

# EnergyPlus Exercise Basics 2

## Running EnergyPlus with EP-Launch, Building Envelope, Internal Loads, Reports, ResultsViewer

This exercise is similar to Tutorial 1 in "Getting Started with EnergyPlus"

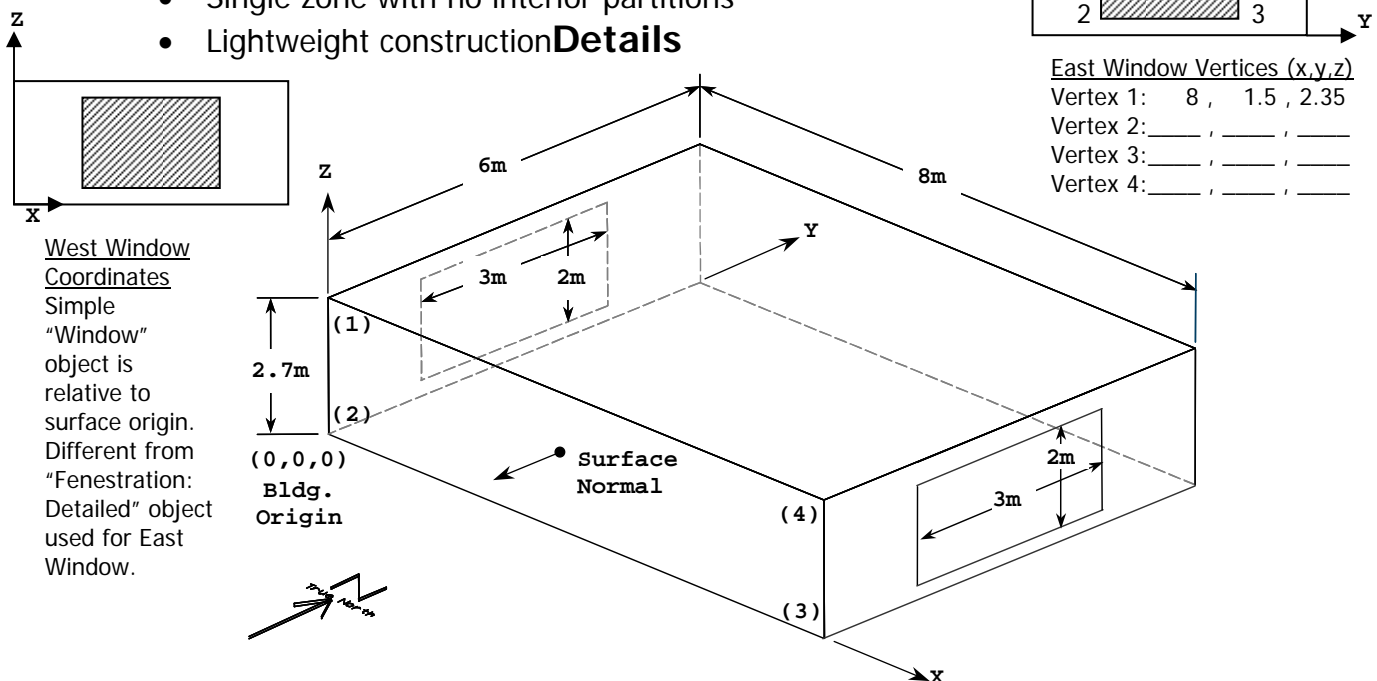
Last revised November 2012 for EnergyPlus v7.2.0.006

### General Description

#### Overview

- Rectangular single story building
- Windows in east and west walls
- Single zone with no interior partitions
- Lightweight construction

#### Details



#### Surface Constructions

Material (listed from outside to inside)	Conduct. (W/m-K)	Thickness (m)	U (W/m <sup>2</sup> -K)	R (m <sup>2</sup> -K/W)	Density (kg/m <sup>3</sup> )	Cp (J/kg-K)
<b>Walls</b>						
WOOD SIDING-1	0.140	0.009	15.556	0.064	530	900
FIBERGLASS QUILT-1	0.040	0.066	0.606	1.650	12	840
PLASTERBOARD-1	0.160	0.012	13.333	0.075	950	840
<b>Roof</b>						
ROOF DECK	0.140	0.019	7.368	0.136	530	900
FIBERGLASS QUILT-2	0.040	0.066	0.606	1.650	12	840
PLASTERBOARD-2	0.160	0.010	1.60	0.625	950	840
<b>Floor</b>						
C5 CONCRETE	1.73	0.1015	17.04	0.059	2243	837

