GLD Skill Booster #2:
Design Day, Monthly and Hourly Loads

The GLD Skill Booster Series is a series of documents that guide you through the process of performing a specific task in GLD. With this series you can hone your functional skills in only a few minutes.

In this Skill Booster module we will learn about the differences between Design Day, Monthly and Hourly loads and what you can do with each type of loads set in GLD.

As a geothermal designer, you will benefit from understanding these differences because:

- It will enable you to better understand the GLD outputs
- It will enable you to design better systems
- It will enhance your professional skills

Design Day (DD) Loads

Design Day loads are the minimum loads data that GLD requires to design a ground source heat exchanger.

GHX types compatible with DD loads:

Vertical, horizontal and surface water

Loads Modules compatible with DD loads:
Average block loads module and Zone manager loads module

DD Data:

DD loads consist of at least the following (per block load or zone):

- one peak hourly heating load and/or one peak hourly cooling load
- Annual Equivalent Full Load Hours (AEFLH) for heating and/or cooling (note that AEFLH generally are not required for surface water designs)

DD Loads Data Source:

Typically, a designer generates DD loads from a building energy simulation tool that can calculate loads for both peak and non-peak times over the course of a full year. Examples of energy simulation tools include Trane Trace, Carrier HAP, IES <VE>, eQUEST, etc. The sum of the peak and non-peak values over the course of the year add to the annual load or AEFLH.

In some cases, designers use simpler heat loss calculation tools that provide only a peak heating and a peak cooling value. In such a case, designers sometimes estimate or guess the AEFHL. A wrong "guess" can result in a heat exchanger length that could be oversized or undersized by 40% or more. For example, for a particular design with a fixed set of peak loads, here is what happens to calculated DD lengths when the user changes the AEFLHs:

Cooling/Heating AEFHL	Calculated DD Length
350/950	209 ft
950/350	252 ft
1,800/700	288 ft

Guessing is **_not_** a recommended engineering strategy.

Calculation Method:

With these loads data, the Design Day method determines three heat pulses (a long term heat pulse, a medium term/monthly heat pulse, and a short duration heat pulse on the design day). These heat pulses are then integrated into a "Design Day" calculation that determines required cooling and/or heating lengths for the heat exchanger based on the other user inputs (EWTs, soil conditions, field geometry, grout, mechanical equipment selection, etc.).

Results:

Results from the DD method include heat exchanger lengths, inlet and outlet temperatures, predicted average soil temperature changes and heat pump COP/EER values during DD/peak conditions.

Note: With only DD Loads, you _cannot_ perform a monthly simulation.

Monthly Loads

Monthly loads provide an intermediate data set that enables you to design a ground heat exchanger using both the Design Day and the Monthly methods in GLD.

GHX types compatible with Monthly loads:

> **Vertical, horizontal, and surface water** (note that horizontal and surface water heat exchangers designs can accept the import of monthly loads but are limited to the Design Day method calculation)

Loads Modules compatible with Monthly loads:
Average block loads module

Monthly Data:

Monthly loads consist of at least the following for *each and every month of the year*:

- one peak hourly heating load and/or one peak hourly cooling load

- the cumulative heating and/or cumulative cooling load

Monthly Loads Data Source:

A designer generates Monthly loads from a building energy simulation tool that can calculate loads for both peak and non-peak times for each hour of a year (there are 8760 hours in a year). Examples of energy simulation tools include Trane Trace, Carrier HAP (which stands for Hourly Analysis Program), IES <VE>, eQUEST, etc. Some programs (such as Trace) export a monthly loads file that GLD can read in natively. For other programs, monthly loads can be exported to a spreadsheet program and then copied/pasted into GLD.

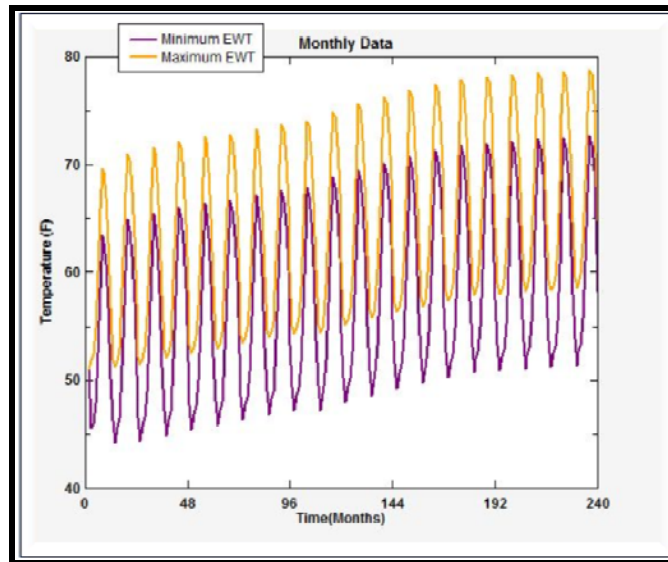A monthly loads profile in GLD is shown below:

Note that at the bottom of the image above there is an "hours at peak" text box for heating and cooling peaks. In the example above, the values for both are set to 3.0. As a designer, you should enter a number that represents the duration of your peak load (this is typically somewhere between 1 and 6 hours). Changing this value will influence simulation results.

