

# Contribution of Research in Product Testing and Safety Design in Buildings



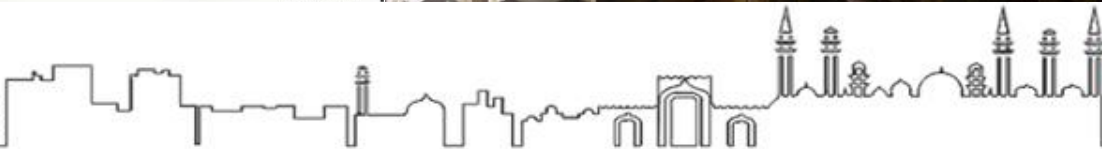
Approval Standard

Water Mist Systems

Class Number 5560  
May 2005



Safety Design in Buildings



Intersec Conference

DWTC Dubai Tuesday, January 20, 2014

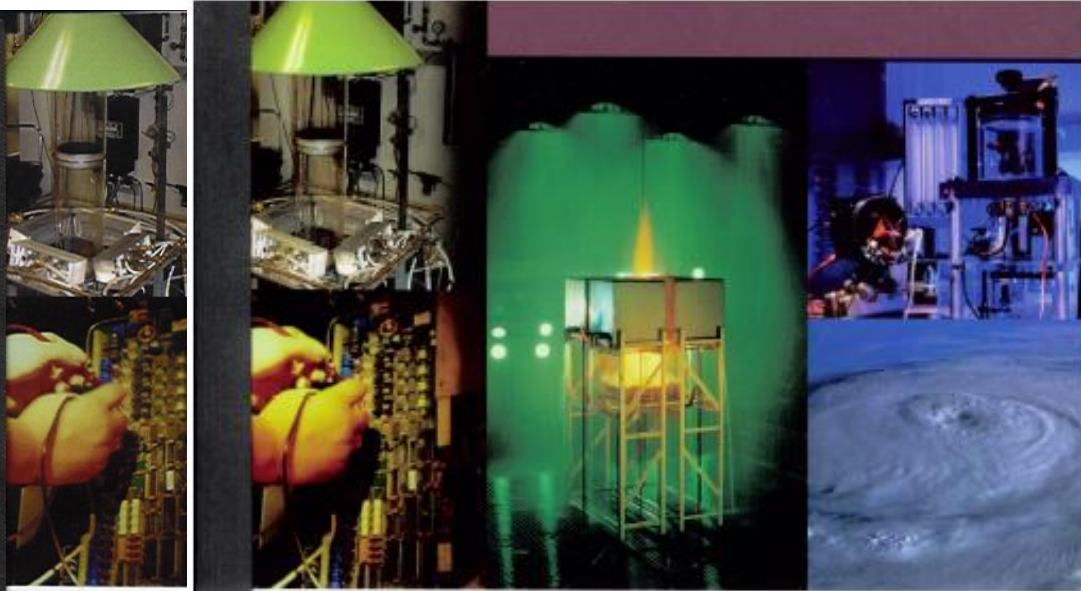


Since 1897 the FM Approvals' Certification Mark is recognized and accepted in markets throughout the world

FM Approvals approves and certifies products and services with unique focus on:

- Objectively testing property loss prevention products and services and certifying those that meet rigorous loss prevention standards;  
**FOCUSED TESTING AND CERTIFICATION**
- Encouraging the development and use of Approved products and services that improve and advance property loss prevention practices.  
**DEPTH OF KNOWLEDGE**

# Write Product Testing Standard



## Approval Standard

Water Mist Systems

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- Over 210 standards
- Based on Research
- Publicly Available for free through [www.fmapprovals.com](http://www.fmapprovals.com)
- ANSI , OSHA, ASTM, BSI, EN, GB Recognized

- Sprinkler System Equipment, General
- Deluge Sprinkler Systems
- Pre-Action Sprinkler Systems
- Refrigerated Area Sprinkler Systems
- Limited Water Supply Deluge Sprinkler Systems
- Temporary Automatic Sprinkler Systems
- Automatic On-Off Multicycle Sprinkler Systems
- Automatic Water Control Valves
- Dry Pipe Valves
- Thermal Control Valves
- Accelerators with Built-In Anti-Flooding Device
- Accelerators & Exhausters
- Air Pressure Maintenance Devices
- Anti-Flooding Device
- Air Drying Units for Refrigerated Area and Dry Pipe Systems
- Excess Pressure Pumps
- Waterflow Detector & Excess Pressure Maintenance Device
- Alarm Check Valves
- Waterflow Detectors (Vane Type)
- Testers for Vane Type Waterflow Indicators
- Fire Service Meters
- Waterflow Detector Check Valves
- Fire Pump Flowmeters
- Automatic Drip Valves
- Water Motor Gongs
- Sight Drains
- Sprinkler Contractors, General and Misc. Mfrs.
- Indicator Posts
- Indicator Post Valve Assembly
- Indicating Valves
- RIMO-Remote Indicating, Manually Operated Sprinkler Control Valves
- OS&Y and NRS Gate Valves
- Valves, General and Specifications
- Valves (Quick Open Type), Ball Valves
- NOVA-Normally Open Constant Energy to Close Valve Assembly
- Single Check Valves
- All Bronze Check Valves
- Backflow Preventers - Reduced Pressure Principle Type
- Anti-Water Hammer Check Valves
- ½ through 1-1/4 in. Trim Check Valves
- Centrifugal Fire Pumps, Horizontal Split-Case
- Centrifugal Fire Pumps, Vertical Shaft, Turbine Type
- Positive Displacement Fire Pumps (Rotary Gear Type)
- Limited Service Fire Pumps
- Fire Pump Units - Gasoline Engine Driven
- Fire Pump Units - Portable
- Jockey Pumps
- Centrifugal Fire Pumps, End Suction Type
- Control Panels For Fire Pumps
- Fire Pump Controllers for Electric Motor Drive
- Fire Pump Controller Circuit Breakers
- Fire Pump Controllers for Diesel Engine Drive
- Battery Chargers for Fire Pump Service
- Batteries for Internal Combustion Engines
- Diesel Engines for Fire Pump Drive
- Gasoline Engines
- Gas Turbine Engines for Fire Pump Drive
- Pump Drive Couplings
- Right Angle Gear Drives
- Replacement Rubber Discs for Steam Fire Pumps
- Air Release Valves
- Trim Water Pressure Relief Valves ¼ inch through 2 ½ Inch Nominal Size
- Water Pressure Relief Valves
- Water Pressure Reducing Valves
- Water Pressure Regulating Valves
- Surge Dampers (Fire Pumps)
- Vortex Inhibitors for Fire Pump Suction Lines
- Centrifugal Fire Pumps, Vertical Turbine Barrel Type
- Centrifugal Fire Pumps, In-Line
- Underwriter Playpipes
- Short Playpipes
- Monitor Nozzles
- Hydrants (Dry Barrel Type) for Private Fire Service
- Fire Hydrants (Wet Barrel Type) for Private Fire Service
- Hose Manifolds
- Hose Valves
- Angle Hose Valves
- Straightway Hose Valves
- Hydrant Valves, Bolted Type
- Hose Station Control Valves
- Fire Department Connections
- Wall Hydrants
- Pipe & Fittings & Couplings, Underground, Ductile Iron
- Pipe & Fittings, Underground, Asbestos-Cement (AC)
- Pipe & Fittings, Underground, Polyvinyl Chloride (PVC)
- Pipe & Fittings, Underground, Polyethylene (PE)
- Pipe & Fittings, Underground, Fiber-Reinforced Composite (FRP)

