



Interior Firefighting

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- 1. Incidents**
- 2. Rapid fire developments**
- 3. Fire Behaviour Training**
- 4. Techniques & Tactics**
- 5. Protective Clothing**
- 6. When it goes wrong...**
- 7. A typical fire...**

INCIDENTS AT FIRE SCENES



Flashover, 2 hurt, Raesfeld 5/2004

The number of fires drops

But...

The number of injured or killed
firefighters does not ↓

German Data...

1995	3† - 20	2000	0† - 4
1996	1† - 4	2001	1† - 6
1997	0† - 3	2002	0† - 23
1998	2† - 4	2003	2† - 23
1999	0† - 5	06/2004	0† - 4

www.Atemschutzunfaelle.de

Even in Belgium...

- 2003, House fire, 2 injured, Zottegem
- 2002, Spanish Embassy, 1† Brussel
- 2002, Gyproc factory, 1†, Wijnegem



Flashover, 2 †, London, 7/2004

Analysis of the data

Causes...



Collapse, 3 t, Haarlem, 05/2003

Type of incidents

- | | |
|----------------------------|-----|
| – Burns | 67% |
| – Breathing difficulties | 7% |
| – Heart failure | 4% |
| – Other 'Cuts and Bruises' | 21% |

Causes

- **Rapid Fire Development**
- Technical (Clothing,...)
- Lost orientation
- Ran out of air
- Collapse / Falls

Analysis of the data

Rapid fire develop.

Less Fires...

=> Less experienced

Newer Buildings (insulation)

=> Flashover & Backdraft ↑

Faster intervention (mob. phone)

⇒ Pre-flashover

Old techniques & principles

⇔ **Venting a fire**

⇔ **Controlling a fire before rescue**

⇔ **3D-fog, PPV, CAFS**

Backdraft, 5⁺, Paris, 9/2002

RAPID FIRE DEVELOPMENTS



Rapid Fire Developments

Types

1. Flashover

Heat- induced transition to fully developed compartment fire

Started by ignition of **smoke gases** in the overhead (= *Lean flashover, dancing angels*)

2. Backdraft

Deflagration due to **sudden air admission** into a zone containing to rich **smoke gases** and an **ignition source**

3. Fire gas ignitions

Ignition of accumulated **smoke gases**, present as an ideal explosive mix, mostly due to **introduction of an ignition source**

Rapid Fire Progress

Flashover



Rapid Fire Progress

Flashover



FLASHOVER
THERMAL TRANSITION TO
FULLY DEVELOPED FIRE

FIRE BEHAVIOUR TRAINING

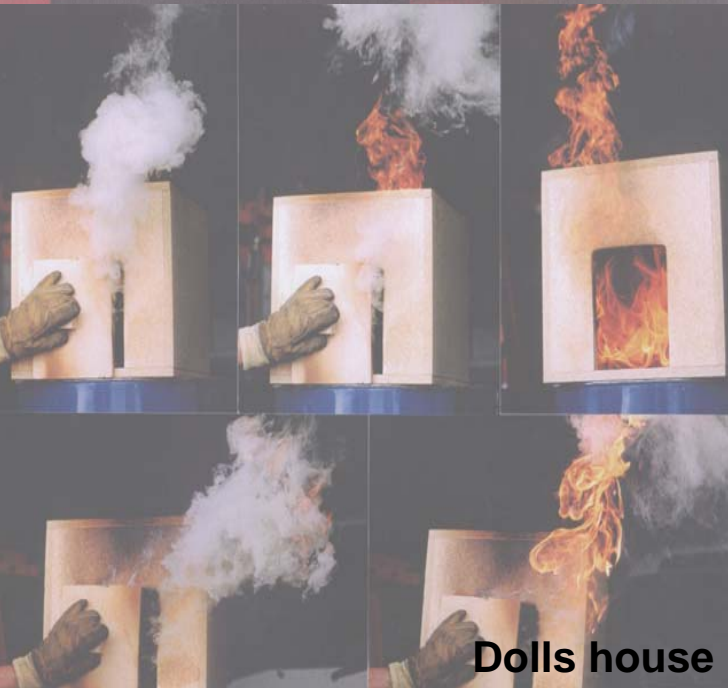


CFBT = Compartment Fire Behaviour Training

- Started in **Zweden** in 1980
- Followed by Finland, UK, Germany, France, Spain, Australia, USA,...
- Goal:
 - Reduce incidents ↓
 - Insight ↑
 - ⇒ Efficiency ↑, Safety ↑, Motivation ↑



Aquarium



Dolls house

1. Theory

Fire development, firefighting techniques, ventilation, recognising signals, cases...

