Computer Models
For
Fire and Smoke

Model Name:	JASMINE
Version:	3.1
Classification:	CFD or Field
Very Short Description:	A CFD or field model for predicting consequences of fire to evaluate design issues such as the assessment of smoke ventilation design and/or interactions with HVAC and other fire protection measures
Modeler(s), Organization(s):	Suresh Kumar (Dr), Stewart Miles, Richard Chitty, Building Research Establishment
User's Guide:	JASMINE comes with an easier-to-use graphical interface "JOSEFINE" that has interactive on-line help facility. JOSEFINE provides a fast way of building the geometry of the structure, its thermal properties, specifying the fire source, and heating and ventilation conditions before and during the fire, design of the numerical grid and graphical visualisation of the geometry, grid and the results
Technical References:	Cox G and Kumar S. 'Field Modelling of Fire in Forced Ventilated Enclosures', Combustion Science and Technology, 52, 7, (1986).
Validation References:	(all of the following papers cite experimental comparisons with the model) Kumar S and Cox G. 'The Application of a Numerical field Model of Smoke Movement to the Physical Scaling of Compartment Fires', In Proc. Numerical Methods in Thermal Problems ed Lewis R W, Johnson J A and Smith W R, Pinerridge Press, 1983, pp 837-848.

Markatos N C, Malin M R and Cox G. ‘Mathematical Modelling of Buoyancy-Induced Smoke Flow in Enclosures’, Int J Heat Mass Transfer, 25, 1982, pp 63-75.

Kumar S, Hoffman and Cox G. 'Some validation of JASMINE for fires in hospital wards', Lecture Notes in Engineering No 18, Numerical Simulation of Fluid Flow and Heat Mass Transfer Processes, Springer, 1986, pp 159-169.

Kumar S and Cox G. 'Mathematical modelling of fire in road tunnels', In Proc 5th Intl Symposium on Aerodynamics and Ventilation of Vehicle Tunnels, BHRA, 1985, pp 61-76.

Pericleous K A, Worthington D R E and Cox G. 'The Field Modelling of Fire in an Air-Supported Structure', In Proc 2nd International Symposium on Fire Safety Science, 1988, p 871.

Kumar S. Field Model Simulations of Vehicle Fires in a Channel Tunnel Shuttle Wagon', In Proc 4th International Symposium on Fire Safety Science, Ottawa, Canada, 1994, p 995.

Fardell P J, Kumar S, Ellwood J A, Rowley J A and Vollam S. 'A Study of Life Threat in Bus Fires', Interflam '93, p 401, 1993.

Miles S D and Cox G. ‘Prediction of fire hazards associated with chemical warehouses’, Fire Safety Journal, 27, 265-287, 1996.

Miles S D, Kumar S and Cox G. 'Comparisons of 'blind predictions' of a CFD model with experimental data', Proc 6th International Symposium on Fire Safety Science, Poitiers 1999-*to be published.*

Availability: Available from Building Research Establishment,
Watford WD2 7JR, UK
Tel: +44 (0) 1923 66 4921
Fax: +44 (0) 1923 66 4910
Email: kumars@bre.co.uk

Price: Available on request (both academic and full commercial licenses are available)

Necessary Hardware:	Currently supported on PC, and runs under Windows 95 and NT. Requires a minimum of 64MB RAM, 150 MHz processor and 1 Gbyte disc space in excess of system requirements. Can be adapted to workstations (e.g. COMPAC). A 300MHz, 64MB RAM PC can churn out a calculation overnight with a modest number of cells. A 600MHz PC with 1GB RAM is competing with the workstation speeds.
Computer Language:	FORTRAN 77/90
Size:	Approximately 50MB of disk space and a minimum of 64MB RAM required
Contact Information:	Suresh Kumar (Dr) Building Research Establishment, Garston, Watford WD2 7JR, UK Tel: +44 (0) 1923 66 4921 Fax: +44 (0) 1923 66 4910 Email: kumars@bre.co.uk

Detailed Description:

The FRS model JASMINE (Analysis of Smoke Movement In Enclosures) uses computational fluid dynamics (CFD) to describe the heat and mass transfer processes associated with the dispersion of combustion products from a fire. The processes of convection, diffusion and entrainment are simulated by the Navier-Strokes equations. JASMINE has been developed, validated and improved over a twenty year period and includes the key processes of buoyancy, convection, entrainment, turbulence, combustion, thermal radiation and boundary heat transfer relevant to the movement of smoke.

JASMINE is a structured, finite-volume code using a staggered, Cartesian grid and is based on the SIMPLEST pressure-correction procedure. The 'upwind' discretisation scheme is employed. Transient solutions are advanced by a first-order, fully implicit scheme. Turbulent closure is provided by a standard, high Reynolds number, two-equation (k, ε) model. Various physical sub-models are included for combustion and radiation processes, gas phase properties (density and specific heat) and solid boundary heat transfer.

JASMINE is unique among CFD fire models because of its realistic treatment of the 'fire science' and its extensive validation over a long period. It has been successfully used to simulate fire and smoke movement in a wide variety of construction projects (e.g. atria, hospitals, sport stadia, warehouses, tunnels etc.), as well as in other

applications such as a nuclear containment cell, transportation vehicles and marine ships.

The end user may specify a multi-compartment enclosure with any number of openings (doors, windows, vents etc.) and one or more fire and/or heat sources. Furthermore, the user may also specify, arbitrary internal and external (Cartesian) blockages, flow rates of ventilation and extraction, external wind boundaries, and locations of active fire protection measures such as heat detectors and sprinklers.

JASMINE provides predictions within the volume of the enclosure of gas temperatures, densities, pressures, gas velocities and chemical compositions, in both time and three space dimensions. It also provides estimates of wall surface temperatures, predictions of convective and radiative heat transfer to solid boundaries, and mass and heat flow rates through ventilation openings (natural or forced).

In addition to modelling smoke movement inside an enclosure, JASMINE can also be used for modelling smoke propagation in the external environment with different wind and atmospheric conditions. Recently JASMINE has been used for modelling the dispersion of combustion products from a fire inside a warehouse (see enclosed papers on the related work, namely, “Modelling the environmental consequences of fires in warehouses” and “Prediction of fire hazards associated with chemical warehouses”).

The current version of JASMINE, with a new graphical user interface JOSEFINE, is a performance-based design and assessment tool for the comprehensive FSE evaluation of new or refurbished constructions. (JOSEFINE can also be used as interface for the CFD model SOFIE, q.v.).The introduction of a graphical user interface is a significant step forward in the twenty-year development and validation of JASMINE. The user interface allows the geometry of any building to be modelled accurately and quickly, with automatic creation of grids within the building. It also provides a fast, easy way of building in the geometry of the structure, its thermal properties and the heating and ventilation conditions before and during the fire. Outputs can be viewed in a highly attractive graphical format. Visualisation facilities allow the user to see how fire and smoke move through a building and variables such as the velocity, temperature and heat flux levels can be easily obtained for comparative evaluation. The consequences of the fire can then be simulated to address design issues such as when detectors and sprinklers operate, time to untenable conditions from a fire atmosphere and evacuation of occupants.

Recent applications of JASMINE include designing smoke ventilation system for a new shopping complex, a cinema complex and a large exhibition hall, and development of a fire safety strategy for the Brussels’s airport.