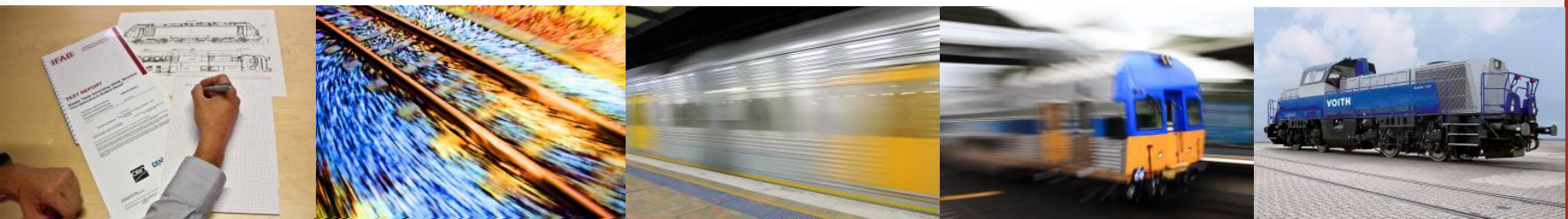




IFAB

Institute for Applied Fire Safety Research

Consulting - Design - Testing - Verification



IWMA Research Project - Phase One -
Determination of fire test protocols for the
protection of buildings with automatic water
mist nozzles

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14th International Water Mist
Conference

Contents

- General
- Overview
- Comparison by
 - Hazard
 - Fire Scenario
 - Fire Load
 - Ignition Source
 - Variety of Test Duration
 - Variety of Test Procedure
 - Measurements
 - Evaluation Criteria
- Discussion



General

- protection of buildings with sprinkler systems has been used for almost two centuries
- big collection of positive results in terms of actual fires controlled by the correct operation of sprinkler systems
- installed in accordance with the available international standards
- series of tests were carried out to assess the design criteria of the sprinkler systems



General

- fire protection technology using water in small droplets to fight fires has been developed
- based on the use of nozzles closed with a thermal released mechanism
- technology has been proposed for the protection of building occupancies
- problem immediately arose about the acceptance criteria



General

- when the water mist technology is used for extinguishment purpose, the acceptance criteria to be used for the system is quite clear: extinguishment
- when the technology is applied to class A fires and it is used with the closed nozzles approach, the acceptance criteria are a bit more complex
- no clear definition of fire control or fire suppression



Overview

- data base “Perinorm” was used to search for norms and standards
„*Perinorm* - database for standards and technical regulations.
[available at www.perinorm.com. Viewed on 02.04.2014.]”
- fire test institutes, carrying out such fire test, have its own developed or adopted standards available on its web pages or were contacted
- supplier and manufacturer of water mist industries



Overview

General Standard

Country	Guideline with fire test protocol	Occupancy	Name of the fire test protocol
EU	DIN CEN 14972	Ordinary hazard (OH 1) office	Fixed fire fighting systems - Water mist systems - Design and installation
		Ordinary hazard (OH 3) storage	
US	FM 5560	Small compartment	Water Mist Systems for Fire Protection
		Large compartment	
		Open space ⁴	
UK	DD 8458	Residential/domestic compartment	Fixed fire protection systems. Residential and domestic water mist systems. Code of practice for design and installation
UK	DD 8489-7	Small compartment	Fixed fire protection systems. Industrial and commercial water mist systems. Tests and requirements for water mist systems for the protection of low hazard occupancies
		Large compartment	
		Open space	
		Workshop	

Overview

Laboratory developed standard

Country	Guideline with fire test protocol	Occupancy	Name of the fire test protocol
FR	CNPP T2	Double room	Règles techniques, spécifications et méthodes d'essais
		Double room (sidewall)	
		Single room (wardrobe)	
		Archive	
DE	VDS	Ordinary hazard (OH 1) office	Fire tests office (OH1)
DE		Ordinary hazard (OH 1) hotel	Fire tests hotel (OH1)
DE		Ordinary hazard (OH 1) false ceiling	Fire tests false ceilings (OH1)
DE		Ordinary hazard (OH 2) garages	Fire tests parking garages (OH2)
DE		Ordinary hazard (OH 3) storage compact	Fire tests for department stores (OH3)
		Ordinary hazard (OH 3) storage shelf	

Overview

Maritime standard

Country	Guideline with fire test protocol	Occupancy	Name of the fire test protocol
US	UL 2167	Small (cabin)	Standard for Safety for Water Mist Nozzles for Fire-Protection Service
		Small (corridor)	
		Large	
		Public space	
		Ordinary hazard	
		Residential	
Light hazard			