Calculation Method:

The Monthly method is a simulation method. In essence, the designer specifies everything except the target EWTS/inlet temperatures and then hits 'Calculate.' The Monthly method then looks at the total and peak loads for each month of the year as well as the "hours at peak" and runs a series of overlapping heat pulses into/out of the ground over the design time frame (10 years, 15 years, etc). The Method determines how the temperatures in the borehole and the fluid evolve over time. As these temperatures evolve, the dynamic heat pump performance evolves as well.

Results:

Results from the Monthly method include peak and average inlet and outlet temperatures, peak and average COP/EER values (average COP/EER values are quite useful for lifecycle costing analyses) and predicted mechanical system kWh consumption. These results can be viewed numerically or graphically as can be seen below for a cooling dominant system.

Hourly Loads

Hourly loads provide a comprehensive data set that enables you to design a ground heat exchanger using the Design Day, Monthly and Hourly methods in GLD.

GHX types compatible with Hourly loads:

> **Vertical, horizontal, and surface water** (note that horizontal and surface water heat exchangers designs can accept the import of hourly loads but are limited to the Design Day method calculation)

Loads Modules compatible with Monthly loads:
Average block loads module

Hourly Data:

Hourly loads consist of the following for each and every hour of the 8760-hour year:

- one peak hourly heating load and/or one peak hourly cooling

Hourly Loads Data Source:

A designer generates Hourly loads from a building energy simulation tool that can calculate loads for both peak and non-peak times for each

hour of a year (there are 8760 hours in a year). Examples of energy simulation tools include Trane Trace, Carrier HAP (which stands for Hourly Analysis Program), IES <VE>, eQUEST, etc. Some programs (such as IES) export an hourly loads file that GLD can read in natively. For other programs, hourly loads can be exported to a spreadsheet program and then imported into GLD as a csv file. The file format for hourly data in a csv file is as follows (note that the data MUST start on row 5):
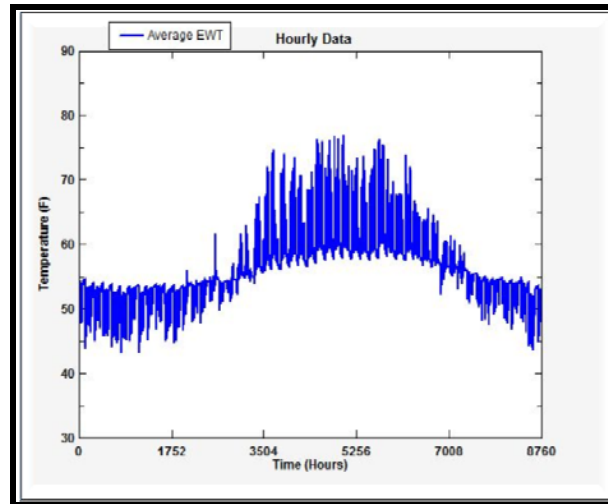
	A	B
1	Cooling Load (kBtu/h)	Heating load (kBtu/h)
2		
3		
4		
5	0	0.594
6	0	2.784
7	0	4.236
8	0	7.049
9	0	14.025
10	0	20.007
11	0	25.766
12	0	594.778
13	0	321.447
14	0	231.081
15	0	193.14
16	0.302	167.496
17	3.601	164.834
18	13.685	136.203
19	14.035	126.045
20	3.519	131.079
21	0	145.852
22	0	197.255
23	0	225.316
24	0	0

Calculation Method:

The Hourly method is a simulation method. In essence, the designer specifies everything except the target EWTS/inlet temperatures and then hits 'Calculate.' The Hourly method then looks at loads for each hour of the year and runs a series of sequential heat pulses into/out of the ground over the design time frame (10 years, 15 years, etc.). The Method determines how the temperatures in the borehole and the fluid evolve over time. As these temperatures evolve, the dynamic heat pump performance evolves as well. Note that the Hourly method is computationally intensive and therefore we recommend starting with shorter (i.e. 1 year) simulations.

Results:

Results from the Hourly method include inlet and outlet temperatures and COP/EER values for each hour of the year. With the Hourly Method there are no average inlet or outlet temperatures: the temperatures calculated for a particular hour are the only temperature results. In addition, GLD calculates mechanical system kWh consumption. These results can be viewed numerically or graphically as can be seen below for a cooling dominant system.

In summary, Design Day, Monthly and Hourly loads each provide the designer with different (and increasing) degrees of design control. GLD strives to provide the designer with maximum design control to help ensure long term, thermally stable designs. On a final note, please remember that good outputs require good inputs. Calculate your loads with as much detail and accuracy as possible (we like hourly loads for this reason assuming they are based on a reasonable building energy model) and then use them in GLD to design your systems.