and rehandling of cuttings or flats and, if proper drainage is established, no loss from overwatering. It is fairly easy and inexpensive to construct, easily modified for particular requirements, and uses an inexpensive rooting medium. With dormant narrowleaf cuttings we are able to prepare cuttings during the late winter slack period and hold them in cold storage until they are able to be stuck.

This sandbed technique is not new or original. It is just our adaptation of an old principle in outside propagation made more efficient by modern advances in electric solenoid valves and time clocks. More important is that whatever we find can be propagated successfully in our outside sandbeds will use less energy, and be just that much more economical and cost effective to produce. We think that is a worthwhile endeavor and in a positive direction.

ENERGY SAVING PROPAGATION GREENHOUSE

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In 1972 a poly tunnel 15 x 180 feet was constructed at Spring Hill Nurseries to propagate evergreen cuttings. The house was designed and built to accommodate CPVC plastic pipe for bottom heat. A pit was dug and the house was placed two feet into the ground to cut down on heat loss.

The ½ inch CPVC pipe was placed on 6″ centers and buried halfway in 8 inches of sand. A boiler was installed midway in the house so each end could be controlled separately. Circulating pumps run continuously to give even heating throughout the house. We circulate 140°F water for bottom heat in the house. The boiler water temperature is controlled by thermostats. Details of consturction are available in the 1973 Proceedings (1).

We have used the greenhouse for 6 years to root evergreen cuttings. We have always had good results. In 1979 we discontinued rooting evergreens and switched the greenhouse to perennial production. At the present time, it is full of newly dibbled perennials. These plants respond well to the 70°F temperature. The air temperature will be between 40 and 65°F this time of the year. After establishing, the perennials are moved to a cool house for hardening off.

We feel that submerging the house and insulating the side walls made this a very economical house to heat. During the winters of 1972-73, 1973-74, 1974-75 the house was heated with propane. The three year annual average usage of propane was

3,762 gallons for a cost of $946.90 per heating season. To cut heating costs in the fall of 1975, it was converted to natural gas and individual records were no longer maintained. The house has a capacity of 204,600 rooted cuttings. Based on the 1972 through 1975 average cost of propane, we rooted 200 cuttings for one penny. Converted to natural gas at our present rate of 32¢ per 100 cubic feet, the cost to heat the house is $1,203,84 per year. Using present rates we could root 166 cuttings for one penny. Natural gas costs 5 times what it did in 1972.

The house is going into the eighth heating season and we have had only two leaks in the plastic pipe. We did have some difficulty isolating one of the leaks and if we were going to install the system again we would put valves on each heating loop.

We have had no problems with expansion of the pipe; however, we would put expansion loops in a new house. When we start the house each fall the pipe moves as much as 18 inches. For this reason we cool the house only once each year.

From our experience, if we were to build the structure again, we would follow the same plan with these modifications:

1) Install a valve at the inlet and the outlet of each heating loop to simplify finding leaks.
2) Install swing joints for expansion within each heating loop to cut down on movement of the heating pipes.

We have used double poly on the house since 1975, but we are not convinced it is a worthwhile investment. Early in the morning during the coldest days of winter, it is not uncommon to see frost on the cuttings while the root temperature is 68 to 70°F.

With the flats of evergreens covering the floor of the house, we find this house cheaper to heat than the same size above ground house with individual unit heaters at each end. It has lived up to our expectations for rooting cuttings.

LITERATURE CITED

1. Kyle, J.H. 1973 New propagation house using plastic pipe bottom heat. *Proc. Inter. Plant Prop. Soc.* 23:247-250.

TECHNIQUES TO REDUCE ENERGY USE

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In a paper presented at the 1978 IPPS meeting I described our pithouse propagation facility (1). The building is H-shaped