DEUTERIUM ARRAY MEMO #033

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To: Deuterium Array Group

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Subject: Proposed use of geothermal heat exchange for receiver box temperature stabilization

The soil temperature a few feet below the surface is a relatively constant 50º F (10º C) in the local area. The large thermal mass and relatively low thermal conductivity of the soil results in very little annual variation in temperature just a few feet down.

I propose to test the use of geothermal heat exchange with the soil to cool the receiver box to a relatively constant temperature. The simplest method is to use a fan to circulate air through the receiver box and then through a section of thin walled PVC pipe buried a few feet below the surface and connected to the receiver box via flexible hoses, as shown in figure 1.

a) Air circulation rate required

The receiver box dissipates about 400 W so that given the specific heat of air 1 kJ/kgm/K) and density (1.25 kg/m^3) it will take a flow rate of 67 cu.ft/min to maintain 10º C temperature differential.

b) Surface are of pipe required

With a flow rate of 67 cu.ft/min the velocity of air in a 4" diameter pipe is 3 ft/sec. With this flow rate a surface area of about 1 m^2 is needed to transfer the heat to the pipe with less than 10º C temperature rise.

c) Length of pipe required

If we assume heat conduction from a buried pipe is radially normal to the pipe the heat loss is

$$2\pi kL\Delta T / \ln(r_2 / r_1)$$

where k = soil conductivity ≈ 1 w/m/K
L = length of pipe m
ΔT = temperature difference between the pipe radius r_1 and the radius at which the flow becomes radial.

The ln(r_2/r_1) function changes slowly so that the assumed values of r_1 and r_2 are not critical. Assuming r_1 = 2" and r_2 = 200" the heat loss is about 1.4 w/m/K so that a pipe length of about 100 feet to transfer 400 w with under 10° C temperature rise. [The recommended pipe length for homes which use geothermal heat exchange is about 100 feet per kilowatt.] The requirement for 100 feet more than satisfies the surface area requirement even if 1" diameter pipe is used.