Fire & Rescue NSW

NSW GOVERNMENT

What to look at in fire engineering analysis

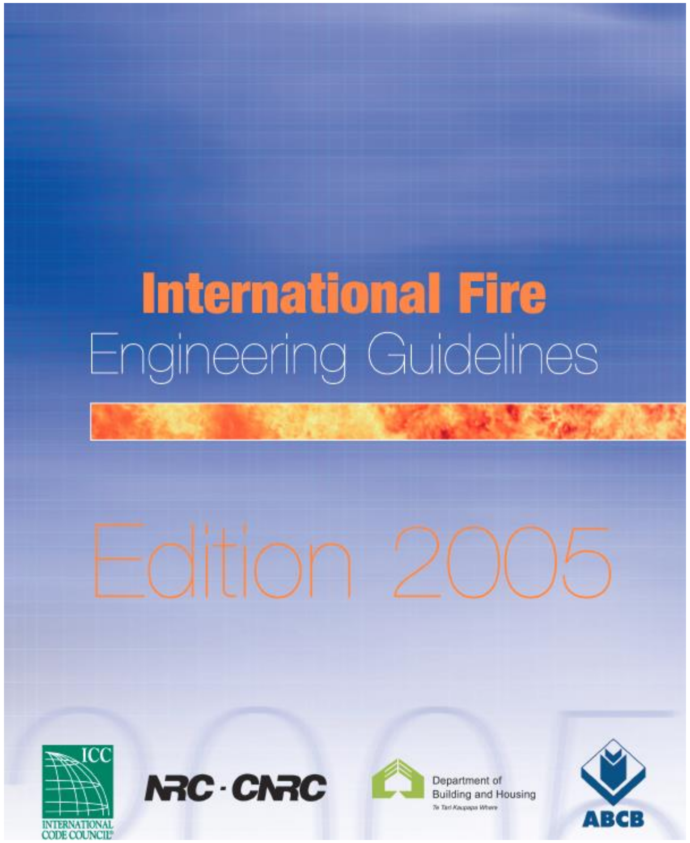
Jamie Vistnes
Manager, Fire Safety Policy Unit

Approaches and Methods of Analysis

- Absolute
- Comparative

- Qualitative
- Quantitative

- Deterministic
- Probabilistic



1.2.9.4 Methods of analysis

There are many forms of analysis methods:

- formulas, equations and hand calculations
- spreadsheet calculations
- statistical studies
- experiments with physical scale models
- full-scale experimental tests such as fire tests or trial evacuations of real buildings
- computer simulation of fire development and smoke spread
- computer simulation of people movement.

1.2.9.4 Methods of analysis

The methods chosen should:

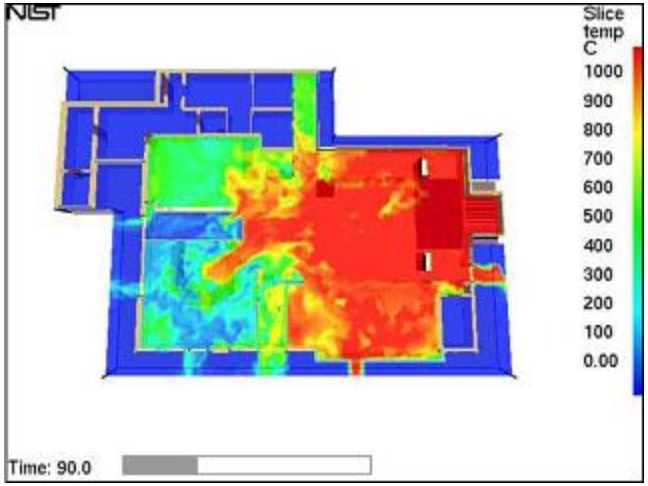
- be well documented (especially their limitations and assumptions) either in the literature or by the fire engineer
- be well validated
- be suitable for the task
- generate outputs that can be compared with the acceptance criteria agreed for the analysis
- have clearly defined limitations and assumptions that are well documented.

“The FEB report should record, as appropriate, the above information for each method chosen.”

