

## Protective Technology Research Centre

### Short Course On

### Plume, Zone and CFD Modelling of Fires

#### Course Instructors:

**Professor Vasily B. Novozhilov**

*Chair in Fire Dynamics  
School of Built Environment  
University of Ulster, United Kingdom*

**Associate Professor Tan Kang Hai**

*School of Civil and Environmental Engineering  
Nanyang Technological University, Singapore*

**Associate Professor Adrian Wing-Keung Law**

*School of Civil and Environmental Engineering  
Nanyang Technological University, Singapore*

Date: 17 and 18 July 2006

Time: 8:30 am to 6:00 pm  
(Registration on the first day is at 8.00 am)

Venue: Seminar Room A  
Centre for Advanced Construction Studies  
Blk N1, Level B1, N1-B1b-04,  
School of Civil and Environmental Engineering  
Nanyang Technological University  
50 Nanyang Avenue, Singapore 639798

#### **About the Course**

This short course aims at presenting participants with basic ideas of Plume, Zone and Computational Fluid Dynamics (CFD) Modelling for Fire Safety Engineering Design. Emphasis will be placed on the fundamental engineering principles for Plume and Zone modelling, and their comparisons with experimental results (where appropriate). Practical worked examples to illustrate their use will be given for Plume and Zone modelling. As for CFD, the focus is on giving participants the basic skills in working with Fire Dynamics Simulator (FDS).

In the first part of the course, assumptions and limitations of different Plume models will be introduced. This is followed by an introductory course to Zone models which include heat release rate, pressure profiles and vent flows for enclosure fires, gas temperatures, heat transfer in compartment fires and conservation equations. For the CFD part, the principal mathematical models essential for fire modelling will be discussed. These include the Navier-Stokes equations, combustion, radiation and fire suppression models. Discretization principles for governing equations will also be discussed, and some basic guide into CFD technique will be given.

Following the theoretical aspects, the following parts will be discussed in greater detail: realization of specific models in FDS, validation of FDS and basic skills in working with FDS. Finally, a number of case studies will be presented giving insight into possibilities and limitations of the software.

#### **Course Instructors**

**Professor Vasily B. Novozhilov**

Professor Novozhilov received his PhD in "Mechanics of fluids, gas and plasma" and "Mathematical modelling of hydrodynamic consequences of large-scale fires and explosions" from the Moscow Aviation Institute in 1993. He had been an Associate Professor of the Nanyang Technological University before joining the University of Ulster in UK as full professor in 2003. Currently, he is the Chair in Fire Dynamics. His main areas of research include CFD and Analytical Modelling of Fire Dynamics and Suppression, Combustion Modelling, Computational and Experimental Studies of Soot Production Rates in Fires, Advanced Computational Techniques for Heat Transfer Problems and Bioengineering. Professor Novozhilov has won several international awards and is the author and co-author of 5 books, 46 international journal papers and 33 conference papers.

**Associate Professor Tan Kang Hai**

Dr Tan received his PhD from the University of Manchester, UK. Since 1990, he has been an Associate Professor at the School of Civil & Environmental Engineering of the Nanyang Technological University. Dr Tan works on both numerical simulations of fire effects on structure and experimental testing of members under simulated elevated temperature using electrical heating furnace. Dr Tan is the Chairman of the performance-based design guide for fire resistance of structural steelworks of the Productivity Services Board. Dr Tan is also one of the 3 external panel members for the selection of Fire Safety Engineers in Singapore. Dr Tan is the author and co-author of over 60 international journals.

**Associate Professor Adrian Wing-Keung Law**

Dr. Law received his undergraduate degree from the University of Hong Kong, and graduate degrees from the University of California at Berkeley. He worked in the San Francisco office of the Bechtel Corporation (USA) before coming to NTU to teach in the area of environmental hydraulics and coastal engineering. During the industry period, he was involved in the ventilation design (fire scenarios) for the San Francisco MUNI Turnaround Project and the McCarran Airport Project in Las Vegas. His current research interest is in environmental fluid mechanics, including topics such as the turbulence modeling of buoyant jets and plumes and their interactions with wall boundaries.

### Day 1 – 17 July 2006

TIME	PROGRAMME	SPEAKER
8:00am – 8:30am	Registration	-
8:30am – 9:30am	Session 1 – Characteristics of Fire Plumes and Flame Heights	A/P Adrian Law Wing-Keung
9:30am – 10:30am	Session 2 – Differential and Integrated Modelling of Fire Plumes	A/P Adrian Law Wing-Keung
10:30am – 10:45am	Tea/Coffee	-
10:45am – 11:45am	Session 3 – Energy Release Rates and Design Fire Loads	A/P Tan Kang Hai
11:45am – 12:45pm	Session 4 – Pressure Profiles and Vent Flows	A/P Tan Kang Hai
12:45pm – 1:45pm	Lunch	-
1:45pm – 2:45pm	Session 5 – Principles of CFD. CFD for Fire Engineering. Governing equations and discretization principles	Prof Vasily B. Novozhilov
2:45pm – 3:45pm	Session 6 – Combustion and Radiation modeling	Prof Vasily B. Novozhilov
3:45pm – 4:00pm	Tea/Coffee	-
4:00pm – 5:00pm	Session 7 – Suppression modelling	Prof Vasily B. Novozhilov
5:00pm – 6:00pm	Session 8 – Introduction of Fire Dynamics Simulator (FDS). Realization of models in FDS	Prof Vasily B. Novozhilov

### Day 2 – 18 July 2006

TIME	PROGRAMME	SPEAKER
8:30am – 9:30am	Session 9 – Validation of FDS	Prof Vasily B. Novozhilov
9:30am – 10:30am	Session 10 – Gas Temperatures in Ventilated Enclosure Fires	A/P Tan Kang Hai
10:30am – 10:45am	Tea/Coffee	-
10:45am – 11:45am	Session 11 – Heat Transfer in Compartment Fires	A/P Tan Kang Hai
11:45am – 12:45pm	Session 12 – Conservation Equations and Computer Modelling of Enclosure Fires.	A/P Tan Kang Hai
12:45pm – 1:45 pm	Lunch	-
1:45pm – 2:45pm	Session 13 – Basic skills in working with FDS, commands, namelist groups, etc	Prof Vasily B. Novozhilov
2:45pm – 3:45pm	Session 14 – Case Studies	Prof Vasily B. Novozhilov
3:45pm – 4:00pm	Tea/Coffee	-
4:00pm – 5:00pm	Session 15 – Case Studies	Prof Vasily B. Novozhilov
5:00pm – 5:15pm	Certificate Presentation / Sum-up of Workshop	-

