# Computer Models
# For
# Fire and Smoke

*Model Name*: B-RISK

*Version*: 2014.01

*Date*: January 2014

*Classification*: Zone Model

*Very Short Description*: A zone model with probabilistic (Monte Carlo) functionality to predict the fire environment in an enclosure.

*Modeler(s), Organization(s)*: Colleen Wade, BRANZ Ltd, New Zealand.

*User's Guide*: Wade C, Baker G, Frank K, Robbins A, Harrison R, Spearpoint M, and Fleischmann C. B-RISK User Guide and Technical Manual. BRANZ Study Report No 282. BRANZ Ltd, Porirua, New Zealand, 2013.

*Technical References*: Wade C, Baker G, Frank K, Robbins A, Harrison R, Spearpoint M, and Fleischmann C. B-RISK User Guide and Technical Manual. BRANZ Study Report No 282. BRANZ Ltd, Porirua, New Zealand, 2013.

*Validation References*: (all of the following papers cite experimental comparisons with the model):

Harrison, R., Wade, C.A., Spearpoint, M., 2014. Predicting Spill Plumes with the Fire Risk Zone Model B-RISK. Fire Technology 50, 205–231.

Wade C. B-RISK Software Benchmarking Examples. BRANZ Study Report No 292. BRANZ Ltd, Porirua, New Zealand, 2013.

Wade, C.A., 2013. Room size limits when using a fire zone model for smoke-filling calculations (Technical Recommendation No. 17). BRANZ.

Baker, G.B., Collier, P.C.., Frank, K. Sazegara, S., Spearpoint, M.J., Fleischmann, C.M., and Wade, C.A. A comparison of a priori modelling predictions with experimental results to validate a design fire generator submodel. Fire and Materials Conference, San Francisco, January 2013.

Baker, G.B., Spearpoint, M.J., Fleischmann, C.M., and Wade, C.A. Experimental Validation for an Item-to-Item Fire Spread Submodel, Proceedings Fire and Materials 2011 – 12th International Conference, Interscience Communications Ltd, London, UK, pp. 209-220, 2011.

Frank K., Spearpoint, M., Fleischmann, C.M. and Wade C., 2011. A Comparison of Sources of Uncertainty for Calculating Sprinkler Activation. Fire Safety Science 10: 1101-1114. 10.3801/IAFSS.FSS.10-1101.

*Availability*: Download at http://www.b-risk.net or
http://www.branz.co.nz/cms_display.php?sn=75&st=1&pg=11092

*Model Actively Supported?*: Yes

*Price*: Free

*Necessary Hardware*: PC with OS - Windows XP, Windows 7, 32 or 64 bit.

*Computer Language*: Microsoft Visual Studio and VB.NET

*Size*: Full installation file ~ 8 MB.

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*Detailed Description*: B-RISK is a zone model with probabilistic (Monte-Carlo) capability. B-RISK uses a probabilistic latin-hypercube Monte-Carlo sampling technique with a deterministic fire zone model calculation engine to automate repeat iterations of a fire scenario, each time sampling inputs from user-defined statistical distributions. B-RISK therefore allows the time for critical performance thresholds to be exceeded to be presented as cumulative density functions that indicate the probability of the threshold level being exceeded, or not, at a given time.

It also includes:

- a Design Fire Generator and item-to-item fire spread module allowing building contents to be randomly placed within a room and the overall rate of heat release to be determined;
- a comprehensive sprinkler response module, including operation of multiple heads, and parameters for effectiveness and reliability of sprinkler systems;
- reliability of other systems such as smoke detectors, mechanical ventilation, and passive elements such as doors;
- visualisation of geometry and results using the Smokeview software;

- balcony spill plume relationships to facilitate the design of smoke management systems;
- a glass fracture submodel; and
- flame spread calculations on combustible walls and ceilings.

B-RISK is used to calculate the time dependent distribution of smoke, fire gases and heat throughout a collection of connected compartments during a fire. In B-RISK, each compartment is divided into two layers. The modeling equations used in B-RISK take the mathematical form of an initial value problem for a system of ordinary differential equations (ODE). These equations are derived using the conservation of mass, the conservation of energy, the ideal gas law and relations for density and internal energy. These equations predict as functions of time quantities such as pressure, layer heights and temperatures given the accumulation of mass and enthalpy in each of the two layers. The B-RISK model then solves of a set of ODE's to compute the environment in each compartment and a collection of algorithms to compute the mass and enthalpy source terms. The model incorporates the evolution of species, such as CO, CO2, H2O, HCN and soot some of which are important to the safety of individuals subjected to a fire environment.

B-RISK models up to 12 compartments, unlimited number of vents, mechanical extract or supply to/from the exterior, optional ignition and flame spread on walls and ceilings, multiple plumes and fires, sprinklers and detectors, visibility through smoke based on optical density, and calculation of fractional effective dose based on oxygen, carbon dioxide and carbon monoxide concentrations. The geometry includes variable area/height relations with an option for a sloping ceiling, material properties and fire object databases, two-layered walls, and flow through wall openings and holes in floor/ceiling connections.

The flame-spread algorithms are based on thermal flame spread theory. Both upward (wind-aided) and lateral flame spread is modeled. Ignition is predicted making use of the Flux Time Product method based on analysis of cone calorimeter time to ignition data. Heat release contribution by linings is determined based on the calculated pyrolysis area and time dependent heat release data from cone calorimeter tests.

The program allows results to be viewed in graphs or tabular form, and will save results directly to an Excel spreadsheet with automatic generation of Excel charts for selected variables (for users with Microsoft Excel installed).