ultimate replacement of PPE remains the employer's responsibility. The employer cannot evade any of his responsibilities in this matter by contracting-out the cleaning of textile PPE and must therefore ensure that the subcontractor can and in practice does comply with the manufacturers' recommended cleaning methods.

34. The educational materials to promote the model include a Powerpoint presentation on its different sequences, available in Swedish and English on the "Friskabrandmän" ("Healthy Firefighters") website – a project with more all-embracing ambitions which may in future include other initiatives for firefighters' preventive health: http://www.friskabrandmän.nu
35. Paragraph 2.4 of Annex II to Directive 89/686/EEC.
36. Article 4.6 of Directive 89/656/EEC.

Promote the purchase of equipment that reduces on-scene risks

Recent decades have seen designers and manufacturers putting out a steady stream of ever more sophisticated equipment, machinery and tools to improve not only firefighters' operational efficiency but also their protection in fireground operations. One such is the thermal imaging device (i.e., thermal image camera), introduced into the fire service with signal success. It considerably eases reconnaissance and searching through thick smoke and darkness, and enables hotspots, whether victims or concealed fires, to be quickly located. By giving a better reading of the scene, a thermal imaging device enables crew and equipment to be deployed more appropriately and safely. Also, by cutting attendance time, it helps reduce the human and economic costs of the disaster.

Examples of technological innovations that improve operational efficiency and responder safety abound. Although still in comparatively unofficial use in Europe, the coldcut COBRA™ extinguishing system developed by a Swedish company is one such. The system comprises a nozzle which delivers a high pressure water jet combined with an abrasive cutting sand, making it possible to drill through a wall or other structure in a few seconds and then switch to a water spray to fight the fire as with a conventional fog nozzle (i.e., at a rate of 200 metres per second at a pressure of 300 bar for a flow of 50 litres per minute). This immediately cools down the hot gases that cause the most common and most dangerous fire events (i.e., backdraft and flashover). It can be used safely from outside the structure – so without dangerous venting interventions – thereby reducing exposure of the two-in attack team who make entry into the fire room when the temperature of gases has been reduced to the point where the risk of a flashover or smoke explosion is eliminated.

Some recent technologies therefore significantly improve responders' safety. Their cost, however, tends to put employers off purchasing them, notwithstanding that in the medium to long term, this would be offset by the material and human gains from the improved efficiency and safety they deliver during firefighting operations.

Making such equipment affordable is also something for trade unions to address, for instance by promoting the most worthwhile equipment and tools to standardization bodies, given that product standardization not only helps improve quality, but also opens the market up to healthy competition and hence brings prices down.

The importance of drilling and specific training

Self-awareness for an optimum performing work unit

The extreme conditions involved in firefighting make it essential that firefighters - but also their superiors and other crew members – should be fully aware of their physical abilities and physiological capacities. Where safety is concerned, knowing an individual's capacities is at least as important as those capacities themselves. In fireground operations, overestimating one's physical condition or physiological capacities can put one's own safety or that of other crew members at risk. Simply put, the main thing in firefighting is self-awareness. Drilling and practice are decisive to developing that self-awareness.

Regular physical training is essential to maintain and even improve fitness that is put under heavy demands by fireground operations (e.g., carrying heavy loads, climbing flights of stairs, negotiating obstructions, etc.). Maintaining or improving physical fitness is not the only point of such training, however. It must be done properly[37] so as to provide firefighters with credible information about what "reserves" they can reasonably draw on during operations (e.g., endurance, recovery after exertion, etc.), their limits and their changes over working life.

Firefighting also places firefighters under extreme physiological stress. Prolonged exposure to inordinately high temperatures must surely be the most obvious. Unlike physical abilities, physiological capacities cannot really be significantly improved by exercise[38]. Where physiological capacities are concerned, specific medical tests are essential to inform firefighters of their own tolerance to different physiological stresses typically encountered in firefighting. The results of these tests should be used to assign on-scene roles. For example, a firefighter with below-average physiological responses should self-evidently not be assigned to the two-in attack team – which is typically the most exposed.

