FIRE AND SECURITY
CONSULTING SERVICES
ABN 67 166 244 105

17 McKenna Court
NOOSAVILLE
QUEENSLAND, 4566
AUSTRALIA

Phone: +61 (0)7 5455 5148, Mobile: 0409 399 190, Email: rafoster@bigpond.net.au

HEAT FLUX (RADIATION) CALCULATIONS FOR PERFORMANCE BASED ALTERNATIVE SOLUTIONS

Software and Methodology

For radiation calculations, Fire and Security Consulting Services (FSCS) uses the spreadsheet “Rad Parll Surf.xls” written by I.D Bennetts and K.W.Poh from CSARE VUT – Feb. 2000 (Victoria University of Technology).

This is a simplified version of the CSIRO FireCalc programme “Radiation”, but using only parallel surfaces. The following information is provided with the programme:

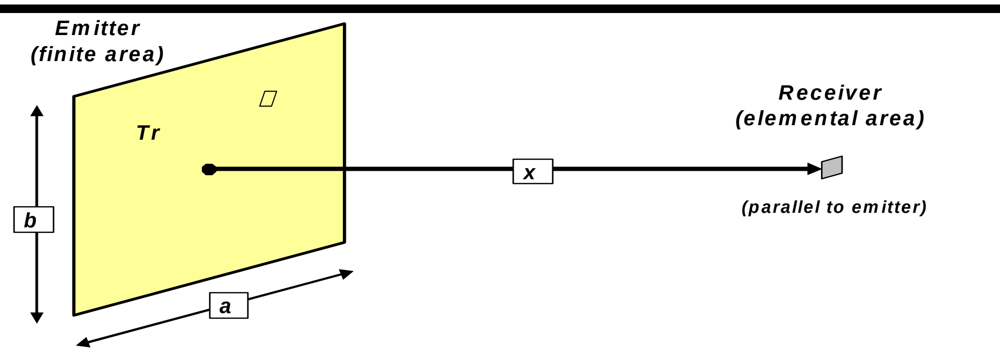
The program computes maximum radiation at a point in the assumption that the fire sources are not dispersed so that the fire sources are not dispersed so that the direction of maximum radiation is significantly aside from the centre of gravity of fire sources. For instance, the case of two fire sources located at an angle more than 90° is not covered by this program. All fire sources are supposed to be of rectangular shape and located in the rectangular planes as shown in the introductory screen. Emissivity of fire sources is assumed to be 1.0, i.e. "temperature of sources" is radiation temperature.

The radiation is computed using the formula: $dQ = \sigma T^4 \cos\alpha \cos\beta / (\pi r^2)\, dF1\, dF2$, where σ is Stefan-Boltzmann's constant, T is absolute temperature, α and ß are angles between radius-vector r and infinitesimal areas dF1 of radiation and dF2 of a receptor located in the origin.

Temperatures are estimated for the expected fire source and FireCalc advises that temperatures of between 750°C and 1,000°C are appropriate for compartment fires. FireCalc also advises that for petroleum fires a flame temperature of 1,026°C is appropriate.

- For Radiation from the adjacent property this analysis contemplates a maximum heat flux of 80kW/m^2 (From BCA Verification Method CV1) on the boundary which equates to a flame temperature of 817°C.
- For Radiation to the adjacent property this analysis contemplates a flame temperature of 1,000°C within the building in general occupancy areas.

The calculation methodology produces data in the format shown below.



INPUT DATA				
width	a	=	3.5	m
depth	b	=	0.8	m
distance	x	=	1.5	m
temperature	Tr	=	817	°C
emissivity	ε	=	1	

RESULTS			
emitted radiation	=	80.04	kW/m²
configuration factor	=	0.22	
received radiation at surface	=	17.74	kW/m²

Typical Heat Flux Calculation

Acceptance Criteria - Radiation Heat Flux

Adjoining Lots

For radiation heat flux on adjoining buildings on adjoining lots, acceptance criteria will be from BCA CV1 as below:-

CV1 *Compliance with CP2 (a) (iii) to avoid the spread of fire between buildings on adjoining allotments is verified when it is calculated that-*

