The Collection of Topics which Comprise Fire Protection Engineering

FCIA
Key Biscayne, FL
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Jim Milke, Professor and Assoc. Chair
Department of Fire Protection Engineering
University of Maryland
U.S. FPE Degree Programs

- University of Maryland
  - B.S., M.S., M.Eng., Ph.D.

- Worcester Polytechnic Institute
  - M.S., Ph.D.
University of Maryland FPE Programs

<table>
<thead>
<tr>
<th>Degree</th>
<th>Number of credits</th>
<th>Time (years)</th>
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</thead>
<tbody>
<tr>
<td>Bachelor of Science (B.S.)</td>
<td>122</td>
<td>4-5</td>
</tr>
<tr>
<td>Master of Science (M.S.)</td>
<td>B.S. + 30 (including thesis)</td>
<td>1-2</td>
</tr>
<tr>
<td>Master of Engineering (M.Eng.)</td>
<td>B.S. + 30 (no thesis)</td>
<td>1.5-3</td>
</tr>
<tr>
<td>Doctor of Philosophy (Ph.D.)</td>
<td>B.S. + 60 (done in cooperation with other engineering departments)</td>
<td>4-6</td>
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</tbody>
</table>
History of UMD FPE Department

- 1956 – B.S. program initiated by Dr. John L. Bryan
- 1962 – 1st B.S. graduate (936 graduates)
- 1976 – B.S. program 1st accredited by ABET
- 1990 - Graduate program initiated
- 1992 - 1st M.S. graduate (151 graduates)
- 1995 - 1st M. Eng. Graduate (86 graduates)
- 1998 - 1st Ph.D. awarded (17 graduates)
- 2003 – Distance option for M. Eng. initiated
Current Enrollment (approximate)

- B.S. – 130 students
- M.S. – 20 students
- M.Eng. – 60 students (10 on-campus, 50 distance)
- Ph.D. – 10 students
Full-time Faculty

- Marino di Marzo, Professor and Chair
  - Suppression, Fire fighter safety

- Jim Milke, Professor and Associate Chair
  - Detection; Structures; Egress; Smoke management

- Jim Quintiere, John L. Bryan Professor
  - Fire dynamics; Scaling; Flammability

- André Marshall, Associate Professor
  - Fire flows; Combustion; Suppression

- Arnaud Trouvé, Associate Professor
  - Turbulent Combustion; Fire modeling

- Peter Sunderland, Assistant Professor
  - Soot; Hydrogen; Diagnostics; Vehicles
Graduates should

- Have the *technical knowledge and skills needed to practice fire protection engineering* locally, nationally and internationally in a variety of modern professional settings

- Have the *basic competencies needed to pursue advanced studies* in fire protection engineering or related fields

- Have the ability to *understand and communicate societal, environmental, economic and safety implications* of engineering decisions on the local and global communities

- Are prepared to attain *professional certification and licensure*

- Appreciate the need to *maintain continual professional competency and to practice ethically*. 
BS Program

- 122 credits total
  - 24 credits general education
    - (writing/communication, literature, history, arts, social sciences)
  - 30 credits math, physics, chemistry
  - 15 credits engineering fundamentals
  - 38 credits fire protection engineering
  - 15 credits math and engineering electives
Engineering Fundamentals

- Statics
- Mechanics
- Dynamics
- Fluid Mechanics
- Thermodynamics
- Heat Transfer
Fire Protection Engineering

- Fire Phenomena
- Response to Fire
Fire Phenomena

- Experimental fire assessment methods
- Fire dynamics
- Computer modeling (zone and CFD)
Experimental Fire Assessment methods

- Perform experiments following standard test methods and ad hoc methods involving material burning behavior and suppression

ASTM E648 carpet test

ASTM E1321 ignition test

1/20th scale test of World Trade Center
Fire Dynamics

- Introduction to premixed and diffusion flames
- Ignition
- Flame spread and rate of burning
- Combustion products
- Fire plumes
- Flame radiation.
Fire Dynamics

\[ \dot{m}_p(Z,t) = 0.21 \rho_\infty (gZ)^{1/2} Z^2 Q^* (Z,t)^{1/2} \]

where \[ Q^* = \frac{(1 - \lambda_f) \dot{Q}(t)}{\rho_\infty C_p T_\infty (gZ)^{1/2} Z^2} \]
Fire Modeling

- Computer-based fire modeling applications to explore enclosure fire development.
- Development of computational methods to review aspects of enclosure fires (ceiling jets, smoke layer development, onset of flashover, etc.)
- Application of models – FAST, FDS.
Fire Modeling

Frame: 0
Time: 0.1
Response to Fire

- Life safety analysis
- Suppression systems
- Detection and alarm systems
- Structural fire protection
- Smoke management
- Hazard and risk analysis
Life safety analysis

- Introduction to fire protection engineering and building regulation, building safety systems, and egress system design.
- Building survey (Life Safety Code)
Evacuation Analyses

FEMA Report of WTC

The Station Fire

SFPE Handbook of Fire Protection Engineering
Special Hazard Suppression Systems

- Study of gaseous and particulate fire suppression systems.
- Examination and evaluation of code criteria, performance specifications and research.
- Design special hazard system (with detection) for actual hazard
  - Aircraft hangar
  - Clean room
  - Computer room
  - Museum space
Water-based Suppression Systems

