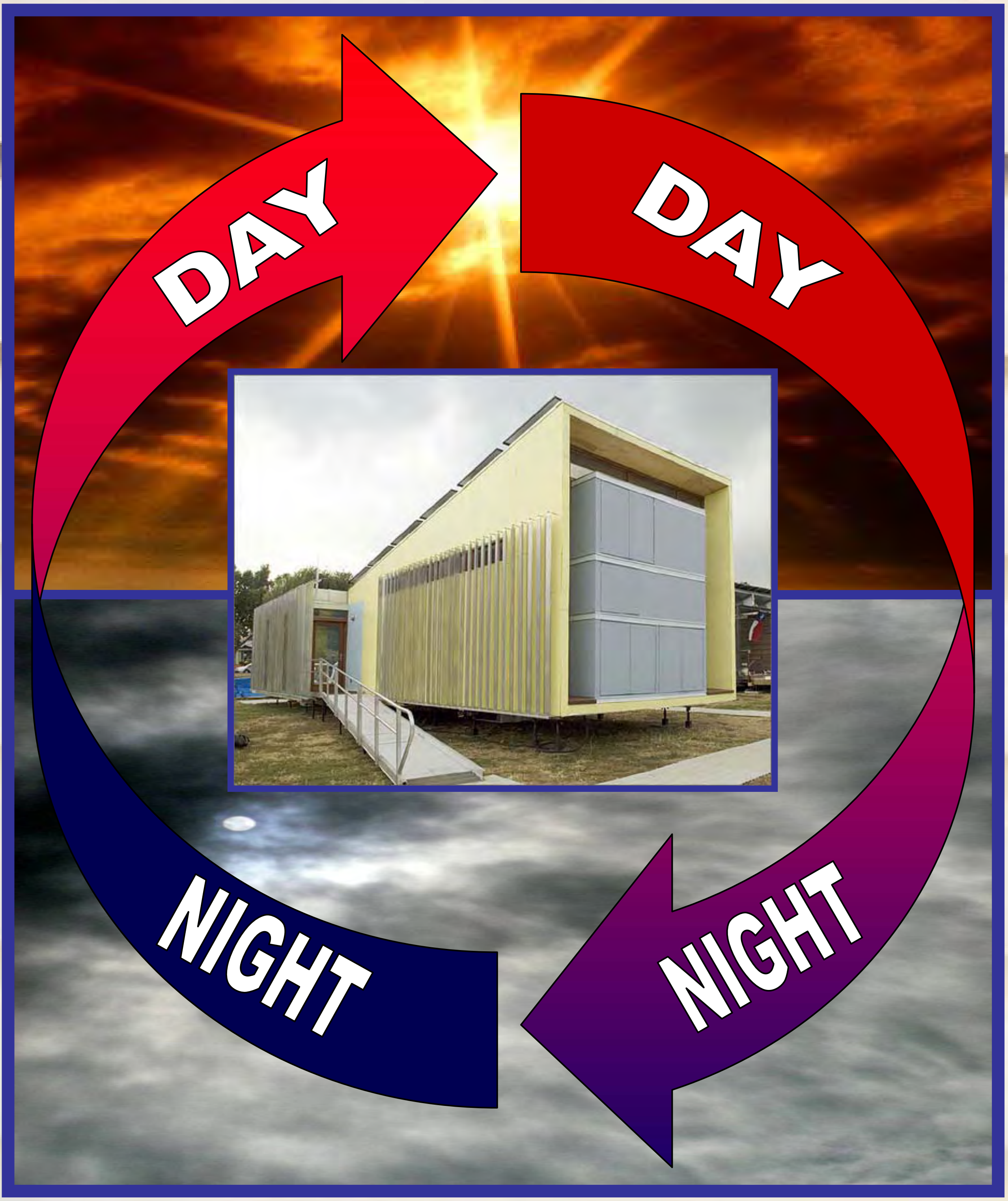
FlatICE™
Solar House
Thermal Energy Storage Systems



