Alex Forrest

Occupational Cancer and Firefighting

IARC and Firefighting

Stockholm, Sweden – September 7, 2023


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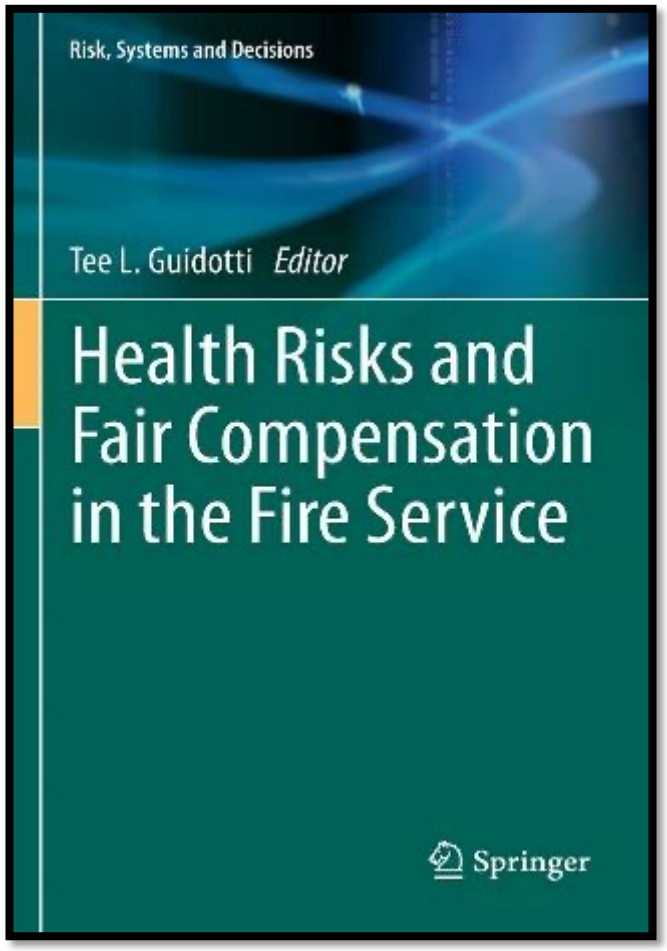
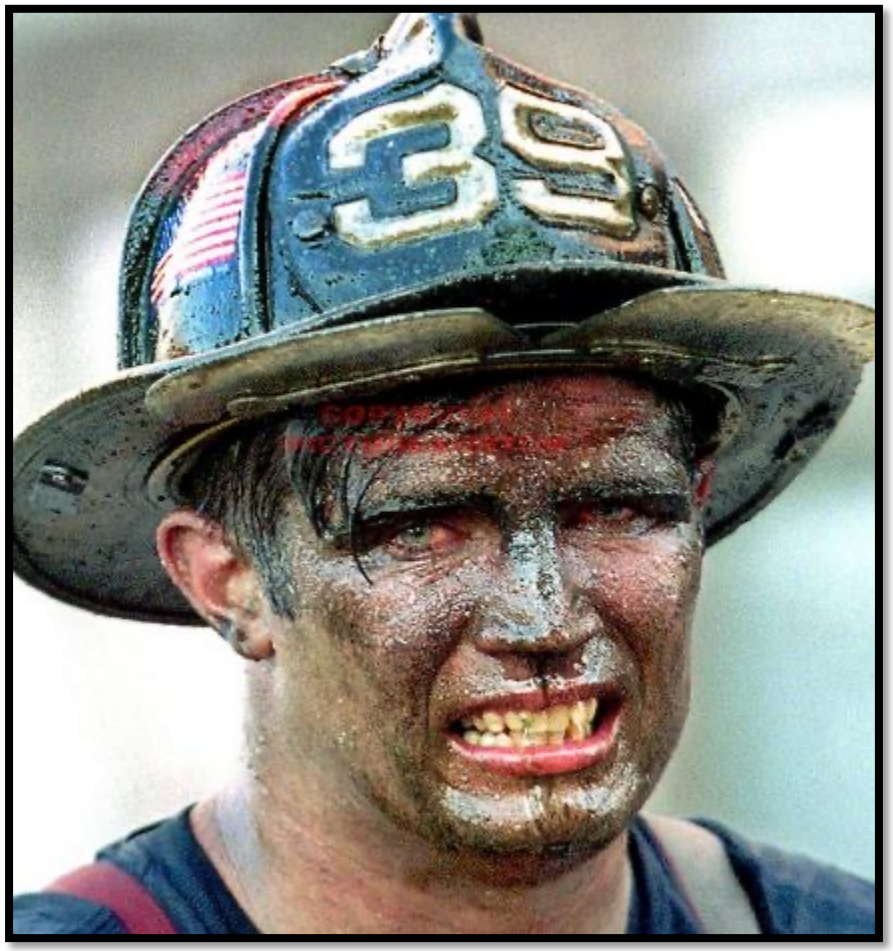