Changes in firefighters' physical abilities and physiological capacities over working life are inevitable. However, it would be ludicrous to use this as an excuse for sidelining them from the work unit. While commonsense says that older firefighters cannot compete with the young recruits in terms of physical fitness and physiological capacities, their experience and prowess in "reading" a fire are major assets in a high-risk situation. The firefighting work unit can only be strengthened by allying the former's skills with the latter's strength.

Understanding fire: practical training is a lifesaver

Obviously, responding effectively to a fire demands a thorough understanding of key technical concepts: the different combustion processes, methods of heat transfer (convection, conduction, radiation), the strength of materials and structures, air flow and ventilation techniques, conditions for the onset of fire events, health and safety risks, equipment characteristics, etc. (Persoglio *et al.* 200). Firefighters must be trained in the theory, therefore, but that alone is not enough[39]. To tackle a fire, a firefighter must be able to "read" it. Obviously, this requires theoretical knowledge but more than that, a scene awareness ability that can only be acquired through practice. Scene awareness obviously improves with incident scene experience: over time, the indicators of a hostile fire event (or "thermal phenomenon") are identified more quickly – even anticipated – and appropriate responses become reflexes. Until that ability is honed by experience, novice firefighters must be given practical safety training in realistic conditions. Shipping container firefighting simulators are a boon for this. They enable exercises to be run in near real-life conditions under the supervision of certified instructors. These exercises teach the rudiments of reading a fire, and familiarize novices with other fire suppression procedures: donning SCBAs and other equipment, teamwork, exertion in a hot environment, diminished sensory perception, stress, not to mention fear.

The frequency and severity of hostile fire events, called "silent killers" in the job, prompted the development of purpose-designed observation and training containers in the late 1970s and 1980s. Based on shipping containers – and therefore comparatively low-cost – they can be used to reproduce the trigger conditions of flashovers and backdrafts.

37. Some firefighters' representatives argue that professional sports coaching should be available for physical training to increase motivation – eg, through a personal training programme with objectives tailored to each firefighter - but also to provide each firefighter with objective information on the state and development of his physical fitness.
38. Notwithstanding that the heat acclimation training provided to firefighters in some European countries can help develop useful breathing techniques for very hot environments.
39. This may seem self-evident. But, prior to 2004, French-speaking firefighters in Belgium had only classroom training.

These simulators give firefighters training and practice in recognizing the warning signs of these events (e.g., "fire snakes" or "dancing angels" – i.e., fire flashes heralding a "roll-over") and appropriate control techniques. Some countries – Sweden and the UK, for example - have been using this kind of simulator to complete the practical training of their firefighters for decades. Surprisingly, many European countries have no such or too few simulators to train all staff in a timely manner (e.g., Belgium). Given that such fireground phenomena kill many European firefighters each year, the lack of employer investment in such specialized training facilities is concerning. The Framework Safety and Health at Work Directive[40] requires employers to ensure that workers have adequate training in the risks of their job. Such observation and training containers are currently the very best means of ensuring proper training for these fire events that can be triggered in any fire in any open or semi-closed compartment.

Driver training to cut the road traffic accident rate

Given the road risks associated with emergency responses and the concerning figures for road traffic accidents involving emergency vehicles, high performance driving courses[41] could also be usefully added to measures to improve emergency vehicle safety.

Rethinking health surveillance at work

Very incomplete data collection

Preventing and controlling specific occupational hazards means having the most comprehensive information available on work accidents and occupational diseases. EU Framework Directive 89/391/EEC makes it the employer's responsibility to organize the collection of data on safety at work by keeping a list of occupational accidents (Article 9 of the Directive) and data on health at work by organizing health surveillance (Article 14). The collection and some centralization of these data are essential to determine the incidence and prevalence of accidents and diseases for a given occupation[42] so that preventive measures more appropriate to the typical working conditions and exposures of the job can be implemented.

