

Watermist – State of the Art Technology

IWMA Seminar
19th January 2014
Dubai, UAE

By Alex Palle, VID Fire-Kill, Denmark

Agenda:

- 1) Introduction to VID Fire-Kill.
- 2) What is a fire.
- 3) What is Watermist and how does it fight fires.
- 4) How to accept Watermist and where can it then be applied.
- 5) Some Watermist Benefits and Limitations.

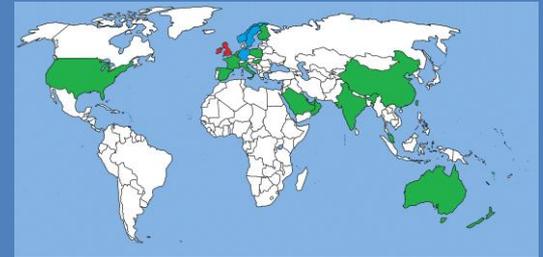
In-house Production and Testing



Covering most applications found on - and offshore



World wide Player



1. VID Fire-Kill

Low Pressure, low flow

Environmentally friendly solutions



Smart Designs

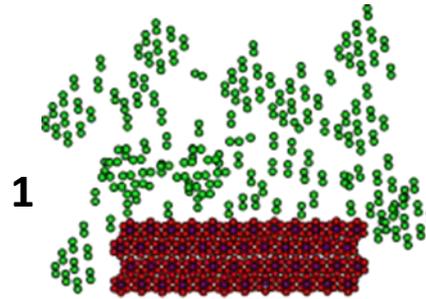
Tested and Approved



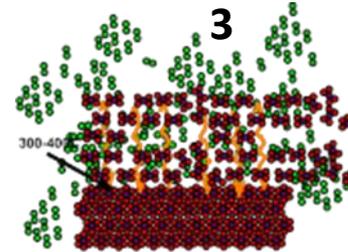
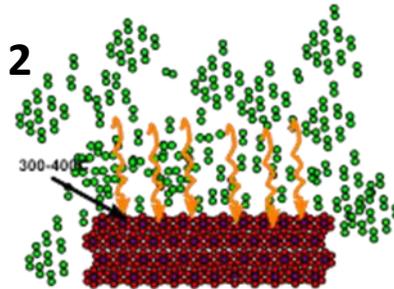
2. What is a Fire?

Air: 21% O₂+78,8% N₂ + ?

Fuels: Carbon + Hydrogen + ?



Energy to
Fuel (heat)

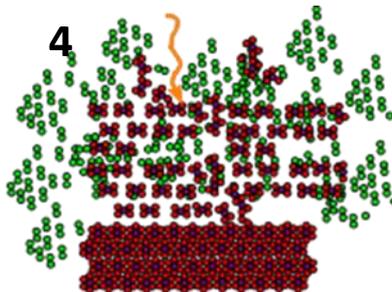


Pyrolysis process

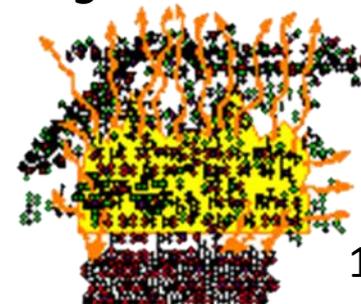
Fuel => Pyrolysis gasses

Example: CH₄

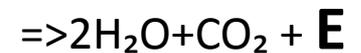
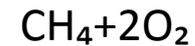
Energy to
Pyrolysis gas +
Atmosphere =>
Oxidation process



5 Fire ignition



Fire example:



1kg O₂ => 13.000.000 joule

1. Pyrolysis gasses are created.
2. Oxidation process happens.
3. Energy is released (seen as flames).



As more heat will create more pyrolysis gasses,
A fire will grow exponential until there is no more O₂ or fuel.
This creates the big risk of fat fire spread (flashover).



3. What is **Watermist** and how does it **fight fires**?

Watermist consist of small water droplets. Water is:

H(1)

O (16) Mole

H (1) 18g

- Water = Liquid H_2O
- 1 mole Water $V_0=18$ ml
- Steam = Gas H_2O
- 1 mole steam $V_0 = 0,0224m^3$
($0^\circ C$, 1 bar) = 22,4l steam

Phase change

1mole Water + 47000 Joule

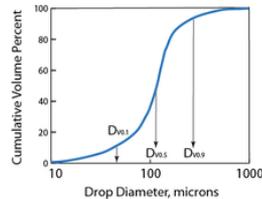
=> 1mole Steam



What is watermist?

