## Analytical Cases

Figure 3.2: Ambient conditions for test case with no fire and non-conducting surfaces, with a mechanical ventilation system injecting 0.1 m3/s of air into the compartment for 10 s. CFAST verification file basic\_mechvent.in.

Ambient\_Temperature\_Added\_Mass

Ambient\_Pressure\_Added\_Mass

Figure 3.3: Conditions for test case with no fire and 5/8 in Gypsum Board walls and ceiling, with the temperature raised from 20 C to 25 C. CFAST verification file basic\_tempequilib\_in.

Temperature\_Equilibrium\_Test

Pressure\_Change\_Temperature\_Equilibrium\_Test

Figure 3.4: Heat release rate conditions for test case with a 10 s, 100 kW fire. CFAST verification file 100kW\_fire\_in.

Analytical\_Heat\_Release\_Rate

## Base Room, Equilibrium

Figure 3.5: Ambient conditions for test case with no fire, no vents, and no additional features. Initial conditions set to 20 C. CFAST verification file Base.in.

Ambient\_Temperature

Ambient\_Pressure

Figure 3.6: Test case conditions with no ventilation. Exterior conditions set to 25 C. CFAST verification file basic\_tempequilib.in.

Temperature\_Equilibrium\_Test

Pressure\_Change\_Temperature\_Equilibrium\_Test

Figure 3.7: Test case conditions with no ventilation and non-conducting surfaces. Exterior conditions set to 25 C. CFAST verification file basic\_tempequilib\_wallsoff.in.

Temperature\_Equilibrium\_Walls\_Off

Pressure\_Change\_Temperature\_Equilibrium\_Test\_With\_Walls\_Off

Figure 3.8: Test case conditions with exterior conditions set to 25 C. CFAST verification file basic\_tempequilib\_window.in.

Temperature\_Equilibrium\_Ventilation

Pressure\_Change\_Temperature\_Equilibrium\_Test\_With\_Walls\_Off

Figure 3.9: Test case conditions with exterior conditions set to 25 C and elevation raised to 1500 m. CFAST verification file basic\_tempequilib\_window\_elevation.in.

Temperature\_Equilibrium\_Elevation\_Change

Pressure\_Change\_Temperature\_Equilibrium\_Test\_Elevation

Figure 3.10: Test case conditions with exterior conditions set to 25 C and compartment dimensions altered to 10 m x 10 m x 5m. CFAST verification file basic\_tempequilib\_window\_geometry.in.

Temperature\_Equilibrium\_Compartment\_Dimension\_Change

Pressure\_Change\_Temperature\_Equilibrium\_Test\_Compartment

Figure 3.11: Test case conditions with exterior conditions set to 25 C and wind speed raised to 10 m/s. CFAST verification file basic\_tempequilib\_window\_wind.in.

Temperature\_Equilibrium\_Wind\_Speed\_Change

Pressure\_Change\_Temperature\_Equilibrium\_Test\_Wind

Figure 3.12: Comparison graphs displaying Upper Layer Temperature, Lower Layer Temperature, and Pressure for the temperature equilibrium case varying increased elevation, increased wind speed, and increased compartment size.

ULT\_Comparison

LLT\_Comparison

PRS\_Comparison

Figure 3.13: Test case conditions with interior pressure set to 100000 Pa. CFAST verification file basic\_pressure\_vent.in.

Pressure\_Equilibrium\_Ventilation

Temperature\_Change\_Pressure\_Equilibrium\_Test\_With\_Windows

Figure 3.14: Test case conditions with interior pressure set to 100000 Pa and no ventilation. CFAST verification file basic\_pressure.in.

Pressure\_Equilibrium

Temperature\_Change\_Pressure\_Equilibrium\_Test

Figure 3.15: Test case conditions with interior pressure set to 100000 Pa with surfaces off. CFAST verification file basic\_ pressure\_wallsoff.in.

Pressure\_Equilibrium\_Walls\_Off

Temperature\_Change\_Pressure\_Equilibrium\_Test\_With\_Walls\_Off

Figure 3.16: Model with mechanical vent and non-inhibited drop off pressure of 2000 Pa versus model with mechanical vent and interfering drop off pressure of 200 Pa.