- Mildew-Proofed
- Friction Loss
- Approved Hose - Mfd. Under Different Trade Names
- Chemical Engine Hose
- Woven Jacket Lined Fire Hose
- Unlined Linen Fire Hose
- Hose Couplings
- Hose Racks and Reels
- Hose Houses & Cabinets
- Padlocks for Hose Houses
- Air, Steam, & Water Type Gauges
- Circular & Strip Chart Pressure Recorders
- Flood Water Barriers
- Fire Alarm Systems (Heat, Smoke, Manually, Electrically Actuated)
- In-Combination
- Central Station (S) - Fire Alarm Systems
- Proprietary Stand-Alone Fire Alarm Attendance
- Local
- Auxiliary Supervised
- Public Alarm Systems
- Alarm Signaling System
- Supervisory Signal Systems - Sprinkler Service
- Watchman Supervisory Systems
- Central Station Service - Burglar Alarms
- Central Station Alarm Systems
- Remote Watchman
- Fire Alarm Boxes
- Supervisory Control Panels
- Signaling Transmitters
- In-Plant Signaling Transmitters
- Temperature Actuated Transmitters
- Tank Water Level Actuated (Water Level Transmitters)
- Alarm Valve Transmitters (Clapper Actuated)
- Signaling Valve Transmitters
- Signaling Switches
- Liquid Level Switches
- Water Pressure Actuated Switches
- All Pressure Actuated Switches
- Sprinkler Tank Temperature Warnings
- Sprinkler Valve Position Warnings
- Process Control Valve, Supervisory Switches
- Alarm Valve Switches (Clapper Actuated)
- Annunciations
- Alarm Signaling - Recorded Telephone Messages
- Alarm Communication Systems
- Coded Radio Signaling Systems
- Audible Signal Appliances
- Burglar Inhibit Systems
- Hermetical Protection
- Fixed Temperature Thermostats
- Combination Fixed Temperature & Rate-of-Rise Thermostats
- Radiation Thermopile Thermostats
- Back-Exhaust Thermostats
- Infrared Thermopile Thermostats
- Expandable Gas (Rate-of-Rise) - Expandable Liquid Thermostats
- Smoke Detectors - Photoelectric and Ion
- Airborne Particle Meter for Detector Calibration
- Aerosol Detector
- Smoke Detector Gas Sampling
- Flame Radiation - U.V. and I.R.
- Electrically Operated
- Inertial Collectors
- Photoelectric Detectors
- Hazardous Collectors
- Anti-Static Material
- Permanent & Electro Magnet
- Switching Gas Flow - Vent Pressure Safety for Combustion Controls
- Switching Infrared Gas Sampling
- Time Delay Switches
- Fire-Pumps or Combustion-Control Circuit Switches
- Combustion Control Circuit Switches
- Combustion Control Circuit Switches
- Temperature Limit and Supervisory Switches
- Liquid Level (Limit) Switches
- Disconnect Switch for Vehicles
- Safety Air-Flow Switches
- Safety Air-Flow Switches - Air-Flow Electric
- Deflection Monitoring Device (DMD)
- Non-electrical equipment certified under European Directive 94/9/EC (ATEX)
- Communication Equipment Repair Service
- Repair of Hazardous (Classification) Location Equipment
- Intrinsically Safe Equipment - Class 1, Class II, Class III, Div. 1
- Electric Equipment - Class 1, Div. 2 - Non-Incendive
- Encapsulation for Division 1
- Electric Flashlights and Lanterns for use in Class I, Division 2, Zone
- 2

- Roof Coverings (Including Hail Damage)
- Standing Seam Roofs
- Specification Test Protocol for Impact Resistance Testing of Rigid Roofing Materials by Impacting with Freezer Ice Balls
- American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures
- Class 1 Steep Slope Roof Coverings
- Spray Foam Insulated Steel Roof Deck
- Roof Contractor Services
- Lightweight Insulating Concrete Roof Deck Contractors
- Fire Endurance Tests
- Gypsum Wallboard Manufacturers
- FM Rated Wall and Partition Assemblies
- Acoustical Office Dividers and Partitions
- Floor/Ceiling Fire Endurance Tests
- Roof/Ceiling Fire-Endurance Tests
- FM Rated Floor/Roof and Ceiling Assemblies
- Suspended Ceilings
- Plastic Ceiling Panels
- Beam and Joist Fire Endurance Tests
- Non-Rated Beam Assemblies
- Building Column Fire Endurance Tests
- FM Rated Column Assemblies
- Fire-Resistant Glazing
- ISO 9001:2015 Factory Mutual Tests for Manufacturers
- ASTM-E-136 Testing - Factory Mutual Tests for Manufacturers
- Laboratory Research - FM, UL, SWRI
- FM Construction Materials Calorimeter
- Smoke Density and Toxicity
- Floor Coverings
- FM Wall/Ceiling Channel Tests
- Class 1 Insulated Wall or Wall & Roof/Ceiling Panels, Plastic Interior
- Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior or \*Exterior Finish Systems
- Exterior Wall Systems
- Class 1 Interior Wall Panels in Smoke Sensitive Occupancies
- Insulation, Exposed Interior
- Poured-In Insulation
- Treated Cellulose - Loose Fill
- Insulation Mineral
- Insulation Foam - Plastic
- Packaging - Materials
- Furnishings
- Third Party Certifications
- Material Explosion Characteristics
- Clean Room Materials Flammability Test Protocol
- Water Carriers for Use in Cleanrooms
- Fireproofing - Lumes
- A - Fireproofing Collectors, Exhaust Cleaners, Kitchen Hoods
- Ducts, Plastic and Glass Fiber
- Filters for Compressed Gas
- Pipe Insulation
- Air Compressors
- Chimney Liners
- Cooling Towers
- Storage Tank Exterior Insulation
- Storage Tank Insulating Roof
- Chain and Cable Equipment
- Work Operations
- Fire Retardant Treated Products (Other than Lumber)
- Battery Blankets
- Incinerators
- FM High Temperature Furnace Tests, General
- Fireproofing of Steel, High Hazards
- LPG Tank Fireproofing, Coatings
- Fire Retardant Paints and Coatings
- Insulating Materials
- EPS Insulation
- Doorway Spill Barriers
- Penetration Seal & Fire Stop
- Fire Stop Contractors
- Extension/Seismic Joint Systems
- Plastic Pallets and Totes
- Classification of Idle Plastic Pallets as Equivalent to Wood Pallets
- Conveyor Belts
- Spray Coatings
- Pump Tanks
- Anti-Freeze Extinguishers
- Water-Filled Extinguishers
- Wet Chemical Portable Fire Extinguisher - Class K - Rating
- Soda-Acid Extinguishers
- Conversion Equipment
- Pressure Gauges - Water and Foam
- Chemical Foam, Portable
- Air-Foam
- Foam Charges
- Chemical-Foam Generators

- Fusible closures for steel drums
- Bonding and Grounding Connections
- Flexible Couplings for Liquids other than Fuel Oil Systems
- Fuel/Water Separators
- Fire Resistive or Flameproofed
- Waterproofed (Waterproof Covers)
- Welding Cloth
- Portable Gas Indicators
- Fixed Gas Indicating Systems
- Performance Requirements for Open Path Gas Monitors
- Alarm or Limit Control Systems
- Low Concentration (PPM) Gas Analyzers
- H2S (Hydrogen Sulfide) Detectors
- NH3 (Ammonia) Detectors
- CO (carbon Monoxide) Detectors
- O2 (Oxygen) Detectors
- Household Fuel Gas Detectors
- Halon & Carbon Dioxide Concentration Measuring Device
- Cleaning Compound for Spray Booths
- Drum Racks
- Drum Lifters
- Hydrogen Peroxide Storage Tanks
- Floating Manhole Covers for Hydrogen Peroxide Storage Tanks
- Oily Waste Cans and Refuse
- Containers for Combustible Waste
- Oil Absorbent Compounds
- Less Flammable Hydraulic Fluids
- Quench Fluids
- Heat Transfer Fluids
- Transformer Fluids
- Transformer Fluids, Less Flammable
- Industrial Fluids, Non Flammable, Specification Tested
- Fire Retardant Paints
- Fire Retardant Treated Paper
- Insecticides and Mothproofing
- Paint Spray Gun Cleaning Station
- Web Press Automatic Blanket Cleaner
- Safety Solvents
- Finishing Materials
- Flux Applicator
- Surface Active) Agents
- Fire Equipment Location and Identification Markers
- Illuminated Exit Signs
- Pipe Soldering Heaters - Chemical
- Couplings for Pneumatic Conveying Systems
- Aerosol Flammability Testing
- Sterilizers, ETO Type
- Acetylene Generators
- Portable Type
- Control Unit
- Gas Generators (Other than Acetylene)
- MAPP Industrial Gas
- Regulators, Compressed Gas
- Torches
- Hydraulic Flame Arresters
- Dry Type Flame Arresters (Restricted Use)
- Station Outlet Valves
- Reels for Gas Hose
- Oxygen Separators, Line Filters
- Gas Fluxers
- Powder Dispensers
- Manifolds for Compressed Gases
- Flammable Gas Generators
- Gas Manifolds - Gases Other Than Acetylene, Stationary and Portable
- Enclosures for Aerosol Filling Equipment Using Flammable Gas
- Propellants
- Propane and Butane Fuel Systems
- LP-Gas Vaporizers
- LP-Gas Tank Relief Valves
- LP-Gas Tank Gauges
- LP-Gas Vaporizer/Mixer
- LP-Gas Mixer
- LP-Gas Breakaway Couplings
- Compressed Gas Handling Equipment Cylinder Valve Protector
- Liquid Natural Gas Equipment
- Airless Spray Equipment
- Tire Spray Machines
- Spray Booths, Water Wash Type
- Powder Coating Booths
- Continuous Spray Coater
- Combination Spray Booth and Oven
- Spray Booth Ventilating Fans
- Spray Material Containers
- Paint and Lacquer Mixers
- Paint Filters, Overspray Collectors
- Paint and Lacquer Heaters
- Electrostatic Finishing Equipment
- Electrostatic Spray Equipment - Hand Operated Atomizers