Risk, Systems and Decisions
Tee L. Guidotti Editor
Health Risks and Fair Compensation in the Fire Service
Springer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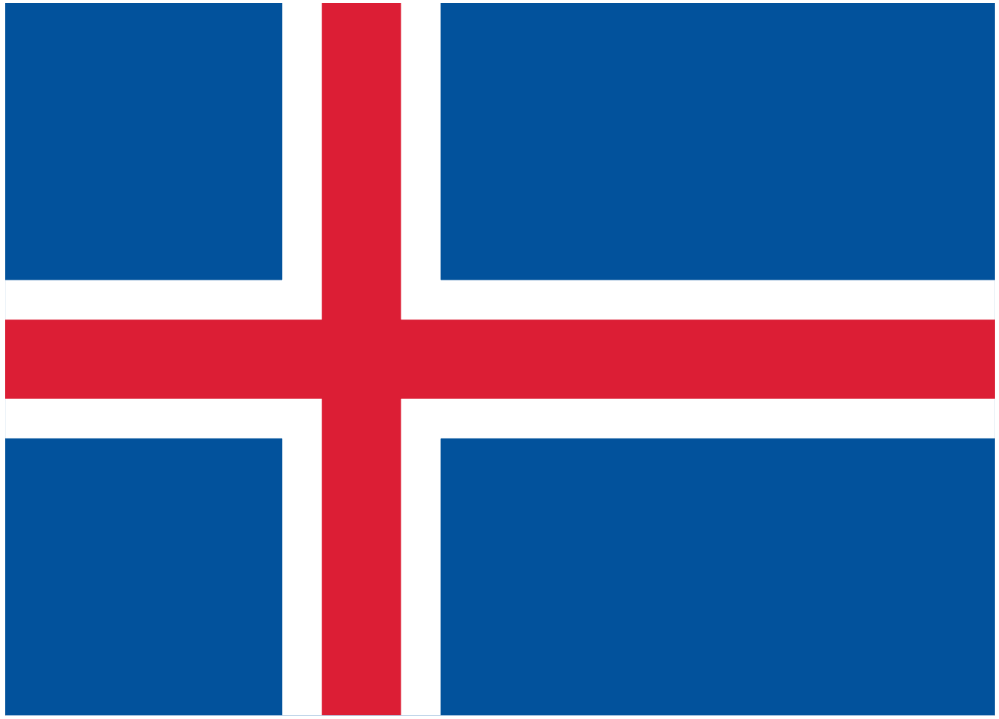


19 CANCERS COVERED

- Ovarian
- Cervical
- Multiple Myeloma
- Thyroid
- Esophageal
- Testicular
- Pancreatic
- Prostate
- Penial
- Ovarian
- Cervical
- Multiple Myeloma
- Thyroid
- Esophageal
- Testicular
- Pancreatic
- Non-Hodgkin's Lymphoma
- Prostate
- Penial

International Agency for Research on Cancer

- A specialized agency of the United Nations created in 1965, located in Lyon, France
- First Monograph on carcinogenic risks in 1972

IARC Working Groups evaluate:

1. Studies of exposure
2. Cancer in humans (epidemiology)
3. Cancer in experimental animals
4. Mechanistic evidence

Four classifications:

- Group 1: Carcinogenic in humans
- Group 2A: Probably carcinogenic in humans
- Group 2B: Possibly carcinogenic in humans
- Group 3: Not classifiable

IARC Evaluation of Exposure as a Firefighter (Monograph 132)

Working Group met in Lyon, France in June 2022

25 scientists from 8 countries

Working Group divided into three sub-groups:

- **Exposure Sub-Group** reviewed studies on:
  - All types of firefighting and exposures
  - How exposure was measured in studies of human health effects
- **Cancer in Humans Sub-Group** reviewed epidemiologic evidence
- **Mechanistic Evidence Sub-Group** reviewed studies of potential carcinogenic effects that may lead to cancer

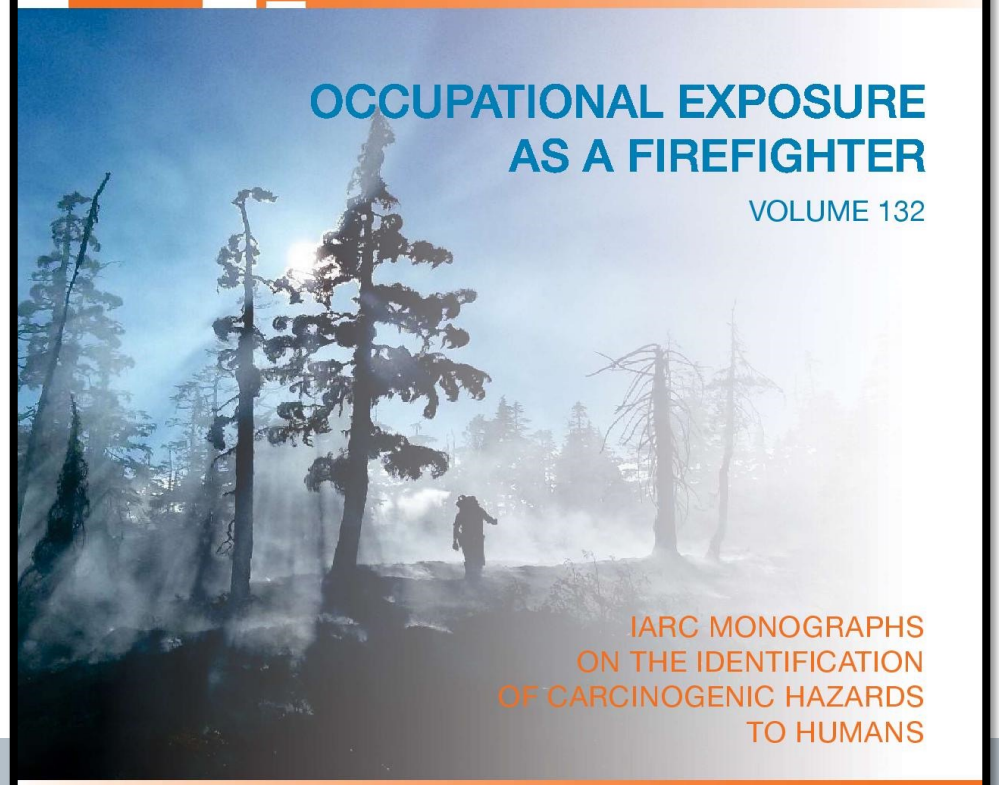
IARC – A tragic validation of 25 years of work

IARC Monograph 132 – Firefighting

- June 2022, Lyon, France
- Not the first look at firefighting
- This time a firefighter was in attendance and was given status as an observer, was given ability to comment throughout

IARC MONOGRAPHS

50
IARC MONOGRAPHS ANNIVERSARY 2021



OCCUPATIONAL EXPOSURE AS A FIREFIGHTER

VOLUME 132

IARC MONOGRAPHS
ON THE IDENTIFICATION
OF CARCINOGENIC HAZARDS
TO HUMANS

International Agency for Research on Cancer
World Health Organization

IARC Monograph

- Classification system
  - Sub groups

The IARC Monograph results…

The tragic reality of our job

IARC Monograph 132

Firefighting profession was classified as a Class 1 carcinogen to humans

Effectively said the profession of firefighting in itself is carcinogenic to humans

