Computer Models
For
Fire and Smoke

Model Name: CFAST

Version: 6.2

Date: November 1, 2014

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. Applications compared to experimental data have ranged from a single compartment at a residential scale to large multi-compartment spaces up to more than 100,000 m^3.
Modeler(s), Organization(s):	NIST
User's Guide:	R. Peacock, P. Reneke, and G. Forney, CFAST – Consolidated Model of Fire Growth and Smoke Transport (Version 6): User's Guide, NIST SP 1041r1, 2013, http://dx.doi.org/10.6028/NIST.SP.1041r1
Technical References:	R. Peacock, G. Forney, and P. Reneke, CFAST – Consolidated Model of Fire Growth and Smoke Transport (Version 6): Technical Reference Guide, NIST SP 1026r1, http://dx.doi.org/10.6028/NIST.SP.1026r1
Validation References:	R. Peacock, W. Jones, and P. Reneke, CFAST – Consolidated Model of Fire Growth and Smoke Transport (Version 6): Software Development and Model Evaluation Guide, NIST SP 1086r1, http://dx.doi.org/10.6028/NIST.SP.1086r1
Availability:	http://cfast.nist.gov
Model Actively Supported?:	Yes

Price: Free

Necessary Hardware: Windows and Linux operating systems (GUI front end available only for Windows).

Computer Language: FORTRAN 2003

Size: Case dependent

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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. Applications compared to experimental data have ranged from a single compartment at a residential scale to large multi-compartment spaces up to more than 100,000 m^3.

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.