Pressure\_Dropoff\_Test

Figure 3.17: Side-by-side base case compartments with mechanical vents added from outside to compartment one, compartment one to compartment two, and compartment two to outside. CFAST verification file basic\_mechvent.in.

Mass\_Flow\_Test\_Mechanical\_Vent

## Base Case Model with Fire

Figure 3.18: Base case fire heat release rate curve and data table.

JPEG File: Mass Energy Balance>Screen Shots>Test Case HRR

JPEG File: Mass Energy Balance>Screen Shots>Test Case HRR Chart

## Base Case Model with Fire, Ventilation

(Graphed against Base Room unless otherwise stated)

Figure 3.19: Test case conditions with no ventilation versus the base case model. CFAST verification file fire.in.

Temperature\_No\_Window

HGT\_No\_Window

Species\_Production\_No\_Window

Figure 3.20: Test case conditions with two windows versus the base case model. CFAST verification file fire\_window\_windowchange.in.

Temperature\_Two\_Windows

HGT\_Two\_Windows

Species\_Production\_Two\_Windows

Figure 3.21: Test case conditions with compartment dimensions of 10 m x 10 m x 5 m, versus the base case model. CFAST verification file fire\_window\_geochange.in..

Temperature\_Compartment\_Geometry\_Increase

HGT\_Compartment\_Geometry\_Increase

Species\_Production\_Compartment\_Geometry\_Increase

Figure 3.22: Test case conditions with a ceiling vent of 1 m2 added, versus the base case model. CFAST verification file fire\_ ceiling.in.

Temperature\_Ceiling\_Vent\_Added

HGT\_Ceiling\_Vent\_Added

Species\_Production\_Ceiling\_Vent\_Added

Figure 3.23: Test case conditions with a ceiling vent increased to 2 m2 added, versus the previous test case with a 1 m2 ceiling vent. CFAST verification files: fire\_ ceiling\_ventsize.in, fire\_ ceiling.in.

Temperature\_Ceiling\_Vent\_Area\_Doubled

HGT\_Ceiling\_Vent\_Area\_Doubled

Species\_Production\_Ceiling\_Vent\_Area\_Doubled

Figure 3.24: Test case conditions with a 1 m2 ceiling vent and compartment dimensions increased to 10 m x 10 m x 5 m, versus the test case model with a 1 m2 ceiling vent. CFAST verification files: fire\_ ceiling\_geochange.in, fire\_ ceiling.in.

Temperature\_Ceiling\_Vent\_Compartment\_Area\_Increased

HGT\_Ceiling\_Vent\_Compartment\_Area\_Increased

Species\_Production\_Ceiling\_Vent\_Compartment\_Area\_Increased

Figure 3.25: Test case conditions with a 1 m2 mechanical vent added and no window or ceiling ventilation, versus the base case model. CFAST verification file fire\_mechanical\_vent.in.

Temperature\_Mechanical\_Vent\_Added

HGT\_Mechanical\_Vent\_Added

Species\_Production\_Mechanical\_Vent\_Added

Figure 3.26: Test case conditions with mechanical vent operating at 0% and 50%. CFAST verification files: fire\_filterefficiency.in and fire\_filterefficiency\_half.in.

TS\_No\_Filter\_vs\_Filter

## Base Case Model with Fire, Edited Fire

Figure 3.27: Test case conditions with the maximum heat release rate doubled from 1054 kW to 2108 kW, versus the base case model. CFAST verification file fire\_HRRdoubled.in

Temperature\_HRR\_Doubled

HGT\_HRR\_Doubled

Pressure\_HRR\_Doubled

Species\_Production\_HRR\_Doubled

Figure 3.28: Altered heat release rate triangle fire with maximum heat release rate of 1333.33 kW occurring at 450 s.

JPEG File: Mass Energy Balance>Screen Shots>HRR2 Chart

JPEG File: Mass Energy Balance>Screen Shots>HRR2

Figure 3.29: Test case conditions with the heat release rate curve changed from a t2 fire to a triangle shaped heat release rate, versus the base case model. CFAST verification file fire\_HRRdoubled.in.

