

GSHP Input File Format for ESP-r/HOT3000

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Modification to the Configuration File

In order to specify that there is a GSHP system being simulated, the configuration file (.cfg) must be modified to include tags for two new files – one to describe the ground loop (.gshp) and the other to describe the heat pump loop (.hvac).

In the .cfg file under

* DATABASES

Add the following lines at the end of the list (after the *ctl and before the * PROJ LOG) to let the program know that there will be a GSHP calculation performed.

```
*gshp    ../hvac/*.gshp          # ground loop input file
*hvac    ../hvac/*.hvac          # heat pump input file
```

Format of the .gshp Input File

The format of the .gshp file is dependent on the type of GSHP system being modelled. Four GSHP configurations are possible in ESP-r/H3K.

- Vertical single U-tube per bore hole
- Horizontal 4-pipe, 2x2 arrangement
- Horizontal 2-pipe, side-by-side arrangement
- Horizontal slinky arrangement

The input file contains both global variables and system specific variables. The following details all the required inputs for ground loop simulation (the listed variable names are used in the code).

Global Variables:

```
# GSHP Input
a    igshp_type          # GSHP system type
# Global Variables
b    ID      OD      Kpipe L      # pipe size and properties
c    Density      Cp      Flow    # fluid properties
d    Tmean  Atemp  DAYo          # Exterior conditions
```

System Specific Variables:

Vertical Single U-tube Borehole Systems

```
e    Utube  Nsoil  Depth
f    Ks     Kw     Ds     Dw     # repeated per soil layer
g    SP     Dtop   Dbore  Kgrout
h    FixPara      Nbore/Dbottom
```

Horizontal 4-pipe 2 x 2 arrangement

```
e    Ks     Kw     Ds     Dw
f    PD(1)  PD(2)  SD
```

Horizontal 2-Pipe Side-by-Side

```
e    Ks     Kw     Ds     Dw
f    SD     BD
```

Horizontal Slinky

e Ks Kw Ds Dw
f BD Spiral NumP

Global Variables

The specific GSHP system to be modelled is defined in line **a**. The variable `igshp_type` relates to the GSHP system types as follows:

	<code>igshp_type</code>
vertical single U-tube:	1
horizontal 4 pipe 2x2 arrangement:	2
horizontal 2 pipe side-by-side arrangement:	3
horizontal slinky:	4

The remainder of the global ground loop variables (lines **b**, **c**, and **d**) are specific to the pipe and fluid properties as well as the exterior conditions:

ID	Pipe inside diameter, cm
OD	Pipe outside diameter, cm
Kpipe	Pipe thermal conductivity, W/m K
L	Length of pipe, m
Density	Density of fluid, kg/m ³
Cp	Heat capacity of fluid, J/kg K
Flow	Heat exchanger flow rate, L/s
Tmean	Earth mean temperature, °C
Atemp	Surface temperature amplitude, °C
DAYo	Time of minimum surface temperature

System Specific Variables

a. Vertical Single U-tube Borehole Systems

Utube	Number of U-bends per bore hole
Nsoil	Number of layers of different soil
Depth	Depth of bore hole
Ks	Soil conductivity (per layer) in summer, W/mK
Kw	Soil conductivity (per layer) in winter, W/mK
Ds	Soil diffusivity (per layer) in summer, W/mK
Dw	Soil Diffusivity (per layer) in winter, W/mK
SP	Space between piping, cm
Dtop	Distance below surface of top U-tube, m
Dbore	Diameter of bore holes, cm
Kgrout	Grout conductivity
FixPara	Flag to determine whether following value is <code>Nbore</code> or <code>Dbottom</code> .
If <code>FixPara</code> is 0, then	
<code>Nbore</code>	Number of Boreholes
If <code>FixPara</code> is another integer, then:	
<code>Dbottom</code>	Bottom depth

Note, line **f** for the vertical system will have `Ks`, `Kw`, `Ds`, and `Dw` repeated, as many times as there are different layers of soil.

b. Horizontal 4 pipe 2 x 2 arrangement

Ks	Soil conductivity in summer, W/mK
Kw	Soil conductivity in winter, W/mK
Ds	Soil diffusivity in summer, W/mK
Dw	Soil Diffusivity in winter, W/mK

PD (1)	Depth of heat exchanger pipe 1, m
PD (2)	Depth of heat exchanger pipe 2, m
SD	Spacing between pipes, m

c. Horizontal 2 Pipe Side-by-Side

Ks	Soil conductivity in summer, W/mK
Kw	Soil conductivity in winter, W/mK
Ds	Soil diffusivity in summer, W/mK
Dw	Soil Diffusivity in winter, W/mK
SD	Spacing between pipes, m
BD	Depth below surface, m

d. Horizontal Slinky

Ks	Soil conductivity in summer, W/mK
Kw	Soil conductivity in winter, W/mK
Ds	Soil diffusivity in summer, W/mK
Dw	Soil Diffusivity in winter, W/mK
BD	Depth of heat exchanger pipe, m
Spiral	Diameter of slinky spirals, m
NumP	Number of pipes per trench