IARC Monograph 132

The danger of occupational cancer of firefighters is real and multifaceted

Epidemiological evidence and strong mechanistic evidence

The section related to Cancer in Humans alone was 3 times the size of the entire monograph for firefighting in 2007

Firefighters are exposed to a heterogeneous mixture of chemicals released from fires and non-fire environments. Exposure depends not only on the fuel involved and the fire conditions but also on the firefighting roles and activities being undertaken.

Occupational exposure is from not only fire events but also non fire events

Negative impact of our job – changing types of fires, building materials

At every fire, firefighters are exposed to class 1 cancer causing chemicals

Exposure	Overall evaluation (IARC Group)[a]	Volume	Year	Cancer sites with suff humans
Acetaldehyde	2B	71	1999	
Acrolein	2A	128	2021	
Acrylonitrile	2B	71	1999	
Arsenic and inorganic arsenic compounds	1	100C	2012	Lung, urinary blade
Asbestos (all forms)	1	100C	2012	Larynx, lung, mes
Benz[*a*]anthracene	2B	92	2010	
Benzene	1	120	2018	AML, other acute leukaemia
Benzo[*b*]fluoranthene	2B	92	2010	
Benzo[*j*]fluoranthene	2B	92	2010	
Benzo[*k*]fluoranthene	2B	92	2010	
Benzofuran (coumarone)	2B	63	1995	
Benzo[*a*]pyrene	1	100F	2012	
Bromochloroacetic acid	2B	101	2013	
1-Bromopropane	2B	115	2018	
1-Bromo-3-chloropropane	2B	125	2020	
1,3-Butadiene	1	100F	2012	Leukaemia (all combi haematoly
Cadmium and cadmium compounds	1	100C	2012	Lung
Carbon black (total)	2B	93	2010	
Carbon nanotubes, multiwalled MWCNT-7	2B	111	2017	
2-Chloronitrobenzene	2B	123	2020	
4-Chloronitrobenzene	2B	123	2020	
Chromium(VI) compounds	1	100C	2012	Lung
Chrysene	2B	92	2010	
Cobalt(II) oxide	2B	131	2023	
Crotonaldehyde	2B	128	2021	
Dibenz[*a*,*h*]anthracene	2A	92	2010	

Exposure	Overall evaluation (IARC Group)[a]	Volume	Year	Cancer sites with suffi humans
Dibenzo[*a,i*]pyrene	2A	92	2010	
Dibromoacetic acid	2B	101	2013	
1,3-Dichloro-2-propanol	2B	101	2013	
Dichloroacetic acid	2B	106	2014	
Dichloromethane (methylene chloride)	2A	110	2017	
2,4-Dichloro-1-nitrobenzene	2B	123	2020	
1,4-Dichloro-2-nitrobenzene	2B	123	2020	
1,2-Dichloropropane	1	110	2017	Biliary tract (cho
Diethanolamine	2B	101	2013	
N,N-Dimethylformamide	2A	115	2018	
Engine exhaust, diesel	1	105	2014	Lung
Engine exhaust, gasoline	2B	105	2014	
Ethyl acrylate	2B	122	2019	
Ethylbenzene	2B	77	2000	
Ethylene oxide	1	100F	2012	
Formaldehyde	1	100F	2012	Nasopharyn lymphocyti leukaemia
Furan	2B	63	1995	
Hepatitis B virus	1	59	1994	Liver
Hepatitis C virus	1	59	1994	Liver, N
HIV type 1	1			Anus, u (Kaposi lymph
Hydrazine	2A	115	2018	
Indeno-1,2,3-[*cd*]pyrene	2B	92	2010	
Isoprene	2B	71	1999	
Lead compounds, inorganic	2A	87	2006	
Molybdenum trioxide	2B	118	2018	
3-Monochloro-1,2-propanediol	2B	101	2013	
Naphthalene	2B	82	2002	