NFPA

By definition, water mist is a water spray for which the 99% of the total volume of liquid ($D_{v0.99}$) is in droplets of diameter smaller than 1000 microns at the minimum design operating pressure of the water mist nozzle.



Europe

By definition, water mist is a water spray for which the 90% of the total volume of liquid ($D_{v0.90}$) is in droplets of diameter smaller than 1000 microns at the minimum design operating pressure of the water mist nozzle.



Watermist can perhaps also be seen as a way to develop new optimized products without having to follow existing product approval standards. E.g. minimum requirements for sprinkler orifices and water density inhibits sprinkler to use less water.

How is watermist created?

The small droplets are created with specially designed nozzles at a certain water pressure. Nozzles exist in many forms:

Automatic Nozzle (glassbulb type)



However the Water pressure and droplets size alone does not determine the performance of a watermist system, only fire – and component tests does.

Open Nozzle (deluge type)

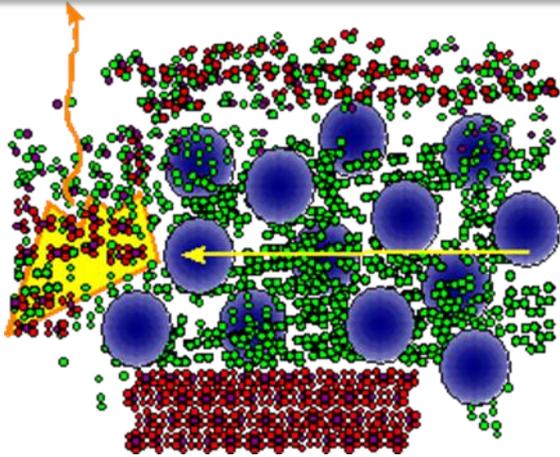


Special Nozzle (pop-up type)

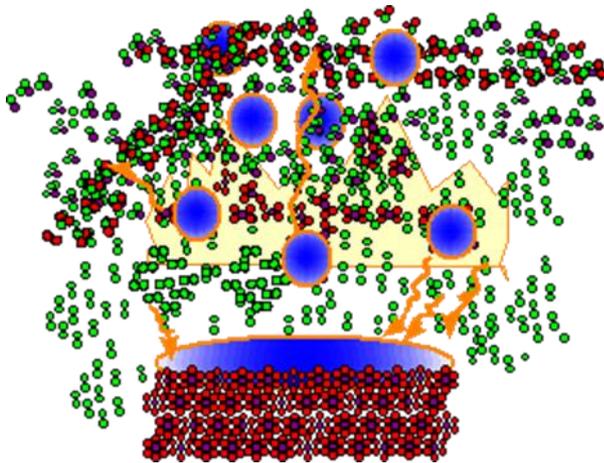


Focus on pyrolysis process

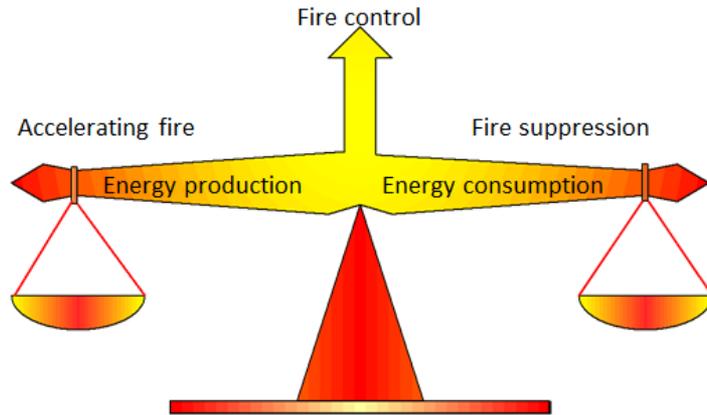
Blow away pyrolysis gasses => blow fire out



