Victaulic Corporate History

• Est. in 1925, Employs over 3,300 with global facilities
• Industry standard in grooved end technology and fire protection
• Philosophy of constant innovation and challenging the status quo
  – R&D driven company with over 150 patents
  – Staff of 100 R&D engineers and technicians
  – UL approval for fire protection use in 1954
  – Revolutionary dry, preaction, deluge devices since 1997
  – Sprinklers since 1998
• 2003 Victaulic began research into special hazards market
  – After 5 years of fire testing with Factory Mutual (FM)
  – In 2008 Victaulic established a presence on NFPA 750 as a board member as a result of the approval of the Vortex system by Factory Mutual.

Victaulic Vortex™ Fire Suppression System for Special Hazards
Victaulic Vortex

- **What a hybrid system is:**
  - Patented supersonic emitter creates a multi-layer shock wave of nitrogen which atomizes the water to a sub 10 micron level
  - Creates a *homogenous* suspension of nitrogen gas and water
  - Vortex is a twin fluid system as described under NFPA 750, 3.3.18
Victaulic Vortex

• **How it works as an inert gas**
  – Nitrogen gas actively dilutes the oxygen level to quickly suppress small fires
    • Even in large rooms
    • Room integrity is *NOT* required for the Vortex System

• **How it works as a water mist system**
  – Atomized water absorbs heat from the fire to vaporize as steam
    • As effective as high pressure water mist system in larger fuel based fires
    • Flame is cooled while steam displaces oxygen at fire
    • No high pressure pumps are required
Victaulic Vortex

• Operational / Design Overview

  – Homogeneous Suspension
    • Created using
      – Nitrogen pressure at emitter of 25 psig
      – Water pressure of only 5 psig at emitter

  – Emitter:
    • Typical Coverage 1500-2500 ft³ per emitter (application dependent)
    • Nitrogen flow
      – 150 Standard Cubic Feet per Minute per MS emitter
      – 250 Standard Cubic Feet per Minute per DC emitter
    • Water flow from:
      – .26 gpm (Data Center)
      – 1.06 gpm (Machine Space)

  – Tested and approved by FM for use up to 128,570 cubic feet (3600 cubic meters). Not a pre-engineered system
Victaulic Vortex

- Created a new fire suppression system per FM and the EPA
  - Hybrid total flooding system per FM 5580
  - Vortex is compliant with NFPA 750 per FM 5580 Listing
  - Incorporates the beneficial features of:
    - NFPA 750 - Water Mist
    - NFPA 2001 - Clean Agent Gas System
      - Both are proven FM and UL tested systems since the early 1990’s
  - Vortex is based on both of these proven technologies
Victaulic Vortex

• Atomization Method
  – Emitter Description
  – Droplet Distribution
  – Explanation of Atomization
Victaulic Vortex

- **Emitter Details**
  - 1/8”, 1/2” or 5/8” Opening for Nitrogen Flow
Victaulic Vortex

- **Emitter Details: Penn State Research**
  - Schlieren Photography
  - Shock disc between foil and emitter
  - Secondary shock fronts at foil
  - **Velocity**
    - At emitter: approx. Mach 1
    - At 2 ft.: approx. 80mph
    - At 8 ft.: approx. 40 mph
Victaulic Vortex

- Emitter Details:
  - Shadow Photography
  - Demonstrates 4+ additional shock waves at foil
- Shockwave = instantaneous transition from supersonic to subsonic velocity
Victaulic Vortex

- **Atomization**
  - Atomization occurs at the emitter (atomization zone):
    - N2 velocity VERY HIGH
    - H2O velocity at zero
    - High We Number
  - Resulting suspension has high momentum due to the high gas velocity
UL Droplet Pattern Disbursement

Victaulic Water Mist Nozzle
Test Number 48
Position; Y = 1 m, X = 0.2 m, Angle = 90
Droplet Pattern Disbursement

Victaulic Water Mist Nozzle
Test Number 48
Position; Y = 1 m, X = 0.2 m, Angle = 90

- Histogram of droplet distribution
- Cumulative Count %
- Cumulative Volume %

High Pressure Mist disbursement representation
Victaulic Vortex

- Relative Droplets Per Minute

![Graph showing relative droplets per minute for Standard Sprinkler, High Pressure Mist, and Vortex.]