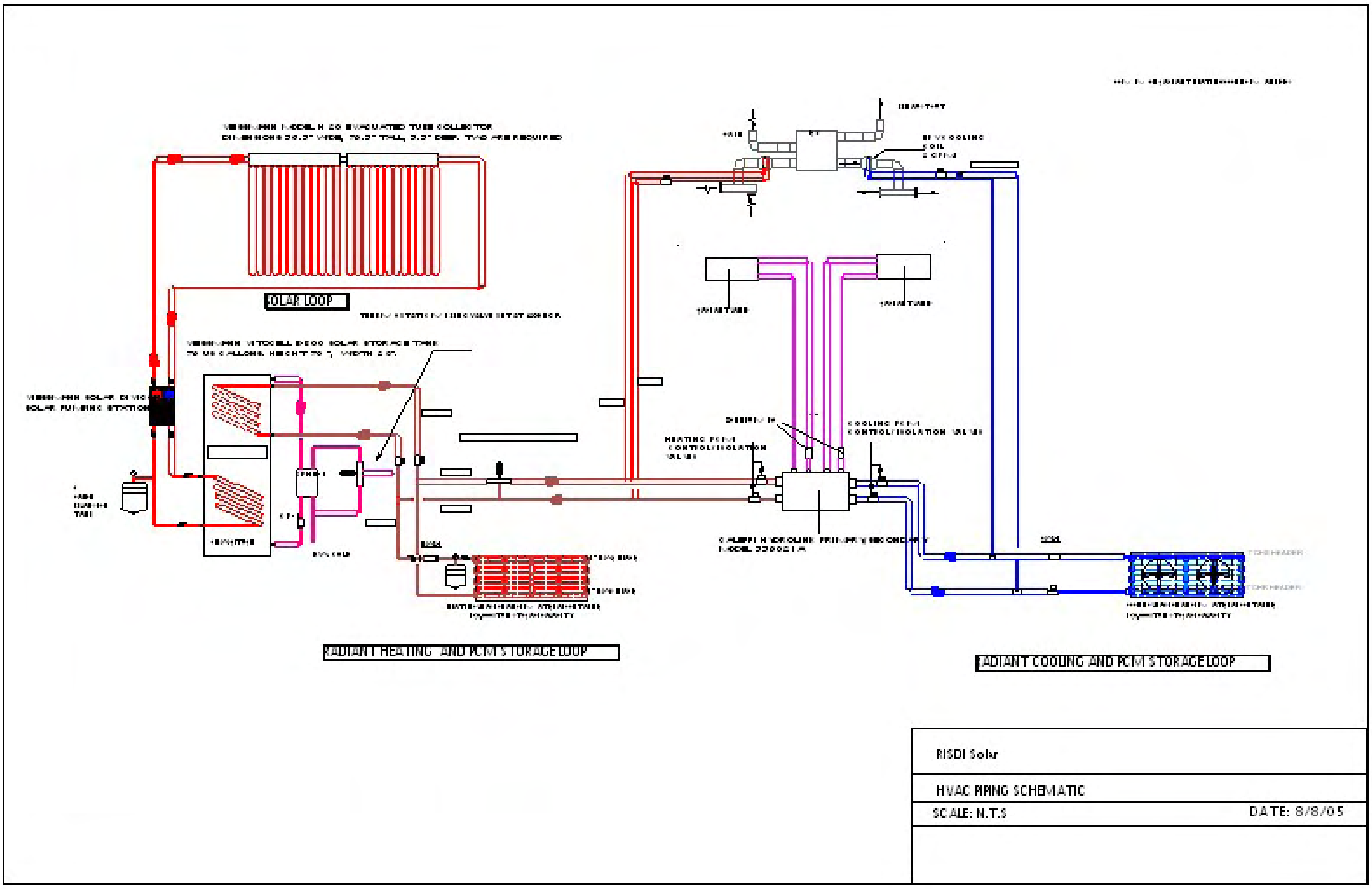
PCM PHASE CHANGE MATERIAL PRODUCTS LIMITED

Solar House Design

General;

As part of the US solar decathlon competition, which required the minimum or no external energy usage domestic dwelling design, this new concept is designed around storing day-time solar energy for heating and hot water usage, and storing night-time cooling energy for day-time cooling requirements, so that both cooling and heating requirements can be met without using any external energy source.

The relevant schematic drawing of the system is a s follows;



Heating Mode;

Hot water is produced utilising the Evacuated Tube Solar Collectors, and stored in the Solar storage tank. The tank has two purposes, domestic hot water and heating. The design takes heat from the domestic hot water and, through a heat exchanger, transfers the heat to the PCM heating box. Once the tank reaches temperature, whenever we have excess heat, heat is stored in the PCMs. At night or very cloudy weather, the system draws heat back off the PCMs and uses it to heat the house with Radiant Heating Ceiling panels. During the competition the system actually had no sun for 8 days, yet it was still possible to heat the house with just the PCMs on one "charge". Daily Temperature ranges were from 25.6 Deg C (78 Deg F) during the day to 12.2 Deg C (54 Deg F) at night.

The heat is transferred to the PCMs via a large self built heat exchanger inside the boxes. In a nutshell, it is a copper piping array that is using thick aluminium heat transfer plates to give heat to the PCMs for storage, and to take it back off when needed. The system is reverse return piped (as is the house) to ensure flow into and off of all the transfer plates. The boxes are heavily insulated, and also are using radiant barriers to keep the heat (or cool) in the boxes and flowing through the transfer plates.

The pumping system for the house is a variable speed primary/secondary zone system. It is a crossover system that we use for both the radiant heating and the radiant cooling.

Cooling Mode;

Radiant cooling only requires a water temperature of around 15.6 Deg C (60 Deg F). The system is based on two very efficient fans on the cooling box, and thermally insulated dampers on both ends. When the ambient temperature is below 15.6 Deg C (60 Deg F), we store the ambient temperature into the PCMs using the variable speed fans.

The dampers are then shut, and water is run through the heat exchangers to transfer the energy. The warmer water from the radiant panels is stored in the PCMs (the heat sink) and during the evening the heat is released with the fans. Dew point is controlled in the house with a small desiccant wheel heat recovery unit that utilises the Solar hot water to drive the moisture off the exhaust side of the wheel before it takes in moist outside air, allowing the dew point to be kept below 15.6 Deg C (60 Deg F) when needed. The heat recovery unit also provides the ventilation air and the exhaust air for the house.

The fans and free cooling (when ambient temperatures permit) were used for cooling. Obviously, if the temperature is above 15,6 Deg C (60 Deg F), as it is most summer nights, it is not possible to provide the necessary cooling by means of free cooling. However, if you utilise a wet bulb adiabatic cooling system to charge the PCM system that design would give us additional 10~15C (18~27 F) lower ambient conditions over-night and this would be sufficient to charge the PCM thermal energy storage modules which in return would enable the design satisfy the day-time cooling requirements.

