Computer Models
For
Fire and Smoke

Model Name:	EXIT89
Version:	Version 1.01
Classification:	Evacuation Model
Very Short Description:	An evacuation model designed to handle the evacuation of a large population of individuals from a high-rise building.
Modeler(s), Organization(s):	Rita F. Fahy, National Fire Protection Association
User's Guide:	User's Manual, EXIT89 v 1.01, An Evacuation Model for High-Rise Buildings
Technical References:	(The most recent and complete description of the model is the author's dissertation, completed in May, 2000.) R.F. Fahy, "EXIT89 - An Evacuation Model for High-Rise Buildings -- Model Description and Example Applications," *Proceedings of the Fourth International Symposium*, T. Kashiwagi, Editor, International Association for Fire Safety Science, 1994, pp. 657-668. R.F. Fahy, "EXIT89 - An Evacuation Model for High-Rise Buildings," *Proceedings - Interflam '93*, Interscience Communications Ltd., London, 1993, pp. 519-528. R.F. Fahy, "EXIT89: An Evacuation Model for High-Rise Buildings," *Proceedings of the Third International Symposium*, G. Cox and B. Langford, Editors, International Association for Fire Safety Science, 1991, pp. 815-823. R.F. Fahy, "EXIT89 - An Evacuation Model for High-Rise Buildings," *Proceedings of the 11th Joint Panel Meeting of the UJNR Panel on Fire Research and Safety*, NISTIR

4449, National Institute of Standards and Technology, Gaithersburg MD, October 1990, pp. 306-311.

Validation References: (The most recent verification exercises can be found in the author's dissertation, completed in May, 2000. The results will be published in the near future.)

R.F. Fahy, "A Practical Example of an Evacuation Model for Complex Spaces," *Proceedings of the First International Symposium on Human Behaviour in Fire*, T.J. Shields, Editor, University of Ulster Fire SERT Centre, Carrickfergus, 1998, pp. 743-751.

R.F. Fahy, "High-Rise Evacuation Modeling: Data and Applications," *Proceedings of the 13th Meeting of the UJNR Panel on Fire Research and Safety, March 13-20, 1996*, NISTIR 6030, National Institute of Standards and Technology, Gaithersburg MD, June 1997, pp. 35-42.

R.F. Fahy, "EXIT89 - High-Rise Evacuation Model - Recent Enhancements and Example Applications," *Conference Proceedings of the Seventh International Interflam Conference*, Interscience Communications Ltd., London, 1996, pp. 1001-1005.

Availability: Planned January 2001

Price: Not set yet

Necessary Hardware: An IBM-compatible PC with a 386 or above CPU

Computer Language: FORTRAN

Size: At least 4 megabytes of physical memory should be able to run the model

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Detailed Description:

EXIT89 is an evacuation model designed to simulate the evacuation of large, high-occupancy buildings, such as high-rises, so that the movement of individuals can be tracked while they travel through the building. The model can handle some of the most relevant components of evacuation scenarios of interest in the evaluation of engineered building designs from a fire safety standpoint. These include:

- accounting for occupants with a range of mobilities, including disabled occupants and young children;
- delay times, both those that can serve as surrogates for specific pre-movement activities that are set by the user at each location, and random additional delays that can account for the variability in start times among building occupants;
- a choice of routing options -- the use of model-calculated shortest routes that can accommodate the simulation of an evacuation with a well-trained and/or staff-assisted occupant population, or the use of user-specified directed routes that can accommodate the simulation of an evacuation where occupants are more likely to follow familiar exits or ignore available emergency exits;
- a choice of walking speeds that can reflect the difference between normal movement which might be appropriate in a drill situation and emergency movement which might be more appropriate for a population reacting with a sense of urgency;
- contra flows which will occur during an evacuation when obstructions develop along travel paths; and
- travel both up and down stairwells, which allows the extension of this model to buildings with occupied floors below grade level, as well as buildings where the path of some occupants will be up rather than down stairs.

EXIT89 can also model the impact of smoke on an evacuation, either through user-defined smoke blockages or from output from a CFAST run for the same building.

Verification examples have demonstrated the effectiveness of EXIT89 in modeling several evacuation exercises that were done in a variety of occupancies. Although the model was originally written with high-occupancy, large-population applications in mind, the results of these examples show that the model can be effectively applied to smaller buildings. While the issues of queuing and crowdedness may not be important in smaller buildings, the evacuation of disabled occupants, the impact of exit choice and the variation in pre-movement times have universal relevance and can all be modeled by EXIT89.

The size of the building and its population that can be handled by EXIT89 is limited only by the storage capacity of the machine used. The dimensions of the storage arrays currently allow for up to 700 occupants in a total of 308 nodes or building spaces over 100 time intervals. These can be changed by the user to handle larger problems. Due to the naming convention for nodes that the program relies on, each floor can have up to 89 nodes and the building can have up to 10 stairways.

The program can print out the movement of each occupant from node to node. It also records the location of each occupant at each time interval so that the output can be used as input to TENAB. TENAB will calculate the hazards to which each occupant was exposed using CFAST output for combustion products and will determine when incapacitation or death occurs. The user can suppress this output and have the model

only print out a summary showing floor clearing times, stairway clearing times and last time each exit was used and how many people used each exit.