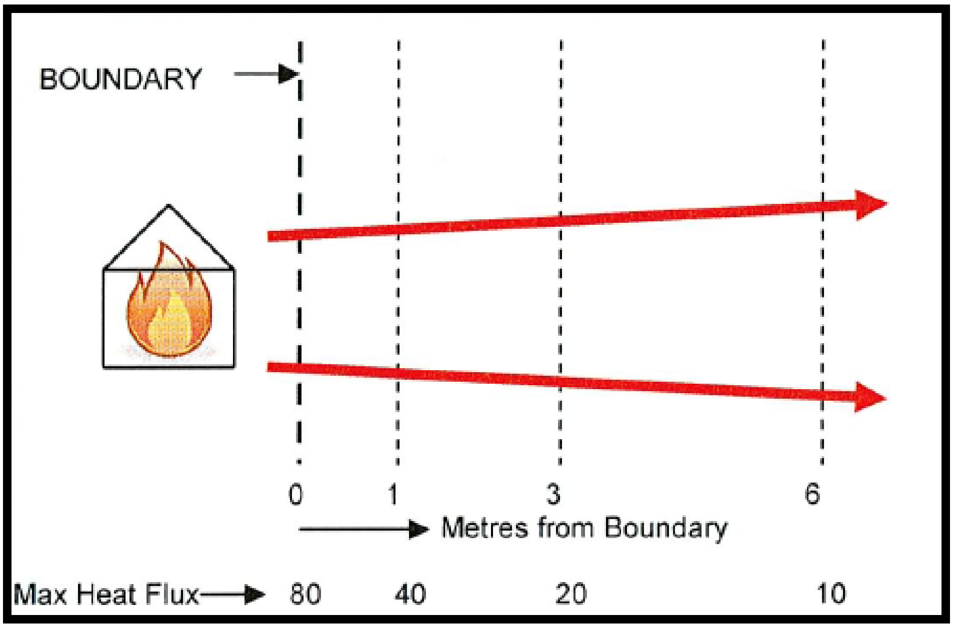
(a) a building will not cause heat flux in excess of those set out in column 2 of Table CV1 at locations within the boundaries of an adjoining property set out in column 1 of Table CV1 where another building may be constructed; and

(b) when located at the distances from the allotment boundary set out in column 1 of Table CV1, a building is capable of withstanding the heat flux set out in column 2 of Table CV1 without ignition.

Table CV1	
Column 1	*Column 2*
Location	***Heat Flux*** *(kW/m²)*
On boundary	*80*
1 m from boundary	*40*
3 m from boundary	*20*
6 m from boundary	*10*

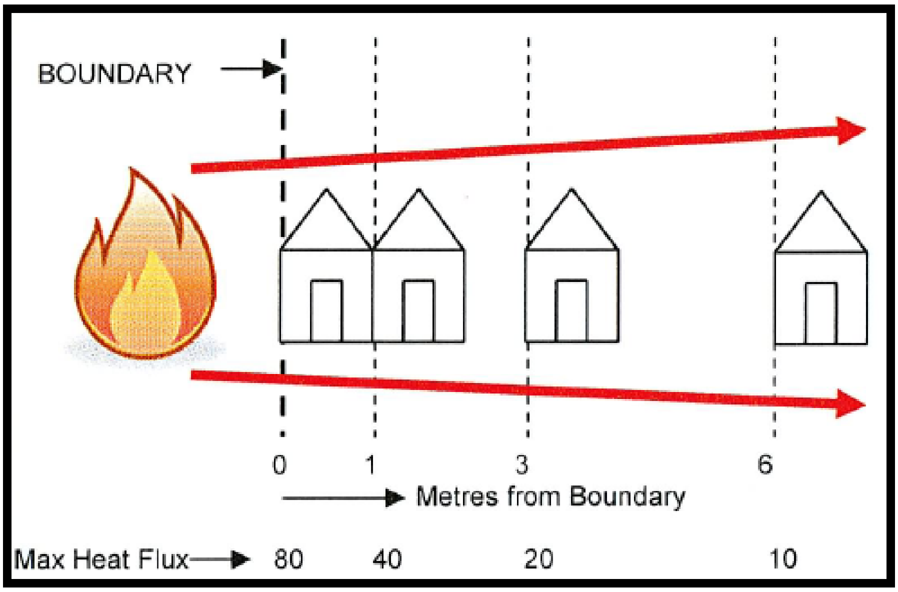
Acceptance of heat flux emitted from and radiated to openings in the building where less than 3m from the boundary are:-