Alternatively, a small ground source or air-to-air heat pump using hot and cold PCM reservoirs can be added to top up the missing ambient condition which would be no more than a few weeks of the year for the temperate climate conditions.

This demonstration project performed extremely well and it appears to be offering a realistic environmentally acceptable domestic dwelling design whereby the comfort of the building can be achieve without compromising the industry standards. This design is based on the use of minimal energy usage by harnessing the natural cooling energy over-night and day-time heating energy utilising the PCM thermal energy storage to fill the gap between the energy availability and energy use.

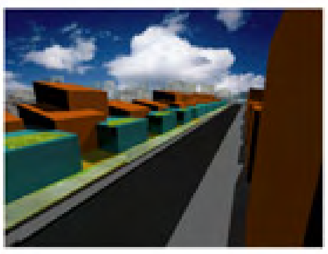
SOLAR DECATHLON

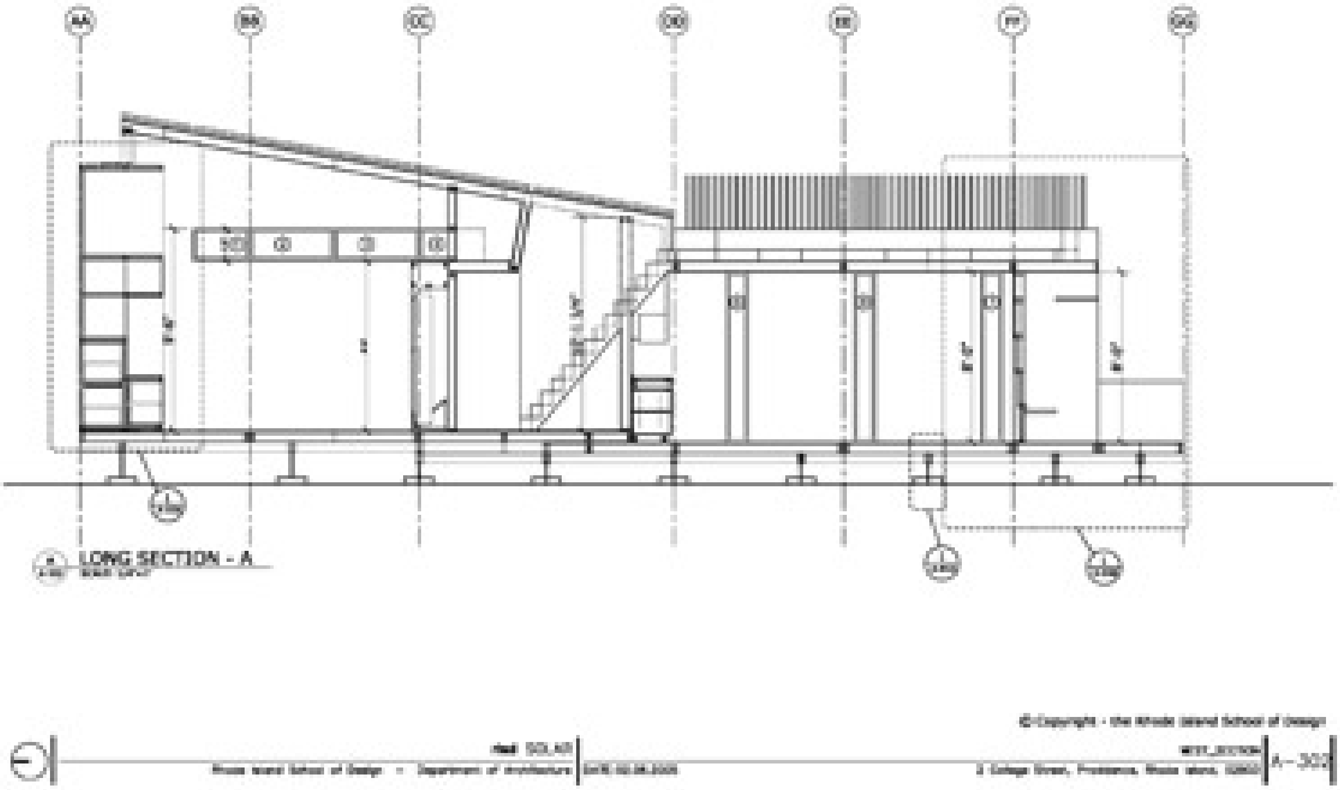
What is the Solar Decathlon?

The Solar Decathlon brings together college and university students from around the globe to participate in an unparalleled solar competition to design, build, and operate the most attractive and energy-efficient solar-powered home.