- Review characteristics of sprinkler systems: response time, suppression effectiveness.
- Design of sprinkler system for selected hazard
- Water mist systems
Detection and Alarm Systems

- Design of detection components – location of initiating devices (heat, smoke, flame detectors), response time
- Alerting – methods, location of devices
Response of Detectors

Radiant heat output from fire
• Heat release rate of fire
• Radiant fraction
• Area of flame envelope

Transmission through air
• Intensity varies with $1/d^2$
• Transmissivity of air

Sensitivity of detector
• Specific to fuel
• Specific to angle
Structural Fire Protection

- Standard tests to assess fire resistance
- Effects of elevated temperatures on structural materials
Structural Fire Protection

- Analytical methods to evaluate fire resistant design of structures
- Computer simulation of response of structural elements
Smoke Management

- Smoke movement characteristics
- Analyze performance of smoke management systems
  - Stairwell pressurization
  - Zoned smoke control
  - Smoke management systems in atria and covered malls
Smoke Management

- Analysis methods for design
Hazard and risk analysis

- Application of systems analysis, probability theory, engineering economics, and risk management
- Methods to develop criteria for the design, evaluation and assessment of fire safety or component hazards.

Analysis of upholstered furniture fires
Hazard and Risk Analysis

- Capstone Course
  - Integrates material from all other courses
  - Project in course involves development of appropriate fire protection strategy for selected hazard
    - Fire safety in single family residences
    - Protection of computer rooms
    - Dormitory fire safety
    - LNG Storage
Capstone Project

- Follow SFPE Performance-Based Design Guide
  - Analyze whether selected fire protection strategies satisfy performance criteria
  - Performance criteria address
    - Level of risk
    - Cost-benefit or cost effectiveness
Special Programs/Options

- Internships
  - On- or off-campus
- Co-op education
- Study abroad
- Hinman CEO (living-learning entrepreneurship program)
- Quest (innovation, quality systems management and teamwork, joint program with business school)
Undergraduate Scholarship Support

- **Sources**
  - Endowed scholarships
  - One-time or annual gifts
  - Outside Sources

  \[ \text{FCIA: Thank you!} \]

\[ \text{\$152,450 in 2008-2009} \]
Master of Science

- Program seeks to explore advanced principles of fire protection engineering; development of analytical tools
- Requires 30 credits (24 credits of coursework + thesis)
- Approximately 10 M.S. graduates per year
- M.S. Theses since 2003 posted online:
  - http://www.fpe.umd.edu/research/index.html
Master of Engineering

- Established M. Eng. Distance Program – Fall 2003
  - Designed to help professionals hone their skills and advance their careers while studying on a part-time basis
  - Focus on the latest performance-based building fire safety analysis and design
  - Coursework can be completed in 15 months

- 2 courses offered per term, 4 terms per year (each term is 12 weeks long)
- No thesis
## FPE Graduate Courses

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<thead>
<tr>
<th>Course</th>
<th>On-campus</th>
<th>Distance</th>
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<tbody>
<tr>
<td>Fire Induced Flows</td>
<td>X</td>
<td></td>
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<tr>
<td>Human Response to Fire</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fire Dynamics Laboratory</td>
<td>X</td>
<td></td>
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<tr>
<td>Analytical Procedures of Structural Fire Protection</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fire Protection Engineering Hazard Analysis</td>
<td>X</td>
<td></td>
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<tr>
<td>Advanced Fire Modeling</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Smoke Detection &amp; Management</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Advanced Fire Dynamics</td>
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<td>X</td>
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<tr>
<td>Fire Assessment Methods</td>
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<td>X</td>
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<tr>
<td>Advanced Fire Suppression</td>
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<td>X</td>
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<tr>
<td>Forensic Fire Analysis</td>
<td>++</td>
<td>X</td>
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<tr>
<td>Performance-based Design</td>
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<td>X</td>
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<tr>
<td>Advanced Fire Risk Modeling</td>
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<td>X</td>
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<tr>
<td>Diffusion Flames and Burning Rate Theory</td>
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</table>
Distance Faculty

- Jim Milke, Ph.D., P.E., Prof. & Director - *Smoke Detection & Management*
- Arnaud Trouvé, Associate Professor, Ph.D. – *Advanced Fire Modeling*

**Adjunct Faculty**
- Douglas Carpenter (Maryland) – *Fire Dynamics*
- Steven Gwynne, Ph.D. (Colorado & UK) – *Human Response to Fire*
- Morgan Hurley, P.E. (Maryland) - *Performance-Based Design*
- David Icove, Ph.D., P.E. (Tennessee) - *Forensic Fire Analysis*
- Marc Janssens, Ph.D., (Texas) - *Fire Assessment Methods*
- Francisco Joglar, Ph.D., P.E. (Virginia) - *Advanced Fire Risk Modeling*
- Susan Lamont, Ph.D., C.Eng. (UAE), *Structural Fire Protection*
- David Purser, Ph.D. (UK) – *Human Response to Fire*
- Richard Roby, Ph.D., P.E. (Maryland) – *Fire Dynamics*
- Eric Rosenbaum, P.E. (Maryland) - *Performance-Based Design*
- Jason Sutula, Ph.D., (Maryland) - *Advanced Fire Suppression*
Doctoral Program

- PhD Option available through cooperation with other engineering departments
  - Graduate 2 – 3 PhD’s per year
- Long-term goal: Initiate FPE PhD program
- Dissertations posted on-line
Thank you for the invitation and scholarship support.