Fire Dynamics Calculations Using the CFI Calculator

These problems are designed to allow the user to become familiar with the use of the CFITrainer.net Fire Calculator tool and get a basic understanding of the effects of changing various input fields.

FLAMEHEIGHT

This calculation can be utilized to estimate the flame height in meters if the heat release rate is known or can be utilized to estimate the heat release rate based on an estimated flame height.

1. Calculate the flame height of a 1-meter diameter pool fire with an estimated heat release rate of 500 kilowatts. The fire is located in the center of a compartment.

   McCaffrey 2.4 m

   NFPA 2.09 m

   Heskestad 1.74 m

2. What effect does changing the diameter of the pool have?

   McCaffrey ____

   NFPA ____

   Heskestad ____

3. What effect would be observed if the fire was in the corner of a compartment?

   McCaffrey ____

   NFPA ____

   Heskestad ____

4. Calculate the estimated Heat Release Rate of a fire with an observed flame plume of approximately 1.2 meters. The fire is in the center of the room and the diameter is approximately 0.4 meters.

5. What effect would be observed if the fire was against the wall?

Responses to Questions 4 and 5

	Fire in Center of Room	Fire Against Wall
McCaffrey	88 kW	88 kW
NFPA	125 kW	63 kW
Heskestad	129 kW	129 kW

HEAT FLUX

This equation is utilized to estimate the amount of heat energy transferred from a source to a target and is expressed in kilowatts/meter^2. It is can be utilized directly if the heat release rate is known, or can be utilized in conjunction with the estimated heat release rate derived utilizing the FLAMEHEIGHT calculations.

1. Estimate the heat flux to an object 1 meter from the axis of a fire. The fire plume is above a pile of wooden debris located in the center of the compartment, described as having a diameter of 0.5 meters and a flame height of 2 meters.

2. Estimate the heat flux to an object 2 meters away from the axis of the above fire. How is it different?

3. What effects would be observed if the above-described fire was gasoline as opposed to wood?

Responses to Heat Flux Questions 1 – 3

	HRR (NFPA)	Radiation Fraction	Flux @ 1m	Flux @ 2m
Wood	448 kW	.35	12.5 kW/m^2	3.1 kW/m^2
Gasoline	448 kW	.55	19.6 kW/m^2	4.9 kW/m^2

Note: The Radiation Factor is found under the HELP button on the HEAT FLUX screen

FLASHOVER

The Flashover correlations are utilized to estimate how much energy is needed to drive a compartment to flashover conditions. The methods utilized include the Thomas correlation, the Babrauskas correlation and the MQH (McCaffrey, Quintiere and Harkleroad) correlation. While each equation utilizes slightly different methodologies, each includes a ventilation factor involving the area of openings (sources of air entrainment) in the compartment. Because of the different factors considered in calculating the energy needed to reach flashover, a wide range of solutions can be observed in the different methods.

1. Given a compartment measuring 3 meters long by 4 meters wide by 2.4 meters high, calculate the energy needed to reach flashover. The compartment has a closed window measuring 1 meter by 1 meter and an opened door measuring 1.98 meters high by 0.91 meters wide and is finished with ½-inch drywall (0.012 meters).

2. What effects would be observed if the compartment was 4 meters long by 4 meters wide?

3. What effect would be observed if the 4 meter by 4 meter compartment had another open door m easuring 1.98 meters high by 0.91 meters wide? (Note double only the opening width as the opening height is the same)

Responses to Flashover Questions 1 – 3

Correlation	4m x 3m Room	4m x 4m Room	4m x 4m Room with second door
Thomas	1394 kW	1493 kW	2438 kW
Babrauskas	1902 kW	1902 kW	3803 kW
MQH	1451 kW	1609 kW	2245 kW

FIRE GROWTH

The Fire Growth calculations are utilized to estimate the heat release rate of a fire at a given time in seconds based on a given growth curve. The growth curves are a function of a fuel's burning characteristics and range from slow to ultra fast. Additionally, the calculator can estimate how long (time in seconds) it will take a fire to reach a given heat release rate based on the various growth curves. The second methodology can be utilized to estimate how long it will take a compartment to reach flashover based on the estimated heat release rate.

1. How much energy will be released from a fire at 60 seconds? (Solution will be a range including calculations of all growth rates.)

2. How much energy will be released from a fire at 120 seconds? (Solution will be a range including calculations of all growth rates.)

Responses to Fire Growth Questions 1 – 2

Burning Characteristics	60 Sec	120 sec
SLOW	10.55 kW	42.19 kW
MEDIUM	42.19 kW	168.77 kW
FAST	168.84 kW	675.36 kW
ULTRA FAST	675.36 kW	2701 kW
MOWRER ULTRA FAST	1440 kW	5760 kW

3. Utlizing the estimated heat release rate values calculated for the 3 meter by 4-meter compartment, how long would it take a fast fire to reach flashover?

4. What effects would be observed if the standard ultra fast growth variable is utilized?

Responses to Fire Growth Questions 3 – 4

Correlation	HRR	4m x 3m Room Fast Fire	4m x 3m Room Ultra Fast Fire
Thomas	1394 kW	172 s	86 s
Babrauskas	1902 kW	201 s	101 s
MQH	1451 kW	176 s	88 s