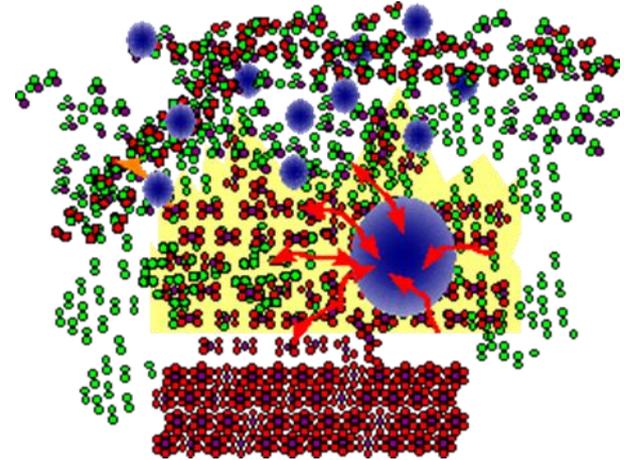
Cooling fuel => reducing the pyrolysis gas production



Focus on oxidation process



Cooling oxidation process => slow down process



Reduce oxygen concentration => reduce heat output

Inert gasses from fires

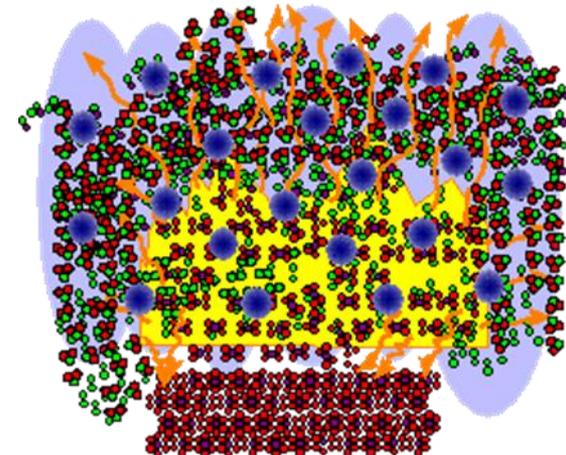
Oxidation processes connects atm.oxygen to hydrogen and carbon from fuel, nitrogen remains in atmosphere => CO₂, H₂O (combustion) + N₂

+

Water Steam (inert gas)

=

Inert gasses reduces O₂ % in the vicinity of oxidation processes. => **making it harder for the oxidation process to run**



Watermist on fires

Water mist spray primarily fight fires by cooling chemical processes and inerting ambients of oxidation processes.

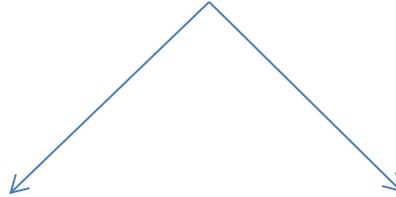
=>

1. Water mist is **most** effective in locations with
 1. Large fires => large steam production
 2. High heat => Large steam production & little steam condensation
 3. Enclosures => Reduced oxygen supply => fast oxygen depletion
 4. Little ventilation => increased oxygen depletion effect.

2. Water mist spray **primarily** fights fires by
 1. Cooling pyrolysis processes
 2. Inerting ambients where the oxidation processes occur.

3. Water Mist sprays **may** in some situations be applied to blow fires out.

4. How to accept Watermist and where can it then be applied.



Notifying Body Approval / Official Approval.

Examples

- FM5560: US light Hazard (EU OH1), machinery rooms/turbines,
- UL2167: Residential areas, LH, OH1.
- VDS: Hotels, Offices, car parks, cable tunnels,
- LPS1283: Hotel, offices.
- CEN/TS14972 annex A: Offices, atriums, cable tunnels, fat fryers.
- Etc.

Testing to an application.

Examples

- CEN/TS 14972 Appendix B.
- Fire test "demonstrations"

Example - FM5560 "HC1"

Approval process:

- Fire tests
- Component tests
- Design manual approval
- Production facility approval
- Periodically follow-up (4 times per year)