# Sprinklers

# Fire Pump Assemblies

# Flood Mitigation Products

# Roofing

# Valves

# Walls and Ceilings

# Couplings

# Fire Floors and Frames

# Water Mist Systems

# Hazardous Locations Equipment

# Pallets and Totes

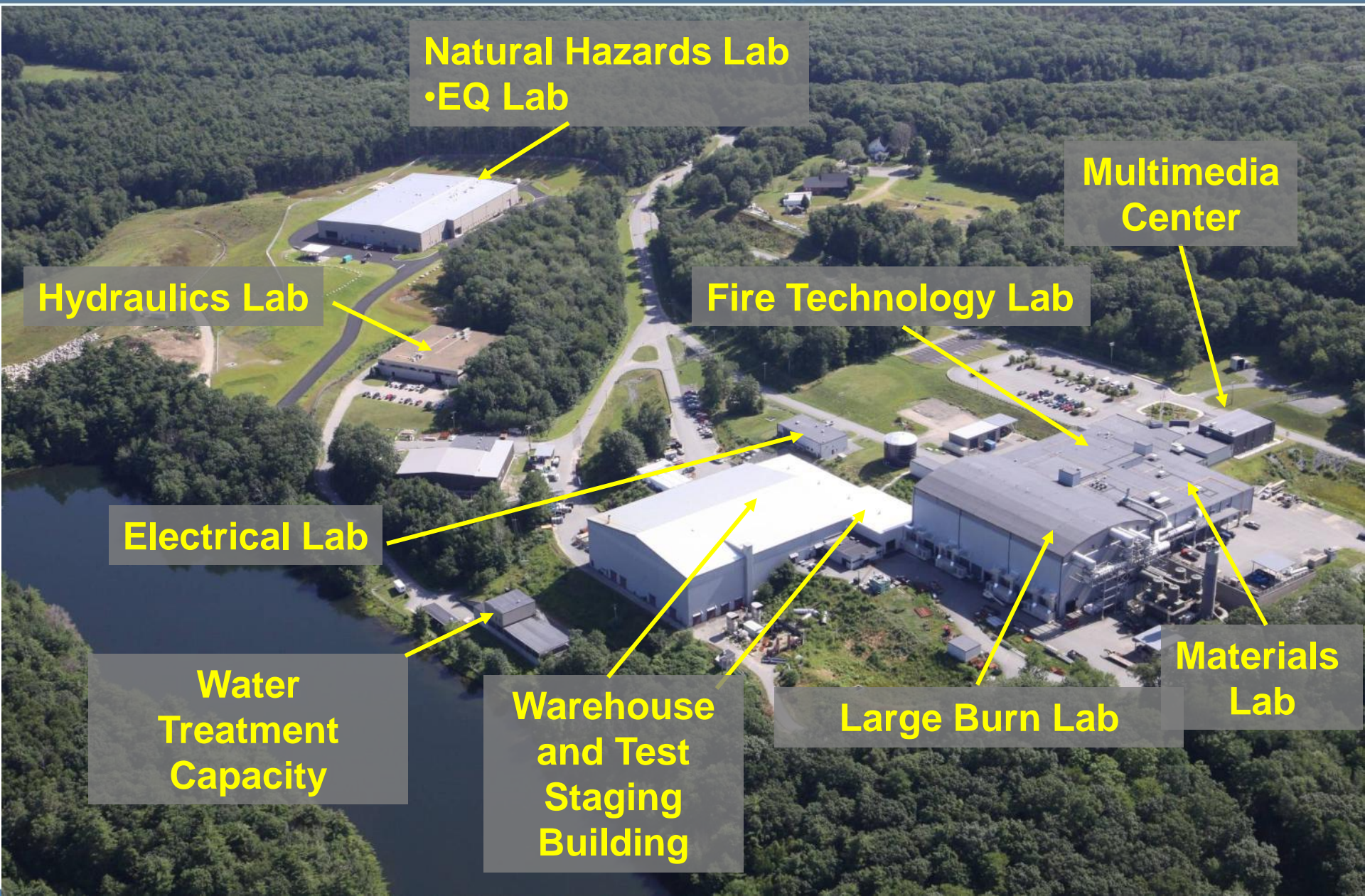
# Detection and Alarms

# Cleanroom Materials

# Gaseous Extinguishment Systems



# Research and Testing Campus



**Natural Hazards Lab**  
•EQ Lab

**Multimedia Center**

**Hydraulics Lab**

**Fire Technology Lab**

**Electrical Lab**

**Materials Lab**

**Water Treatment Capacity**

**Warehouse and Test Staging Building**

**Large Burn Lab**

FM Approvals approves and certifies products and services with unique focus on:

- Objectively testing property loss prevention products and services and certifying those that meet rigorous loss prevention standards;  
**FOCUSED TESTING AND CERTIFICATION**
- Encouraging the development and use of Approved products and services that improve and advance property loss prevention practices.  
**DEPTH OF KNOWLEDGE**

**97 Scientists, Engineers  
and Technicians**

**Fully Funded Internally!**

**Focused Research!**



# Why Invest in Research?

**To develop new knowledge for property loss prevention that finds its way in our product testing standards.**

**To utilize new knowledge in standards in order to reduce the cost and cycle time to the manufacturing industry while maintaining technical integrity.**

**To significantly increase the number of FM Approved products, thus making our working environment a safer place.**

# Well Traveled Journey of R & D.....



Roman  
Abacus  
300 BCE



Ant  
me  
150



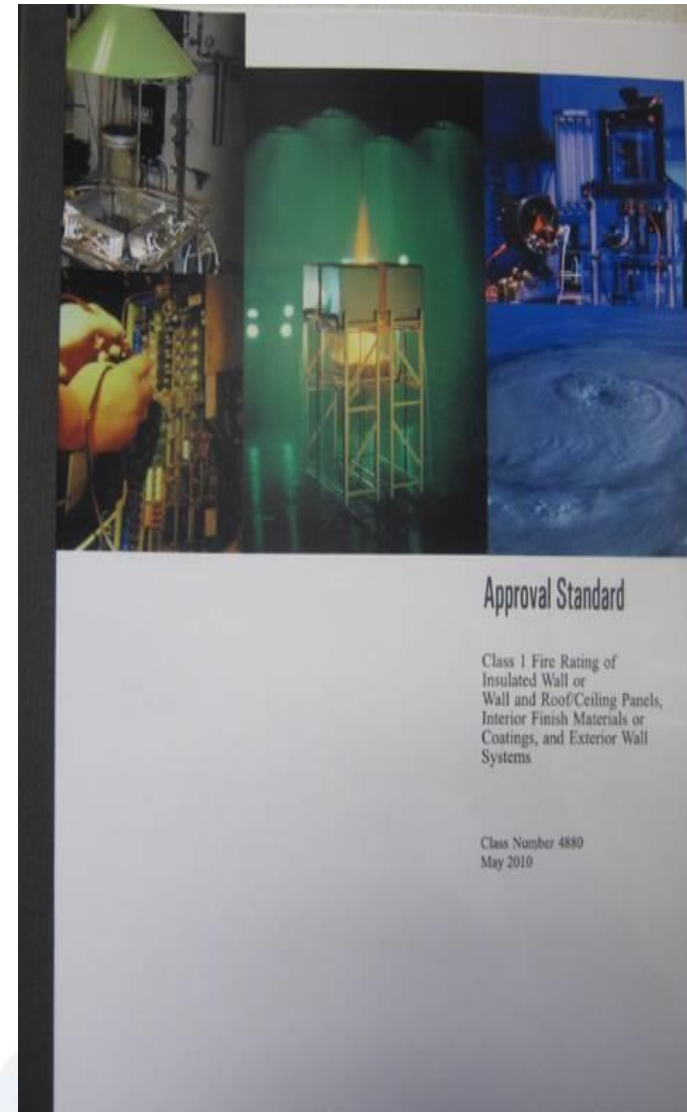
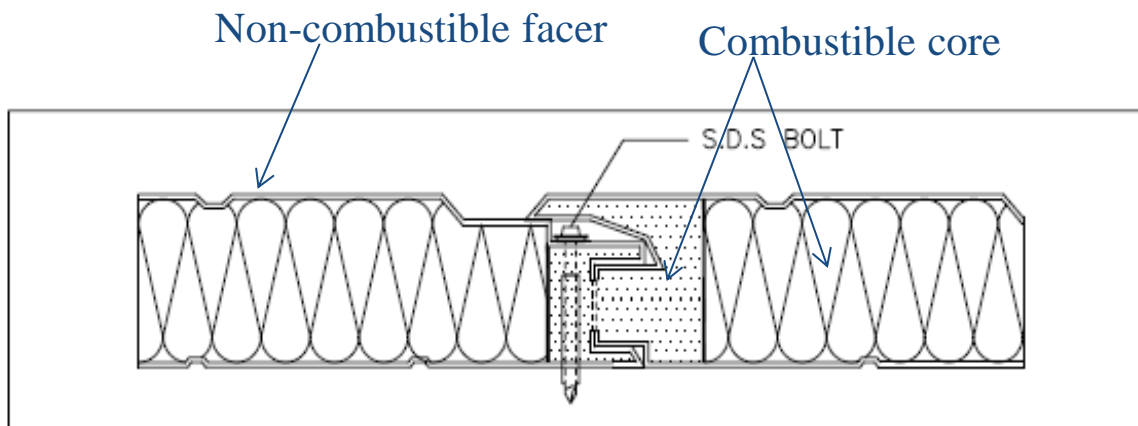
**Over 2000 year Journey**