The job-related epidemiological literature shows that the systems for collecting data on work accidents and medical surveillance in many European countries are inappropriate or deficient. Very often, they provide analysts seeking to determine firefighters' mortality (death rate) and morbidity (disease incidence rate) risks with only incomplete data. There are also clear reliability issues (Labour Research Department/Fire Brigade Union 2008b: 23). So it is unsurprising that the epidemiological literature on firefighters, albeit exposed to clear occupational hazards, is in much shorter supply than for other occupations. This situation can be changed, as an example from France shows.

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40. Article 12 of Directive 89/391/EEC.
41. Recommendations for driver training have been made in France for example (Pourny 2003c: 11, 75).
42. For one or two individuals in a fire service to develop a particular medical condition (e.g., myeloma) is not by itself proof that the disease results from an occupational exposure. That can be established only by showing that the condition is observably more prevalent in a significant sample of firefighters than in an unexposed comparison group.

A French mortality study

In 2002, after two major accidents causing ten firefighter fatalities in the space of ten weeks, the French Interior Ministry instructed Colonel Christian Pourny to make proposals for improving the safety of first responders. In 2003, Colonel Pourny handed in a particularly comprehensive and detailed report containing many recommendations (Pourny 2003a). The report highlights the lack of epidemiological data on work-related accidents and occupational diseases. He calls for the creation of a "reliable national database as the only means of enabling the epidemiological studies essential to (...) any prevention policy" (Pourny 2003a: 6). This recommendation was taken up and acted on. In 2009, the Civil Protection Department decided to set up and run an epidemiological study on firefighter mortality.

The study aims to analyze the causes and age of death for firefighters and identify diseases where there is a significantly excess incidence compared to a base population (e.g., the general population or other occupational group). An analytical epidemiology approach has been taken via a cohort study.

Volunteer firefighters are excluded from the cohort to avoid the effects of occupational hazards of firefighting being confused with those of other walks of life. Only professional firefighters are included. Also, to detect diseases characterized by long latency periods (e.g., some cancers take several years to develop after exposure), the cohort includes all professional firefighters in service from 1 January 1979. The cohort thus formed is called "Cohort C. Prim" (www.cohorte-cprim.fr).

The cohort was designed for the study to be run in three phases. In the pilot period between 2008 and 2010 when the feasibility of the study was still being assessed, the cohort consisted of professional firefighters working at 1 January 1979 in the fire and rescue services of 10 French départements. In 2011, phase two began to generalize data collection to all French fire and rescue services. Phase three will generalize it over time.

In the longer term, the project partners want to "establish a more comprehensive disease risk surveillance system".

Firefighter mortality and morbidity: knowledge and belief

While the epidemiological literature on firefighters is sparse, a small number of studies on firefighter mortality (death rates) and morbidity (disease incidence rates) are nevertheless available.

What is known at present about firefighter mortality and morbidity? Epidemiologists studying firefighter mortality and morbidity have focused on three types of disease condition: cancers, lung disease and heart disease. While each disease has its own specific – they are not necessarily associated with the same risk factors – and complex – they can result from exposure to a combination of risk factors – aetiology, their development is closely connected to the characteristics of firefighting risks.

Cancers

US researchers did a meta-analysis of 32 epidemiological studies to assess the cancer risk among firefighters (LeMasters *et al.* 2006: 1189-1202; Hansen 1990: 805-809). The statistical incidence values calculated for firefighters compared to control populations (i.e., unexposed groups) led the authors to conclude that firefighters had a probably elevated risk of developing multiple myeloma, non-Hodgkin's lymphoma, prostate and testicular cancer as a result of their occupational exposure. This means there is a significant probability that a firefighter will develop one of these four cancers. The study findings, for example, indicated that the probability of a firefighter developing testicular cancer is double that of the general population. The study results also indicated a possible association between firefighting and developing eight other cancers: skin cancer, malignant melanoma, brain cancer, cancer of the rectum, cancer of the buccal cavity and pharynx, stomach cancer, colon cancer and leukaemia. Other studies also suggest that firefighters are at significant risk of kidney, urethra and bladder cancer (Guidotti 2002: 95.7). In 2008, experts at the International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO), recognized occupational exposure as a firefighter as "possibly carcinogenic" (International Agency for Research on Cancer 2008: 49-50).