1.2.9.4 Methods of analysis

These can be summarised as needing to be:

- Well documented and well validated
- Suitable for the task
- Used within limitations and assumptions
- Generate suitable outputs to address acceptance criteria



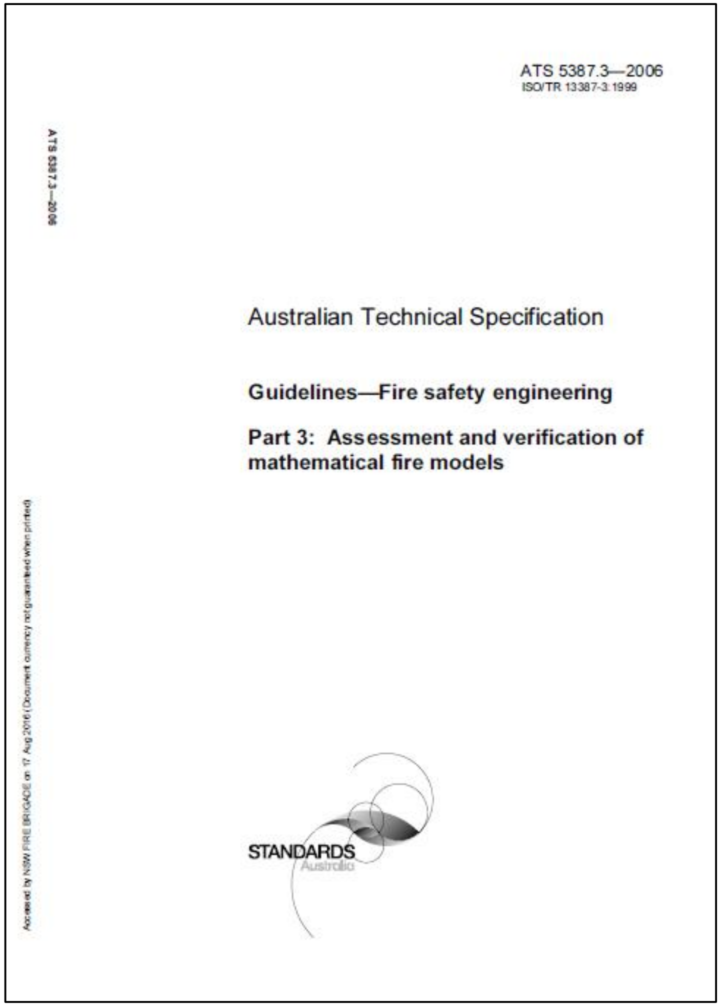
http://www.nist.gov/el/fire_grants.cfm

Well Documented and Well Validated

Standards available for assessing and verifying fire models

ATS 5387.3—2006
ISO/TR 13387-3:1999
Australian Technical Specification
Guidelines—Fire safety engineering
Part 3: Assessment and verification of mathematical fire models

ASTM E 1355-97, Standard Guide for Evaluating the Predictive Capability of Deterministic Fire Models


ATS 5387.3—2006
ISO/TR 13387-3:1999

ATS 5387.3—2006

Australian Technical Specification

Guidelines—Fire safety engineering

Part 3: Assessment and verification of mathematical fire models

STANDARDS Australia

A.6 Review of FRIEDMAN, R., An International Survey of Computer Models for Fire And Smoke, Journal of Fire Protection Engineering, 4, pp. 81-92, 1992

- Reasons why a model may not yield results in complete accord with actual fire behaviour are:

  a) idealizations and simplifications on which the model is based deviate significantly from reality;
  b) input parameters supplied to the model are inaccurate;
  c) "default" values of coefficients used internally in the model are incorrect;
  d) the computation process yields a wrong result (due to poor choice of time steps or mesh size or due to mathematical singularities or instabilities);
  e) the experimental measurements are incorrect or non-repeatable.

A.6 Review of FRIEDMAN, R., An International Survey of Computer Models for Fire And Smoke, Journal of Fire Protection Engineering, 4, pp. 81-92, 1992

- It is generally risky to apply a model to conditions which are drastically different from those for which the model has been validated.