- **Passive Fire Protection - Wall and Ceiling testing**
- **Active Fire Protection - Water Mist Applications**

# Wall Panel Certification

## FM 4880 - Class 1 walls and ceilings

Do not need automatic sprinkler system to protect the building envelope.



# Wall Panel Certification

## 1973 – 1989 Walls certified only up to 30 ft (9.1 m)

- Had to pass the 25 ft (7.6 m) full scale fire test
- Success criteria: Fire does not spread to any extremities of structure in 15 minutes



# Wall Panel Certification

## 1987 – 1994 Wall certification extended for unlimited height

- Had to pass the 25 ft (7.6 m) full scale fire test
- Then had to run 50 ft (15.2 m) full scale test
- Success criteria:
  - If fire spreads to the ceiling, approval for 50ft only
  - If fire does not spread to ceiling, unlimited height

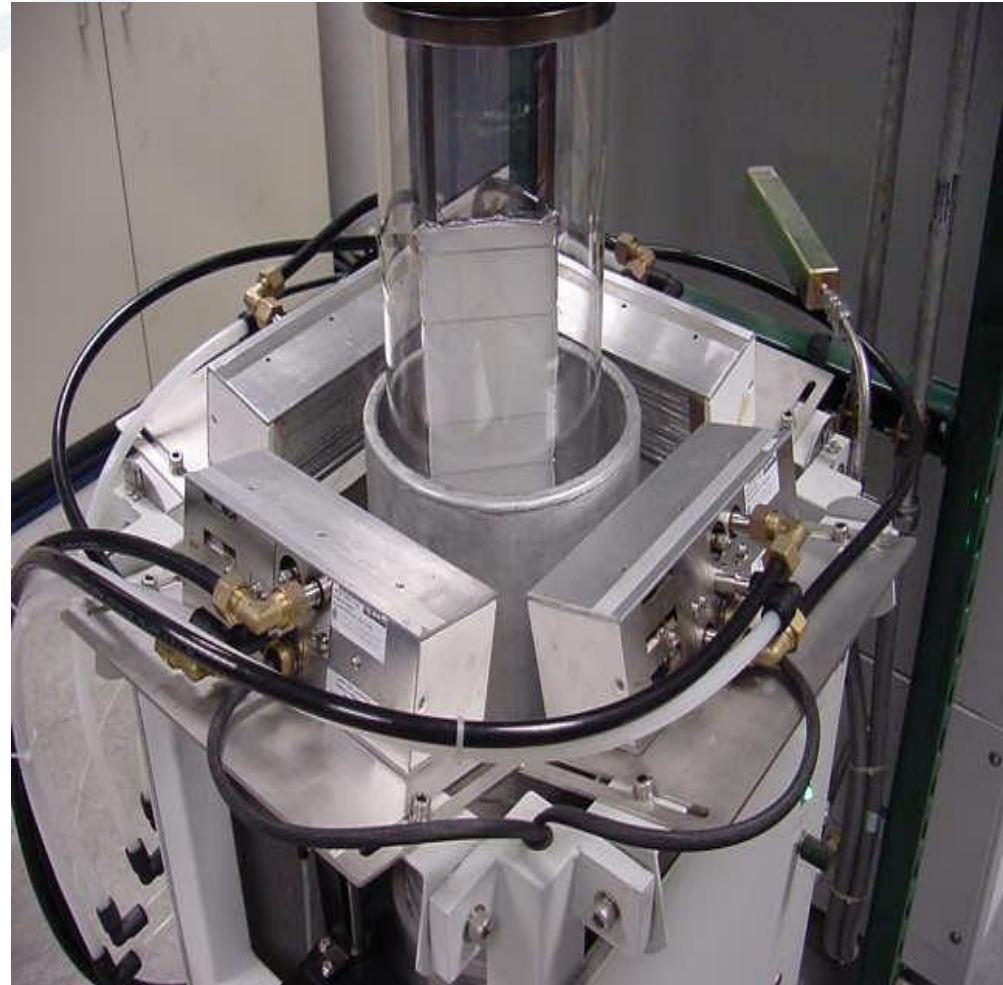


# Wall Panel Certification

## 1994 Introduced: Fire Propagation Apparatus (FPA) (ASTM E2058)

- ❑ Screening test using 10cm x 40cm sample
- ❑ Easy, fast, accurate and inexpensive to run tests

1994 – Introduced Room  
Test ISO 17025



# Wall Panel Certification



## Up to 30 ft (9.1 m) height

**1973 – 1994**

- ~~• 25 ft (7.6m) full scale test~~
- Cost of \$140,000

**1994 – present**

- 10cm x 40cm sample in FPA
- ISO room test
- Cost of \$45,000

## Unlimited height

**1989 – 1994**

- ~~• 25 ft (7.6m) full scale test~~
- 50 ft (15.6m) full scale test
- Cost of \$280,000

**1994 – 2009**

- 10cm x 40cm sample in FPA
- ISO room test
- 50 ft (15.6m) full scale test
- Cost of \$180,000



In late 1990s begun research activities to attempt to:

- Eliminate 50 ft full scale corner test relying on empirical correlations (not expert opinion) between **parallel panel (ANSI FM 4910)** experimental data and actual full scale 50 ft corner test data
- Introduce natural hazards testing such as weathering, hail, wind, windblown debris and corrosion

# Parallel Panel Test – ANSI FM 4910



**Success**



# Wall Panel Certification



## Up to 30 ft (9.1 m) height

**1973 – 1994**

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- ISO room test
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- Cost of \$180,000

# Wall Panel Certification



Up to 30 ft (9.1 m) height

**\$140,000**

- FPA
- ISO room test
- Cost of \$45,000

Unlimited height

**\$280,000**

- FPA
- ISO room test
- Parallel panel test
- Cost of \$75,000

- **No Full Scale Fire Tests due to correlation of large scale to small and intermediate scale data!**
- Reduction in FM Approvals cycle time from over a year to 3 - 4 months
- Reduction time to manufacturer is significant in the development phase due to the availability of screening tests.