At the end of the day, these findings are unsurprising. Firefighters are known to be exposed in firegrounds to certain toxic substances for which there is sufficient evidence of carcinogenicity in humans (e.g., benzene). The statistically-supported epidemiological findings therefore simply bear out that firefighters' exposure to carcinogens has health consequences.

Lung disease

Various epidemiological studies suggest that exposure to irritants during firefighting operations puts firefighters at increased risk of diminished lung function (e.g., ventilatory capacity) (Musk *et al.* 1979: 29-34; Brandt-Rauf 1989: 209-211) and of developing chronic lung disease (Rosénstock *et al.*1990: 462-465).

Heart disease

While some studies had ruled out heart disease as a risk of firefighting (Dibbs *et al.* 1982: 943-946; Guidotti 1995: 1348-1356), a review and meta-analysis of 23 epidemiological studies of heart disease forcefully rejects this conclusion and argues that firefighters are actually at increased risk of developing heart disease (Choi 2000: 1021-1034). A US epidemiological study found that coronary heart disease caused 45% of deaths among firefighters while on duty - a much higher rate than among police officers (22%) or for all occupations combined (15%). The same study also found that most deaths from coronary heart disease while on duty (32%) occurred during fire suppression (Kales 2007: 1207-1215). Contrary to popular belief, therefore, a heart attack appears to be the leading cause of death in this kind of operation. An increased strain on the heart from physical exertion and physiological effort performed in the extreme conditions that typify firefighting combined with the presence of carbon monoxide (Hansen 1990: 807) – a highly toxic gas released on incomplete combustion - are among the causes most commonly cited for such prevalence.

Accidents

As well as diseases, firefighters run the risk of accidents that may result in temporary or permanent disability or even death. Firefighting activities can be responsible for a range of injuries of varying severity: burns, suffocation, fall injuries, impact injuries from an object or building collapse, disorientation, electrocution, etc. Unsurprisingly, "the death rate from these causes is significantly higher among firemen than other workers" (Guidotti 2002: 95.9). The vehicle accident rate is particularly concerning. In Britain, for example, 24% of firefighter deaths while on duty between 1978 and 2008 occurred as a result of road traffic accidents (Labour Research Department/Fire Brigade Union 2008b: 16-17). In France, it is estimated that 38% of firefighter fatalities between 1998 and 2007 were due to accidents on response/return journeys and traffic accidents, making road accidents the leading cause of death among French firefighters (Direction de la Défense et de la Sécurité Civiles/Dexia Sofcap 2008: 5). Outside Europe too, as in the United States, road traffic accident figures are arousing concern (Bercik 2003: 2).

Probable underestimate due to the healthy worker effect

The prevalence of these diseases, however, may be seriously underestimated as a result of a well-known selection bias in the epidemiology of occupational hazards known as the healthy worker effect (Bourgkard *et al.* 2008: 183). What this means is that when comparing the mortality (death rate) or morbidity (disease incidence rate) of a cohort of (exposed) workers to those of the general population, workers usually exhibit lower overall mortality and morbidity. This stems from the selection process inherent in the labour market that favours healthy individuals at initial hiring (e.g., medical checks or physical fitness tests) and a time effect (e.g., workers whose health worsens are ordinarily excluded from employment) (Choi 2000: 1021-1034). If not controlled for, this effect can result in an under-estimation of the mortality or morbidity of occupational groups which, although exposed to known risks, continue to perform statistically better than the general population. In other words, this effect is apt to confound excess mortality or morbidity from occupational exposures and hence prevent the association between risk factors and their health impacts from being correctly identified. Epidemiologists accept that the magnitude of this effect is variable and tends to be more pronounced when the occupations studied are characterized by particularly demanding selection criteria. They also accept that firefighter is one such occupation (Rosénstock *et al.* 1990: 464; Choi 2000: 1021-1034; Guidotti 2002: 95.6; Wagner *et al.* 2006: 9), along with the armed forces, for example. Therefore, epidemiological studies of firefighters have to neutralize this bias by using a reference group that shares similar physical prerequisites, but different exposures (Shah 2009: 79). If this methodological precaution is not taken, mortality and morbidity among firefighters may be under-estimated.