- Standard Sprinkler: 1
- High Pressure Mist: 23
- Vortex: 18,459
Victaulic Vortex

- Relative Surface Area of Heat Exposure

Square Inches Per Minute, normalized
Standard Sprinkler = 1

- Standard Sprinkler: 1
- High Pressure Mist: 7
- Vortex: 81
Victaulic Vortex

- **Droplet Distribution**
  - Adiabatic Flame Temp with N2, H2O, & N2 + H2O

**1600 K required to sustain flame**
Victaulic Vortex

- Major Components
- System Overview
- Layout Design
Vortex System Components

• Detection
  – Smoke, Flame, or Heat Detection or Air Sampling Are All Acceptable (Provided by Contractor)

• Releasing Panel
  – Any FM Approved Agent Release Panel (From Victaulic or Contractor)

• Nitrogen Supply
  – 80 L/540 SCF, 49L/310 SCF Cylinders or Bulk Tubes

• Auxiliary Battery Box
  – Available From Victaulic or Vortex Contractors

• Water Supply
  – Small, Integrated Tanks or Municipal Potable Water Supply

• Victaulic Needle Valve

• Victaulic Emitter

• Nitrogen Pipe
  – Victaulic grooved system on light wall black pipe

• Water – NFPA 13 Standard
  – Copper / galvanized or stainless steel pipe
  – Victaulic’s Vic-Press for Schedule 10S recommended
Victaulic Vortex

• **Nitrogen Supply**
  - Can Be Designed for Single or Multiple Zones
  - Nitrogen sized per largest volume area
    • Multiple Zones Enhances Vortex System Cost Efficiency
      - Better economics
      - Smaller footprint
  - Purpose of Nitrogen
    • Dissipates O2 Content to 14-15%
    - N2 Flow Regulated to 25 PSI at the Emitter(s)
    - Size/Number of Tanks Based on Zone Volume
Two Nitrogen Supply Options

80L Cylinders

Bulk (10,000 SFC) Tubes
Victaulic Vortex

- **Water Supply**
  - **Purpose**
    - Cools Room and Extinguishes the Fire
  - **Water pressure**
    - 5 psi at the Emitter
  - **Water flow**
    - 0.26 to 1.06 GPM per Emitter
  - **Water supplied by:**
    - Integrated Tank or Potable Municipal Supply
  - **Water inlet supervised by:**
    - Victaulic Style 728 Ball Valve
  - **Tank Pressurized with System Nitrogen**
    - Does not require a pump
Victaulic Vortex

- **Automated Needle Valve**
  - **Purpose:**
    - Regulates the nitrogen flow in the system
    - Maintains a constant 25psi discharge at the emitter
  - **Consists of:**
    - 3000 psi bubble tight needle valve
    - Intelligent (Programmed) motor driver
    - Safety relief valve
Typical Combo - Panel

- **System Layout**
  - Combines fluid control / zone control panels into one panel for single zone systems

*Low Pressure tank (450psi) or High Pressure Cylinder (3000psi)
Typical Multi-Zone

- **System Layout**

*Low Pressure tank (450psi) or High Pressure Cylinder (3000psi)*
Victaulic Vortex

- **Vortex Fire - Pac**
  - Computer Rooms
    - Choose:
      - Control Options
        - Dry Contacts
        - Standard Release Panel
      - Number of emitters
      - Time of nitrogen discharge

- **Pre-build and test assembly**
  - Customer could choose integrated fluid tank
Victaulic Vortex

• Pre-built Cabinet
  – Optional integrated fluid supply
  – Eliminates need for water hookup
  – Cabinets for any number of nitrogen cylinders
  – May be chained together with one master panel
## Victaulic Vortex

**Performance Analysis**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Flow, gpm</th>
<th>Drop Size, μm</th>
<th>Pressure, psig</th>
<th>Momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vortex</td>
<td>&lt;= 1</td>
<td>&lt; 10</td>
<td>25</td>
<td>High</td>
</tr>
<tr>
<td>Intermediate Pressure Water Mist</td>
<td>3-5</td>
<td>400-1000</td>
<td>350</td>
<td>High</td>
</tr>
<tr>
<td>High Pressure Water Mist</td>
<td>8</td>
<td>100</td>
<td>1500-2500</td>
<td>Low to Moderate</td>
</tr>
<tr>
<td>Sprinkler Systems</td>
<td>&gt;25</td>
<td>&gt;1000</td>
<td>20-min</td>
<td>High</td>
</tr>
<tr>
<td>Inert Gases</td>
<td>NA</td>
<td>NA</td>
<td>2500</td>
<td>NA</td>
</tr>
<tr>
<td>Halogenated Agents</td>
<td>NA</td>
<td>N/A</td>
<td>350</td>
<td>NA</td>
</tr>
</tbody>
</table>
## Victaulic Vortex