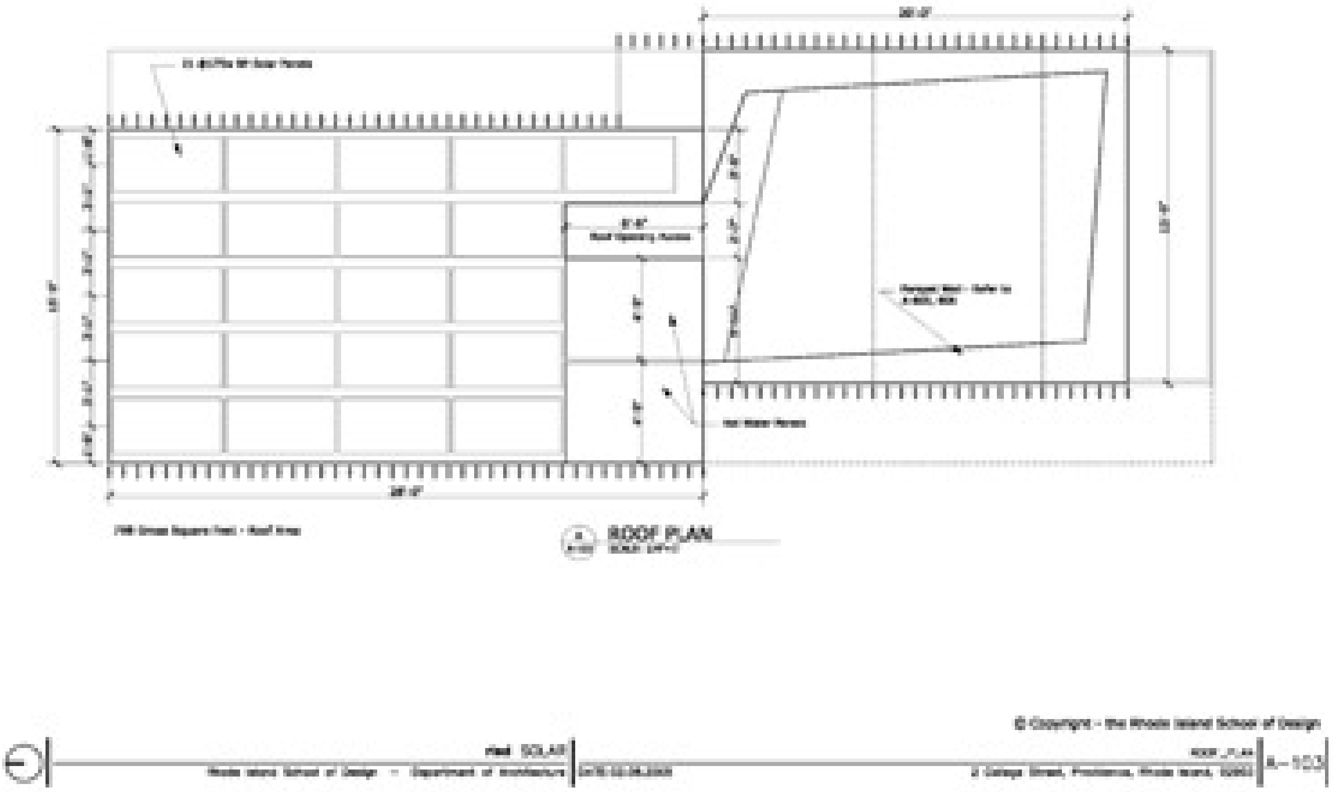
The teams transport their solar houses to the National Mall in Washington, D.C. The village and solar houses were open to the public from 7~16 October 2005. The teams compete into determine an overall winner.

Using only energy from the sun, the teams generate enough electricity / energy to run a modern household. To keep up with the students and organizers' experiences with an eye on energy efficiency, the students carefully choose the systems, products, and appliances used in their houses. The relevant details can be found at 2005 Solar Decathlon web page
www.eere.energy.gov/solar_decathlon