# Wall Panel Certification



Up to 30 ft (9.1 m) height

**\$140,000**

- FPA
- ISO room test
- Cost of \$45,000

Unlimited height

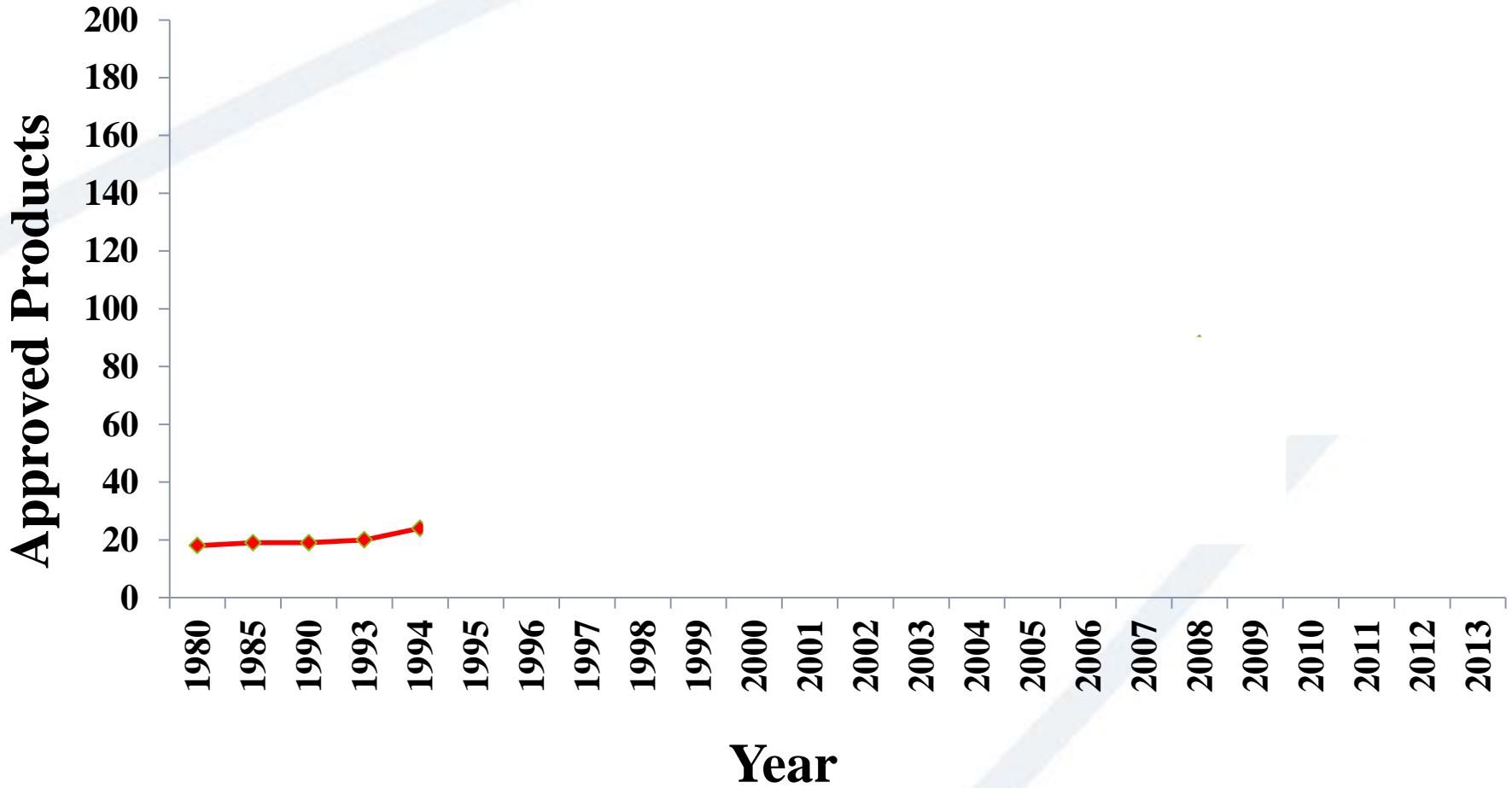
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- ISO room test
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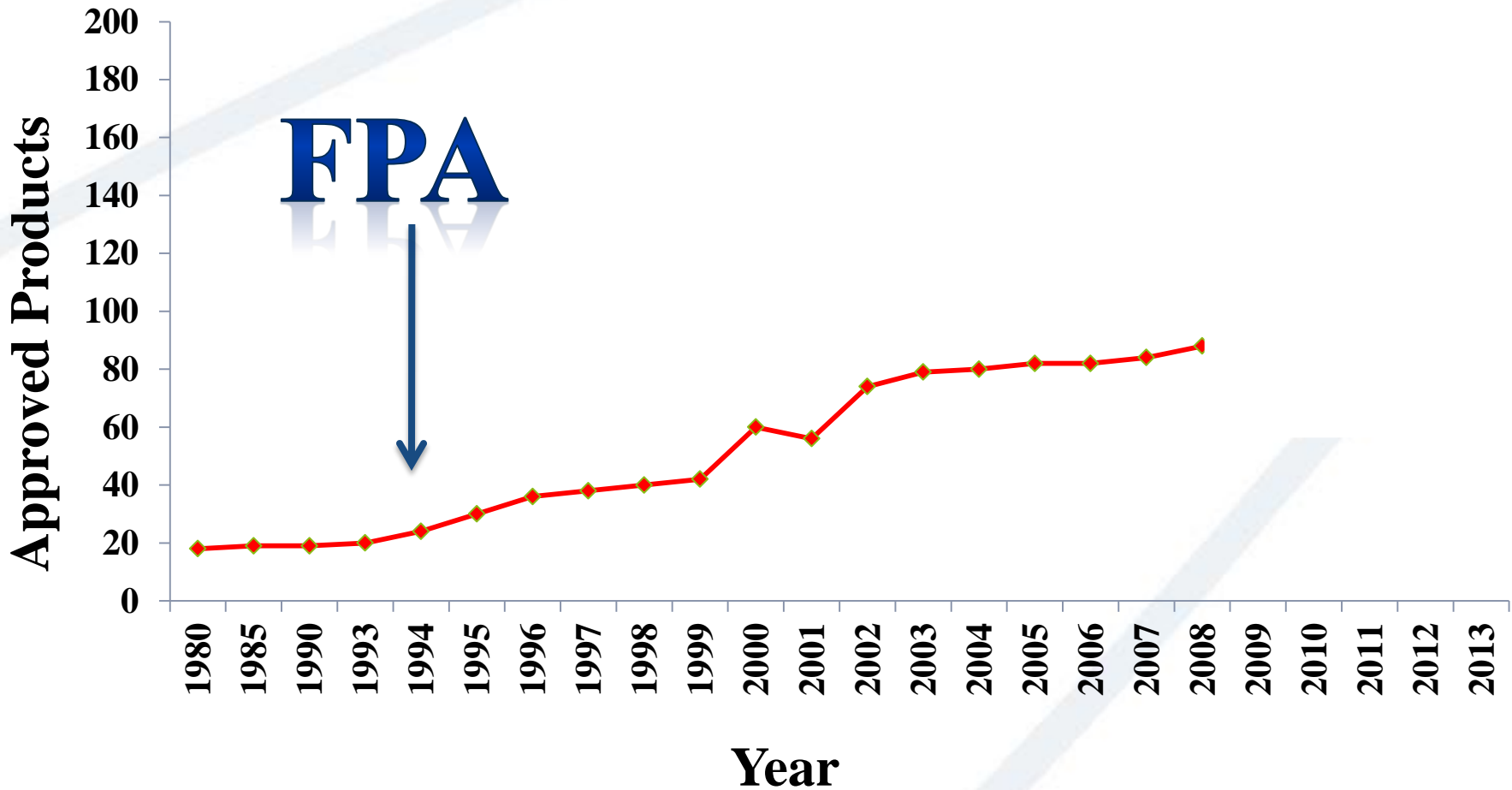
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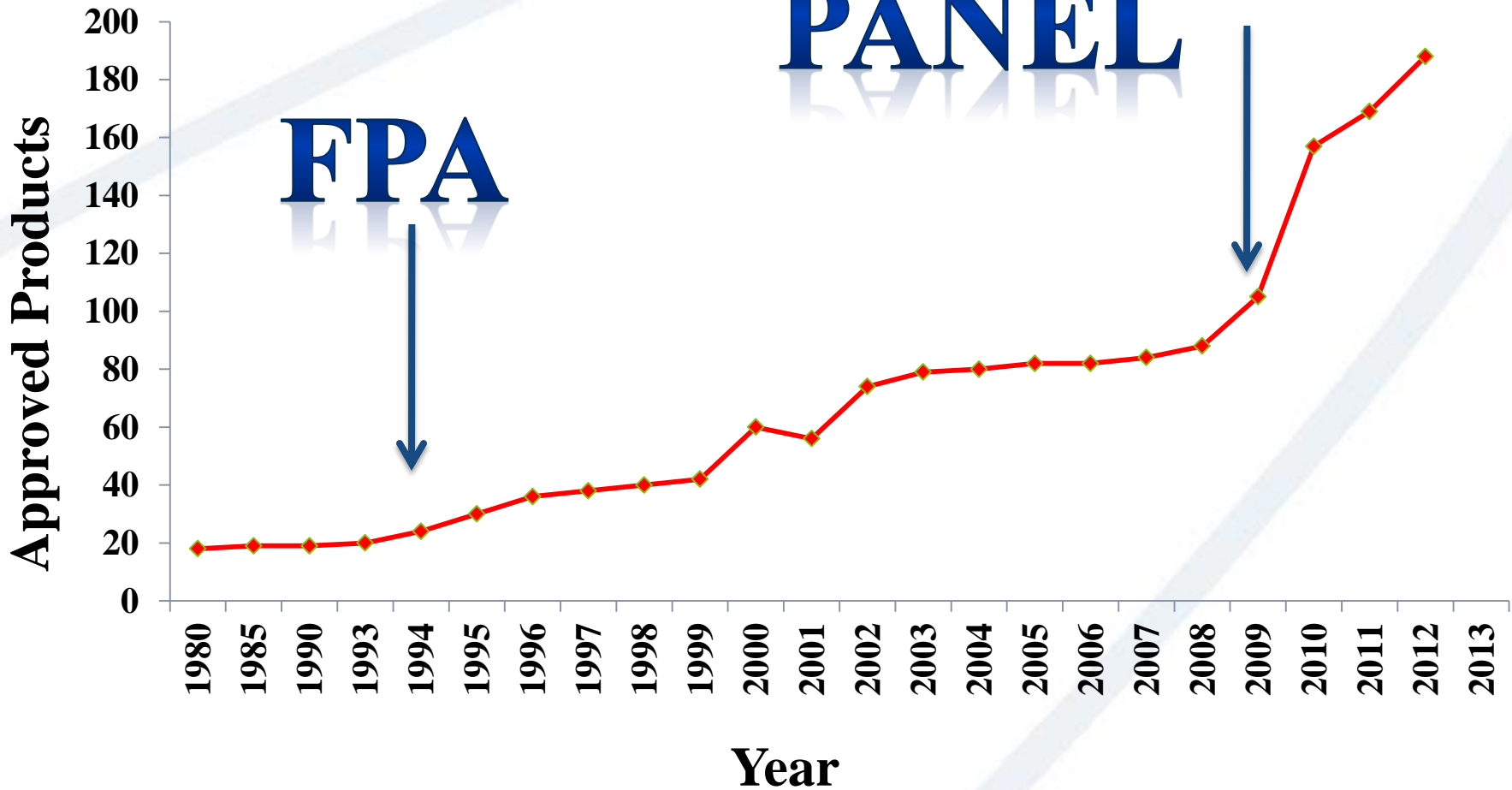
# Wall Panel Certification