### Performance Analysis: Continued

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate Pressure Water Mist</td>
<td>High</td>
<td>Gradual</td>
<td>Fast</td>
<td>Yes</td>
<td>Yes</td>
<td>Deluge (significant wetting)</td>
</tr>
<tr>
<td>High Pressure Water Mist</td>
<td>Minimal</td>
<td>Gradual</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Yes (minimal wetting)</td>
</tr>
<tr>
<td>Sprinkler Systems</td>
<td>High</td>
<td>Gradual</td>
<td>Moderate</td>
<td>Yes</td>
<td>Yes</td>
<td>Deluge (significant wetting)</td>
</tr>
<tr>
<td>Inert Gases</td>
<td>No</td>
<td>Rapid</td>
<td>Minimal</td>
<td>No</td>
<td>No</td>
<td>Yes (no wetting)</td>
</tr>
<tr>
<td>Halogenated Agents</td>
<td>No</td>
<td>N/A</td>
<td>Moderate</td>
<td>No</td>
<td>No</td>
<td>Yes (no wetting)</td>
</tr>
</tbody>
</table>
Vortex Approvals

- Vortex is compliant with NFPA 750
- All Vortex Equipment is FM Approved
- FM Approval
  - Based on FM 5580 Standard for Hybrid Systems
- Applications
  - Machine Spaces
  - Combustion Turbines
  - Special Hazards Machine Spaces
Vortex Approvals (cont’d)

- **Vortex is SNAP Approved**
  - Replacement for Halon 1301 Systems
  - Per US EPA Vortex has received the SNAP Approval as a “hybrid inert gas water based system”

- **Applications**
  - Data processing area
  - Paint mixing rooms,
  - Automated information storage areas,
  - Libraries
  - Museums
  - Pharmaceutical storage areas,
  - Forensic labs
  - Pickle and annealing lines in steel plants, etc.
  - Turbines
  - Generator protection
  - All machines spaces
Vortex Approvals (continued)

- **UL 2127 Clean Agent Tests**
  - Vortex has demonstrated its ability to extinguish numerous Class A & B fires requested by UL&FM
  - Both Agencies witnessed these fire tests
  - Victaulic has letters are on file from both agencies affirming that Vortex successfully extinguished all the fires
Applications

- **Power Generation**
  - Base Load Plants
  - Co-Generation and Combined Cycle Plants
  - Power Parking Units
  - Coal Conversions
  - Coal Storage/Handling/Pulverizing
  - Gas Turbines
  - Machinery Spaces

- **Generator Rooms**

- **Cement Plant/Blast Furnace**
  - Indirect Coal Firing Systems

- **Industrial Ovens**
  - Carbon Fiber Manufacturing Ovens

- **Metal Production and Processing**
  - Electrical Furnaces
  - Continuous Casters
  - Rolling Mills (steel and aluminum)
  - Coating Lines
  - Packaging Areas
  - Pickle and Annealing Lines
  - Pulpits

- **Automotive**
  - Assembly
    - Paint application
    - Mixing and storage
  - Parts
    - Machining
    - Heat Treating
Applications

- Electronic Operations
  - Computer Areas
  - Automated Information Storage Areas
- Electronic/Computer Production
  - Wet Benches
  - Wave Soldering Machines
- Data Processing Rooms
- Underground Storage Vaults
- Research Facilities
  - Test Facilities
  - Anechoic Chambers
- Telecommunications Facilities

- Rare Book Libraries
- Museums
- Petrochemical and Medical Facilities
  - Laboratories
- Printing
  - Newspaper Production
  - Periodical Printing
- Coating Lines
- Food Processing
Vortex: The “Solution Product”

- Does the application have room integrity issues?
  - Sometimes virtually impossible or so expensive to achieve
  - Halocarbons need room integrity
  - Vortex does not require fan tests and room integrity
  - Room sustainability – retrofits for new conduit, etc in walls or floors can render gaseous systems less effective or ineffective
Vortex: The “Solution Product”

- The customer wants a green system!
  - Vortex is totally green with its use of nitrogen (most common element of air) and water
  - Most gaseous systems are not
Vortex: The “Solution Product”

- Recharge costs can be high for alternative systems!
  - FM-200 sells to end customer for around $20 / lb, plus labor to replace
  - 10,000 lb system - $200k!
  - In contrast, equivalent amount of nitrogen is $12.5k
Vortex: The “Solution Product”

- Containment of a discharge
  - If containment systems for a sprinkler discharge are needed, safe to assume collection is hazardous.
  - Expensive to dispose of collected waste
    - Containments oversized because don’t know when sprinklers will be shut off
    - Do not know how much water will be collected
  - The containment system cost can be more expensive than the Vortex system installed!
Vortex: The “Solution Product”

- No water or little water is available at the site
  - Running water lines is very costly
  - Fire pumps and tanks are also
  - Vortex uses very little water, and can provide standalone water tanks
Vortex: The “Solution Product”

- The material in the application is valuable
  - Needs to be protected from damage in fire incident or accidental discharge
  - Data Center emitter flows only .26 GPM
    - High Pressure water mist – 8 GPM and will run for ten minutes
  - If comparing against closed heads – expect bigger fire before activation – Vortex would go off faster on smaller fires
Vortex: The “Solution Product”