- ISO 6182-9 , MSC 265(84) Annex 14 and UL 21675 are actually related for a shipboard protection and are similar
- UL 2167 includes the most fire test protocols

Overview

Other standards

Country	Local testing body	Comments
Spain	AFITI LICOF, LGAI Technological Center, S.A.	referring to VDS and CEN TS 14972
Austria		n.a.
Polen	The Science for Fire Research Center for Fire Protection in Józefów (CNBOP)	standard by CNBOP based on NFPA 750 and PN-EN 12259-1:2001 Stale urządzenia gasnicze – podzespoły urządzeń tryskaczowych i zraszaczowe – Czesc 1: tryskacze
Finnland	-	CEA 4001 - 06 fi Sprinklerilaitteistot Suunnittelu ja asentaminen
Switzerland	-	SES Richtlinie: Planung Einbau und Betrieb, 4.3.2 Sonderanwendungen, referring to international standards
Russia	VNIIPO	SP 5.13130.2009 Fire protection systems. Automated fire alarm and fire extinguishing installations. Design norms and regulations, referring to international standards
South Africa		n.a.
Australia/New Zealand	CSIRO, SAI Global	SA 4578 for Design & Installation, referring von UL 2167; FM 5560
Saudi Arabia	-	Referring to UL 2167; FM 5560, VdS is not accepted in Saudi Arabia, but in Qatar, UAE and Jordan; Brandschutzrichtlinie 19-11, 4.3 Sonderanwendungen
India	-	IS 155519:2004 Water mist fire protection systems - system design, Installation and commissioning - Code of practice, referring to NFPA 750
China	-	Draft standard looking similar to FM 5560
Peru		n.a.

Comparison - Hazard

- basically two types of fire hazards
- low hazards and ordinary hazards
- fire hazards are defined differently
- according to EN 12845 and NFPA 101 / FM 5560



EN 12845

Classification of fire hazards	Examples
Low hazards (LH)	School rooms, jails, offices: rooms < 126 m ²
Ordinary hazards (OH 1)	School rooms, offices: rooms > 126 m ² , hotels, hospitals
Ordinary hazards (OH 2)	Parking garages, laboratories, breweries
Ordinary hazards (OH 3)	Warehouses, furniture industries, show industries

Comparison - Hazard

- according to EN 12845

Country	Guideline with fire test protocol	Name of scenario	Fire hazard (EN 12845)		
			Ordinary hazard		
			OH 1	OH 2	OH 3
EU	DIN CEN 14972	Ordinary hazard (OH 1) office	x	-	-
	DIN CEN 14972	Ordinary hazard (OH 3) storage	-	-	x
FR	CNPP T2	Double room	x	-	-
	CNPP T2	Double room (sidewall)	x	-	-
	CNPP T2	Single room (wardrobe)	x	-	-
	CNPP T2	Archive	-	-	x
DE	VDS	Ordinary hazard (OH 1) office	x	-	-
DE	VDS	Ordinary hazard (OH 1) hotel	x	-	-
DE	VDS	Ordinary hazard (OH 1) false ceiling	x	-	-
DE	VDS	Ordinary hazard (OH 2) garages	-	x	-
DE	VDS	Ordinary hazard (OH 3) storage compact	-	-	x
	VDS	Ordinary hazard (OH 3) storage shelf	-	-	x

Comparison - Hazard

NFPA 101 / FM 5560

Classification of fire hazards	Examples
Low hazard, Hazard category 1 [HC 1]	apartments, schools, hospitals, museums, offices, residential facility
restricted areas	enclosed spaces < height of < 2,4 m
unrestricted areas	open spaces > height of < 5 m
Ordinary hazard, Hazard category 2 [HC 2]	Parking garages, mercantile areas, theatres

- hazard categories (HC 1 – 4) are defined in FM 3-26
- HC 2 and HC 3 shall not be protected by water mist systems (FM 5560)
- HC 2 similar to OH 2 / 3 of EN 12845 !

