DOE/R4/10098--T1

12-0284

10098

DOE/R4/10098--T1

DE84 000745

report

on a system for

PASSIVE PREHEATING OF WATER-HEATER FEED WATER (USING ATTIC HEAT)

Appropriate Technology Small Grants Program

U.S. Department of Energy

Grant Number 12-0284

Fp44-80R410098

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

JANUARY 1982

EDWARD T. KNUDSEN, JR.

1900 60 WAY NORTH

ST. PETERSBURG, FL 33710

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE.

It has been reproduced from the best available copy to permit the broadest possible availability.

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Table of Contents

	<u>Sheet</u>
I. PROJECT DESCRIPTION	1
II. PROJECT DESIGN	2
III. PROJECT CONSTRUCTION	
a) Monitoring Equipment	2-4
b) Phase I	4-6
c) Phase II	6-7
d) Phase III	8
IV. MONITORING	
a) Background Conditions	8-13
b) Phase I	14
c) Phase II	14
V. MONITORING EVALUATIONS	
a) Water Usage	14
b) Water Temperatures	14-16
c) Attic Air Temperatures	16
d) Power Consumption To Heat Water	16
VI. COST EVALUATIONS - OPERATION	
a) Power Cost To Heat Water	17
b) Power Cost Savings	17
c) Maximum Power Cost Savings	17
VII. COST EVALUATIONS - CONSTRUCTION	
a) Pass-through System	18
b) Circulation System	18
VIII. COST COMPARISON	19
IX. SUMMARY	19-20

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Figures

	<u>Sheet</u>
1. CONTROL SYSTEM	5
2. MONITOR SYSTEM	5
3. PIPING SYSTEM - SCHEMATIC	7
4. DIFFERENTIAL TEMPERATURE PUMP CONTROL	9
5. HOUSEHOLD COLD WATER CONSUMPTION	10
6. ATTIC AIR TEMPERATURE VARIATIONS	11
7. ELECTRICAL CONSUMPTION	12
8. (Not Used)	13

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

TablesSheet

1. WATER USAGE	15
2. WATER TEMPERATURES	21
3. ATTIC AIR TEMPERATURES	22

APPENDIX

Following sheet 22

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

I. PROJECT DESCRIPTION

Electrical consumption for residential hot water heating may be reduced using solar heating. Many approaches to this conservation use solar collectors.

The geometry of some residences makes installation of a solar collector expensive and cumbersome. An alternative was investigated. The objectives were:

- a) Preheat water prior to entering hot water heater.
- b) Reduce electrical consumption during periods of peak electrical demands.
- c) Reduce power bill sufficiently to pay for system installation.
- d) Install a system constructed from materials catalogued and sold in plumbing supply outlets.
- e) Install a system that requires minimum maintenance.

The approach to accomplishing this objective was to install baseboard convectors in the attic above the existing electric hot water heater located in the garage. A 17 year-old 40-gallon Hotpoint, 2-4500 watt element, hot water heater was used. An insulating jacket was installed on the water

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

heater in December 1980.

II. PROJECT DESIGN

Several types of residential heating system convectors were considered. All are used with hot water for heating the air in rooms. This project applies a reverse principal using hot air in the attic to heat the water. Design information available from manufacturers was not adaptable to the reverse conditions, therefore, design data had to be obtained as a part of Phase I construction.

Convectors considered include:

- o Commercial fin-tube radiation
- o Horizontal propeller fan unit heaters
- o Horizontal unit heaters, without fan
- o Copper tubing in coils

It was determined that fin tube convectors, using $1\frac{1}{4}$ inch copper tubing and alunmimun fins, was the best application based on space available, estimated heat exchange capability, and cost.

III. PROJECT CONSTRUCTION

a) Monitoring equipment

The following monitoring equipment was purchased and installed during the beginning months of the project:

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

(1) Water meter-

A domestic cold water meter was installed on the feed to the hot water heater to measure the quantity of hot water consumed in our household. The meter was read at intervals no longer than 31 days.

(2) Electric meter-

Time meters, measuring in minutes, were installed on each of the two heating elements of the water heater to measure the time the heating elements are energized. The wattage of the elements was obtained from the heater nameplate data. A simple calculation of time and wattage gives the KWA consumption of the water heater.

(3) Recording thermometer for air temperature-

A PTC recording thermometer was purchased with a 7 day clock rotation, 0°-240° F range and 100 charts. This was placed in the attic to measure weekly temperature variations. Equipment was later purchased to change the range to 40° to 140° F.

