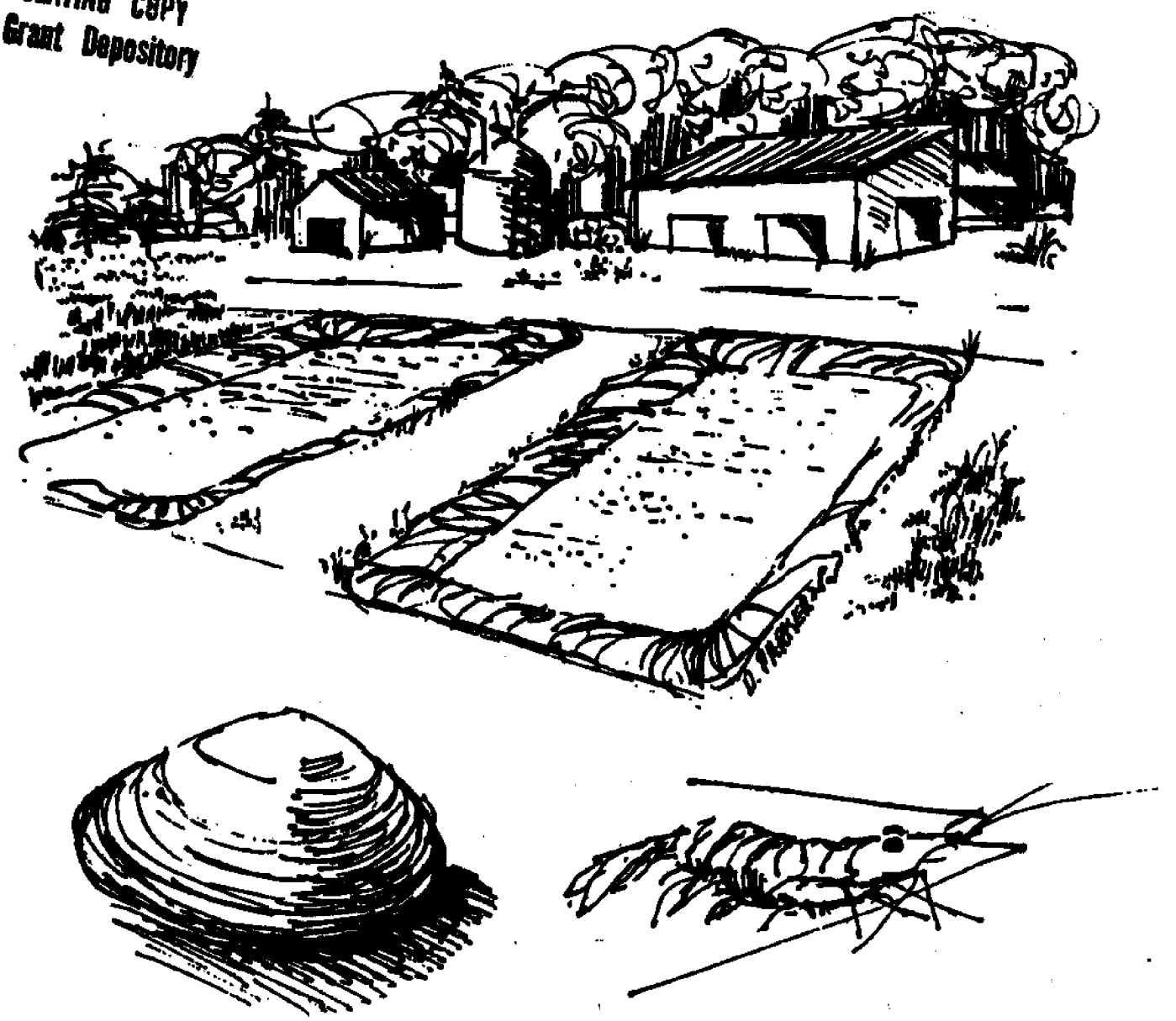
MaGEC

Maximizing Marine Growth Through Environmental Control



The University of New Hampshire

Ocean Projects 1989-1990

Ma.G.E.C.

Maximizing Marine Growth Through Environmental Control

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TABLE OF CONTENTS

ABSTRACT

Raising seafood in artificially controlled environments is becoming a practical and economical method of supplying the seafood demands of the populace. In South Carolina, particular interest lies in the farming of shrimp. It has also been shown that hard shell clams demonstrate a symbiotic relationship with shrimp. For this reason, clams are presently transported from New England, at the end of their summer growing period, to a man-made test pond at the Waddell Mariculture Research and Development Center, in Bluffton, South Carolina. By moving the clams to a milder climate, during October to May, and controlling their environment, the growing season is extended, thus accelerating their growth. The end result is a larger and a higher quality clam, in a shorter period of time. It is therefore more profitable.

This study presents the analysis utilized to determine the technical parameters of a heating system which can artificially raise and maintain the test pond temperature from its winter temperature to 73°F before that which would occur in nature. The raising of the pond temperature would permit the introduction of post-larvae shrimp into the water at a time ahead of which would occur in a similar pond that is not heated. The analysis is based upon experimentation, collection of data, and modelling the heat transfer phenomena with computer simulation. It includes the effects of convection, conduction, and radiation from the pond's heating and recirculation systems and effects from the sun.