Conclusion:

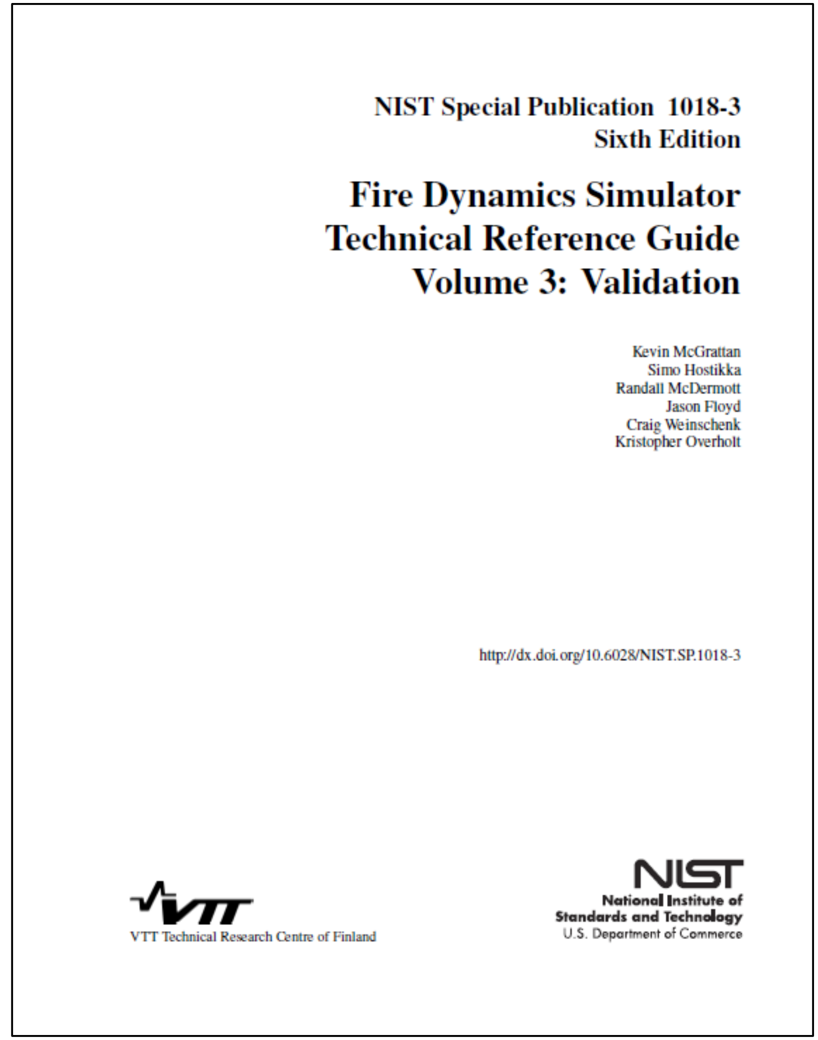
Just because a model exists, doesn't mean it is necessarily accurate and appropriate for use.

Well Documented and Well Validated

How much effort goes in to reviewing validation and verification documentation?

How much effort goes in to investigating whether it even exists?

How much of this review is then documented in the FEB/FER?


NIST Special Publication 1018-3
Sixth Edition

Fire Dynamics Simulator
Technical Reference Guide
Volume 3: Validation

Kevin McGrattan
Simo Hostikka
Randall McDermott
Jason Floyd
Craig Weinschenk
Kristopher Overholt

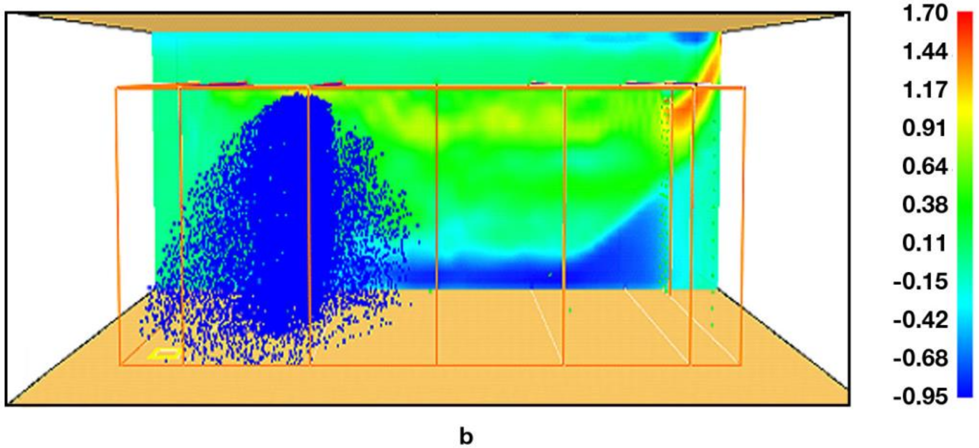
http://dx.doi.org/10.6028/NIST.SP.1018-3