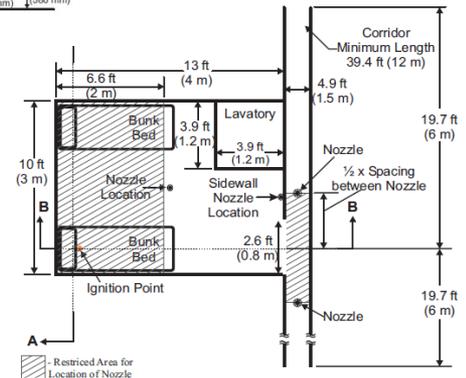
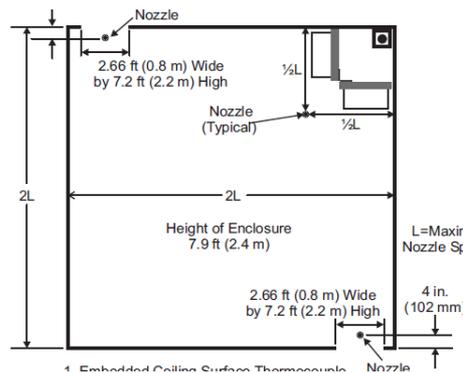
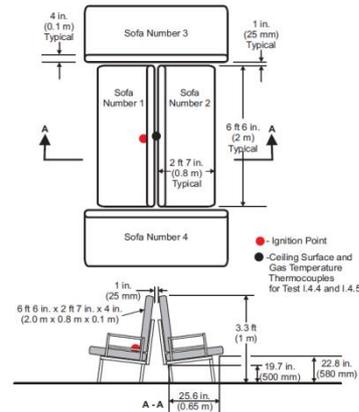
Limitations:

- 5m ceiling height.
- Pendent automatic nozzle
- Sidewall only for small compartments.
- flat ceilings (less than 8.3%)

32 component tests

4.2	WATER MIST NOZZLES	.....
4.2.1	ASSEMBLY LOAD/FRAME STRENGTH (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.2	STRENGTH OF HEAT RESPONSIVE ELEMENT (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.3	LEAKAGE (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.4	HYDROSTATIC STRENGTH (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.5	30-DAY LEAKAGE (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.6	WATER HAMMER (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.7	OPERATING TEMPERATURE (LIQUID BATH) (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.7	TABLE 4.2.7.2 LIQUID BATH CONDITIONS	.....
4.2.8	AIR BATH (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.9	HANG-UP OF OPERATING PARTS (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.9	TABLE 4.2.9.2 TEST PRESSURES	.....
4.2.10	STRENGTH OF DEFLECTOR (FLOW ENDURANCE)	.....
4.2.11	VACUUM (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.12	HIGH AMBIENT TEMPERATURE EXPOSURE (90 DAY TEST) (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.12	TABLE 4.2.12.1 A HIGH AMBIENT TEMPERATURE EXPOSURE TEST CONDITIONS	.....
4.2.12	TABLE 4.2.12.1 C PERMITTED SPLITTING POINTS OF VOLATILE NOZZLE COATINGS	.....
4.2.13	THERMAL SHOCK (GLASS BULB NOZZLES ONLY)	.....
4.2.14	DISCHARGE COEFFICIENT, K-FACTOR	.....
4.2.15	MOIST AIR (ANY NOZZLE WITH MOVING PARTS)	.....
4.2.16	CORROSION - SALT SPRAY	.....
4.2.17	CORROSION - STRESS CRACKING	.....
4.2.18	CORROSION - CARBON DIOXIDE/SULFUR DIOXIDE	.....
4.2.19	CORROSION - HYDROGEN SULFIDE	.....
4.2.20	VIBRATION	.....
4.2.20	TABLE 4.2.20.2 VIBRATION CONDITIONS	.....
4.2.21	ROUGH USE AND ABUSE	.....
4.2.22	HIGH TEMPERATURE EXPOSURE	.....
4.2.23	FREEZING (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.24	MINIMUM OPERATING PRESSURE (ANY NOZZLE WITH MOVING PARTS)	.....
4.2.25	PROCESS RESIDUE	.....
4.2.26	COLD UTILITY (C-FACTOR) (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.26	TABLE 4.2.26.2 RANGE OF TEST CONDITIONS FOR C-FACTOR	.....
4.2.27	SENSITIVITY - RESPONSE TIME INDEX (RTI) (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.27	FIGURE 4.2.27.1 RTI AND C-FACTOR LIMITS FOR BEST CASE ORIENTATION	.....
4.2.28	TABLE 4.2.27.2 PLUNGE TEST CONDITIONS	.....
4.2.28	SENSITIVITY (REFUSED, FLUSH, AND CONCEALED TYPES) (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.29	TABLE 4.2.28.1 RTI AND C-FACTOR CONVERSIONS	.....
4.2.29	TABLE 4.2.28.2 TUNNEL CONDITIONS	.....
4.2.29	SENSITIVITY (AIR OVEN) (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.29	TABLE 4.2.29.1.1 AIR OVEN NOZZLES SENSITIVITY FOR NEW, UNCOATED NOZZLES UTILIZING THE TIME VS. TEMPERATURE DATA PER TABLE 4.2.29.2	.....
4.2.29	TABLE 4.2.29.1.2 AIR OVEN NOZZLES SENSITIVITY FOR NEW NOZZLES HAVING CORROSION RESISTANT COATING UTILIZING THE TIME VS. TEMPERATURE DATA PER TABLE 4.2.29.2	.....
4.2.29	TABLE 4.2.29.1.3 AIR OVEN NOZZLES SENSITIVITY FOR AGED OR ELEVATED TEMPERATURE EXPOSED NOZZLES HAVING CORROSION RESISTANT COATING UTILIZING THE TIME VS. TEMPERATURE DATA PER TABLE 4.2.29.2	.....
4.2.29	TABLE 4.2.29.2 TIME VS. TEMPERATURE POINTS FOR AIR OVEN NOZZLES SENSITIVITY TEST	.....
4.2.30	WATER MIST DISCHARGE CHARACTERISTICS (TO BE CONDUCTED AT THE DISCRETION OF FM APPROVALS)	.....
4.2.31	IMPROVEMENT (AUTOMATIC/CLOSED NOZZLES ONLY)	.....
4.2.32	PROTECTIVE CAPS	.....

