Computer Models
For
Fire and Smoke

Model Name: CFAST

Version: 6.1

Date: August 1, 2007

Classification: Zone

Very Short Description: CFAST is a two-zone fire model used to calculate the evolving distribution of smoke, fire gases and temperature throughout compartments of a building during a fire. These can range from very small containment vessels, on the order of 1 m^3 to large spaces on the order of 1000 m^3.

Modeler(s), Organization(s): NIST

User's Guide: CFAST – Consolidated Model of Fire Growth and Smoke Transport (Version 6) User's Guide, Richard D. Peacock, Walter W. Jones, Paul A. Reneke, and Glenn P. Forney, National Institute of Standards and Technology, SP 1041 (2005)

Technical References: CFAST – Consolidated Model of Fire Growth and Smoke Transport (Version 6) - Technical Reference Guide, Walter W. Jones, Richard D. Peacock, Glenn P. Forney and Paul A. Reneke, National Institute of Standards and Technology SP 1026 (2005)

Validation References: A Comparison of CFAST Predictions to USCG Real-Scale Fire Tests, Journal of Fire Protection Engineering, Vol. 11, No. 1, 43-68, (2001).

Quantifying fire model evaluation using functional analysis, Fire Safety Journal 33 (1999), 167-184.

Development of an Algorithm to Predict Vertical Heat Transfer Through Ceiling/Floor Conduction, Fire Technology 34, 139 (1998).

Calculating Flame Spread on Horizontal and Vertical Surfaces, NISTIR 5392 (1994).

Modeling Smoke Movement Through Compartmented Structures, Journal of Fire Sciences, *11*, 172 (1993).

Improvement in Predicting Smoke Movement in Compartmented Structures, Fire Safety Journal, 21, 269 (1993).

Verification of a Model of Fire and Smoke Transport, Fire Safety Journal 21, 89 (1993).

Additional references are cited in the technical reference guide.

Availability: http://cfast.nist.gov/ Code and manuals are available at this site.

Price: no cost

Necessary Hardware: Intel platform, running Windows 2000 or later

Computer Language: FORTRAN and Visual Basic

Size: Editor is 525kb, model is 3.5 Mb

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Detailed Description: CFAST is a two-zone fire model used to calculate the evolving distribution of smoke, fire gases and temperature throughout compartments of a constructed facility during a fire. In this implementation, each compartment is divided into two layers. The scenarios can range from very small containment vessels, on the order of 1 m^3 to large spaces on the order of 1000 m^3. The appropriate size fire for a given application depends on the size of the compartment being modeled.

The modeling equations used in CFAST take the mathematical form of an initial value problem for a system of ordinary differential equations (ODEs). These equations are derived using the conservation of mass, the conservation of energy (equivalently the first law of thermodynamics), the ideal gas law and relations for density and internal energy. These equations predict as functions of time quantities such as pressure, layer height and temperatures given the accumulation of mass and enthalpy in the two layers. The computer code then consists of a set of ODEs to compute the environment in each compartment and a collection of algorithms to compute the mass and enthalpy source terms required by the ODEs.

It is designed to predict the environment in a building subject to unwanted fires in order to make judgments on safety of occupants and the building structure. The model incorporates the evolution of species, such as carbon monoxide, which are important to the safety of individuals subjected to a fire environment. It also includes estimates of the temperature evolution of targets, detectors and sprinklers.

The CFAST model has been subjected to extensive validation studies by NIST and others. Although some differences between the model and the experiments were evident in these studies, they are typically explained by limitations of the model and uncertainty of the experiments. Most prominent in the studies reviewed was the over-prediction of gas temperature often attributed to uncertainty in soot production, radiative fraction and uncertainty in interpretation of thermocouple data. Still, studies typically show predictions accurate within 10 % to 25 % of measurements for a range of scenarios. Like all predictive models, the best predictions come with a clear understanding of the limitations of the model and care in the choice of data provided to the calculations.