Comparison - Hazard

- according to NFPA 101 / FM 5560

Country	Guideline with fire test protocol	Occupancy	Fire hazard (NFPA 101 / FM 5560)		
			Low hazard		Ordinary hazard
			HC 1 restricted	HC 1 unrestricted	HC 2
US	FM 5560	Small compartment	X	-	-
	FM 5560	Large compartment	X	-	-
	FM 5560	Open space	-	X	-
US	UL 2167	Small (cabin)	X	-	-
	UL 2167	Small (corridor)	X	-	-
	UL 2167	Large	X	-	-
	UL 2167	Public space	-	X	-
	UL 2167	Ordinary hazard	-	-	X
	UL 2167	Residential	X	-	-
	UL 2167	Light hazard	X	-	-
UK	DD 8458	Residential/domestic compartment	X	-	-
UK	DD 8489-7	Small compartment	X	-	-
	DD 8489-7	Large compartment	X	-	-
	DD 8489-7	Open space	-	X	-
	DD 8489-7	Workshop	X	-	-

Comparison - Hazard

- general overview - non storage applications

Guideline with fire test protocol	Occupancy	Fire hazard		Evaluation of area		
		Non storage	Storage	Small	Large	High
				< 12 m ²	> 12 m ²	> 5 m
FM 5560	Small compartment	x	-	x	-	-
UL 2167	Small (cabin)	x	-	x	-	-
UL 2167	Small (corridor)	x	-	x	-	-
DD 8489-7	Small compartment	x	-	x	-	-
FM 5560	Large compartment	x	-	-	x	-
UL 2167	Large	x	-	-	x	-
UL 2167	Residential	x	-	-	x	-
UL 2167	Light hazard	x	-	-	x	-
DD 8489-7	Large compartment	x	-	-	x	-
DIN CEN 14972	Ordinary hazard (OH 1) office	x	-	-	x	-
CNPP T2	Double room	x	-	-	x	-
CNPP T2	Double room (sidewall)	x	-	-	x	-
CNPP T2	Single room (wardrobe)	x	-	-	x	-
UL 2167	Public space	x	-	-	x	(x)
DD 8458	Residential/domestic compartment	x	-	-	x	(x)
FM 5560	Open space	x	-	-	x	x
DD 8489-7	Open space	x	-	-	x	x
DD 8489-7	Workshop	x	-	-	x	x
VDS	Ordinary hazard (OH 1) office	x	-	-	x	n.d.
VDS	Ordinary hazard (OH 1) hotel	x	-	-	x	n.d.

Comparison - Hazard

- general overview - storage applications

Guideline with fire test protocol	Occupancy	Fire hazard		Evaluation of area		
		Non storage	Storage	Small	Large	High
				< 12 m ²	> 12 m ²	> 5 m
CNPP T2	Archive	-	x	-	x	-
DIN CEN 14972	Ordinary hazard (OH 3) storage	-	x	-	x	(x)
UL 2167	Ordinary hazard	-	x	-	x	x
VDS	Ordinary hazard (OH 2) garages	-	x	n.d.	n.d.	n.d.
VDS	Ordinary hazard (OH 3) storage compact	-	x	n.d.	n.d.	n.d.
VDS	Ordinary hazard (OH 3) storage shelf	-	x	n.d.	n.d.	n.d.
VDS	Ordinary hazard (OH 1) false ceiling	-	x	n.d.	n.d.	-

Comparison - Fire scenarios

- Small compartment: 2 bunk beds
- Large compartment: Simulated furniture
- Open space: 4 sofas
- Offices/Workshop: 2 desks
- Storage: Cartons with cups
- Specific: Specific applications



Comparison - Fire scenarios

- 2 bunk beds - large compartment - open space

Guideline with fire test protocol	Occupancy	Fire scenario/mock-ups					
		2 bunk beds	Simulated furniture	4 Sofas	2 desks	Car-ton and cups	Specific
FM 5560	Small compartment	x	-	-	-	-	-
UL 2167	Small (cabin)	x	-	-	-	-	-
DD 8489-7	Small compartment	x	-	-	-	-	-
FM 5560	Large compartment	-	x	-	-	-	-
UL 2167	Large	-	x	-	-	-	-
UL 2167	Residential	-	x	-	-	-	-
UL 2167	Light hazard	-	x	-	-	-	-
DD 8489-7	Large compartment	-	x	-	-	-	-
DD 8458	Residential/domestic compartment	-	x	-	-	-	-
UL 2167	Public space	-	-	x	-	-	-
FM 5560	Open space	-	-	x	-	-	-
DD 8489-7	Open space	-	-	x	-	-	-
VDS	Ordinary hazard (OH 1) hotel	-	-	x	-	-	-