# Wall Panel Certification



## PARALLEL PANEL



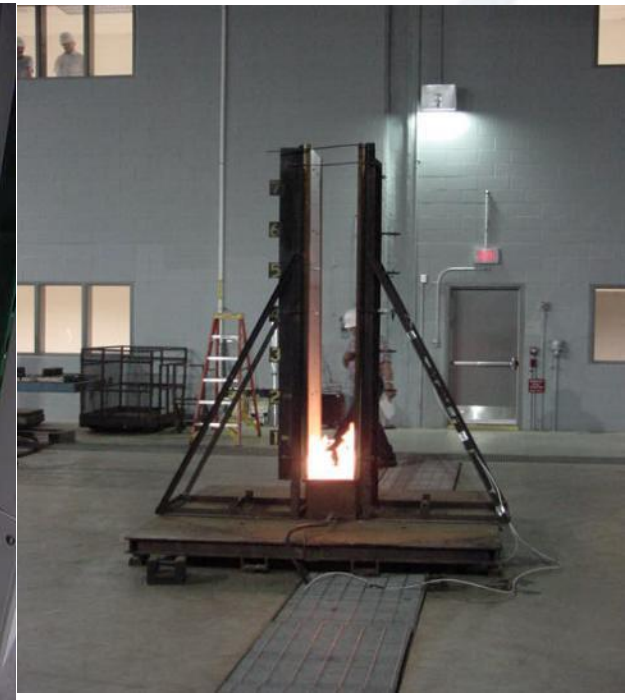
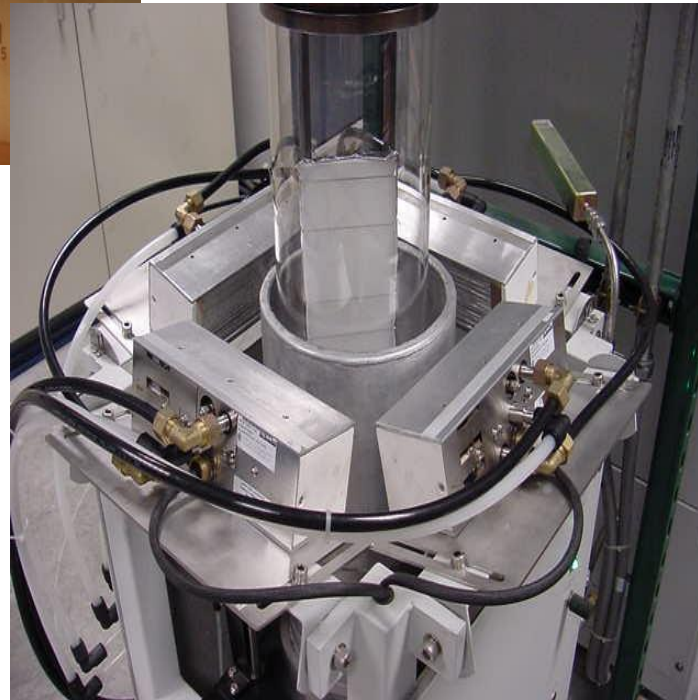