### Window Properties

Type *	Clear
Number of panes	2
Pane thickness	0.006 m
Air-gap thickness	0.0032 m
Conductivity of glass	0.9 W/mK

\* Refers to specific glass type included in the EnergyPlus datasets directory (*WindowGlassMaterials.idf*)

### Internal Loads

Lights: 1000W, Office Lighting schedule, surface mount fluorescent

### Space Conditioning

Heating setpoint 20C, cooling setpoint 24C, no setback

### Environment

Location: Chicago, Illinois, USA

Design Days: Summer

Winter

Annual Simulation Period: Jan 1 – Dec 31

Ground Temperatures: 18.2 C to 22.5 C (from Slab preprocessor, vary monthly)

## **Instructions**

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### **Exercise Basics 2A – Run Pre-Defined Building with no Windows**

*Objective: Learn to use EP-Launch to run an EnergyPlus input file and view output files.*

1. Open EP-Launch.
2. Under "Input File", browse for input file ExerciseBasics2A.idf. This input file contains the 1-zone model described above without the windows and lights.  
*Note: Browse to the folder of EnergyPlus Exercise files that was given to you for this workshop – do not use the Basics files that are in ExampleFiles/BasicsFiles.*
3. Under "Weather File", select "No Weather File" (at the top of the pull-down list).
4. If you prefer to see hourly outputs in IP units, in EP-Launch select View → Options → Miscellaneous and check the option "Convert ESO/MTR to IP Units"  
*Note: This option "sticks" across all simulations and EP-Launch sessions.*
5. Press "Simulate".
6. When the simulation is complete:
  - a. In the EP-Launch View Results section, select the "All" tab.
  - b. Press "Errors" to see the errors and warnings output
  - c. Press "EIO" to see reports summarizing inputs, sizing, and other general results.

- d. Press "Variables" to open the csv output file which contains hourly output variables. In ExerciseBasics2a.csv, review the pattern of outdoor conditions and loads. (To make it easier to read the column headings, select Row 1, format cells, and turn on wrap text; then select cell B2 and select "freeze panes".)
- e. Press "DXF" to see a dxf drawing of the building envelope.  
OR Use SketchUp OpenStudio to open the idf and view geometry.

## Exercise Basics 2B – Add Windows

*Objective: Learn how to add materials, constructions, and a surface using 3-D coordinates.*

1. In EP-Launch, with input file ExerciseBasics2A.idf still selected, press "Edit – IDF Editor". This will open ExerciseBasics2A.idf in the IDF Editor, a tool which assists in editing EnergyPlus input files (idf).
2. In IDF Editor, select File → Save Options . . . and set "Saved Order of Objects" to "Original with New at Top", and "Special Format for Some Objects" to "Yes." Check the "Set as Default" box.
3. In IDF Editor, Select File → Save As . . . and save this file as ExerciseBasics2B.idf.
4. Create the construction definition for the windows which are double-pane clear glass with an air space:
  - a. Using File → Open DataSet, open the WindowGlassMaterials dataset file
  - b. Locate the object which defines the material properties for "CLEAR 6MM" glass. Select this object (by clicking on the column heading).
  - c. Using Edit → Copy (or the toolbar button, or ctl-C), copy this object.
  - d. Switch to file ExerciseBasics2B.idf and paste the window material into this file. (Verify that it has been added by going to WindowMaterial:Glazing to view the object.)
  - e. Open dataset file WindowGasMaterials.idf (File → Open DataSet).
  - f. Locate "AIR 3MM", copy it and paste it into ExerciseBasics2B.idf.
  - g. In ExerciseBasics2B.idf, select the "Construction" class. There are three constructions pre-defined for the walls, roof, and floor.
  - h. Press "New Obj" to create a new blank Construction object.
  - i. Name this new construction "DOUBLE PANE WINDOW".
  - j. Use the pulldown list to select "CLEAR 6MM" for the outside layer, then press "Enter" or "Return" to save this entry and move to the next field.
  - k. Select "AIR 3MM" for Layer 2, and "CLEAR 6MM" for Layer 3.