2. Small Scale Demos

Fire fighters aquarium, Dolls house, ...

3. Large Scale Demos (Container)

Reading the fire, extinguishing the 'gasses'

4. Multicompartiment Training

Scenario-training = ventilation, firefighting, rescue, communication,...

5. Analysis of interventions and incidents

Own experiences and cases

+ Refresher courses...

Fire Behaviour Training

'Container'



Wood fired



Gas fired

	Gas fired	Wood fired
+	Controle Health/environment No time loss (More divers drills)	Signals Smoke gasses Reality
-	Signals Smoke gasses (Cost)	Time Health/environment Controle

Complementarity ...

Initiation on wood ! & Further training on gas
Rigid Safety measures !

A photograph of two firefighters in full protective gear, including helmets and jackets, working in a smoky environment. They are positioned on either side of the central text. The firefighter on the left is looking towards the right, and the one on the right is looking towards the left. The background is filled with thick, grey smoke, suggesting a fire scene. The overall tone is serious and professional.

**TACTICS WITHOUT TECHNOLOGY
IS HELPLESS**

-

**TECHNOLOGY WITHOUT TACTICS
IS USELESS !**

Container training, Paris Firefighters 2003



1. Direct attack (Drowning a fire)

1/3 effect, 2/3 run-off

Enormous water damage

2. Indirect attack (Suffocating a fire)

Fog spray on hot surfaces

Enormous amounts of steam

Flames & heat pushed to other rooms

Getting engulfed, burns...

3. 3D-Fog (Controlling a fire)

Pulsating fog spray in hot gaslayers

Chances on Flashover & Backdraft ↓

Technology & Tactics

3D Fog ?



- **Goal ?**

- Control = rendering less dangerous
- **Not meant to extinguish** => (extra line)

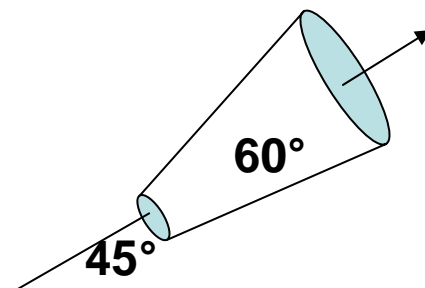
- **How ?**

- Fine **water mist** in hot gaslayers
- => **Cooling & inertisation**

- **Factors**

- No water on surfaces !!! ↔ indirect
- Don't drown the smoke !
- Pulsations = 0.1-0.5 s
- Right cone angle and application angle
- Right droplet size

Ideally 4scloud



Technology & Tactics

3D Fog ?