(4) Remote indicating thermometer-

An Amprobe Fastemp Thermometer was purchased and mounted in the garage. Three 20-foot remote sensors were purchased for mounting in the attic. Attic temperatures were periodically read, in the garage, for various locations of

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

the attic.

(5) Thermometer-

A small water submersible thermometer was purchased to measure cold water and hot water temperatures. Water was collected in an insulated cup and the thermometer immersed for periodic measurements.

b) Phase I

The first phase of construction was to accomplish two objectives:

1. Install water and electric metering equipment.
2. Develop heat exchange coefficients to permit a design for quantity of heat exchange.

To accomplish the goals, time meters were installed on the two elements of the electric water heater. Meters indicated minutes on a totalizer. Readings are made periodically and recorded. Meters were 120v capacity. Elements were 240v capacity. Transformers were installed in the circuit. Figure 1 shows the meter control board.

A piping system was designed to accomodate a final arrangement for the heat exchange. A portion of the piping was installed, which included the water meter, and monitoring commenced. Figure 2 shows the piping modifications for monitoring.

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Note:

1. Water meter for feed water
2. Insulated pipe for preheated water
3. Valve (A) for by-pass is now open
4. Black conduit and wires (at right) go to monitor board

CONTROL SYSTEM

FIGURE 1

Note:

1. Record keeping data board
2. Running time meters connected to heating elements of water heater
3. Thermometer with three remote sensors located in attic

MONITOR SYSTEM

FIGURE 2

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

One 6-foot fin tube convector was ordered (Trane, Series 60 with $1\frac{1}{4}$ -inch copper tube and $2\frac{1}{2}$ -inch by $5\frac{1}{4}$ -inch aluminum fins.) The unit was installed outside in the direct sunlight and data collected. Then the unit was installed in the attic and temporary $\frac{1}{2}$ -inch PVC piping run to the unit. All work was done by the Project Manager. Plumbers were contacted but were "too busy" to make this non-standard installation (working in an attic).

c) Phase II

Calculations indicated that best results would be obtained with 30 feet of fin tube convectors. Four additional 6-foot units were ordered. Through an ordering error, by Trane Company, five units were delivered. The fifth unit was given to the Project Manager to avoid having to inventory this unit, not normally inventoried in Florida.

Six-6 foot fin tube convectors, total length of 36-feet, were installed by the Project Manager and an off duty plumber. Local plumbing contractors (3) contacted to make the installation but did not show up after promising to do the work. Figure 3 shows a schematic diagram of the installation.

Loading calculations concluded that the added weight would not effect the roof support. Support brackets were designed by the Project Manager and installed by a local building contractor. Modifications were made to the air conditioning duct system to make room for the installation.

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

FIGURE 3

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

d) Phase III

After monitoring, it was determined that manually by-passing the system when the evening temperatures were below 70°F was an effective method of controlling the system. An automatic system was designed. The principal components of the automatic system are:

- o circulation pump
- o differential temperature pump control
- o storage tank

A schematic diagram of the differential temperature pump control is shown on Figure 4. This unit is constructed by a local technician and sold to solar water heating contractors.

It was determined that installation of this automatically controlled continuous circulating and cutoff system was not cost effective and not installed.

IV. MONITORINGa) Background conditions

Monitoring consists of year-round monitoring, prior to construction of the preheat system, includes:

- o Cold water inlet temperatures
- o Hot water discharge conditions
- o Attic air temperatures, diurnal and annual variations
- o Total household water usage, monthly
- o Total household hot water usage, monthly
- o Total minutes hot water heating elements are energized.

Figures 5 through 8 show a summary of pertinent monitoring

PROJECT _____

SUBJECT DIFFERENTIAL TEMPERATUREPUMP CONTROLPROJ NO. FIGURE 4

CLIENT _____

COMP BY WRB DATE 12/81 CKD BY _____ DATE _____SHEET 9 OF _____

AXIAL 1.020, .400 Dia.

RADIAL .400 Dia. .800 High .200 Lead Spacing

FIGURE 4

PROJECT HOUSEHOLD WATER CONSUMPTION
SUBJECT 1900 60 WAY N. - ST PETERSBURG, FL
(BASED ON CITY UTILITIES DEPT READINGS)

PROJ NO. _____
CLIENT _____

COMP BY _____ DATE _____ CKD BY _____ DATE _____

SHEET 10 OF _____

— X = 1978
— O = 1979
— Δ = 1980
--- □ = 1981

Readings on 17th to 20th of Month
Consumption in Gals.

