Firefighters' Working Environments and their Personal Protective Equipment (PPE)

Meeting in

Tokyo

May 2010

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Personal Protective Equipment

Known as PPE

is

“Any device or appliance
designed to be worn or held by an Individual
to protect against
one or more
Health and Safety Hazards.”

Definition from the EU PPE “Use” Directive

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Personal Protective Equipment (PPE)

The purpose of PPE is:

- **to allow persons *to work in environments* where without the protection afforded by the PPE, they normally could not work**
  - **without undue stress being caused by the PPE**

and

- **on unexpected exposure to hazards in emergency conditions**
  - **to safeguard personnel by providing protection as persons escape to safety**

JOIFF Handbook: Introduction

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Standards for PPE for Firefighters

Standards for PPE are not what most Users think they are !!!

Most people believe that

standards are driven by User needs

therefore

Users set the Agenda for performance levels

NOT SO

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Firefighters' Working Environments

The protective performance levels of PPE

set down in CEN, NFPA, ISO Standards for

PPE for Firefighters

are aimed at protection against exposure to

"worst possible" fire scenarios,

i.e. flashover conditions

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Flashover – a result of Safety System failure

- **Building Safety System**
  - » **Fire loads exceeded**
- **Occupants Safety System**
  - » **Fire loads exceeded**
  - » **Acts that cause the fire**
- **Incident Safety System**
  - » **Failure to detect the fire in its early stages**

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Firefighters in a Flashover

Happens as a result of failure of the Firefighter Safety System

- Failure to recognise conditions
- Over protection of firefighters
- Command and Control failure
- Lack of correct type of continuous training

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Firefighters' Working Environments and their PPE

ACTUAL

FIREFIGHTERS WORKING ENVIRONMENTS

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Firefighters' Working Environments

•In 1976, USA National Aeronautics and Space Administration (NASA) initiated **Project Fires**

•As the first step of the Project, the firefighting **environment for "structural" firefighting was measured and defined** and **four thermal classes** were designated:

Environment	Air Temperatures	Thermal Radiation
Class 1:	**up to 40°C**	**up to 0.5 kW/m²**
Class II:	**up to 100°C**	**up to 1.0 kW/m²**
Class III:	**up to 250°C**	**up to 1.75 kW/m²**
Class IV:	**up to 800°C**	**up to 40 kW/m²**