Comparison - Fire scenarios

- 2 desks - carton with cups - specific

Guideline with fire test protocol	Occupancy	Fire scenario/mock-ups					
		2 bunk beds	Simulated furniture	4 Sofas	2 desks	Carton and cups	Specific
DIN CEN 14972	Ordinary hazard (OH 1) office	-	-	-	X	-	-
DD 8489-7	Workshop	-	-	-	X	-	-
VDS	Ordinary hazard (OH 1) office	-	-	-	X	-	-
DIN CEN 14972	Ordinary hazard (OH 3) storage	-	-	-	-	X	-
UL 2167	Ordinary hazard	-	-	-	-	X	-
VDS	Ordinary hazard (OH 3) storage compact	-	-	-	-	X	-
VDS	Ordinary hazard (OH 3) storage shelf	-	-	-	-	X	-
UL 2167	Small (corridor)	-	-	-	-	-	X
CNPP T2	Double room	-	-	-	-	-	X
CNPP T2	Double room (sidewall)	-	-	-	-	-	X
CNPP T2	Single room (wardrobe)	-	-	-	-	-	X
CNPP T2	Archive	-	-	-	-	-	X
VDS	Ordinary hazard (OH 2) garages	-	-	-	-	-	X
VDS	Ordinary hazard (OH 1) false ceiling	-	-	-	-	-	X

Comparison - Fire loads

- burnable materials

Fire scenarios	Fire loads	Materials
2 bunk beds	Mattresses/Pillows Fabric covers	Polyether Cotton
Simulated furniture	Plywood Foam cushions	Wood Polyether
4 sofas	Mattresses/Pillows Fabric covers	Polyether Cotton
2 desks	Plywood Table, drawers, chair Folders, Papers Cushions, Folders Fabric covers Others	Wood Chipboard Paper, cardboard Polyether, polyurethane Cotton Other synthetic materials
Cartons and cups	Cardboard Cups	Cardboard Polystyrene
Specific	Folders, Papers Furniture Mattresses, pillows, Fabric covers, Tissues Cars Cables	Paper, cardboard Chipboard, veneer Polyether, polyester Cotton Other synthetic materials

Comparison - Fire loads

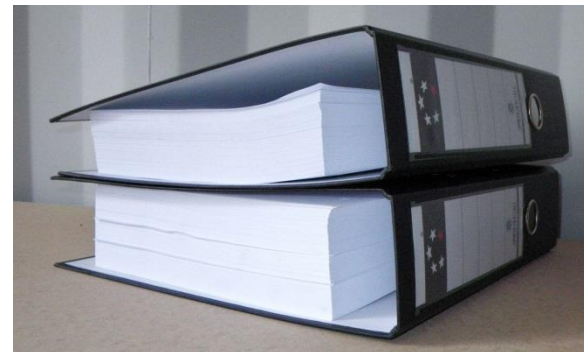
- “general overview”

Guideline with fire test protocol	Occupancy	Fire load	Ignition source	Material	Defined property	Value	Burnable materials	Burnable reproducible materials	Amount of materials	Amount of reproducible materials	Ranking fire scenario %	Scores
FM 5560	Small compartment	Accoustical board	-	Cellulose	Class 0 surface spread of fire (BS476-7)	16 mm	-	-	5	3	60	2,50
					Thickness	16 mm						
		Mattress + Pillow	-	Polyether	Not fire retardant	-	x	x				
					Density:	33 kg/m ³						
		Fabric cover	-	Cotton	Not fire retardant	-	x	x				
					Area weight	140 - 180 kg/m ²						
		-	-	Fibre board	-	-	x	-				
Plastic bag	-			-	x	-						
N-heptane	-			-	x	x						
UL 2167	Small (cabin)	Accoustical board	-	-	Thickness	12-15 mm	-	-	6	3	50	3,00
					Plywood	-						
		Mattress + Pillow	-	Polyether	Not fire retardant	-	x	x				
					Density	33 kg/m ³						
		Fabric cover	-	Cotton	Not fire retardant	-	x	x				
					Area weight	140 - 180 kg/m ²						
		-	-	Fibre board	-	-	x	-				
Plastic bag	-			-	x	-						
N-heptane	-			-	x	x						
DD 8489-7	Small compartment	Accoustical board	-	-		-	-	-	5	3	60	1,75
		Mattress + Pillow	-	Polyether	Not fire retardant	ISO 5660-1: 35 kW/m ²	x	x				
					Density	33 kg/m ³						
		Fabric cover	-	Cotton	Not fire retardant	-	x	x				
					Area weight	140 - 180 kg/m ²						
		-	-	Fibre board	-	-	x	-				
Plastic bag	-			-	x	-						
N-heptane	-			-	x	x						
		N-heptane	-	-	x	x						
		N-heptane	-	-	x	x						
		N-heptane	-	-	x	x						