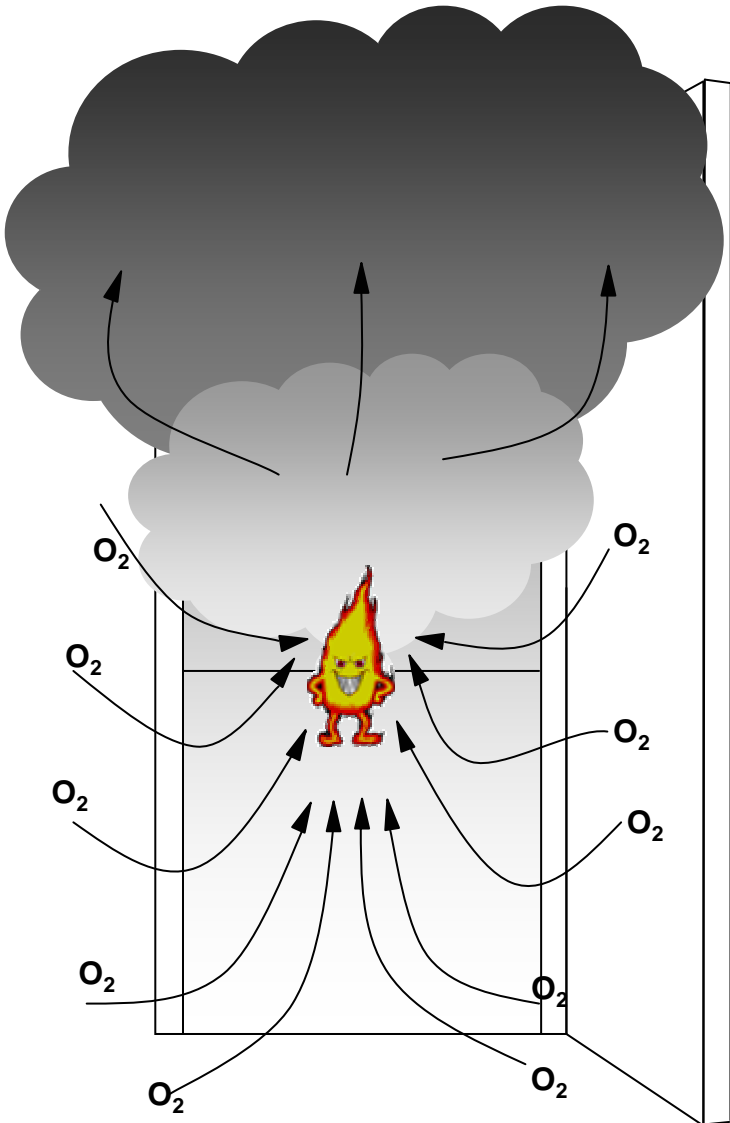


115 L/min at 8 bar

Practical ?

- Modern fog nozzle
- Drills (even blind)
- No sweeping = disturbing gaslayers
- **High pressure hose & Back-up**

**Aim at the fartest corner
where the walls reahc the
ceiling**



We never ventilate ! ↔ Don't open doors ?

Opening & Entry Procedure

Spray water above your heads, right before entry

Anti-ventilation

Close the door partially after entry...

Inflow of air ↓,

⇒ **Combustion ↓,**

⇒ **Smoke layer ↑,**

⇒ **Heat Raditaion ↓,**

⇒ **Chances on Flashover ↓**

⇒ **Seat of fire (victims) visible !**



Why?

Removing Hot Flammable gases

⇒ Heat ↓

⇒ Chances of Backdraft & Flashover ↓

⇒ Visibility ↑

Basics

- As high as possible
- Take note of wind (direction, speed)
- Provide cover hoseline (Don't attack via exit !)
- Full Gear + BA
- Provide means of 'rapid' regress

Coordinated Ventilation

= on demand of attack crew inside



Fire fighting by blowing in some extra air ?

How ?

- Overpressure pushes heat and flames out
- A 'pocket' of clean air to work in + rescue

What ?

1. Locate the fire & note interior lay-out
2. Create exit opening
3. Provide cover at inlet & exit
4. Position ventilator (D = H door)
5. Attack...



DON'T USE PPV WHEN ...

- No **outlet** opening present
 - **Location** of fire unknown
 - Fire outside its **compartment**
 - Chances of **Backdraft**
 - **Powders/ dust**
- 1 †, **Basement fire, High rise, Koln, Ger.**
 - PPV into basement from ground floor
 - Fire intensified...
 - Flowback of smoke gasses rookgassen = PPV engine fails oxygen, stops
 - Attack crew out of air, visibility ↓
 - 1 entangles in guide line...

Against natural ventilation !
To limited outlets !

Basic principle

Surface tension ↓ penetration ↑

Class A foam

Water + foam agent

Compressed Air Foam System (CAFS)

•Water +foam agent + air

Best ? ↔ What do you want to tackle?

- Flashover & Backdraft ?
- Post-Flashover fire ?
- How ? Fog or direct attack ?
- How can you access the fire ?

CAFS

Tests	Type	Water	Class A	CAFS	Conclusion
UK Home Office	wooden palet	Fog/ direct	Nevel/ Vol	NT	No significant difference
University of Canterbury	Post-flashover	Fog	Fog	Direct jet Distance ↑	Equal in extinguishing potential
University of Canterbury	Post-flashover	Fog Cooling ↑	Fog	Direct jet	Equal in extinguishing potential
US, Salem, Conneticut	Roomfire Post-flashover T drop at 1,2m	Direct jet 222.9s	Direct jet 102,9s	Direct jet 38.5 s	CAFS



CAFS-Water (5 bar)

- No comparative test for smoke cooling
- **Advantages CAFS**
 - Post-flashover
 - Attack from greater distances (from outside)
 - Knocks down fires faster compared to direct H₂O
 - ⇒ Fighting capacity watertank ↑
 - Turnover ↓
 - Manouvrability↑ (weight↓)
 - Usable in dry riser
- **Disadvantages foams**
 - Environment and health
 - Increased risk on falls (slippery, ...)
 - Arson investigation ↓



PROTECTIVE CLOTHING ?

Protective Clothing

Standard ?



