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Fire Dynamics Simulator with Evacuation

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FDS+Evac is the evacuation simulation module for Fire Dynamics Simulator (FDS). The software is used to simulate the movement of people in evacuation situations. The evacuation simulations can be fully coupled with the fire simulations.

The main features of FDS+Evac are

- Agent based simulation of humans
- Movement algorithm based on the Panic model
- Simple, text based definition of the scenarios
- Post-processing using Smokeview software
- Fire effects are calculated using the Fractional Effective Dose (FED) concept

These pages contain information on

- Obtaining FDS+Evac
- Documentation
- Application examples
- Validation and verification

The reports of the development project are now available:
Development and validation of FDS+Evac for evacuation simulations
VTT Research Notes 2421, 2008
Experimental observations of evacuation situations
VTT Working Papers 85. 2007
Fire Dynamics Simulator with Evacuation: FDS+Evac - Technical Reference and User's Guide
VTT Working Papers 119. 2009

Disclaimer

VTT Technical Research Centre of Finland makes no warranty, expressed or implied, to users of FDS+Evac, and accepts no responsibility for its use.

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Official Versions

Starting from FDS Version 5, the official versions are the same as the FDS versions available from the FDS-SMV site. You should have downloaded and installed the latest version of FDS before you start using FDS+Evac. Check that your your executable and the FDS+Evac guide have same FDS and Evac version numbers. Check also the FDS+Evac README file for the latest changes to the program code and user input. The latest version number of the evacuation module is "Evac 2.5.0" and it is embedded in FDS versions 6.1.0 onwards.

Beta Versions

Beta versions have updates in the evacuation part that have not yet been implemented in the official versions. The users should notice that the beta versions are under development, and the features and user input may change in the future. For now, there are no beta test versions available. All the features of the evacuation module are embedded in the latest FDS version. The source code of FDS (and FDS+Evac) is open source and it can be found at FDS-SMV Project page hosted by Google Code.

Bug reports and help requests

For a help request, place text 'FDS+Evac Help:' on the subject line and send your email to timo.korhonen(at)vtt.fi. Or use the FDS-SMV discussion group hosted by Google Groups. The discussion group is the prefered method to ask questions, because someone else may have encountered similar problems or might encounter those in the future.

When reporting a bug, place text 'FDS+Evac Bug:' on the subject line and send your email to timo.korhonen(at)vtt.fi. Or use the Issue Tracker at the FDS-SMV Project page hosted by Google Code to report bugs. Please, read the Effective Posting wiki before you post anything to the Issue Tracker. The issue tracker is the prefered method to report bugs.

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Additional information

In code development and technical issues, place text 'FDS+Evac:' on the subject line and send your email to
timo.korhonen(at)vtt.fi

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Manuals

Download the latest User's Guide for FDS+Evac (FDS 6.1.0, Evac 2.5.0, July 15, 2014, under construction: The User Guide part is not yet updated for FDS 6). This is an unpublished version that should not be cited. The users should notice that the FDS+Evac is under development, and the features and user input may change between the different Evac versions, see the Reame file for the changes.

The latest published version of the manual is
Fire Dynamics Simulator with Evacuation: FDS+Evac - Technical Reference and User's Guide
VTT Working Papers 119. 2009

Read the latest changes: Readme.txt

How to debug your input file: Readme_InputErrors.txt

Project reports

Development and validation of FDS+Evac for evacuation simulations
VTT Research Notes 2421, 2008

Experimental observations of evacuation situations.
VTT Working Papers 85. 2007

Other publications

1. Korhonen, Timo; Hostikka, Simo; Keski-Rahkonen, Olavi. A proposal for the goals and new techniques of modelling pedestrian evacuation in fires. Proceedings of the 8th International Symposium on Fire Safety Science. Beijing, China, 18 - 23 Sept. 2005. Gottuk, D. & Lattimer, B. (eds.). International Association of Fire Safety Science (2005), pp. 557 - 569. (preprint 0.32 MB)

2. Korhonen, Timo; Hostikka, Simo; , Heliövaara, Simo; Ehtamo, Harri; Matikainen, Katri. Integration of an Agent Based Evacuation Simulation and the State-of-the-Art Fire Simulation. Proceedings of the 7th Asia-Oceania Symposium on Fire Science & Technology. Hong Kong, 20 - 22 Sept. 2007. Eds. Chow and Y. Hasemi, China Public Security Publisher (2011), pp. 635-645, ISBN 978-988999109-8 (preprint 0.76 MB)

3. Heliövaara, Simo. Computational Models for Human Behavior in Fire Evacuations. M.Sc. Thesis, Department of Engineering Physics and Mathematics, Helsinki University of Technology, 2007. (pdf 0.98 MB)