Comparison - Fire sources

- no general reference in the test protocols to standards
- origin visible

Fire scenarios	Ignition source	Standard
2 bunk beds	Fibre board/ n-heptane in plastic bag	IMO Res. A. 800
Simulated furniture	Wood crib/ n-heptane	IMO Res. A. 800
4 sofas	Fibre board/ n-heptane in plastic bag	IMO Res. A. 800
2 desks	Burner + wood crib/ n-heptane Wood-plastic crib/ white spirit	EN 45545 (Square burner) -
Cartons and cups	N-heptane in pool	IMO Res. A. 800
Specific	Burner	EN 45545-2 (Square burner) or ISO 12952-2



Comparison - Test duration

- counted after the ignition: 10 min or 30 min
- counted after the activation of water mist system: 10 min or 30 min
- no principles or regularity visible

Guideline with fire test protocol	Occupancy	Mock-up	Duration of fire test			
			After ignition		After activation of water mist system	
			10 min	30 min	10 min	30 min
FM 5560	Small compartment	2 bunk beds	x	-	-	-
UL 2167	Small (cabin)		-	-	x	-
DD 8489-7	Small compartment		-	-	x	-
FM 5560	Large compartment	Simulated furniture	x	-	-	-
UL 2167	Large		x	-	-	-
UL 2167	Residential		-	x	-	-
UL 2167	Light hazard		-	-	x	-
DD 8489-7	Large compartment		-	-	x	-
DD 8458	Residential/domestic compartment		-	-	X (domestic)	X (residential)
UL 2167	Public space	4 Sofas	not defined			
FM 5560	Open space		x	-	-	-
DD 8489-7	Open space		-	-	-	x
VDS	Ordinary hazard (OH 1) hotel		-	-	x	-

Comparison - Test duration

Guideline with fire test protocol	Occupancy	Mock-up	Duration of fire test			
			After ignition		After activation of water mist system	
			10 min	30 min	10 min	30 min
DIN CEN 14972	Ordinary hazard (OH 1) office	2 desks	-	-	-	X
DD 8489-7	Workshop		-	-	-	X
VDS	Ordinary hazard (OH 1) office		-	-	-	X
DIN CEN 14972	Ordinary hazard (OH 3) storage	Carton and cups	-	-	-	X
UL 2167	Ordinary hazard		-	-	X	-
VDS	Ordinary hazard (OH 3) storage compact		-	-	X	-
VDS	Ordinary hazard (OH 3) storage shelf		-	-	X	-
UL 2167	Small (corridor)	Specific	-	-	X	-
CNPP T2	Double room		-	-	-	X
CNPP T2	Double room (sidewall)		-	-	-	X
CNPP T2	Single room (wardrobe)		-	-	-	X
CNPP T2	Archive		-	-	-	X
VDS	Ordinary hazard (OH 2) garages		-	-	-	X
VDS	Ordinary hazard (OH 1) false ceiling		-	-	X	-

Comparison - Variety in test scenario

- variety in procedure
- position of mock-up changes (e.g. at the wall or in the centre of the test room)
- position of ignition sources (e.g. at different position on the mock-up, at wall or in the centre of the test room)
- with or without ventilation
- amount of nozzle in test room (e.g. under one nozzle, between 2 or 4 nozzles)



Comparison - Variety in test scenario

Guideline with fire test protocol	Occupancy	Fire scenario/ Mock-up	Variety among fire scenarios				
			Position of mock-up	Position of ignition source	Ventilation	Amount of nozzles	Others
FM 5560	Small compartment	2 bunk beds	-	-	-	-	-
UL 2167	Small (cabin)		-	X	-	X	X
DD 8489-7	Small compartment		-	-	-	-	-
FM 5560	Large compartment	Simulated furniture	-	-	-	-	-
UL 2167	Large		-	-	-	-	-
UL 2167	Residential		X	-	-	-	-
UL 2167	Light hazard		-	X	-	-	-
DD 8489-7	Large compartment		-	-	-	-	-
DD 8458	Residential/domestic compartment		X	-	X	-	X
UL 2167	Public space	4 Sofas	X	X	X	-	X
FM 5560	Open space		X	-	-	-	-
DD 8489-7	Open space		-	X	-	-	-
VDS	Ordinary hazard (OH 1) hotel		-	-	-	X	-