Table 1.1 (continued)

Exposure	Overall evaluation (IARC Group)[a]	Volume	Year	Cancer humar
Nickel compounds	1	100C	2012	Lung.
Night shift work	2A	124	2020	
2-Nitroanisole (*ortho*-nitroanisole)	2A	127	2021	
Perfluorooctanoic acid (PFOA)	2B	110	2017	
Polybrominated biphenyls	2A	107	2016	
Polychlorophenols	2B	71	1999	
2,3,4,7,8-Pentachlorodibenzofuran	1	100F	2012	All c
3,4,5,3′,4′-Pentachlorobiphenyl (PCB-126)	1	100F	2012	
Pentachlorophenol	1	117	2019	NH
2,4,6-Trichlorophenol	2B	117		
Polychlorinated biphenyls	1	107	2016	Ma
Pyridine	2B	119	2019	
Radioactivity (γ activity)	1	100D	2012	Al
Radionuclides (α-particle-emitting)	1	100D	2012	A
Radionuclides (β-particle-emitting)	1	100D	2012	A
Silica (crystalline: quartz or cristobalite)	1	100C	2012	
Styrene	2A	121	2019	
Styrene-7,8-oxide	2A	121	2019	
Sulfuric acid[b]	1	100F	2012	
Tetrabromobisphenol A	2A	115	2018	
2,3,7,8-Tetrachloro dibenzo-*para*-dioxin (2,3,7,8-TCDD)	1	100F	2012	
Tetrachloroethylene (perchloroethylene)	2A	106	2014	
1,1,1-Trichloroethane	2A	130	202	
Toluene diisocyanates	2B	71	199	
Trichloroethylene	1	106	201	
Trichloromethane (chloroform)	2B	73	199	

PPE – and breathing apparatus

Dermal absorption primary but also ingestion and inhalation exposures

Other non cancer issues – breathing, fertility,

Diesel particulates, flame retardants, shift work,

Positive confounding factors, healthy work effect, smoking,

Higher levels of cancer and earlier in life

Mechanistic evidence.
Just how many ways we get exposed and to what levels.

Science is evolving
DNA – Bio Markers

Table 1.24 Biomarkers used to assess firefighters' exposures to agents othe

Analyte	Sample type	Concentration	
		Minimum	Maximum
Polybrominated diphenyl ethers (PBDEs)			
BDE-28, BDE-47, BDE-99, BDE-100, BDE-153, BDE-197, BDE-207, BDE-209	Serum	0.1 ng/g lipid	253 ng/g lipid
BDE-28, BDE-47, BDE-99, BDE-100, BDE-153, BDE-209	Blood	NR	NR
PBDEs (sum of 27)	Serum	1.58 ng/g lipid	95.2 ng/g lipid
*Polychlorinated dibenzo-*para*-dioxins and dibenzofurans (PCDD/Fs)*			
1,2,3,6,7,8-HxCDD, 1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF	Serum	ND	674 pg/g lipid
2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 2,3,4,6,7,8-HxCDF	Serum	2.24 pg/g lipid	NR
PCDD/Fs (sum of 17)	Serum	6.3 pg (TEQ)/g lipid	18 pg (TEQ)/g lip
Polychlorinated biphenyls (PCBs)			
PCB-66, PCB-74, PCB-99, PCB-118, PCB-138, PCB-153, PCB-156, PCB-170, PCB-180, PCB-183, PCB-187, PCB-194, PCB-203	Serum	1.09 ng/g lipid	15.4 ng/g lipid
PCB-105, PCB-118, PCB-157, PCB-167	Serum	1.02 ng/g lipid	105.76 ng/g lipid
PCBs (sum of 38)	Serum	36 ng/g lipid	317 ng/g lipid
Organophosphate and other flame retardants			
BCEtP, BDCPP, DPCP, DBuP, TBBPA	Serum	NR	NR
BCEtP, BCPP, BDCPP, DEP, DETP, DEDTP, DMP, DMTP, DMDTP, DBuP, DPhP, IPPPP, TBBA, TBPPP	Urine	< LOD	300 ng/mL
Per- and polyfluoroalkyl substances			
PFHxS	Serum	0.22 ng/mL	326 ng/mL
PFOS	Serum	< LOD	391 ng/mL