FIGURE 5

PROJECT DOE Grant - Appropriate Technology
SUBJECT Daily Attic Air Temp. Variations
8/30/80

PROJ NO. _____
CLIENT _____

COMP BY ETK DATE 11/81 CKD BY _____ DATE _____

SHEET 11 OF _____

FIGURE 6

Page :
1 of 2

Sheet 12

Continued, next Page

FIGURE 7

WATER HEATER ELECTRICAL CONSUMPTION / COSTS 1981

Page
262

Days	DATE	FEED WATER		ELECTRICAL - HEATING ELEMENTS						KWH per 1000 gals.	\$/1000 gals @ 7¢ per KWH	REMARKS	
		MTR. READ.	GALS.	TOP ELEM.		BOTTOM ELEM.		TOTAL					KWH (HRS. x 4.5)
				READ.	MINS.	READ.	MINS.	MINS.	HRS.				
	12/7/80	11663		802		21353							
26			2242		454		4287	4741	79.02	355.6	158.6	11.10	
	11/1/81	13905		1256		25640							
37			3617		1029		6905	7934	132.23	595.0	164.5	11.52	
	2/7/81	17522		2285		32545						Installed insul. Jacket on water heater 1/17/81	
21			2062		367		3253	4120	68.67	309.0	149.9	10.49	
	2/28/81	18192 1392		2652		36298							
28			2840		394		5089	5483	91.38	411.2	144.8	10.13	
	3/28/81	4232		3046		41387						Turned Preheat syst. on	
35			3233		116		5264	5380	89.67	403.5	124.8	8.74	
	5/2/81	7465		3162		46651							
32			2692		43		4189	4232	70.53	317.4	117.9	8.25	
	6/3/81	10,157		3205		50840							
24			1542		0		2295	2295	38.25	172.1	111.6	7.81	
	6/27/81	11,699		3205		53135						Turned Preheat syst off	
18			1243		12		1881	1893	31.55	142.0	114.2	8.00	
	7/15/81	12942		3217		55016							
12			701		15		1026	1041	17.35	78.1	111.4	7.80	
	7/27/81	13,643		3232		56042						Turned Preheat syst. on	
19			1401		10		2052	2062	34.37	154.65	110.4	7.73	
	8/15/81	15,044		3242		58094							
20			1391		23		1995	2018	33.63	151.35	108.8	7.61	
	9/4/81	16,435		3265		60089						Cool weather starts.	

FIGURE 7 (CONT.)

Sheet 13

FIGURE 7 (CONT.)

Sheet 13

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

records.

b) Phase I monitoring

During Phase 1, background conditions were continued to be monitored. In addition, the possible benefits of 1-6 foot fin tube convectors were measured.

c) Phase II monitoring

From May 15, 1981 to September 20, 1981, the system was placed in service. The six parameters measured for background conditions were measured. During the period of June 27, 1981 to July 11, 1981, the system was bypassed to recheck background conditions.

V. MONITORING EVALUATIONS

a) Water usage

Water usage of gallons of hot water used per month, gallons of total water purchased monthly from the city, and the percent hot water/total water are shown in Table 1. Water purchased from the City does not include irrigation water. Usage is for five family members with additional guests during the summer of 1981. Additional comments are contained in Appendix A.

b) Water temperatures

City water mains in the area are 2-inch galvanized pipe, 18 to 24 inches under the grass surface. Temperatures vary significantly by ambient or ground temperature variations. In general, cold water temperatures are 65°F during the winter and

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

TABLE 1

WATER USAGE

MONTH	HOT WATER USAGE			HOT WATER USAGE AS % TOTAL WATER		
	1980	1981	AVG	1980	1981	AVG.
	gals/day	gals/day	gals/day	%	%	%
January		98	100		33.7	33.0
February		98			32.2	
March		101			33.3	
April		92	85		29.0	26
May		84			24.6	
June		67			21.3	21.5
July	70	61	70	23.6	21.2	
August	80	72		26.9	23.7	
September	70			23.4		24.0
October	79		75	27.1		
November	91			31.4		
December	93		90	32.2		32.0

23.7%

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

83°F during the summer. Hot water temperatures vary between 128°F and 132°F year round. Temperatures, by month, are tabulated in Table 2.

c) Attic air temperatures

Diurnal air temperatures vary significantly. In general, summer temperatures increase during the late morning then decrease after dark. Usually, temperatures between 11:AM and 9:PM are high enough to provide measurable heat input into ^{the} system.