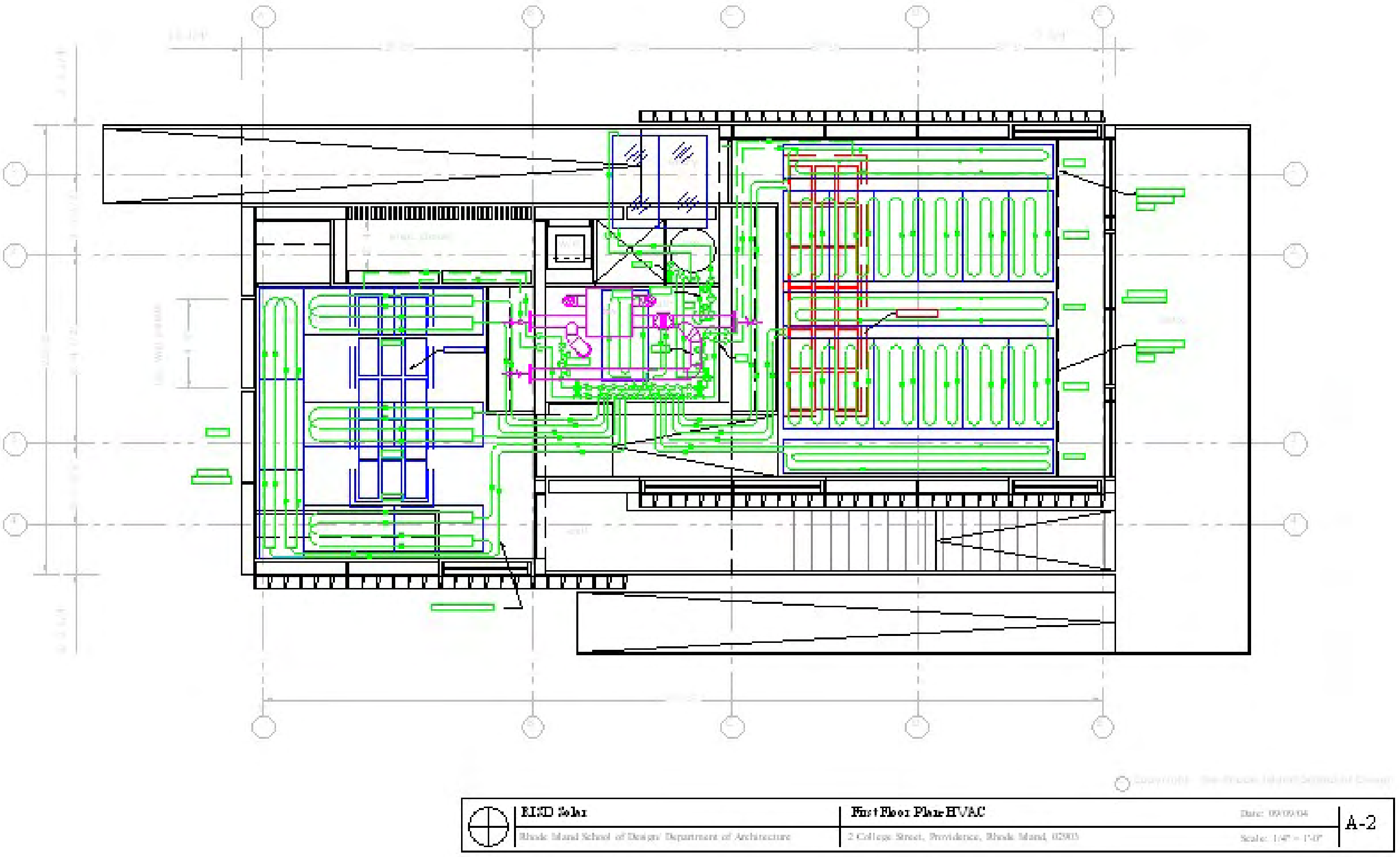




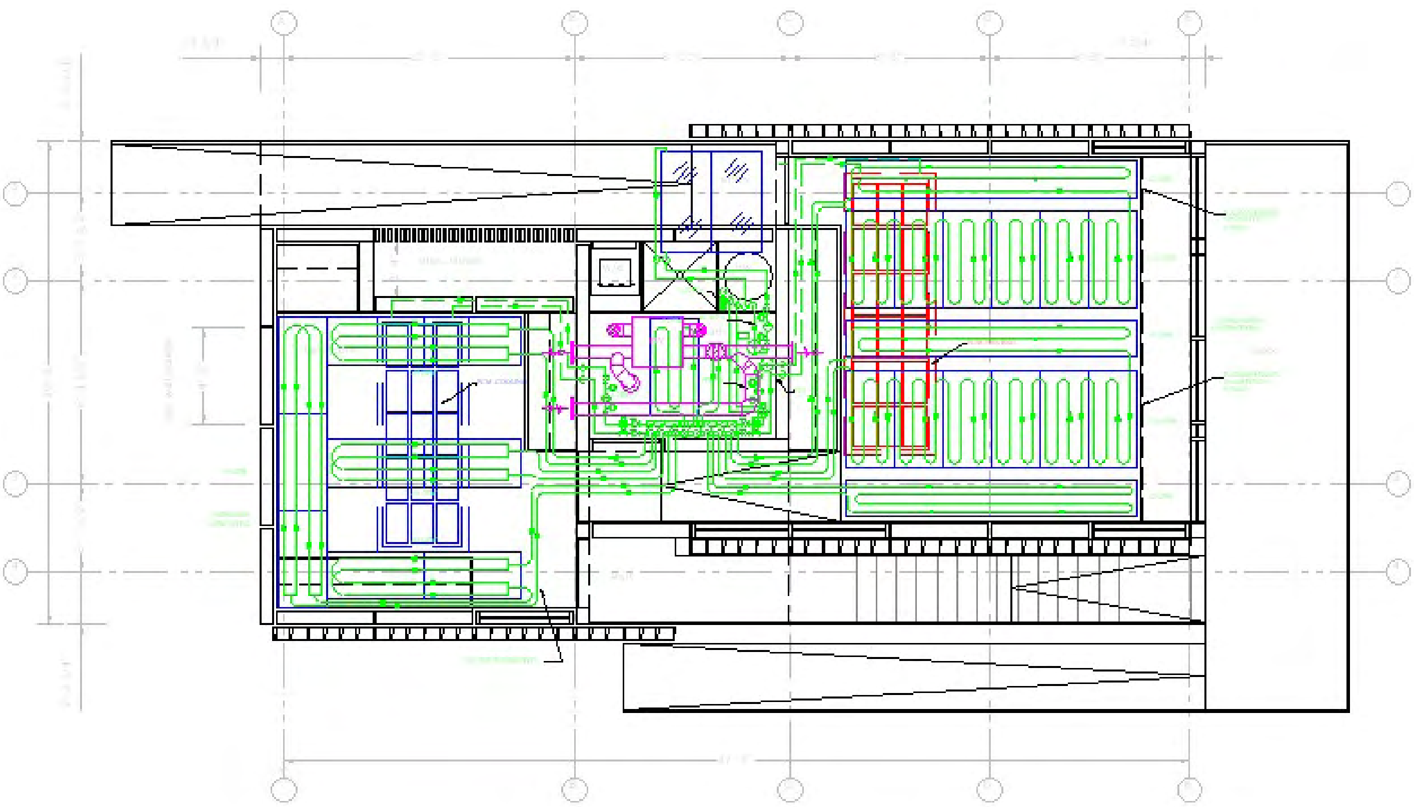
Cross Section