Table 1.24 (continued)

Analyte	Sample type	Concentration	
		Minimum	Maximum
PFHpA	Serum	< LOD	1 ng/mL
PFOA	Serum	0.25 ng/mL	7535 ng/mL
PFNA	Serum	< 0.06 ng/mL	17.95 ng/mL
PFDA	Serum	< LOD	20.7 ng/mL
PFUnDA	Serum	0.1 ng/mL	10.85 ng/mL
PFBS	Serum	< LOD	0.4 ng/mL
PFOSA	Serum	NR	0.4 ng/mL
Me-FOSAA	Serum	NR	3.80 ng/mL
Et-FOSAA	Serum	NR	1.00 ng/mL
PFTrDA	Serum	< 0.06 ng/mL	28.5 ng/mL
PFDoA	Serum	0.13 ng/mL	0.15 ng/mL
PFBA	Serum	< LOD	0.99 ng/mL
PFHxA	Serum	< LOD	< LOD
Sb-PFOA	Serum	ND	ND
Sm-PFOS	Serum	1.91 ng/mL	2.23 ng/mL
Heavy metals			
Antimony	Serum	NR	NR
Arsenic	Serum	NR	NR
Cadmium	Blood	0.18 µg/L	0.21 µg/L
Cadmium	Serum	NR	NR

Table 1.24 (continued)

Analyte	Sample type	Minimu
Lead	Blood	0.87 µg/d
Lead	Serum	NR
Mercury	Blood	2.36 µg/l
Mercury	Serum	< LOD
Uranium	Urine	NR

[a] [The blood lead levels reported in Kim et al. (2020b) probably have a unit er
BCPP, bis(1-chloro-2-propyl) phosphate; BCEtP, bis(2-chloroethyl) phosphat
phosphate; DEDTP, diethyl dithiophosphate; DEP, diethyl phosphate; DETP,
thiophosphate; DpCP, di-*para*-cresyl phosphate; DPhP, diphenyl phosphate;
dioxins; HpCDF, 1,2,3,4,6,8,9-heptachlorodibenzofuran; HxCDD, 1,2,3,7,8,9
phenyl)phenyl phosphate; LOD, limit of detection; Me-FOSAA, 2-(*N*-methyl-
acid; PFBS, perfluorobutane sulfonic acid; PFDA, perfluorodecanoic acid; PF
PFHxA, perfluorohexanoic acid; PFHxS, perfluorohexanesulfonic acid; PFNA
perfluorooctane sulfonamide; PFTrDA, perfluorotridecanoic acid; PFUnDA,
isomers; TBBA, 2,3,4,5-tetrabromobenzoic acid; TBBPA, tetrabromobisphen

Epigenetic issues –negative effects to your bodies immunity system

DNA damage

What is the epigenetic age?

What is the epigenetic age?

The epigenetic age reflects the biological events that lead to aging. It is similar but not identical to the chronological age. When it moves faster it is an indication of faster aging and when it moves slower aging is slowed down

Aging and cancer development are tightly interwoven processes. You can prevent cancer by reducing or reverting epigenetic age. IARC lays out the framework of targeting the mechanisms that drive DNA methylation clocks in Firefighters.

Specific cancers.
Tip of the iceberg.

This monograph is the beginning, not the end

Other issues in future:

Electric battery society

PFAS

CONCLUSION

- This is not a good news story
- Science is a puzzle – picture is tragic consequences of cumulative exposures
- Underestimated
- PPE
- Positive to the profession “We now know the issue”
- New technologies
- Education
- Compensation
- Future challenges
- Third world nations

This issue will get worse –

More cancers and higher cancer rates in the future

“This presentation is dedicated to all the worlds firefighters who have died from occupational cancer without any formal recognition of their sacrifice”