4. Matikainen, Katri. KÄYTTÄYTYMINEN UHKATILANTEESSA – Poistumisreitin valintaan vaikuttavat sosiaalipsykologiset tekijät tulipalossa. Pro Gradu -tutkielma, Valtiotieteellinen tiedekunta, Helsingin yliopisto, 2007. (pdf 0.30 MB)

5. Korhonen, Timo; Hostikka, Simo; Heliövaara, Simo; Ehtamo, Harri; Matikainen, Katri. FDS+Evac: Evacuation Module for Fire Dynamics

Simulator. Proceedings of the Interflam2007: 11th International Conference on Fire Science and Engineering. London, UK, 3 - 5 Sept. 2007. Interscience Communications Limited (London, UK, 2007), pp. 1443-1448. (preprint 0.13 MB)

6. Korhonen, Timo; Hostikka, Simo; Heliövaara, Simo; Ehtamo, Harri. An Agent Based Fire Evacuation Model. 4th International Conference on Pedestrian and Evacuation Dynamics. Wuppertal, Germany, 27 - 29 Feb. 2008. (preprint 0.28 MB)

7. Heliövaara, Simo; Ehtamo, Harri; Korhonen, Timo; Hostikka, Simo. Modeling Evacuees' Exit Selection with Best-Response Dynamics. 4th International Conference on Pedestrian and Evacuation Dynamics. Wuppertal, Germany, 27 - 29 Feb. 2008. (preprint 0.26 MB)

8. Korhonen, Timo; Hostikka, Simo; Heliövaara, Simo; Ehtamo, Harri. FDS+Evac: Modelling Social Interactions in Fire Evacuation. Proceedings of 7th International Conference on Performance-Based Codes and Fire Safety Design Methods. Auckland, New Zealand, 16 - 18 Apr. 2008. SFPE (Bethesda, MD, USA, 2008), pp. 241-250. (preprint 0.21 MB)

9. Ehtamo, Harri; Heliövaara, Simo; Korhonen, Timo; Hostikka, Simo. Game Theoretic Best-Response Dynamics for Evacuees' Exit Selection, Advances in Complex Systems, Vol. 13 (2010), No. 1, pp. 113-134.

10. Korhonen, Timo; Hostikka, Simo; Kling, Terhi. FDS+Evac: V&V of the Staircase Model, in Proceedings of the 8th International Conference on Performance-Based Codes and Fire Safety Design Methods. SFPE, Bethesda, MD, USA (2010), pp. 335-346.

11. Heliövaara, Simo; Korhonen, Timo; Hostikka, SImo; Ehtamo, Harri. Counterflow Model for Agent-Based Simulation of Crowd Dynamics, Building and Environment, Vol 48 (2012), pp. 89-100.

12. Korhonen, Timo; Heliövaara, Simo. FDS+Evac: Herding Behavior and Exit Selection, Fire Safety Science 10 (2011), pp. 723-732. (Fire Safety Science - Proceedings of the Tenth International Symposium, Editor M. Spearpoint, International Association for Fire Safety Science, Interscience Communications Ltd (2011), ISNN 1817-4299, pages 723-732.)

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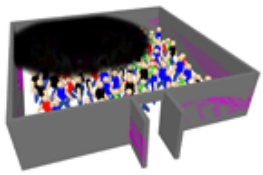
This page contains FDS+Evac sample calculations. The samples have been created using the FDS6 based version of the evacuation prgram (FDS 6.1.0, Evac 2.5.0, svn number 19770).

The input files contain many comments. By reading these files carefully, one should be able to make evacuation simulations with FDS+Evac. One should, of course, know how to set up a FDS input file.

Example 1: A simple one floor geometry

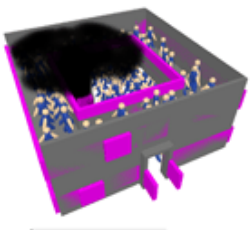


The simple one floor geometry presented in the User's Guide.

Larger image

Case A	Full fire + evacuation calculation.	fds file
Case B	Use fire data from Case A (CHID_evac.fed) and run only the evacuation part.	fds file
Case C	Use fire data from Case A (CHID_evac.fed) and the evacuation flow fields from Case B (CHID_evac.eff) to run the evacuation. This is useful when one is doing several runs for a given evacuation scenario, for example to do Monte Carlo simulation, where the same evacuation scenario is repeated with a little bit different human inputs.	fds file

Example 2: A simple two floor geometry



The simple two floor geometry presented in the User's Guide.