Monthly high and low temperature variations are shown in Table 3. It is expected that the system will be effective during the months of June through September. Marginal benefits should be expected during May and October.

d) Power consumption to heat water

The total kilowatt hours to heat a measured volume of water was determined by month. In general, 111 to 114 KWH of electricity was used per 1000 gallons of water during summer months without the preheat system. After installation of the preheat system, 108 to 110 KWH of electricity was used per 1000 of gallons of water.

Measurements were made of water temperatures exiting the preheat system. The range of the temperature rise of the exiting water was as follows:

After 30 to 60 mins. resident time in system	5° to 10°F
After 30 seconds (water running)	0° to 1°F

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

VI COST EVALUATIONS - OPERATIONa) Power cost to heat water

Currently, power costs for heating water are approximately 7.3¢ per KWH. Power costs are:

Without system: $(111+114) \div 2 \times 7.3¢ = \$8.21/1000 \text{ gals.}$
With system : $(108+110) \div 2 \times 7.3¢ = \$7.96/1000 \text{ gals.}$

b) Power cost savings

During the summer months, 23.7% of the total household water consumption is passed through the water heater. The average May to October monthly water consumption is 9140 gallons. Therefore, an average of 2166 gallons of water pass through the water heater during each summer month. The annual cost savings is calculated to be $2166 \times 6 \text{ months} \times (\$8.21 - \$7.96) = \3.25 .

It is interesting to note that the power costs for heating water, without the system, is \$17.79 a month during summer months and \$35.37 during winter months.

c) Maximum power cost savings

It is estimated that most of the water is only preheated 1° before entering the water heater due to the one pass-through design. Solar and other water heating systems are designed for a continuous circulation system until water reaches its optimum temperature. If water was run continuously through the system to achieve a 6° temperature rise, the annual power savings would be about \$20.

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

VI COST EVALUATIONS - CONSTRUCTION

a) Pass-through system

Materials for the project, if installed in a new home or an existing home, are:

6 fin tube convectors	\$370
5 ft. of $1\frac{1}{4}$ " pipe	8
20 ft. of $\frac{1}{2}$ " pipe	12
2- $\frac{1}{2}$ " valves	10
Fittings	15
Total	\$415

Labor costs for one half day for plumber and helper, at \$240 per day, are \$120. The total construction cost is \$535 for a system designed to operate only when hot water is being drawn in the house.

b) Circulating system

Modifications of the existing pass-through system to a continuous circulation system are estimated to cost an additional \$265. This cost is summarized as follows:

Circulation Pump	\$ 60
Differential Temperature	
Pump Control	50
Electrical	25
Plumbing	45
Storage tank	85
Subtotal	\$265
Cost of Basic System	535
Total	\$800

It is expected that two convectors could be eliminated with a continuous circulating system. This will reduce the total cost to \$677.

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM
 DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
 EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

VIII COST COMPARISON

The payback period, less interest, for the pass-through system is:

$$\$535 \div \$3.25 = 165 \text{ years}$$

The payback period, less interest, for the continuous feed system is:

$$\$677 \div \$20 = 34 \text{ years}$$

Therefore, neither method of operation is cost effective. During the summer months, it is estimated that the monthly hot water consumption will be 2300 gallons. The temperature rise for the pass-through system may be as high as 3°F. The temperature rise for the 60° to 70° cold water condition in a continuous circulation system is estimated to be 20°.

The cost comparisons of the two systems are:

	<u>SYSTEMS</u>	
	<u>Pass-through</u>	<u>Continuous</u>
Temperature rise	3°	20°
Annual cost saving	\$10	\$71
Payback Period	41 years	10 years

IX SUMMARY

Fin tube convectors installed in an attic absorb heat from the attic air at a very low rate of heat exchange. Resident time of cold water in the heat exchanger is considerably longer than expected to effect a temperature rise approximating half the temperature differential between the cold water and the attic air temperature. This long resident time requires continuous circulation of water in the system.

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM
DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284
EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Florida ground waters are heated in the water distribution system due to shallow pipeline installations. Therefore, the water temperature entering the test house in the summer months is considerably higher than expected.

Homes located in areas with cold water temperatures of 60° to 70° entering the home during summer months may effectively preheat the water heater feed water for a cost saving which could be recovered in 10 years.