5. Add the east window (3m wide by 2m high, centered on wall, *see the drawing on page 1 to determine coordinates*):

- a. Select "FenestrationSurface:Detailed" class.
- b. Add a new object named "EAST WINDOW".
- c. Set the remaining fields as listed:

Surface Type	= Window
Construction Name	= DOUBLE PANE WINDOW
Building Surface Name	= ZONE SURFACE EAST
Outside Boundary Condition Object	= <blank>
View Factor to Ground	= autocalculate
Shading Control Name	= <blank>
Frame And Divider Name	= <blank>
Multiplier	= 1
Number of Vertices	= 4

Vertex coordinates = *as determined from the drawing on p.1.*  
*Coordinates in this input are in World Coordinates (all relative to the global origin of 0,0,0). Coordinates are specified as viewed from the outside of the surface, using the rules specified in the GlobalGeometryRules object.*

*Check your coordinates against the answer at the back of this exercise.*

6. Add the west window, similar to the east window, but use the simpler "Window" object.

- a. Select "Window" class.  
*Note: "Window" is an alternate option for defining a window, with simpler inputs than FenestrationSurface:Detailed.*
- b. Add a new object named "WEST WINDOW".

- c. Set the remaining fields as listed:

Construction Name	= DOUBLE PANE WINDOW
Building Surface Name	= ZONE SURFACE WEST
Shading Control Name	= <blank>
Frame and Divider Name	= <blank>
Multiplier	= 1
Starting X Coordinate	=
Starting Z Coordinate	=
Length	=
Height	=

*Note: For the simple Window object, starting coordinates are the lower left-hand corner of the window relative to the lower left-hand corner of the base surface. The horizontal direction is relative "X", not "Y". See notes on diagram on p. 1.*

*Check your coordinates against the answer at the back of this exercise.*

7. Add a new Output:Surfaces:List object, Report Type=Details. This report produces a list of all surfaces in the eio output summarizing area, azimuth, tilt, etc.
8. Save and close the IDF file, select ExerciseBasics2B.idf in EP-Launch, run the simulation and view outputs.
  - a. Always review the Errors file for errors and warnings. Fix problems if needed and re-run.
  - b. Are the windows in the right place in the dxf drawing file.  
OR Use SketchUp OpenStudio to open the idf and view geometry.
  - c. Review the surface details report in the eio file, search for "Zone/Shading Surfaces" to find this report. This report is easier to read by pasting this section into a spreadsheet and using the text to columns function with comma as a delimiter).
  - d. Open the Variables output file and compare the heating and cooling loads with the results from ExerciseBasics2A.csv.

## **Exercise Basics 2C – Add Internal Loads**

*Objective: Learn how to add schedules, internal loads, and report variables.*

1. Save ExerciseBasics2B.idf as ExerciseBasics2C.idf.
2. Open the dataset file Schedules.idf: (File→Open DataSet→Schedules)
  - a. Copy the Schedule:Compact object named "Office Lighting", and paste it into ExerciseBasics2C.idf.
  - b. Copy the ScheduleTypeLimits object named "Fraction", and paste it into ExerciseBasics2C.idf.