Comparison - Variety in test scenario

Guideline with fire test protocol	Occupancy	Fire scenario/ Mock-up	Variety among fire scenarios				
			Position of mock-up	Position of ignition source	Ventilation	Amount of nozzles	Others
DIN CEN 14972	Ordinary hazard (OH 1) office	2 desks	-	-	-	x	-
DD 8489-7	Workshop		-	x	-	-	-
VDS	Ordinary hazard (OH 1) office		-	-	-	x	-
DIN CEN 14972	Ordinary hazard (OH 3) storage	Carton and cups	-	-	-	x	-
UL 2167	Ordinary hazard		x	-	-	-	-
VDS	Ordinary hazard (OH 3) storage compact		-	-	-	x	-
VDS	Ordinary hazard (OH 3) storage shelf		-	-	-	x	-
UL 2167	Small (corridor)	Specific	x	-	-	-	x
CNPP T2	Double room		-	-	-	-	-
CNPP T2	Double room (sidewall)		-	-	-	-	-
CNPP T2	Single room (wardrobe)		-	-	-	-	-
CNPP T2	Archive		-	x	-	-	x
VDS	Ordinary hazard (OH 2) garages		-	-	-	x	-
VDS	Ordinary hazard (OH 1) false ceiling		-	-	-	-	-

Comparison - Test repetition

- fire scenarios are defined to be repeated with and/or without any changes of test conditions

Guideline with fire test protocol	Occupancy	Fire scenario/ Mock-up	Test repetition	
			Conditions changed	Same test repeated
FM 5560	Small compartment	2 bunk beds	-	(x)
UL 2167	Small (cabin)		x	-
DD 8489-7	Small compartment		-	x
FM 5560	Large compartment	Simulated furniture	-	(x)
UL 2167	Large		-	-
UL 2167	Residential		x	x
UL 2167	Light hazard		x	-
DD 8489-7	Large compartment		-	x
DD 8458	Residential/domestic compartment		x	-
UL 2167	Public space	4 Sofas	x	-
FM 5560	Open space		x	(x)
DD 8489-7	Open space		x	-
VDS	Ordinary hazard (OH 1) hotel		x	x
DIN CEN 14972	Ordinary hazard (OH 1) office	2 desks	x	-
DD 8489-7	Workshop		x	-
VDS	Ordinary hazard (OH 1) office		x	x

Comparison - Test repetition



Guideline with fire test protocol	Occupancy	Fire scenario/ Mock-up	Test repetition	
			Conditions changed	Same test repeated
DIN CEN 14972	Ordinary hazard (OH 3) storage	Carton and cups	X	-
UL 2167	Ordinary hazard		X	-
VDS	Ordinary hazard (OH 3) storage compact		X	X
VDS	Ordinary hazard (OH 3) storage shelf		X	X
UL 2167	Small (corridor)	Specific	X	-
CNPP T2	Double room		-	-
CNPP T2	Double room (sidewall)		-	-
CNPP T2	Single room (wardrobe)		-	-
CNPP T2	Archive		X	-
VDS	Ordinary hazard (OH 2) garages		X	X
VDS	Ordinary hazard (OH 1) false ceiling		-	-

Comparison - Measurements

- temperature measurements and the determination of fire damages in almost all cases
- some require gas analyses, measurement of water pressure and flow rates, radiation, video recording as well as a comparison with a reference fire fighting system



Comparison - Measurements

Guideline with fire test protocol	Fire scenario/ Mock-up	Measurement variables						
		Temperature	Burning damages	Gas concentration	Water pressure	Water flow rate	Reference system	Others
FM 5560	small compartment 2 bunk beds	X	X	-	-	-	-	-
UL 2167		X	X	-	X	X	-	-
DD 8489-7		X	X	X	X	X	-	-
FM 5560	large compartment Simulated furniture	X	-	-	-	-	-	-
UL 2167		X	-	-	X	X	-	-
UL 2167		X	-	-	-	-	-	-
UL 2167		-	X	-	-	-	-	-
DD 8489-7		X	X	X	X	X	-	-
DD 8458		X	-	X	X	X	-	-
UL 2167	open space 4 sofas	X	X	-	-	-	-	-
FM 5560		X	X	-	-	-	-	-
DD 8489-7		X	X	X	X	X	-	-
VDS		X	X	-	X	X	X	-