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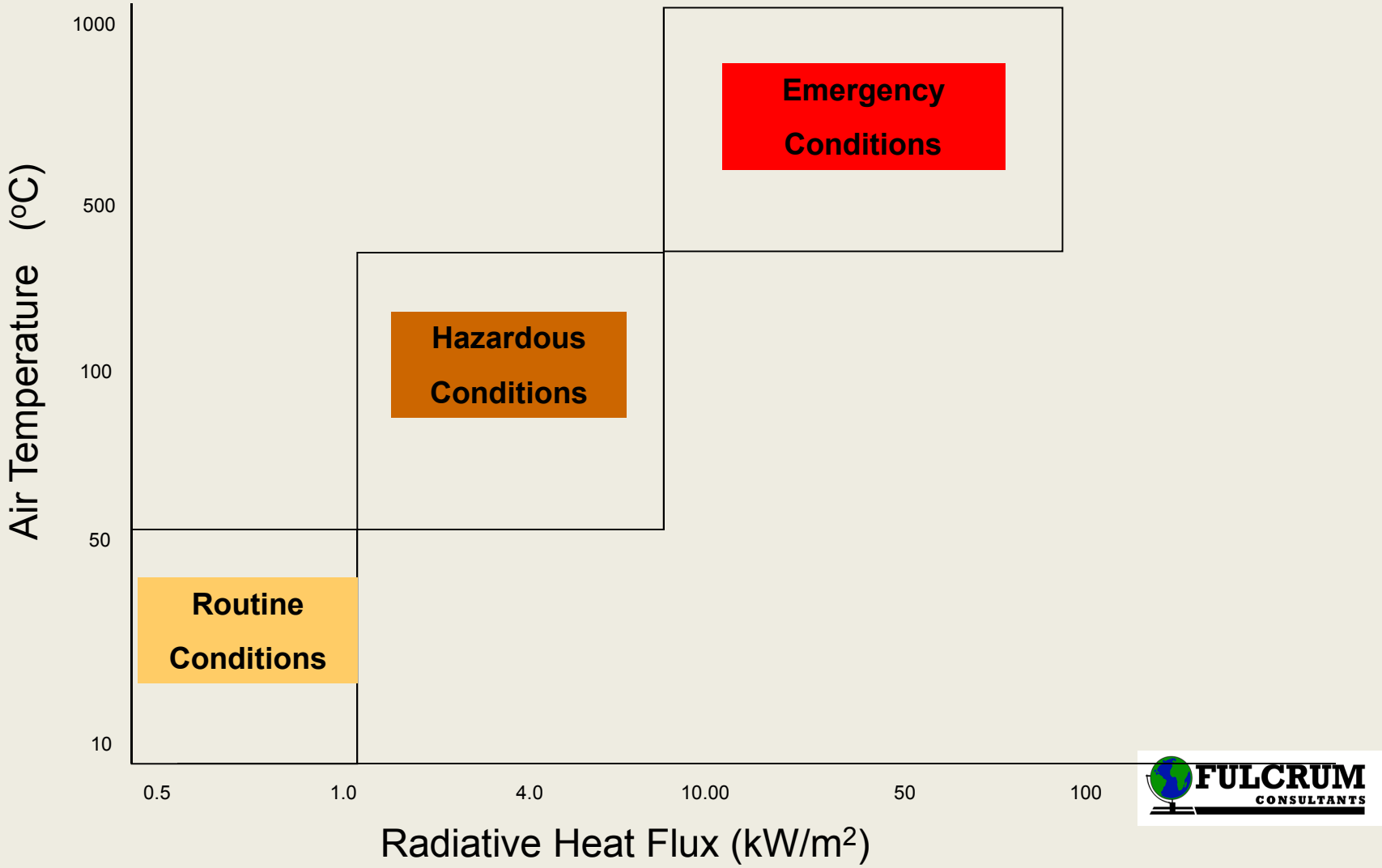
Firefighters' Working Environments

•In 1994, the United Kingdom Joint Committee on Fire Research carried out a Study entitled **"Measurements of the Firefighting Environment"**

•The various conditions under which Firefighters and their equipment have to operate was classified into four groups as follows:

Environment	Exposure time limit	Thermal radiation limit
Routine conditions:	**25 minutes at 100°C**	**1 kW/m²**
Hazardous conditions:	**10 minutes at 160°C**	**4 kW/m²**
Extreme conditions:	**above 160°C but not exceeding 235°C**	**above 4 kW/m² but not exceeding 10 kW/m²**
The Study states that these conditions would not be acceptable operationally		
Critical conditions:	**above 235°C**	**above 10 kW/m²**
The Study state that a Firefighter would not be expected to operate in these conditions		

Hoschke Table (Fire Safety Journal 4 1981)



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Heat Flux Levels – Hoschke Table

Heat Flux Level	Occurrence
• Routine conditions 0.7 - 1 kw/m²	0.1 – 1.5 kw/m² • Sun burn
• Hazardous conditions 5 kw/m² - 10 kw/m²	1.5 – 10 kw/m² • 2nd degree burns in 25 secs.
• Emergency conditions 50 kw/m² - 84 kw/m²	10 - 100 kw/m² • 2nd degree burns in 1 sec.

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Firefighters' Working Environments

Research (2001) showed that

working in Environments

where Firefighters are likely to be exposed

to extremes of heat and flame

i.e. extreme heat and possible Flashover

forms just a small percentage of the work carried out by them

– a figure of 10% or less would appear to be the case

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Firefighters' Working Environments

This practice means that

for approximately 90% or more

of the work of Firefighters,

they are wearing what could be considered as

inappropriate PPE

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Firefighters' Working Environments

Why in the case of Firefighters, is PPE

to protect against the worst possible scenario

issued to all personnel, on almost all occasions?