3. In ExerciseBasics2C.idf, add a Lights object and set fields as follows:
  - a. Name = (any name)
  - b. Zone Name = Zone One (pulldown menu)
  - c. Schedule Name = Office Lighting
  - d. Design Level Calculation Method = LightingLevel
  - e. Lighting Level = 1000W
  - f. Fraction Radiant = 0.72
  - g. Fraction Visible = 0.18

*Hint: The Fraction Radiant and Visible values come from a table in the Input Output Reference for surface mounted fluorescent lights. To find this table, use search button on docs main menu page, search for "Luminaire", in the search results for Input Output Reference, click on the first link.*

4. Save and close the IDF file, select ExerciseBasics2C.idf in EP-Launch, run the simulation and review outputs.
5. Open the rdd file (the report variable data dictionary) and find report variable names related to Lights. Add a new Output:Variable object to report the lighting electric power.
6. Run the simulation and find the lighting electric power in the Variables output file.
7. Compare heating and cooling loads with ExerciseBasics2A and ExerciseBasics2B.
8. Add more Output:Variable objects as desired.

## Exercise Basics 2D – Annual Simulation and Table Reports

*Objective: Learn how to run an annual simulation using a weather data file and add table reports.*

1. Save ExerciseBasics2C.idf as ExerciseBasics2D.idf.
2. Edit the Simulation:Control object to turn off the Sizing Periods simulations and turn on the Weather File (annual) simulation.
3. Add a RunPeriod object to run a full annual simulation, let other fields default or remain blank.
4. Add an Output:Table:SummaryReports object, and select the following reports: "AnnualBuildingUtilityPerformanceSummary" (ABUPS), "InputVerificationandResultsSummary" (IVRS), "ClimateDataSummary", and "EnvelopeSummary".
5. Add an OutputControl:Table:Style object, and select HTML format (ColumnSeparator).
6. If you prefer to see results in IP Units, select the InchPound Units Conversion option in the OutputControl:Table:Style object.
7. Edit existing Output:Variable objects and change the reporting frequency from Hourly to Monthly.
8. Save and close the IDF file, select ExerciseBasics2D.idf in EP-Launch.
9. Select Chicago TMY3 weather file (or the weather file of your choice) and run the simulation.
10. Review outputs.
  - a. Check the Errors file.
  - b. Look at the monthly results in the Variables output.
  - c. Press the Tables output button to view the table reports.

## List of New Objects

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This is a listing of new and modified objects created in this Exercise.