Comparison - Measurements

Guideline with fire test protocol	Fire scenario/ Mock-up	Measurement variables						
		Temperature	Burning damages	Gas concentration	Water pressure	Water flow rate	Reference system	Others
DIN CEN 14972	office 2 desks	X	X	-	X	X	X	Video
DD 8489-7		X	X	X	X	X	-	-
VDS		X	X	-	X	-	X	Radiation
DIN CEN 14972	storage Cup and cartons	X	X	-	X	X	X	Video
UL 2167		X	-	-	-	-	-	-
VDS		X	X	-	X	X	X	Radiation
VDS		X	X	-	X	X	X	Radiation
UL 2167	Specific	X	-	-	X	X	-	-
CNPP T2		X	X	O ₂	X	X	X	-
CNPP T2		X	X	O ₂	X	X	-	-
CNPP T2		X	X	O ₂	X	X	-	-
CNPP T2		X	X	O ₂	X	X	-	-
VDS		X	X	-	X	X	X	Radiation
VDS		X	X	-	X	X	X	-

Comparison - Evaluation

- Pass/fail criteria according to limit values for temperatures and burning damages
- Pass/fail criteria by comparison of reference system: fire damages and temperatures shall be lower than of the reference system
- differing parameters:
 - diameter of thermocouples
 - summarising temperatures by mean values
 - position of thermocouples used as evaluation criteria
 - limit values of temperatures
 - fire damages and its definitions how it is measures
 - limit values of oxygen
 - comparison to a reference system



Comparison - Evaluation

Guideline with fire test protocol	Occupancy	Fire scenario/ Mock-up	Type of criteria			
			Reference system		Limit values	
			Temperatures	Damages	Temperatures	Damages
FM 5560	Small compartment	2 bunk beds	-	-	X	X
UL 2167	Small (cabin)		-	-	X	X
DD 8489-7	Small compartment		-	-	X	X
FM 5560	Large compartment	Simulated furniture	-	-	X	-
UL 2167	Large		-	-	X	X
UL 2167	Residential		-	-	X	-
UL 2167	Light hazard		-	-	-	X
DD 8489-7	Large compartment		-	-	X	-
DD 8458	Residential/domestic compartment		-	-	X	-
UL 2167	Public space	4 sofas	-	-	X	X
FM 5560	Open space		-	-	X	X
DD 8489-7	Open space		-	-	X	X
VDS	Ordinary hazard (OH 1) hotel		X	X	-	-

Comparison - Evaluation

Guideline with fire test protocol	Occupancy	Fire scenario/ Mock-up	Type of criteria			
			Reference system		Limit values	
			Temperatures	Damages	Temperatures	Damages
DIN CEN 14972	Ordinary hazard (OH 1) office	2 desks	X	X	-	-
DD 8489-7	Workshop		-	-	X	X
VDS	Ordinary hazard (OH 1) office		X	X	-	-
DIN CEN 14972	Ordinary hazard (OH 3) storage	Cups and cartons	X	X	-	-
UL 2167	Ordinary hazard		-	-	X	X
VDS	Ordinary hazard (OH 3) storage compact		X	X	-	-
VDS	Ordinary hazard (OH 3) storage shelf		X	X	-	-
UL 2167	Small (corridor)	Specific	-	-	X	-
CNPP T2	Double room		X	X	-	-
CNPP T2	Double room (sidewall)		-	-	X	X
CNPP T2	Single room (wardrobe)		-	-	X	X
CNPP T2	Archive		-	-	X	X
VDS	Ordinary hazard (OH 2) garages		X	X	-	-
VDS	Ordinary hazard (OH 1) false ceiling		X	X	-	-

Discussion

- suitable evaluation of fire test protocols is not possible
- establish a relationship between the single protocols impossible
- relate the single protocol to an more abstract superior guideline
- ISO/IEC 17025 forces laboratories
 - to verify measurement methods
 - validate testing methods
 - for a **defined** testing field



Discussion

- implementation of ISO/IEC 17025 ensures qualitative correct results
- independent from location and institution, where the test is carried out
- as long as the institutions are accredited for the same field of application
- ISO/IEC 17025 focuses strongly on the reproducibility of a test method
- reproducibility influenced by methodical aspects:
 - Safety objectives
 - Mock-up
 - Fire loads
 - Ignition sources
 - Duration of test
 - Measurement system
 - Evaluation criteria