5 fires tests



Example - FM5560 "HC1"

Scope (well defined):

- Apartments
- Atriums
- Churches
- Concealed spaces
- Gymnasiums
- Hospitals and hospital laboratories*
- Hotel rooms
- Institutions
- Kitchens
- Libraries*
- Meeting rooms in convention centers and hotels
- Metalworking shops with nonhydraulic cutting operations
- Mineral processing such as: glass, cement, ore treating, gypsum processing, etc.
- Museums
- Nursing or convalescent homes
- Offices
- Restaurant seating areas
- Schools and universities classrooms
- Unused attics

* = additional limitations.



Final proof – an approval certificate:

	Certificate of Compliance	
	<small>This certificate is issued for the following:</small>	
<small>System Description:</small>	<small>Mixed CH2-CH3 Fire Water Spray System</small>	
<small>System Type:</small>	<small>Water Mist System for the Protection of Light Hazard Occupancies</small>	
<small>Design, Installation, Operation, and Maintenance Manual:</small>	<small>Design, Installation and Service Manual For Factory Mutual Approved VID Fire-Kill CH2-CH3 System, Div. No. 130811-01-07, 23-Aug-2012</small>	
<small>Prepared for:</small>	<small>VID FIRE-KILL</small>	<small>Manufactured at:</small>
<small>DE-708 SVENDBORG DENMARK</small>	<small>SVENDBORGEVEJ 13</small>	<small>VID FIRE-KILL</small>
		<small>SVENDBORGEVEJ 13</small>
		<small>DE-708 SVENDBORG DENMARK</small>
	<small>FM Approval Class: 5560</small>	
<small>Approval Identification: 3043897</small>	<small>Approval Granted: October 1, 2012</small>	
<small>Not Approved is subject to satisfactory field performance, continuing Surveillance Audits, and strict conformity to the construction as shown in the Approval Guide, as initial review of FM Approvals.</small>		
<small>For more than 100 years FM Approvals has partnered with business and industry to reduce property losses.</small>		
	 <small>Richard A. Dixon Group Manager - Fire Protection FM Approvals 1715 Boston Providence Turnpike Norwood, MA 01861</small>	
 <small>Member of the FM Global Group</small>		

Scope (limited)

The Application / scenario tested.

Verification process:

- Fire tests conducted in ISO17025 acc. test lab
- Production facility shall be ISO9001.
- AHJ often involved from beginning.

Limitations:

The results do only reflect exactly what tested.