If water heater is energized by electric power, preheating water with passive solar heat will also effect a reduced demand of 3,500 to 5,000 KW per home during periods of peak electrical demands. This may be considered a benefit to override the poor cost benefit.

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

TABLE 2

COLD WATER TEMPERATURES
(WATER FROM CITY MAINS)

MONTH	TEMPERATURE °F	AVERAGE °F
Jan.	60	
Feb.	64	
March	70	
April	76	
May	78	
June	83	
July	85	
August	85	
Sept	85	
Oct	84	
Nov.	75	
Dec	64	

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

APPENDIX

Misc. Figures, Tables and Data
not referenced in report text.

PLOT OF COLD WATER TEMP ENTERING HOME

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

HOUSEHOLD WATER CONSUMPTION RECORDS

CITY UTILITY BILLING
to
1900-60th WAY N., ST PETE, FL.

Month Meter	1977	1978	1979	1980	1981	1982
<u>Read</u>	GALS	GALS	GALS	GALS	GALS	GALS
JAN		10,600	10,000	11,000	8,900	
Feb		9600	9000	11,100	8,800	
Mar		8000	7800	9200	8,500	
Apr.		12400	10,800	5,900	10,500	
May		8600	11400	9900	8200	
June		10200	10800	10600	12,000	
July		8400	8800	6700	8,500	
Aug		9600	7600	7200	9800	
Sept		9400	10,000	8900	8500	
Oct		9200	9400	8500	6900 ^E	
Nov		8600	10600	8100	8500	
Dec	8,600	8,000	11,800	9,100	6,200 ^E	

NOTE: City reads meter on the 22nd ± of the month.

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

PUMPED SYSTEM (USING TWO TANKS)

A & B Pump Temp. Sensors - To pump control box
C & D Water Tank Heating Elements - both active.

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Alternate Pumped System (Using one Tank)

SCHEMATIC

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

5/12/80

TELCON Tom Weatherington - F.P.C. 866-5660

1. Set Time Clock on heating element for power consumption

2. Avg tank losses = 60 to 90 KWH/month

3. Avg elect use /month

family 4 354 KWH/MO

family of 5 384 KWH/MO

1 96 KWH/MO

2 157 "

3 256 "

4. Storage Loss @ 150°, 52 gal HW hts

Std insul. 117 KWH/MO

Super insul. 90 KWH/MO

@ 120°

Std insul 80 KWH/MO

Super insul 45 "

5. Supervised by A.O. Smith (Charles Sales)

Rheem/Beas

State / words

6. Temp in Attic

110°F Max w/conc. tile roof

Nite T. = ambient

APPROPRATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Water Consumption per activity
Hot water only
Family of 5
Weekly Avg

Shower	2 gal - 7 gal	110 gals
Bath	10 gal	30 gals
Wash clothes	20 gal to 0 gal	0 - 60 gals
Dish Washer	20 gal	180 gals
Sink/Lavatory	3 gal/day	21 gals
Misc		30 gals
		<u>430 ± gals</u>

Actual

Shower	6/28	4.5 gals	0.133 KWH elect used
"	9/14	5.3 gals	

APPROPRIATE TECHNOLOGY SMALL GRANTS PROGRAM

DOE GRANT NO. DE-FG-44-80R4.10098.000; PROPOSAL NO. 12-0284

EDWARD T. KNUDSEN, JR., 1900-60 WAY N., ST. PETERSBURG, FL 33710

Summary of Materials & Supplies Purchased

I. Equipment

A. Incorporated into permanent installation

1. 6 - Trane convectors	\$384.28
2. Brackets	13.33

B. Not reusable

1. Batteries	\$3.75
2. Soldering torch	9.35

C. Surplus, to be disposed of

1. Recording thermometer
PTC, 7 day clock 20°-220°F w/charts
conversion kit 40°-140°F w/charts	\$135.20
2. Pocket thermometer 0°-220°F	26.65
3. 2 elect. time clocks, 110 V., mins.	7.20
4. Thermo w/3-20' probes	29.35
5. Rockwell 5/8" x 3/4" cold water meter	98.20
	41.60

Total

\$749.87

II Materials/Supplies

A. Incorporated into permanent installation

1. 2 - 3/4" check valves	
6 - 3/4" ball valves	
2 - 3/4" boiler drains	\$88.71
2. Copper pipe & fittings (3/4")	110.32
3. Insulation	10.50
4. Misc.	10.00

B. Used and disposed

1. PVC pipe & fittings (1/2")	25.50
2. Misc	10.00

Total

\$255.03