Plan



Floor Layout



Floor Layout

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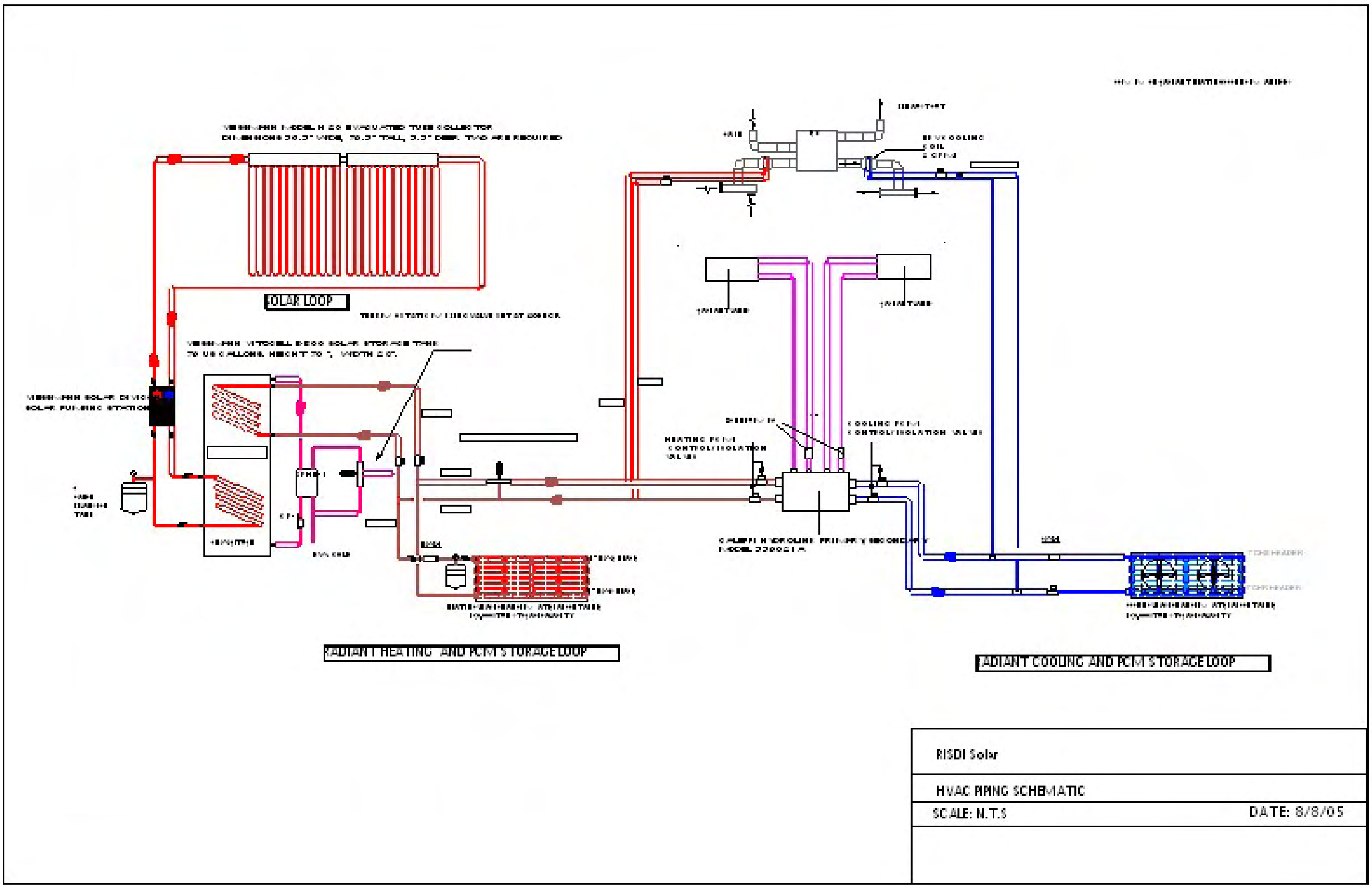
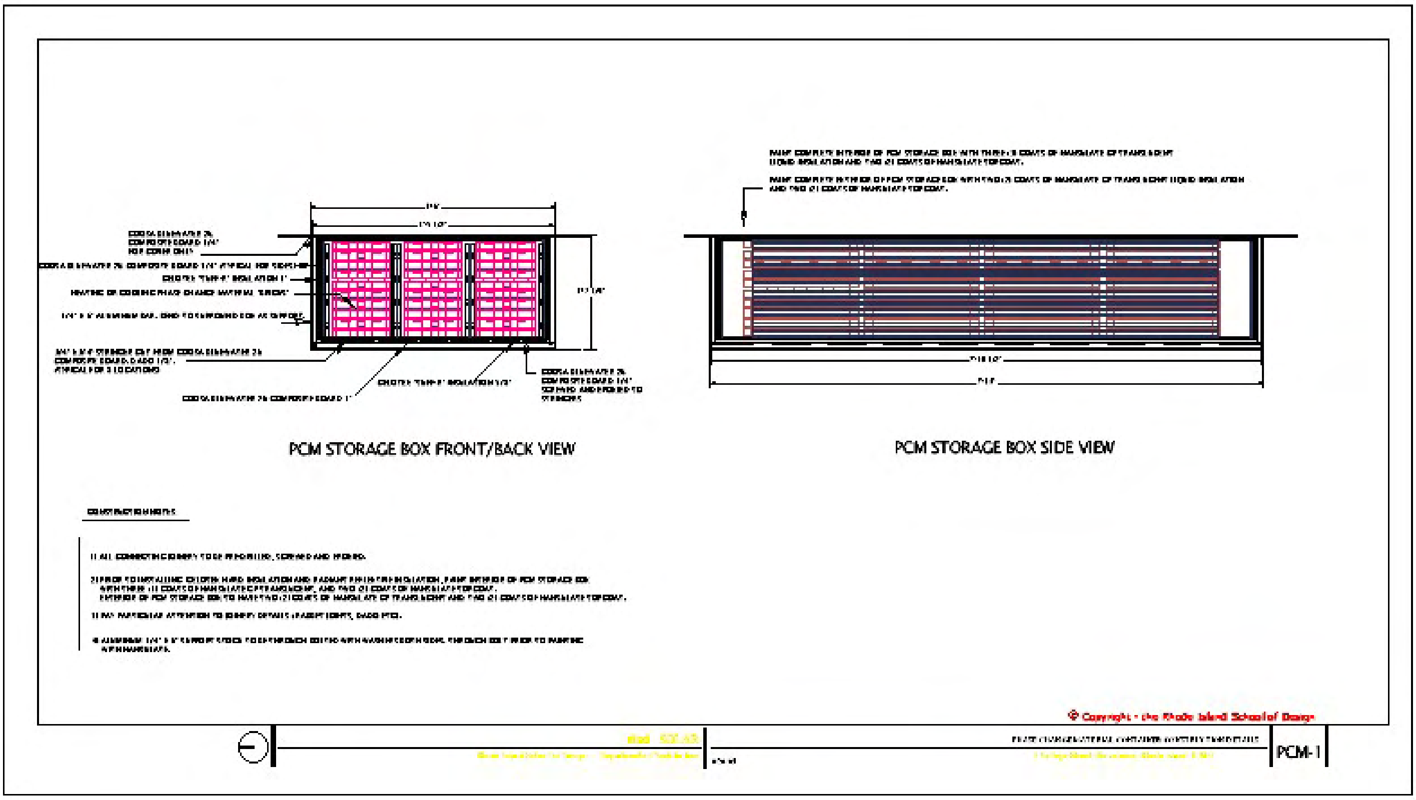
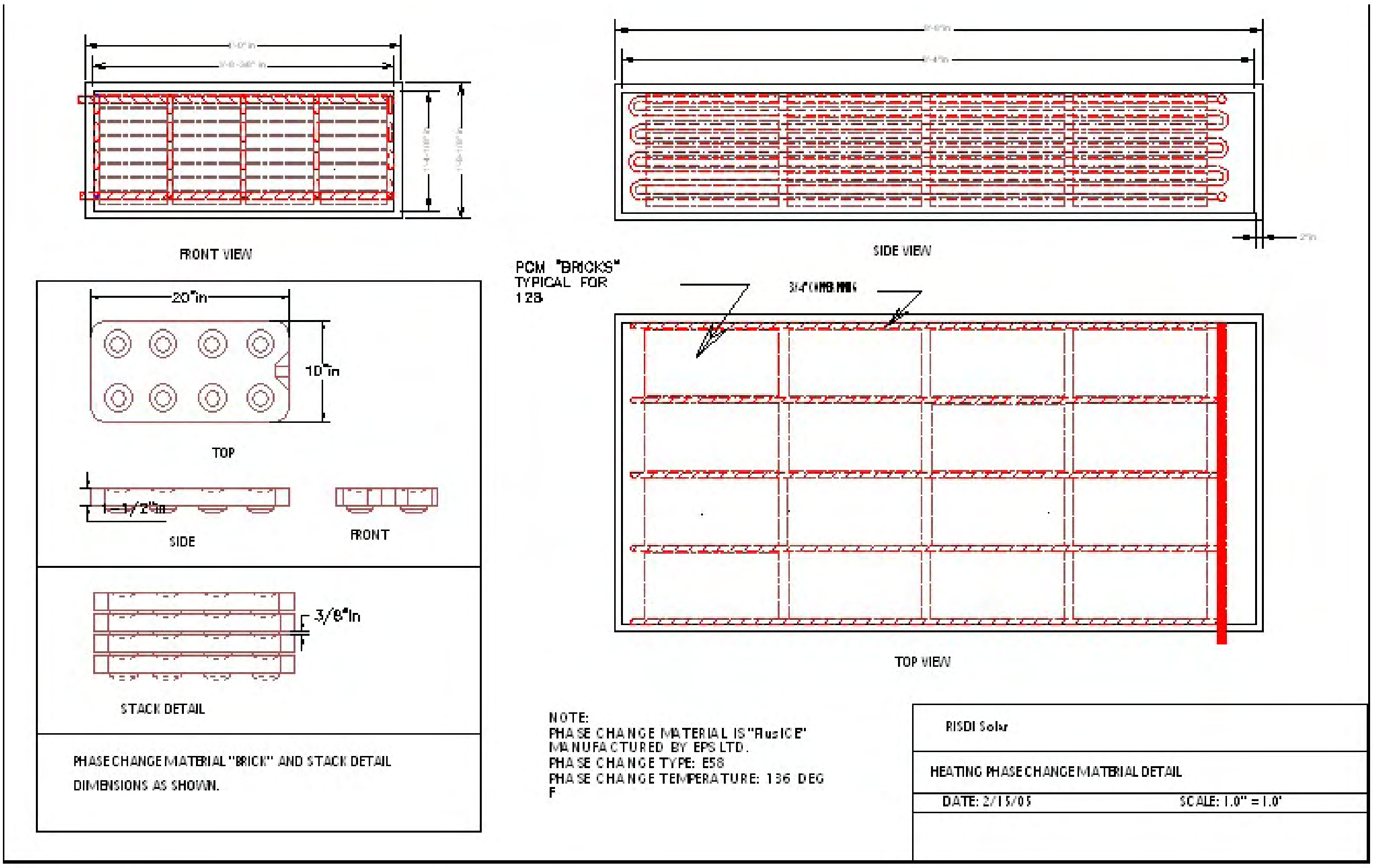