21 component tests

- 1) Operating temperatures
- 2) Water flow
- 3) Water distribution
- 4) Water droplet size
- 5) Functional tests
- 6) Strength of nozzle body
- 7) Strength of release element
- 8) Leak resistance
- 9) Heat exposure
- 10) Thermal shock
- 11) Stress Corrosion
- 12) Salt spray corrosion
- 13) Moist air exposure
- 14) Water hammer
- 15) Dynamic heating (RTI, C)
- 16) Resistance to heat
- 17) Resistance to
- 18) Impact Test
- 19) Lateral discharge test
- 20) Thirty-day leakage test
- 21) Vacuum test

Process to develop a fire test standard

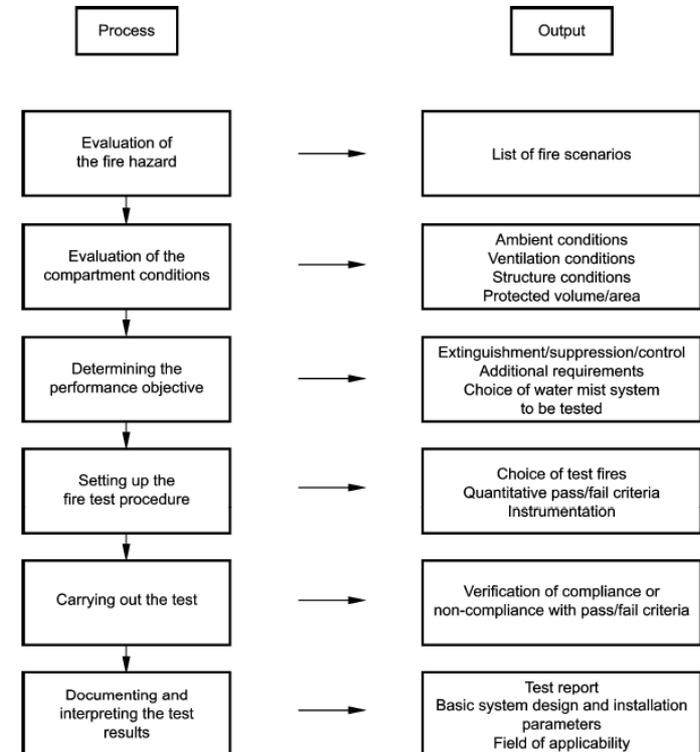


Figure B.1 — Process of developing a fire test procedure

Wooden Church, Norway:

-Large and high open space with low fuel loads (sofas, benches) placed at floor. Fire spread risk high due to all wood.

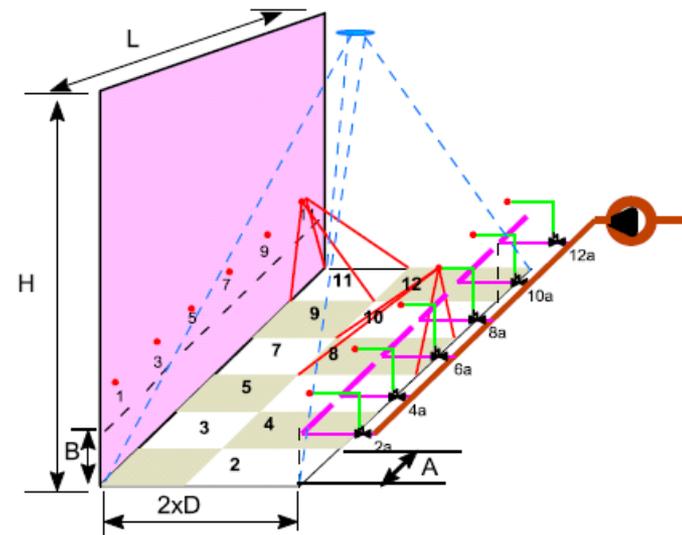
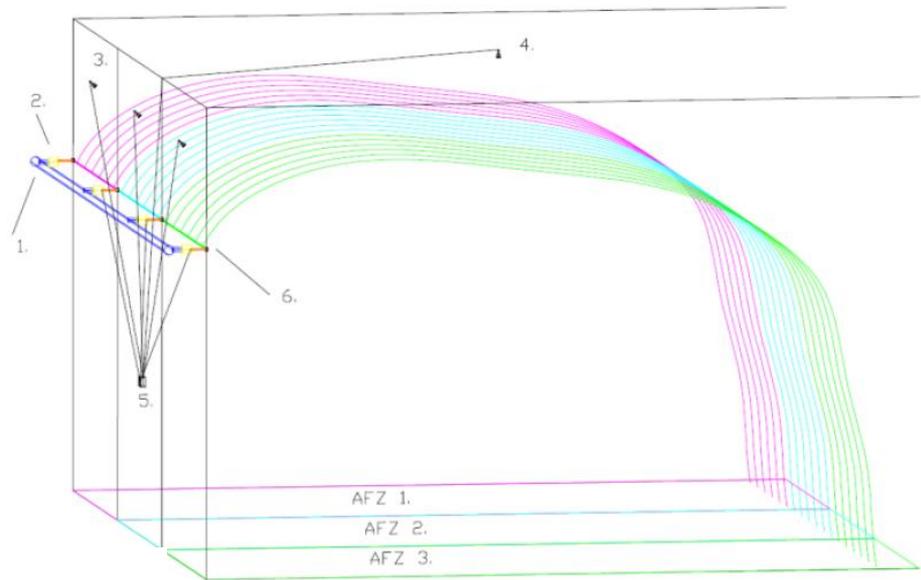
-Heated and unheated areas with natural ventilation.