*Try not to look at this section until you have completed the Exercise.*

```
WindowMaterial:Glazing,
  CLEAR 6MM,           !- Name
  SpectralAverage,     !- Optical Data Type
  ,                   !- Window Glass Spectral Data Set Name
  0.006,              !- Thickness {m}
  0.775,              !- Solar Transmittance at Normal Incidence
  0.071,              !- Front Side Solar Reflectance at Normal Incidence
  0.071,              !- Back Side Solar Reflectance at Normal Incidence
  0.881,              !- Visible Transmittance at Normal Incidence
  0.080,              !- Front Side Visible Reflectance at Normal Incidence
  0.080,              !- Back Side Visible Reflectance at Normal Incidence
  0.0,                !- Infrared Transmittance at Normal Incidence
  0.84,               !- Front Side Infrared Hemispherical Emissivity
  0.84,               !- Back Side Infrared Hemispherical Emissivity
  0.9;                !- Conductivity {W/m-K}

WindowMaterial:Gas,
  AIR 3MM,            !- Name
  Air,                !- Gas Type
  0.0032;             !- Thickness {m}

Construction,
  DOUBLE PANE WINDOW, !- Name
  CLEAR 6MM,          !- Outside Layer
  AIR 3MM,            !- Layer 2
  CLEAR 6MM;          !- Layer 3

FenestrationSurface:Detailed,
  EAST WINDOW,        !- Name
  Window,             !- Surface Type
  DOUBLE PANE WINDOW, !- Construction Name
  ZONE SURFACE EAST,  !- Building Surface Name
  ,                   !- Outside Boundary Condition Object
  autocalculate,      !- View Factor to Ground
  ,                   !- Shading Control Name
  ,                   !- Frame and Divider Name
  1,                  !- Multiplier
  4,                  !- Number of Vertices
  8,1.5,2.35,         !- X,Y,Z ==> Vertex 1
  8,1.5,0.35,         !- X,Y,Z ==> Vertex 2
  8,4.5,0.35,         !- X,Y,Z ==> Vertex 3
  8,4.5,2.35;         !- X,Y,Z ==> Vertex 4

Window,
  WEST WINDOW,        !- Name
  DOUBLE PANE WINDOW, !- Construction Name
  ZONE SURFACE WEST,  !- Building Surface Name
  ,                   !- Shading Control Name
  ,                   !- Frame and Divider Name
  1,                  !- Multiplier
  1.5,                !- Starting X Coordinate {m}
  0.35,               !- Starting Z Coordinate {m}
  3,                  !- Length {m}
  2;                  !- Height {m}

Output:Surfaces:List,
  Details;            !- Report Type
```



```

Output:Variable,
*,                               !- Key Value
Lights Electric Power, !- Variable Name
Hourly;                       !- Reporting Frequency

Schedule:Compact,
Office Lighting,              !- Name
Fraction,                    !- Schedule Type Limits Name
Through: 12/31,              !- Field 1
For: Weekdays SummerDesignDay, !- Field 2
Until: 05:00,                !- Field 3
0.05,                        !- Field 4
Until: 07:00,                !- Field 5
0.1,                         !- Field 6
Until: 08:00,                !- Field 7
0.3,                         !- Field 8
Until: 17:00,                !- Field 9
0.9,                         !- Field 10
Until: 18:00,                !- Field 11
0.5,                         !- Field 12
Until: 20:00,                !- Field 13
0.3,                         !- Field 14
Until: 22:00,                !- Field 15
0.2,                         !- Field 16
Until: 23:00,                !- Field 17
0.1,                         !- Field 18
Until: 24:00,                !- Field 19
0.05,                        !- Field 20
For: Saturday WinterDesignDay, !- Field 21
Until: 06:00,                !- Field 22
0.05,                        !- Field 23
Until: 08:00,                !- Field 24
0.1,                         !- Field 25
Until: 12:00,                !- Field 26
0.3,                         !- Field 27
Until: 17:00,                !- Field 28
0.15,                       !- Field 29
Until: 24:00,                !- Field 30
0.05,                        !- Field 31
For: Sunday Holidays AllOtherDays, !- Field 32
Until: 24:00,                !- Field 33
0.05;                        !- Field 34

ScheduleTypeLimits,
Fraction,                    !- Name
0.0,                         !- Lower Limit Value
1.0,                         !- Upper Limit Value
Continuous;                  !- Numeric Type

Lights,
ZONE ONE Lights,            !- Name
ZONE ONE,                   !- Zone Name
Office Lighting,            !- Schedule Name
LightingLevel,              !- Design Level Calculation Method
1000,                       !- Lighting Level {W}
,                             !- Watts per Zone Floor Area {W/m2}
,                             !- Watts per Person {W/person}
0,                           !- Return Air Fraction
0.72,                       !- Fraction Radiant
0.18,                       !- Fraction Visible
1,                           !- Fraction Replaceable
General,                    !- End-Use Subcategory
No;                          !- Return Air Fraction Calculated from Plenum Temperature

```

```

RunPeriod,
,                !- Name
1,              !- Begin Month
1,              !- Begin Day of Month
12,             !- End Month
31,             !- End Day of Month
UseWeatherFile, !- Day of Week for Start Day
Yes,            !- Use Weather File Holidays and Special Days
Yes,            !- Use Weather File Daylight Saving Period
No,             !- Apply Weekend Holiday Rule
Yes,            !- Use Weather File Rain Indicators
Yes,            !- Use Weather File Snow Indicators
1;              !- Number of Times Runperiod to be Repeated

Output:Table:SummaryReports,
  AnnualBuildingUtilityPerformanceSummary, !- Report 1 Name
  InputVerificationandResultsSummary, !- Report 2 Name
  ClimateDataSummary, !- Report 3 Name
  EnvelopeSummary; !- Report 4 Name

OutputControl:Table:Style,
  HTML,          !- Column Separator
  InchPound;     !- Units Conversion

SimulationControl,
No,              !- Do Zone Sizing Calculation
No,              !- Do System Sizing Calculation
No,              !- Do Plant Sizing Calculation
No,              !- Run Simulation for Sizing Periods
Yes;             !- Run Simulation for Weather File Run Periods

```