Larger image

Case A	Full fire + evacuation calculation.	fds file
Case B	Use fire data from Case A (CHID_evac.fed) and run only the evacuation part.	fds file

Case C	Use fire data from Case A (CHID_evac.fed) and the evacuation flow fields from Case B (CHID_evac.eff) to run the evacuation. This is useful when one is doing several runs for a given evacuation scenario, for example to do Monte Carlo simulation, where the same evacuation scenario is repeated with a little bit different human inputs.	fds file

Example 3: Atrium

This is a fictitious atrium fire with 70 people on the first floor and 70 on the second floor. This example demonstrates the simultaneous simulation of fire and evacuation.
Flash video
Fds file

Larger image

More Examples

More examples can be found at the FDS+Evac Miscellaneous Examples page.

See also the Validation and Verification section for more examples.

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Validation and Verification

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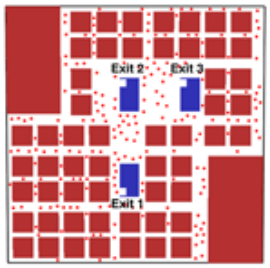
Validation and verification of the simulation tool are essential parts of the code development. This page contains information on the various validation and verification cases of FDS+Evac.

Validation by comparison against other models

Below some validation test cases are listed, where FDS+Evac is compared agains another evacuation simulation programmes. See the FDS+Evac Manual for the details of the test cases and for the results.

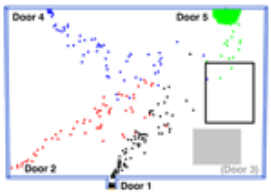
Case A: Open floor office



Larger image

Case A considers one floor of a multi-storey office building. The floor has dimensions of 40×40 m2 and there are initially 216 persons on this floor. The properties of these humans were assumed to be as the 'Office Staff' category in the Simulex model and the reaction times of the humans were assumed to follow a normal distribution with mean of 90 s and standard deviation of 11 s (fds files d1, d2, d3, d12, d13, d23, d123). These FDS+Evac calculations were done using FDS6 based version (FDS 6.1.0, Evac 2.5.0). These results are compared against Simulex in the FDS+Evac Manual.

Case B: Sports hall



Larger image

Case B is a sports hall with 500 people. The hall is used to practice different kind of sports, including track and field and football (soccer). There are no spectator stands in the hall and neither are there any social spaces. Three different reaction time scenarios were considered (fds files N(60,15), N(60,15)_B, N(180,15), N(180,15)_B, logN, logN_B). These FDS+Evac calculations were done using FDS5 based version (FDS 6.1.0, Evac 2.5.0). These results are compared against Simulex in the FDS+Evac Manual.

Case C: Fictitious Assembly Space

Larger image

Case C is a large fictitious public space having dimensions of 50× 60 m2, and only one, 7.2 m wide corridor leading to the exit. There are 1000 persons initially in the space (fds files CorrA, CorrB, DoorC, DoorD). These FDS+Evac calculations were done using FDS5 based version (FDS 6.1.0, Evac 2.5.0). These results are compared against Simulex in the FDS+Evac Manual.

Case D: Specific flows through doors

This geometry is commonly used in the literature to calculate the specific flows through doors. In the test, there are 100 agents randomly located at the 5x5 m2 square in front of a door. Door widths 0.8 m to 3.0 m are used. See the FDS+Evac manual for the details and results. The example input file is on the FDS+Evac Miscellaneous Examples page.

Validation by comparison against experimental results

See the FDS+Evac Manual for the results of these validation tests.

Case	Description	Input File
Corr	Specific flows in corridors	See: FDS+Evac Miscellaneous Examples
Stairs	Office Building: fire drill	Type 1, Type 2, Type 3
Library	Public library: fire drill	Lambda 0.3, Lambda 0.5

Verification of Some Submodels

See the FDS+Evac Manual for the details and results of these verification tests. Note that the IMO test cases contain many more verification tests, but they are not listed here.

Case	Description	Input Files
FED Index	Fractional Effective Dose calculation	all, O2, CO2, CO
SmokeSpeed	Smoke density vs walking speed	0mg/m3, 500mg/m3, 1000mg/m3, 1500mg/m3
DoorAlgo	Door selection algorithm: A, B no smoke C, D: with smoke	A, B, C, D

Verification: IMO test cases

Test cases defined by IMO MSC/Circ.1238 (30 October 2007) 'Guidelines For Evacuation Analyses for New and Existing Passenger Ships', Annex 3, are listed on a separate page.

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FDS+Evac is developed by the researchers of VTT (Fire safety technology team), in co-operation with the following laboratories:

- Building and Fire Research Laboratory, National Institute of Standards and Technology, USA
- Systems Analysis Laboratory, Helsinki University of Technology, Finland
- Department of Social Psychology, University of Helsinki, Finland

The development project has been funded by the Finnish Funding Agency for Technology and Innovation, the Finnish Fire Protection Fund, the Ministry of the Environment, and the Academy of Finland.

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