1. In accordance with BCA Verification method CV1a, emitted heat flux from the building shall not exceed 80kW/m^2 at the boundary, 40kW/m^2 at 1m from the boundary, 20kW/m^2 at 3m from the boundary and 10kW/m^2 at 6m from the boundary. This is graphically shown below.



CV1a

2. In accordance with BCA Verification method CV1b, the building shall be able to withstand emitted heat flux of 80kW/m^2 at the boundary, 40kW/m^2 at 1m from the boundary, 20kW/m^2 at 3m from the boundary and 10kW/m^2 at 6m from the boundary. This is graphically shown below.



CV1b

Additionally, the Guide to the BCA provides the following data in respect to ignition of materials from radiant heat flux;

- Ignition of timber in the presence of a spark – 20kW/m^2.
- Ignition of timber in the absence of a spark – 35kW/m^2.
- Ignition of curtains in the presence of a spark – 10kW/m^2.
- Ignition of curtains in the absence of a spark – 20kW/m^2.

On the Same Lot

For radiation heat flux on adjoining buildings on the same lot, acceptance criteria will be from BCA CV2 as below:-

CV2 Compliance with CP2 (a) (iii) to avoid the spread of fire between buildings on the same allotment is verified when it is calculated that a building-

(a) is capable of withstanding the heat flux set out in column 2 of Table CV2 without ignition; and

(b) will not cause heat flux in excess of those set out in column 2 of Table CV2, when the distance between the buildings is as set out in column 1 of Table CV2.

Table CV2	
Column 1	Column 2
Distance between buildings	**Heat Flux** (kW/m^2)
0 m	80
2 m	40
6 m	20
12 m	10

Additionally, the Guide to the BCA provides the following data in respect to ignition of materials from radiant heat flux;

- Ignition of timber in the presence of a spark – 20kW/m^2.
- Ignition of timber in the absence of a spark – 35kW/m^2.
- Ignition of curtains in the presence of a spark – 10kW/m^2.
- Ignition of curtains in the absence of a spark – 20kW/m^2.

DtS or Performance Based Assessment?

FSCS has experienced varying advice from different Building certifiers as to the application of Verification Methods CV1 and/or CV2. Some have advised that the use of CV1 and / or CV2 with satisfactory results meets the Deemed to Satisfy (DtS) criteria of the BCA and have instructed FSCS to carry out the heat flux calculations independently of any other Report.

Other Building Certifiers have advised that the use of CV1 and / or CV2 constitutes a Performance Based Alternative Solution necessitating the complete Fire Engineering process of a Fire Engineering Brief (FEB) and Fire Engineering Report (FER).

Accordingly FSCS always seeks each Certifier's interpretation and requirement.

Heat Flux Attenuation

Heat flux emitted from or received at a building may be attenuated by screening to the windows or openings to reduce the heat flux.

Using Crimsafe ® stainless steel mesh screens, the resultant heat flux can be calculated using the agreed design tools and the application of the available heat flux attenuation from the stainless steel screens.

CSIRO testing of Crimsafe ® stainless steel mesh screens show a reduction of 40% in the radiant heat flux when subjected to the standard time- temperature protocol in a test furnace.

The Figures below show typical screening of windows and building openings.

Stand Off Screening

Flush Screening

I trust that this document clarifies FSCS's approach to heat flux calculations and assessment.

Regards

Richard A Foster RPEQ 7753

Dip Mech Eng; Dip Mar Eng; MSFPE; Member IE (Aust) SFS

Fire Safety Engineer

Principal – Fire and Security Consulting Services