-Ceiling painting not to be destroyed by installation or water spray

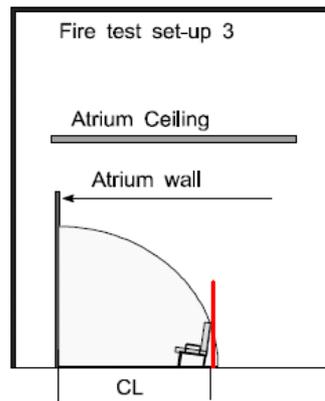
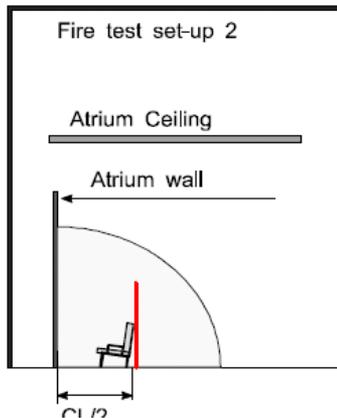
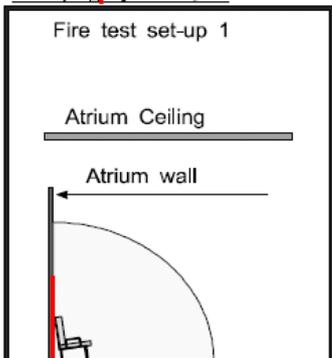
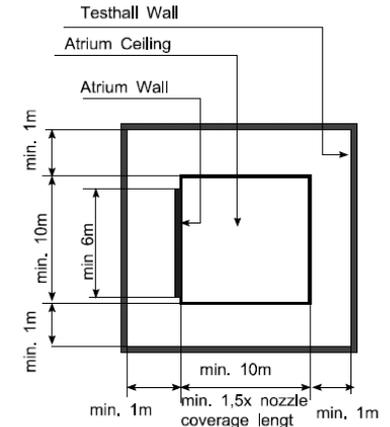
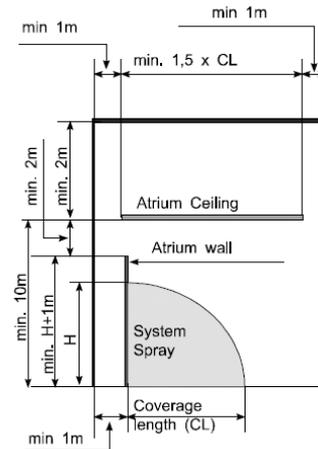
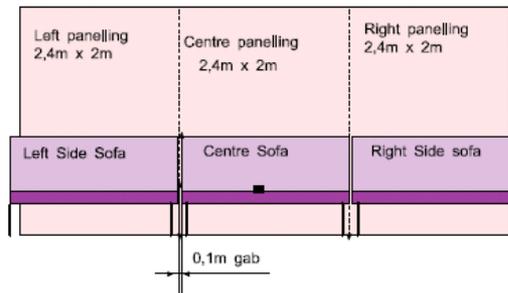
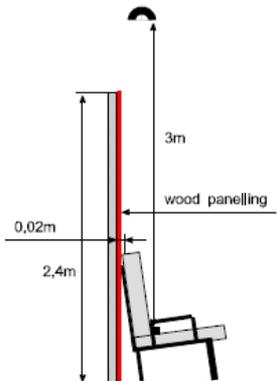
-Authority was fire brigade.

System chosen: SPECIAL WATERMIST SYSTEM tested to the application

Length (L):	unlimited
Height (H):	unlimited
Width (2xD) Type A	max. 16m
Type B	max. 20m
Type C	max. 26m
Nozzle wall height (B):	3,5m – 7m



Test scenarios from test method designed in accordance to CEN/TS 14972 Annex B.