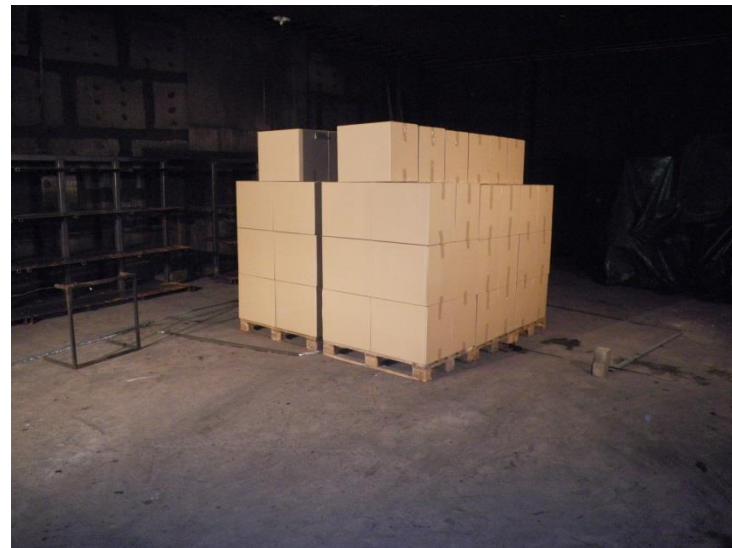
Discussion

- following test parameters shall be kept simple and be well-defined, because the fire process itself appears often randomly:
 - size of room
 - size of item
 - clear definition of the materials, duration and procedures
 - clear definition of measurement variables including definition and retraceability
 - clear definition of evaluation criteria



Discussion

- two questions possible:
 1. How shall a fire test protocol for water mist applications look like that fulfils the requirements of ISO/IEC 17025?
 2. How shall existing fire test protocols be discussed to which extent these requirements are already considered?
- two aspects important:
 1. Reproducibility
 2. Representativenessboth important, depends on the right balance among them



Discussion

balance of reproducibility and representativeness

- Clear definition of occupancy and fire hazard
- Definition of effective area and height
- Definition of fire scenario
 - Simple and abstract mock-up
 - Fire loads and ignition sources shall have a reasonable and limited variation and materials shall be defined and standardised
- Definition of test procedure
- Definition of the measuring method:
 - Type of sensor
 - Definition of position of sensors
- Measurements made by the laboratory shall be retraceable
 - Method to measure temperatures, gases, water pressures and flow rates
 - Method to determination of fire damages
 - Method to compare to a reference systems
- Repetition of a fire test with the same parameters shall give a similar result
- Definition of evaluation criteria: correlation to standards

Discussion

- it's obvious that at the moment none of the investigated fire test protocols fulfils the above mentioned necessary criteria completely
- following parameters might need more improvement to comply with the IEC/ISO 17025
 - Definition of fire scenario
 - Definition of the measuring method
- quality of definitions can be ranked easily
- complexity of a fire scenario shall be determined by the experimental standard deviation

Discussion

- ranking example referring to quality of definitions of fire loads

Guideline with fire test protocol	Occupancy	Fire scenario/mock-up	Amount of burnable materials	Amount of well-defined materials	Ranking fire scenario %	Scores
FM 5560	Small compartment	2 bunk beds	5	3	60	2,75
UL 2167	Small (cabin)		6	3	50	3,00
DD 8489-7	Small compartment		5	3	60	2,75
FM 5560	Large compartment	Simulated furniture	5	4	80	1,75
UL 2167	Large		4	4	100	1,00
UL 2167	Residential		4	4	100	1,00
UL 2167	Light hazard		2	2	100	1,00
DD 8489-7	Large compartment		5	2	40	3,50
DD 8458	Residential/domestic compartment		4	3	75	2,00
UL 2167	Public space	4 sofas	6	1	17	4,25
FM 5560	Open space		5	3	60	2,75
DD 8489-7	Open space		5	2	60	2,75
VDS	Ordinary hazard (OH 1) hotel		5	2	60	2,75

Ranking		
Ranking [%]	Score	Comment
100%	1	Reproducible
88%	1,5	
75%	2	
68%	2,5	
50%	3	-
38%	3,5	Not reproducible
25%	4	
13%	4,5	
0%	5	

Summary

- the determination of fire test protocols have shown that a great variety of fire test protocols exists
- the different fire test protocols are not well comparable due to the different approaches of test methods
- a chance to harmonise might be to organise and enhance them in order to fulfil the requirements of the superior standard to testing laboratory ISO/IEC 17025
- whenever characteristics of a certain system shall be determined by measuring, this standard demands a validated standardised test method that creates reproducible results
- accredited test laboratories must follow the requirements of the ISO/IEC 17025 anyway
- at present none of the investigated fire test protocols fulfil the requirements of the standard completely
- future water mist fire test protocol shall consider this

Thank you very much!

- IFAB has experiences with more than 200 full scale fire tests
- different technologies were tested
- high and low pressure water mist, conventional deluge, foam
- measurement setups with up to 300 sensor positions were realized
- an extensive data base available
- IFAB offers the entire implementation process
 - risk assessment
 - safety measure conception
 - proof of efficiency
 - planning / design
 - LCC evaluation