VTT Technical Research Centre of Finland

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Well Documented and Well Validated

- FDS may be considered generally well validated for predicting smoke movement in a building.
- Can also be used to predict fire spread and sprinkler operation
  - ➢ Questions still remain as to how accurately are these predicted.
- Therefore, just because something is included in a model, doesn't mean it can always be used.



http://www.tyco-fire.com/TFP_common/DoorWayFlowsWP.pdf

Suitable for task

- Some typical examples not considered suitable for the task:
  - Egress modelling may be undertaken to demonstrate that the evacuation time is short compared to the FRL prescribed, however these times do not correlate.
  - Fire Brigade Intervention is often analysed and quantified (to some extent), however not linked to the acceptance criteria

- Whilst quantitative modelling and robust technical analysis is encouraged, it needs to be appropriate to the agreed acceptance criteria and not used as a “smoke screen” to fill out the report.

Within Limitations and Assumptions

- How well do you know the limitations and assumptions of a tool?
- Have you looked at the basis for deriving the tool?
  - For example, fire severity calculations derived from experiments in relatively small compartments.
- When is it OK to move outside these limitations?
  - For example, using a zone model for a 2,500m^2 compartment?
- Again, are these clearly documented in the FEB/FER?

Generate suitable outputs to address acceptance criteria

- Can the results generated be used to demonstrate that the acceptance criteria has been achieved?

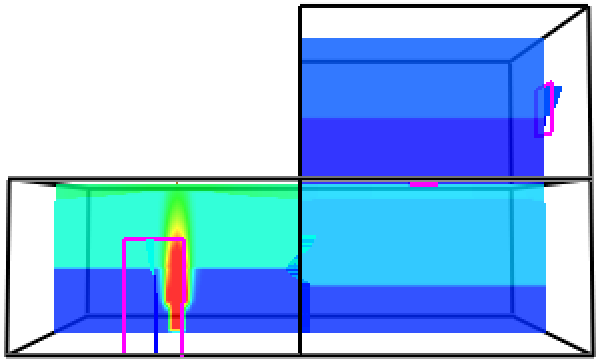
- Without sufficient outputs:
  - ➢ The conclusions drawn from the analysis cannot be appropriately documented
  - ➢ Makes it difficult for a reviewer to determine how much engineering judgement has been used

Use of Technical Tools - Inputs

- Obviously affect the outcome – so critical
- FRNSW experience a general lack of detail in FEB, therefore how can we agree
  - Need to further work on what are considered critical to the analysis
  - All inputs/assumptions clearly justified and documented
  - Also often find changes occur between FEB and FER, but not documented
- Note: New Zealand Verification Method not considered an appropriate reference as this is a VM for an different country's building code with no specific supporting references

Use of Technical Tools - Inputs

- Sensitivities need to be considered, which may vary according to the tool being used
  - These should also be identified at FEB stage
  - FRNSW experience a wide variation in how this is considered



https://pages.nist.gov/cfast/

Use of Technical Tools - Outputs

- Need to be sufficient to justify the results/conclusions made
- FRNSW experience a wide variation in both what outputs are shown and how they are used, for example:
  - No results, only reference to modelling being undertaken
  - A random sample of CFD results provided that may not directly correlate with times concerned
  - CFD results at certain locations only
  - A full set of CFD results for each criteria and time of interest
  - Only thermocouple readings

Use of Technical Tools

- Most frequent “technical tool” used is arguably the fire engineer themselves!
- More development in models, less use in practice?
- Is this because of the types of issues being addressed by fire engineering, or fire engineers changing methods of analysis to reduce costs?

What is Needed for the Future?

- Encourage more robust quantitative analysis using technical tools, rather than qualitative comparisons to obscure DtS designs that are far from what is proposed

- Full probabilistic risk assessments utilising technical tools to determine the risk
  - Individual and societal risk likely to drive policy development / direction in the built environment
  - AFAC part of BCC working group in this space
  - Wider consultation likely to occur
  - Quantifiable risk likely to be the underpinning structure on which building codes developed – need for proper risk assessment

Questions

Jamie Vistnes
Manager - Fire Safety Policy Unit

| **E** Jamir.Vistnes@fire.nsw.gov.au
| **T** (02) 9742 7434
| **www.fire.nsw.gov.au**