Test 1:
No system



Test 2:
Sprinkler ref.
Test

5 l/min/m²
0,6 bar
3.7m spray



Test 3:
WM system:

2 l/min/m²
6 bar
10m spray



Scope:

Church main hall floor and wooden walls with no large obstructions hanging in the air and with main fuel load being wooden chairs, benches with upholstery.

Design limitations:

- Horizontal installed zoned deluge system activated with electrical detection system not being slower than 2 min from a 0.25MW fire.
- Installation height: 4 -7m
- Minimum zone size: 13m x Ym
- Minimum zones to activate: 3 (4)



Final proof – a test report and perhaps witness letter:

DFL Design Fire Laboratory

Fire test report no: 090204-31

Customer: VID Fire K&L, Trindebakvej 11, DK-1700 Sandbjerg, Denmark.

Project: Internal access road according to DFL standard No. 80738-010

Location of test: DFL, Dansk Fire Laboratorium, Trindebakvej 11, DK-1700 Sandbjerg, Denmark.

Operator DFL: Mr. Kenneth Christensen, Mr. Jørgen Svendsen, Mr. Egon Hansen, Mr. Thomas Lyndt Hansen and Mr. Steen Ahrhøj.

Date of testing: February 3 and 4 2009

Reference: VID Fire K&L did in February 2009 conduct a series of fire-entrapment tests in DFL, Dansk Fire Laboratorium, Sandbjerg, Denmark. The purpose of the tests was to test the fire-fighting effectiveness of the VID FIREKILL, Model 050-010, according to the DFL standard No. 80738-010.

The complete DFL test report 090204-31 can be downloaded on the website of the DFL standard No. 80738-010 with the PDF approved Global Hazardous Material, Model 050-010, Standard Response 010 (Appendix A).

Comparing the results from these tests with the VID Fire K&L Model 050-010 showed results that were as good as better than the Global Hazardous Material, Model 050-010, Standard Response 010, specifies.

The requirements to pass the DFL standard No. 80738-010 is listed in the table below.

Requirements of DFL, test standard No. 80738-010			
Test parameter	Minimum value in test	Minimum requirement	Minimum value passed in test
1. Alarm time	30 s	30 s	30 s (2009 test)
2. Alarm time	30 s	30 s	30 s (2009 test)
3. Alarm time	30 s	30 s	30 s (2009 test)
4. Alarm time	30 s	30 s	30 s (2009 test)
5. Alarm time	30 s	30 s	30 s (2009 test)
6. Alarm time	30 s	30 s	30 s (2009 test)

Test of internal access (SR-05) Page 1 of 14

DFL Design Fire Laboratory

DET NORSKE VERITAS
TO THORHEIM MAY CONCRETE

Manufacturer: VID Fire K&L ApS, Trindebakvej 11, DK-1700 Sandbjerg, Denmark.

Product: Automatic inside Model 050-010

Test of VID Fire K&L automatic inside Model 050-010
DFL Test Report No. 090204-31-2

The test was conducted by Dansk Fire Laboratorium (DFL) in three phases on February 3 and 4 2009. The laboratory is ISO 9001:2008 certified, with accreditation no. 0171.

The applied test standard was DFL test standard No. 80738-010 ver. 090204-31, approved as accordance with EN 14725, Annex B.

All test equipment for test set up, test results, monitoring equipment and extension of the test were as described in the test report.

Reference to DFL test report no. 090204-31, the Model 050-010 inside complied with all the required approval requirements regarding temperature and design criteria.

Det Norske Veritas
DANSK BRANDEKONTROL
DANSK BRANDTEKNIK

Page 1 of 14

5. Some Watermist Benefits and Limitations.

Benefits

- Optimization of water use which gives many other benefits such as smaller reservoirs, less water damage, smaller system dimensions, etc.
- Possibility to create "special" products for the industry which otherwise could not be accepted and used.
- Good fire performance which is proven in actual fire tests.
- Safety factor inbuilt for fires in enclosures – the larger the fire the better the system perform.

Limitations

- Can only be used in applications and scenarios where realistic tested and where approved to.
- More caution is needed when treating the systems as less experience is available.
- Knowledge on test standards, design codes, and system design manuals are needed to work with watermist therefore more time is required to use watermist.

Thank you for your attention.

The full presentation including videos can be requested on sales@vidaps.dk