Better assessment of risks and their consequences for better prevention: possibilities

First, something must be done about the failings in monitoring and recording accidents, diseases and deaths among firefighters before preventive measures appropriate to the typical working conditions and exposures of the job can be implemented. The criteria of systems for recording data on firefighter mortality and morbidity must be harmonized to enable centralization and comparison so that reliable epidemiological studies can be done.

Second, the nature of the risks of the job make post-employment health surveillance essential (Perret 2009: 13). First, it ensures the timeframe needed for diseases with long latency periods (e.g., some cancers that occur in retired firefighters) to manifest and be diagnosed. Introducing post-employment health surveillance would be consistent with proven exposure to certain carcinogens. However, as firefighters who leave the job early probably do so on health grounds (Musk *et al.* 1977: 629; Rosénstock *et al.* 1990: 464; Wagner *et al.* 2006: 8), excluding them from health surveillance amounts to introducing a major selection bias in any attempt to estimate the job-related risks and denies prevention experts key data on the health of workers who have the physical and mental prerequisites at initial hiring but leave the fire service early. To deny firefighters post-employment health surveillance would be tantamount to openly spurning some of those physically suffering the early consequences of their past work. At the present time, only Slovakia in Europe provides retired firefighters with two-yearly health checks. All the union representatives who attended the seminars organized by the ETUI and EPSU called for post-employment health surveillance.

Finally, while it is clear that more must be done to prove the impacts of exposures associated with firefighting on firefighters' health, it is equally necessary to improve knowledge about the exposures themselves. This is essential to clarify the aetiology of diseases suspected to be job-related. Without accurate data on exposures, it is hard to establish causal links. Therefore, and to address long-standing complaints from epidemiologists (Musk 1977: 629; Wagner 2006: 6; Lemasters *et al.* 2006: 1201) exposures need to be measured and recorded. It would, for example, be useful to have information on typical exposures or individual exposures (e.g., frequency and duration of operations, job, whether SCBA worn, etc.). While such a system would probably be demanding to run, the results could be particularly informative both for epidemiology and prevention.

Conclusion

Firefighting is fraught with occupational hazards. No-one would dispute that. The reverence felt for firefighters is based on recognition of the risks they run, the bravery of those who knowing that no fire is risk-free accept that they may forfeit their life in saving the lives of others.

Unlike business, where risks are often run for the sake of productivity and profit, firefighting makes a trade-off of risks according to the urgency and human cost of each operation. So, where rescue is concerned, taking a high risk may be judged "acceptable". But limits must be set on such risk taking and all appropriate means of prevention and protection deployed to prevent accidents. The acceptability of risk must never mean a disregard of risk that depends on firefighters' dedication. The motto "save or die trying" is overused: it is not a risk culture that is needed, but a safety culture. Even in a sector like firefighting, accidents do not have to happen.

A health culture also needs to be firmly established in the sector. The often tragic consequences of accidents that can happen in firefighting operations may foster a disregard for the health risks that first responders run. Routine health surveillance of both active and retired firefighters is crucial in order to objectively measure the impact of exposures, raise firefighter awareness and develop appropriate prevention measures. The system for cleaning personal protective equipment designed by Swedish firefighters to eliminate post-incident contamination shows the way. Given the epidemiological indicators currently available on firefighting, it is to be hoped that more such projects will be seen in European fire services and that firefighters' health will become a priority for themselves and their employers.

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Annexe

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