This can mean that for 90% or more of the work of Firefighters

they are wearing PPE

that could add to the risk of heat stress

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Why is this ??

SOME PEOPLE,

EVEN FIREFIGHTERS !!,

BELIEVE THAT

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=

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NOT

TRUE

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Core Body Temperature

Physiological facts

- **1°C rise in core body temperature** ***(to 38°C)***
  - seeing and hearing are impaired,
- **2°C rise in core body temperature** ***(to 40°C)***
  - risk of collapse
- **2.5°C rise in core body temperature** ***(to 40.5°C)***
  - 50% of people have impaired thinking and their speech makes little sense

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"Heat Stress" – overheating of the body

Firefighters are regularly submitted to rises in core body temperature of or greater than 2.5°C

» **critical decisions are taken – not questioned**
» **is medical attention sought ?**

Short Term –

- **What is the <u>actual</u> quality / value of the work being carried out ?**

Long Term –

- **what permanent damage is being caused to the body and brain ?**

How many Firefighters suffer medical complaints, disability and premature death after completing active service, due to unnecessary stress to which they have been exposed during service ?

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Effects of Temperature – PPE and the Body

°C	°F	Observed effect
37	98.6	Average human body core temperature
39	*102*	*Limit of efficiency/health of human body core temperature*
44	*111*	*Human skin temperature – discomfort and pain*
60	*140*	*Human skin temperature – maximum pain*
120	*248*	*Firefighters Helmet – visor melts*
350 +	*660 +*	*Aramids Nomex/Kermel begin to char*

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Recommended Firefighter Exposure Times

Thermal exposure	Recommended maximum exposure times when dressed in suitable PPE
Level 1 - Routine Conditions: Air Temperature up to 100°C Radiant source ≤ 1.25 kW/m²	A number of hours at the lower end of the temperature range Approximately 20 minutes at the upper end of the temperature range.
Level 2 - Hazardous Conditions: Air Temperature up to 250°C Radiant source ≤ 8 kW/m²	A few minutes
Level 3 Emergency Conditions: Air Temperature ≤ 800°C Radiant source ≤ 80 kW/m²	A few seconds

Exposure Times in Testing PPE for Firefighters

Radiant heat exposure	Standards for Clothing	Standards for Gloves	Standards for Helmets
Level 1 ***- Routine Conditions:*** Air Temperature up to 100°C Radiant source ≤ 1.25 kW/m²			
Level 2 ***- Hazardous Conditions:*** Air Temperature up to 250°C Radiant source ≤ 8 kW/m²			
Level 3 ***- Emergency Conditions:*** Air Temperature ≤ 800°C Radiant source ≤ 80 kW/m²	40 kW/m²	40 kW/m²	14 kW/m²

Know what your PPE can do

PPE to current Standards can withstand extreme exposures without any damage whatsoever for a long time – conditions that the human body cannot deal with

Weakest part of PPE – helmet visor – starts to fail
@ human body limit of efficiency x 3 (120°C)

Outer clothing starts to fail
@ human body limit of efficiency x 9.6 (350°C)

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Know what your PPE can do

- Performance levels in PPE standards are not based on facts
  - They are based on what people who write Standards think are facts
- The main risk to the health of a Firefighter is Heat Stress
- It is critical that PPE is correctly cared for and maintained
- It is essential that Firefighters are regularly trained and updated on the correct use of their PPE, its protective properties and limitations
- It is critical to the safety of Firefighters to limit their exposure times to extreme environments

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21st Century

HAVE RECENT STANDARDS

HELPED US TO

MAKE PROGRESS ?

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Hikeshi (17th Century)

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Today (21st Century)

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Material Assemblies

SASHIKO (17th Century)

Modern Multi-layer (21st Century)

17th Century – 21st Century

IS

THIS

PROGRESS ??????

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THANK YOU FOR YOUR ATTENTION

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