Temperature\_HRR\_Area\_Change

HGT\_HRR\_Area\_Change

Pressure\_HRR\_Area\_Change

Species\_Production\_HRR\_Area\_Change

Figure 3.30: Test case conditions with the burning material set to hexane instead of the standard methane, versus the base case model. CFAST verification file fire\_hexane.in.

Temperature\_Hexane

HGT\_Hexane

Species\_Production\_Hexane

Figure 3.31: Test case conditions with the burning material set to urethane instead of the standard methane, versus the base case model. CFAST verification file fire\_urethane.in.

Temperature\_Urethane

HGT\_Urethane

Species\_Production\_Urethane

Figure 3.32: Test case conditions with the burning material set to hardwood instead of the standard methane, versus the base case model. CFAST verification file fire\_hardwood.in.

Temperature\_Hardwood

HGT\_Hardwood

Species\_Production\_Hardwood

Figure 3.33: Comparison graphs displaying the Upper Layer Temperature, Lower Layer Temperature, and Hot Gas Layer Height of the four tested materials: methane, hexane, urethane, and hardwood.

Upper\_Layer\_Temperature\_Materials

Lower\_Layer\_Temperature\_Materials

HGT\_Materials

Figure 3.34: Comparison graphs displaying the Upper Layer Temperature, Lower Layer Temperature, and Hot Gas Layer Height of four test cases each with a different Gaseous Ignition Temperature.

Upper\_Layer\_Temperature\_Ignition\_Temperature

Lower\_Layer\_Temperature\_Ignition\_Temperature

HGT\_Ignition\_Temperature

Figure 3.35: Test case conditions with the soot yield raised to 0.500, versus the base case model. CFAST verification file fire\_sootyield.in.

Species\_Production\_Soot\_Yield

Figure 3.36: Test case conditions with the CO yield raised to 0.500, versus the base case model. CFAST verification file fire\_CO\_yield.in.

Species\_Production\_CO\_Yield

## Base Case Model with Fire, Sprinkler

Figure 3.37: Test case conditions with a sprinkler added to the compartment versus the base case model containing no sprinkler. CFAST verification file fire\_sprinkler.in.

Temperature\_Sprinkler

HGT\_Sprinkler

Species\_Production\_Sprinkler

Figure 3.38: Test case conditions with the sprinkler spray density doubled from 7x10-5 m/s to 1.4x10-4 m/s added to the compartment versus the test case containing the standard sprinkler. CFAST verification file fire\_sprinkler\_density.in.

Temperature\_Sprinkler\_Density\_Doubled

HGT\_Sprinkler\_Density\_Doubled

Sensor\_Activation\_Time\_Sprinkler\_Density\_Doubled

Species\_Production\_Sprinkler\_Density\_Doubled

Figure 3.39: Test case conditions with the response time index (RTI) reduced to from 100 m1/2s1/2 to 50 m1/2s1/2, versus the test case containing the standard sprinkler. CFAST verification files: fire\_sprinkler\_RTI.in, fire\_sprinkler.in.

Temperature\_Half\_Sprinkler\_RTI

HGT\_Half\_Sprinkler\_RTI

Sensor\_Activation\_Time\_Half\_Sprinkler\_RTI

Species\_Production\_Half\_Sprinkler\_RTI

Figure 3.40: Test case conditions with the standard sprinkler and the maximum heat release rate of the fire doubled to 2108 kW, versus the test case containing the standard sprinkler. CFAST verification files: fire\_sprinkler\_HRRdoubled.in, fire\_sprinkler.in.

Temperature\_Sprinkler\_and\_HRR\_Doubled

HGT\_Sprinkler\_and\_HRR\_Doubled

Sensor\_Activation\_Time\_Sprinkler\_and\_HRR\_Doubled

Species\_Production\_Sprinkler\_and\_HRR\_Doubled

## Department of Energy Test Cases

Figure 3.41: Department of Energy test cases, CFAST Version (XX) versus CFAST Version 6.

DOE202\_Temperature\_Generated\_vs\_CFAST

DOE202\_ULO2\_Generated\_vs\_CFAST

DOE202\_LLCO2\_Generated\_vs\_CFAST

DOE202\_Trace\_Species\_Generated\_vs\_CFAST