- Some projects are so volatile – there was no really good answer before Vortex was developed
  - Protection of Annealing & Pickling lines – Victaulic’s design team worked with manufacturers to jointly develop an automated system – presented at IWMA – NFPA at Factory Mutual’s request
- Victaulic welcomes the opportunity to work with you on high-challenge installations
Vortex: The “Solution Product”

1. If Room integrity is not attainable
   • Air tight rooms are not required

2. Green System is wanted
   • Nitrogen and water are green

3. Hazard area has no water
   • Vortex discharges as little at .26 gpm

4. Recharge cost is a $$ concern
   • Clean Agents can be up to 100 times more expensive than nitrogen

5. Worried about containment costs
   • No residue from discharge to be contained

6. Water damage is not tolerable due to valuable artifacts or conductivity can not be tolerated due to electrical equipment.
   • Virtually no wetting of protected area
Vortex Testing

- Moisture Accumulation
- Sensitive Electronics
- High Voltage Exposure
Sub Floor Testing-FM Global

- **ANSI/FM 5560 Computer Cabinet**
  - Cabinet used for AS 400 system
  - Placed on vented sub floor
  - 4 dishes of Anhydrous Calcium Sulfate (Dririte) placed throughout the cabinet along with 2 mirrors.
  - System discharged through vented sub floor
Post Test

Vented Floor
Safe For Sensitive Electronics

- Test1: Energized PLC Equipment
- Side vented enclosure with door closed
- Placed in corner of room
- Microprocessor based electronics along with LCD display and 2 - 24VDC power supplies
- Cup of heptane and wax candle are lit and allowed to burn
- **Test2: Tower and Laptop Computer**
- Desk top PC with vented CRT type monitor
- Placed between 2 emitters (4 total in system)
- Both computers running while system is discharged
- 2 dishes of Dririte- 1 inside PC and the other placed under the emitter
- RH sensor placed inside enclosure
- Pan fire with heptane placed in room
Test Results

• Fire extinguished in 96 seconds
• Relative Humidity (RH) of 73.9% Peak (Net 30% increase)
• Dri-rite remained blue in color
• Evaluation after 36 months of operation shown no corrosion of components
• Equipment remains functional today
Result Data

RH Reading

Chip Inside PLC

DriRite Samples
Safe For Use On High Voltage

- Test 1: Direct Discharge Onto Plate
- Test similar to ANSI/UL 711 for rating class “C” fire extinguishers
- 10KV, 23 MA power supply
- Emitter electronically isolated from system and grounded
- Copper plate placed from 10” to 2” from emitter
• Test2: Enclosed Bus Bar
• 2 - Copper bus bars placed 1.5” apart inside a vented enclosure
• 10KV,23 MA power supply
• Heptane fire lit in enclosure then door closed
• System discharged for 5 minutes
• Test3: Unshielded Bus Bar

• 2 - Copper bus bars placed 1.5” apart

• Placed 7 feet directly below emitter

• 10KV, 23 MA power supply

• System discharged for 5 minutes
Results

- No arc was measured in any test arrangement
- Test 1 Plate- reached a net current of 169μA at 2”
- Test 2 Enclosed Bus Bar- max current of 68.9μA
- Test 3 Unshielded Bus Bar- net current of 463μA
- All results are far below NIOSH* standards

*National Standard For Occupational Health
- 1mA “Barely Noticeable” Current
- 16mA Max “Let Go” Current
Maintenance: Simple, Inexpensive

• Weekly Visual Inspection
  – Inspect N2 & H2O supply lines
  – Review Annunciator Panel history
  – Inspect Emitters to be sure they are not obstructed
  – Verify that emitter covers are in place

• Semi-Annual Inspection
  – Complete weekly inspection steps
  – Inspect Nitrogen tank pressure levels. If low pressure condition exists, determine root cause, repair and refill tanks
  – Inspect water storage tank level (if applicable), fill if required
Maintenance Simple, Inexpensive

• Annual Inspection
  – Complete weekly and semi-annual steps
  – Cycle N2 & H2O Valves for proper operation (discharge not required)
  – Replace H2O in storage tank
  – Inspect all system hoses, replacing any damaged or deteriorated hoses

• Five-Year Inspection
  – Complete annual inspection items
  – N2 cylinders that are continually in service without being discharged shall be given a complete external visual inspection a minimum of every 5 years
  – All hoses shall be tested or replaced a minimum of every 5 years
So, What Can Vortex Offer You?

- Installation Flexibility
- No Room Integrity Issues
- Extinguishes Small Fires in Large Rooms
- Inexpensive Agent to Recharge
- No Residual Damage from the Agent
- A Totally Green Product
- Simple, Inexpensive Maintenance
Victaulic Vortex™
Next Generation Fire Suppression System
Vortex Video
Vortex Video