# Well Traveled Journey of R & D.....

**41 year journey**



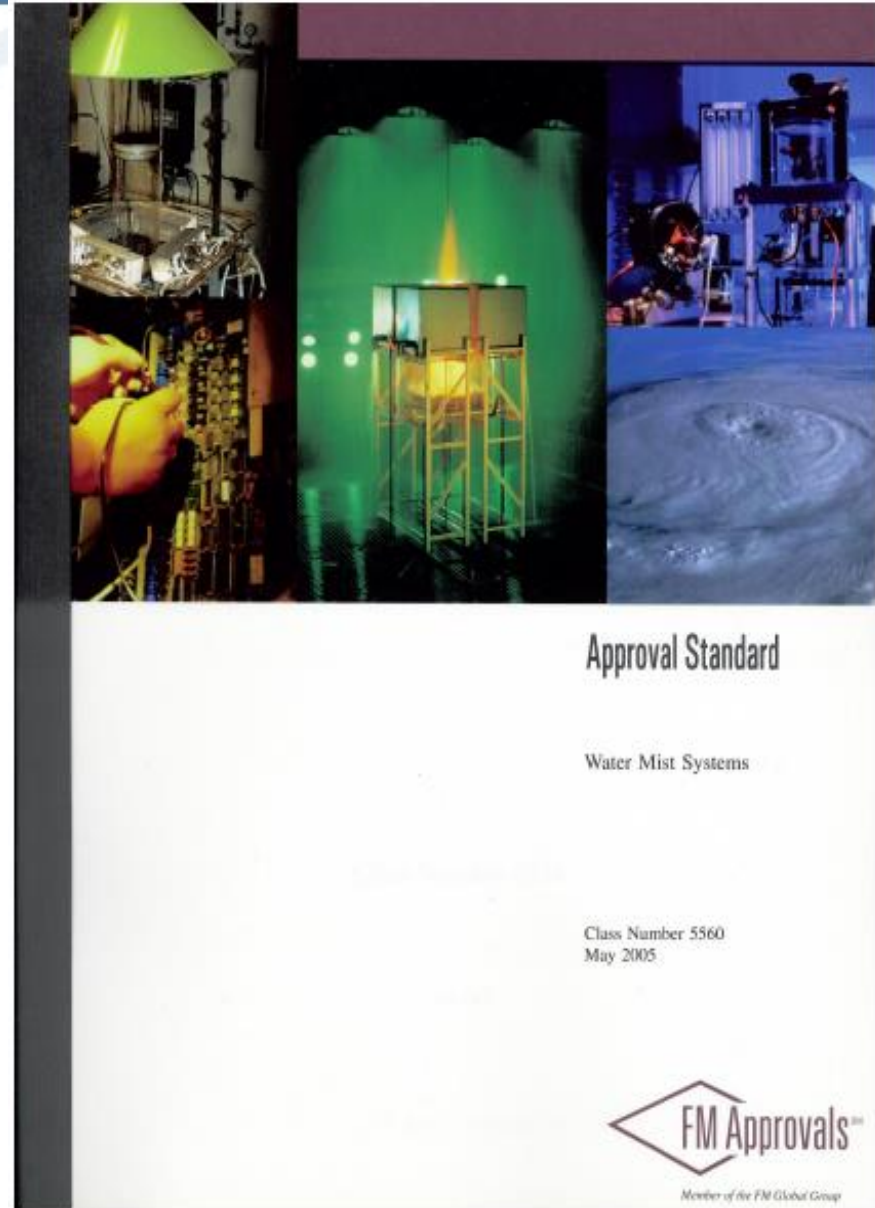
**Full Scale  
Mechanism  
1973 CE**



# Water Mist Systems Certification



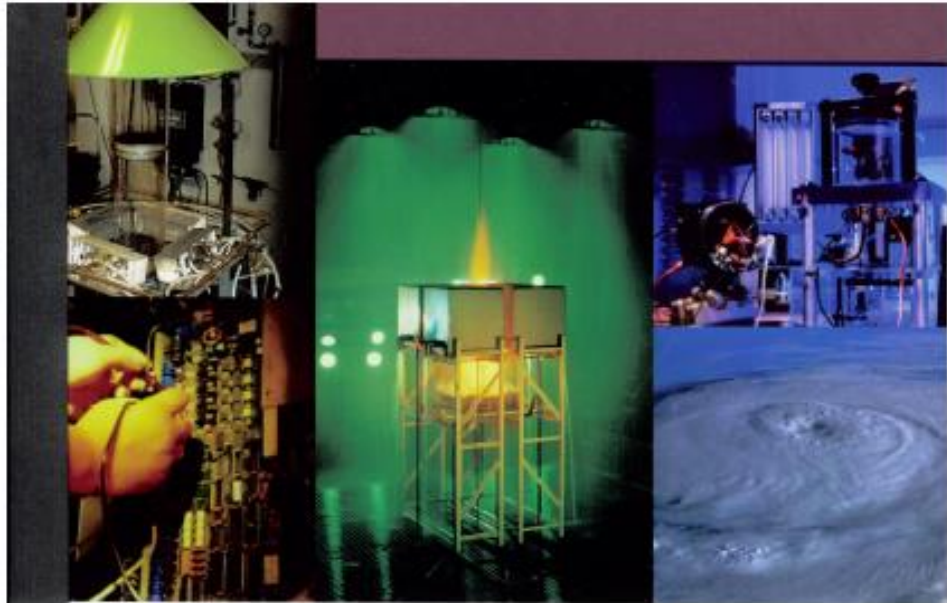
- First Application in 1995
- ANSI/FM 5560
- Continuously update standard with new applications
- All applications full scale tested
- Cost of one application about \$130,000 (total flooding)



# Water Mist Certified Applications

## CURRENT APPLICATIONS

- **Chemical Fume Hoods**
- **Combustion Turbines in Enclosures**
  - Volumes Not Exceeding 2825 ft<sup>3</sup> (80 m<sup>3</sup>)
  - Volumes Not Exceeding 9175 ft<sup>3</sup> (260 m<sup>3</sup>)
  - Volumes Exceeding 9175 ft<sup>3</sup> (260 m<sup>3</sup>)
- **Computer Room Raised / Sub Floors**
- **Continuous Wood Board Presses**
  - Industrial Oil Cookers
  - Local Application
- **Machinery in Enclosures**
  - Volumes Not Exceeding 2825 ft<sup>3</sup> (80 m<sup>3</sup>)
  - Volumes Not Exceeding 9175 ft<sup>3</sup> (260 m<sup>3</sup>)
  - Volumes Exceeding 9175 ft<sup>3</sup> (260 m<sup>3</sup>)
- **Non-Storage Occupancies , Hazard Category 1 (HC-1) [Formerly Designated As Light Hazard Occupancies]**
- **Wet Benches and Other Similar Processing Equipment**