Without Nomex,
Hessen (D), '95, 4 injured

Basic equipment

- 'Nomex'- jacket & -trousers
- Helmet with 'Nomex' attached or 'Nomex' hood
- Gloves, Safety boots
- Breathing apparatus

Burns and skin temperature



- 48°C = 1 th degree
- 55°C = 2 th degree
- >55°C = 3th degree
- 62°C = Numb
- 72°C = Immediate destrtuction skin

**Burns are function of time
and temperature**

Protective Clothing

Burns

Turnout gear = 4 layers + 1



1. **Outer shell** = Nomex, -Kevlar, PBI, PBO,...
2. **Moisture barrier** = Breathing water barrier
3. **Isolation** = Luchtlagen bv. in Nomex weefsel
4. **Smooth inner layer** = Comfort, sweat,...
5. **Station wear** = No synthetics eg nylons...

Burns

- **Compression** = isolation ↓
 - Crawling, BA, ... (extra thick padding)
- **Water** = isolation ↓
 - Crawling through water, sweat, ...
- **Steam** = gas
 - passes permeable liner + burns alle exposed skin
- **Hot liquids**
 - Droplets of tar, plastics, ...



Nomex
T > 250°C discoloration,
No protection loss,
T > 450°C charred
Loss of protection

Protective Clothing

Burns

Burns

1. 1st pain = signals, react = Shake off, move !
2. **Exit hot zone**
3. Remove clothing !!!
4. Apply **water**...

Cooling somebody with water in a hot zone... ?
= Burn risk↑

**Turnout gear =
max 10s protection
in Flashover conditions!!!**

Quick-out system

Helmet



Burns

1. Not without **'hood**
2. Raise **collar**
3. **BA !!**

**Still want to feel the heat ?
Even in a sudden Backdraft?**



Flashover, '95
Hessen (D), 4injured



Flashover, '98, Bayern
(D), 1†, 2 injured

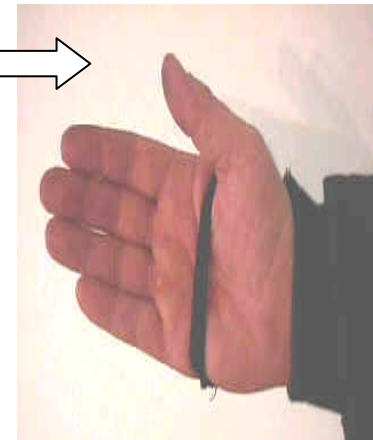


Gloves



Test

- No House and garden equipment !
- Use sleeve restrainers !
- Bunsen test 'Feuerwehr Dusseldorf'
 - **Leather** shrinks (-)
 - **Nomex** chars (+)
 - **Elk leather** with liner & Nomex insulation (++)



Well protected ?

Heatstress

Hot and humid environments

⇒ Body can't lose heat

Turnout gear

⇒ Slows body temperature rise

1. Heat exhaustion

- Circulatory distress
- Lack of minerals ⇒ muscle cramps
- Concentration ↓, strength ↓, headache, ...

Rehydration = Isotone fluids & Handcooling

2. Heatstroke, hyperthermia

- BT > 41°C
- Possibly lifethreatening
- Delirium, loss of consciousness, sweating stops

Cool the body & Medical treatment

3 injured Herrstein (D) 03/2004

WHAT IF IT STILL GOES WRONG ... ?



Flashover in room,
Baltimore (US)

Extra gear



Feuerwehr Düsseldorf (D)



1 scissors →
2 Wallhydrant tools ←



3 Band →



4 PASS ←



5 Markers →

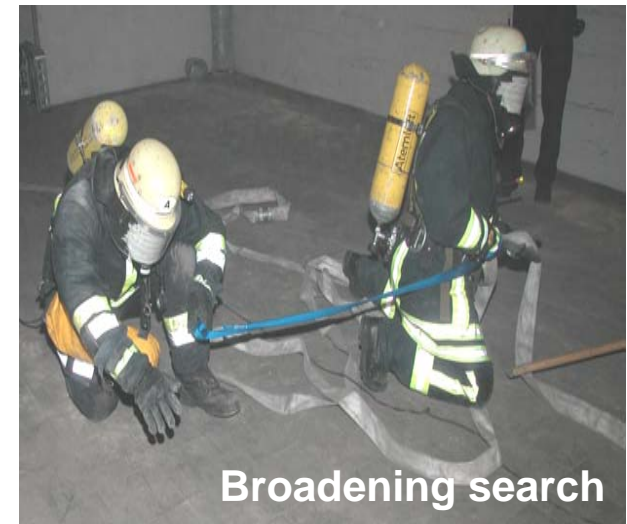
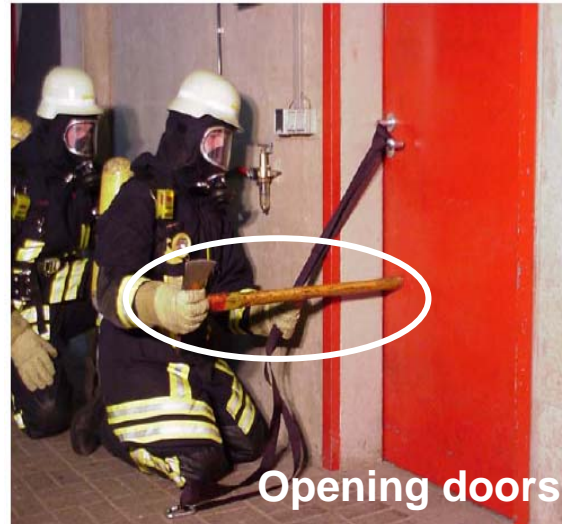