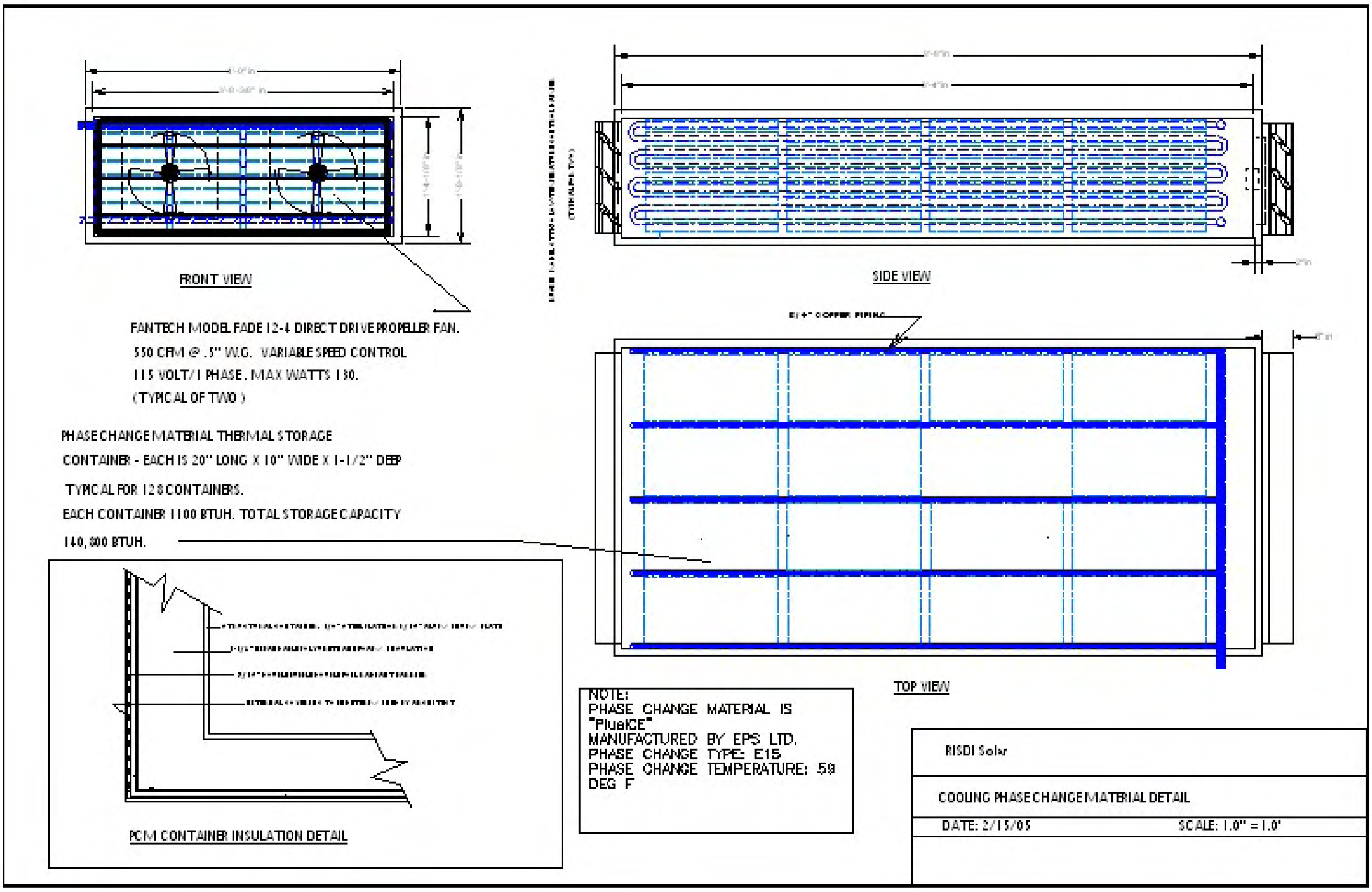
Schematic Layout



FlatICE PCM Thermal Energy Storage Module



FlatICE PCM Heating Thermal Energy Storage Module



FlatICE PCM Cooling Thermal Energy Storage Module

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