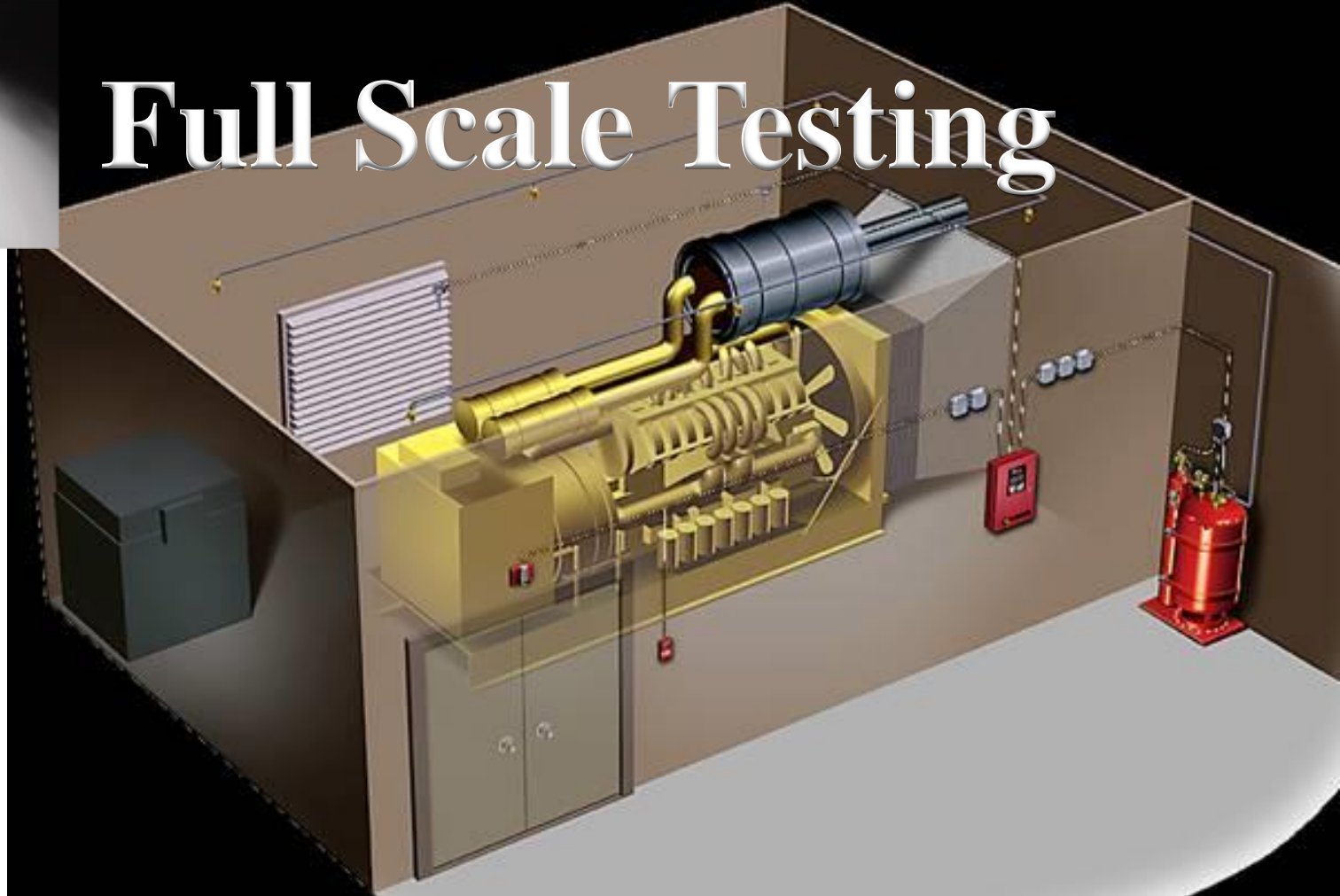


Approval Standard

Water Mist Systems

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## Full Scale Testing



## Full Scale Testing

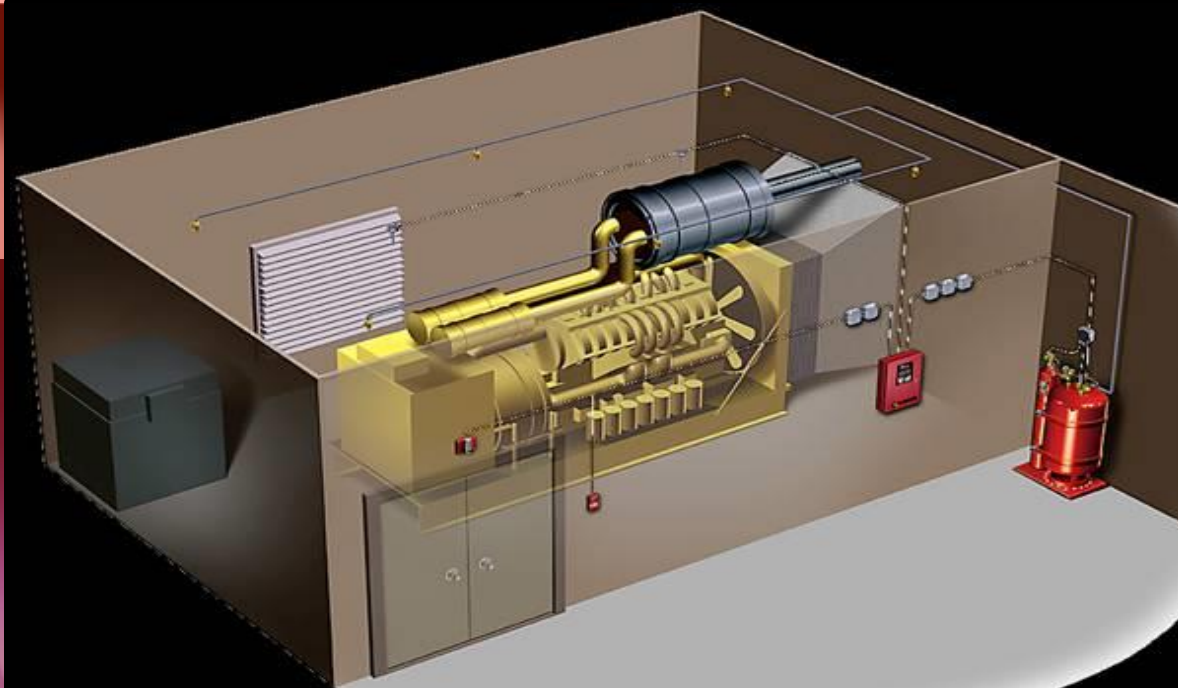
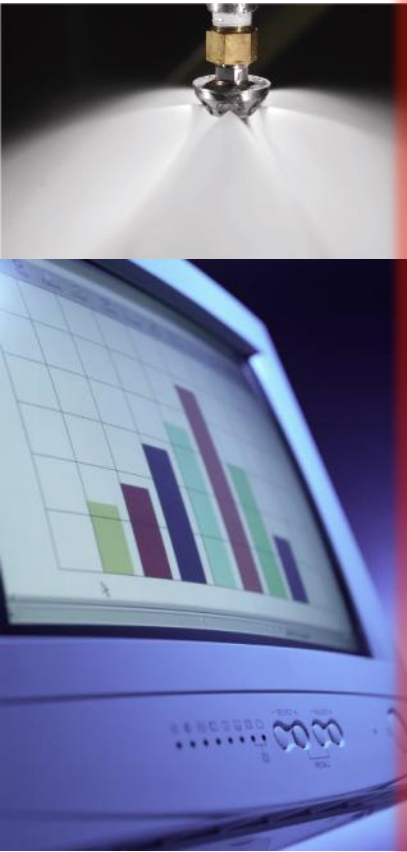


Have been working in an attempt to reduce testing from large scale to intermediate scale for total flooding water mist applications. New approach includes:

- **Nozzle water droplet characterization** (drop size distribution, droplet momentum, spray angle/pattern, etc.)
- **Well mixed model** – the use of a proprietary model to identify potential for success of a particular nozzle protecting a particular application (screening)
- **Scaling methodology** to scale down the large scale fire tests. The scale could be 1/2 or 1/3 of previous large scale fire tests.

# Well Traveled Journey of R & D.....

FM Approvals



**1/2 or 1/3 scale  
8 year journey, so far....**

# Benefits to Industry



- Initial reduction in cost by approximately 30%
- Expected initial reduction in FM Approvals cycle time by approximately 20%.
- Potential reduction time to manufacturer could be significant in the development phase due to the screening test availability.
- Potential reduction in required number of reduced scale tests in the future (after gaining some experience)
- Ultimately increase the number of certified applications!

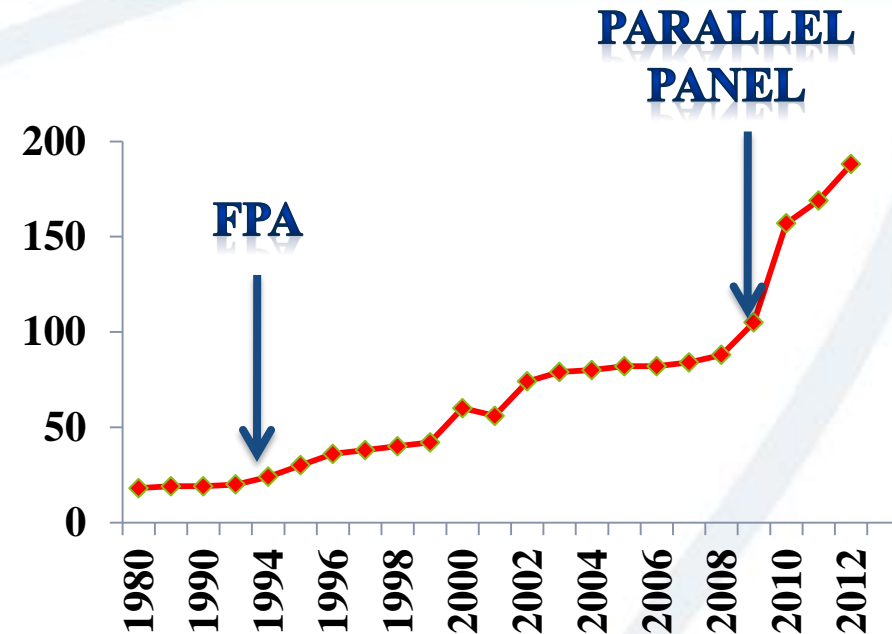


# Why Invest in Research?

To develop new knowledge

To utilize new knowledge

To significantly increase the number of FM Approved products, thus making our working environment a safer place.



# Water Mist Certified Applications

## CURRENT APPLICATIONS

- Chemical Fume Hoods
- Combustion Turbines in Enclosures
  - Volumes Not Exceeding 2825 ft<sup>3</sup> (80 m<sup>3</sup>)
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- Computer Room Raised / Sub Floors
- Continuous Wood Board Presses
  - Industrial Oil Cookers
  - Local Application
- Machinery in Enclosures
  - Volumes Not Exceeding 2825 ft<sup>3</sup> (80 m<sup>3</sup>)
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  - Volumes Exceeding 9175 ft<sup>3</sup> (260 m<sup>3</sup>)
- Non-Storage Occupancies , Hazard Category 1 (HC-1) *[Formerly Designated As Light Hazard Occupancies]*
- Wet Benches and Other Similar Processing Equipment

## FUTURE APPLICATIONS

- Cable Spreading Room / Cable Tunnels
- CNC Machines
- Combustion Turbine - Large Spray Fire
- Combustion Turbine - Re-ignition Fire (Decaying Pressure System)
- Conveyor Belts
- Data Centers / Data Processing Equipment Rooms
- Engine Test Cells
- Flight Simulators
- Flue Gas Oil Coolers
- Ignitable Liquid Storage / Cut-Off Rooms
- Industrial Exhaust Ducts
- Kitchen Cooking Surfaces / Hoods / Ducts
- Libraries
- Off-Road Vehicles
- Ordinary Occupancy Hazard - Group I
- Paint Spray Booths
- Paper Machine / Paper Machine Dryer Hoods
- Printing Presses
- Rack Storage
- Semiconductor Mini-Environments
- SX Plants - Ignitable Liquid Pool / Tank (Local Application)
- Ventilated Emergency Generators

THANK YOU