6 Door blocks ←



Extra Gear

'Band'



BA monitoring



Untill it goes wrong

Furniture factory, Lustenau, Austria, jan. 02

- Firefighters gets blocked in
- >15 min before rescue
- 2th & 3th degree burns

**Do you have a team stand-by to rescue
your colleagues?**

**Registration is step 1,
Rescue is step 2**

RIT = Rapid Intervention Team

Rapid Intervention Team

What ? When ?



What ?

2 firefighters armed to the teeth

- Extra BA
- Axe, ropes, escape hoods,...
- ‘Stretcher’
- Attack hose line
- Radio, lights

When ?

ASAP !!!

When ?

Persons trapped / No occupants

Where?

Close to the ‘**entrance**’ at ‘hearing’ range of chief

Close to the actual **fire** location eg High rise fires

Rapid Intervention Team

Equipment ?



Rescue bag



Rescue basket



Rescue set

Rapid Intervention Team

Evacuation?



Rapid Intervention Team

Training

1. Search techniques
2. Air supply
3. Rescue from position
4. Evacuation



E.g. Out of air ?

- Feel if breathing ? ↔ Hear ?
- Remount BA (Blind)
- Purge



A TYPICAL FIRE
BERLIN 2 APRIL 2004

A typical fire



Berlin, April 2004

Appartement fire 1st floor, Buesselstraße 72

- Started in couch
- Occupant attempts fail
- Rans out to the street (Door remains open)
- Calls 112 (911)

- 17h55 : First call
- 17h57 : Alarm Fire crew
- 17h59 : On site
- 2 pumpers, 1 arial ladder, 1 ambulance

Arrival

- **Heavy smoke** from 1st floor
- **Persons** hanging from 3th floor

A typical fire



Berlin, April 2004

Rapid overview ?

- All clear untill first floor landing
- Possible several persons on upper floors
- No persons visible from rear

Intervention ?

1. 2 teams persons rescue
2. Ventilate stairs = position PPV
3. Position attackline
4. Request Assistance (18h02)
5. Rescue attempt via ladder : changing wind + smoke, failed, repositioned
6. 'Rescue mattress' at front

Rear

A typical fire

Berlin, April 2004



- Water crew, Did hydrant > put on BA for attack
- Water crew start attack on 1st floor
- **Flashover... + fire in whole stairwell**
- Watercrew retreats for protection
- **Rescue team 1 on 4th** sends 'mayday' and breaks window
- Firefighters at rear report persons hanging from window
- 'Rescue mattress' to rear
- **2 firefighters jump = 17,10m**

A typical fire

Berlin, April 2004



A typical fire

Berlin, April 2004



A typical fire

Berlin, April 2004



A typical fire

Berlin, April 2004



A typical fire

Berlin, April 2004

- **2 firefighters land in safety mattress**
 - 1 : Hip fracture + 10% burns
 - 2 : 30% burns
- Fire spread to penthouse and 4th floor
- **Rescue team 2 got blocked in flat on 3th floor**
- Scale-up of firefighting and rescue
 - 20 BA firefighters
 - Attack with 4 LP hoses
 - 5 persons + rescue team 2 evacuated via laddertruck

Evacuation of victims

A typical fire



Stairs to 4th floor

Conclusion

- To little insights in fire development & risks
- To little insight in smoke gas spread
- Rescue teams go up passed opened door to fire !

What is the correct priority...

Rescue or Fire fighting ?

**SAFE INTERVENTION REQUIRES FAST
CONTROL
OF THE FIRE**



Backdraft, Forth Worth, US

***THE LESSONS FROM
OTHERS ARE THERE TO
BE LEARNED...'***

P. GRIMWOOD

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