INTRODUCTION

Aquacultural/maricultural engineering is the application of science and technology to the farming of marine life. By controlling the water quality, chemistry, temperature, flow rates and feeding flux, as well as the density and the distribution of the organisms, marine plants and animals can be grown faster, with higher quality and less crop loss than in nature. Such controlled production, permits much cheaper harvesting costs than those associated with commercial fishing, and is demonstrating the important role of engineering to maintaining as well as increasing the world's food supply.

The United States was once a major fishing nation, but now imports over half of all its consumption of seafood products. This annual consumption has increased from 10 lb. to 15 lbs. per capita over the past 25 years. More than half of their consumption is imported, and, along with fuel oil, automobiles and electronics, is a major contributor to the U.S. balance of payments deficit (U.S. Department of Commerce, 1989). Over-fishing and pollution of the coastline of the nation have encouraged the creation of fish farming in the United States. One of the participants in this new industry is the state of South Carolina.

The original fish farmers in the U.S. were mostly concerned with raising fresh water catfish in ponds in the Southeast. However, the industry has expanded to include shrimp, clams, oysters, and hybrids, such as the hybrid bass. South Carolina has concentrated on the farming of shrimp and fin fish. There are now over 300 acres of cultivated shrimp ponds in production

in the state.

The original focus of this project was on accelerating the growth of the hard clam (Merceneria-merceneria) by transferring the clams from New England to South Carolina, and back, during the appropriate growing seasons. The milder climate allows the N.E. clams to gain an additional 5 months of growth during a 7 month winter period, in which they would otherwise be dormant. When the clams are between the size of 1 and 20 millimeters, they are very suseptable to preditors and disease. Transporting them eliminates this problem. Hard clams grow and flourish from late April until mid October in New England with a growing cycle that peaks in mid July and late August. Governed by the availability of food and water temperatures, hard clams do not grow when the water temperatures drop significantly below 50°F. In South Carolina, the growing season for clams runs from the middle of October to late in June when the water temperatures begin to exceed 85°F, or when the high temperatures also result in a dormant growth period. By harvesting the clams at the end of each growing season and returning them to the proper growing environment in nature, it is expected that the growth of hard clams can be accelerated to their marketable size of 50 millimeters from 3-4 years to less than 2 years.

Experiments carried out by a prior student project, encouraged the continuation of the effort (UNH Sea Grant Student Project, 1988). Subsequent effort by the faculty advisor of this project, led to the implementation of an environmentally controlled pond in October of 1984. This was located at the

South Carolina State Waddell Mariculture Research and Development Center in Bluffton, South Carolina.

Because of the strong focus of the State of South Carolina upon the growing of shrimp, this pond had a bicultural goal for both clams and shrimp, and would not have been supported by the State of S.C. had it not had a shrimp focus. Originally, the pond's heating system was to be in operation in October of 1989 so that shrimp could be grown with the clams at that time. Due to delays in delivery of a bubble mat, pond insulating cover, and the shortage of labor after the onslaught of hurricane Hugo, these goals were changed.

The goal of the pond has since become, assuming an algae bloom in the pond can be maintained from October until March of the following year, to establish a heating plant within the pond. This system would raise the temperature by the first of March, from natural ambient, to 73°F, and maintain it through March and April.

The purpose of this new goal of the pond was to permit the introduction of the shrimp post-larvae in the first of March. This would place them in a pond in S.C. six weeks before the natural conditions would permit such seeding of a pond. This running start could add as much as $.50/lb. to any shrimp grown in South Carolina, a head start on what is now only a 17-20 week natural growing period. The end product would provide larger shrimp and greater survival by providing shrimp juveniles, rather than post-larvae shrimp (PL's), to be planted at the beginning of May.

PURPOSE

The original purpose of this project was to measure the heating ability of the aeration system of this pond, and its ability to achieve the goal of maintaining the water at 73°F from October through the winter.

Changes in the goal of the Waddell Mariculture Center have necessitated changes in the goals of this project. The new goals, developed in January 1990, are to determine the amount of heat necessary and suggest possible heating systems which would heat the pond up to 73°F in order to install the PL's in early March instead of late April. The resident manager at the Waddell Center estimates that $18,000 would be added to the final value of one million PL's having the head start in such a pond. Additions of up to $25,000 in the value of the 600,000 clams grown in the same pond, indicate the economic desirability of this goal. Thus, the redirected purpose of the overall project has been to determine how much heat must be added to the pond to raise and maintain the temperature from the ponds average Febuary temperature to 73°F by the first of March.

PHYSICAL SYSTEM

The test pond is located about 80 miles south of Charleston, at the Waddell Mariculture Center in Bluffton, South Carolina. It is adjacent to a tidal water inlet from which saline water is pumped directly into the test ponds. It is a man-made test pond that is 180' long, 84' wide. Although there is a slight slope in the depth, it averages about 4'. A black, polyethylene liner, 40 mil/1.0 mm thick, lines the ground, permitting the containment of water. The bottom of the pond is covered with a layer of sand (Fig. 1).

In order to provide and maintain the necessary amount of oxygen and nutrients in the water, along with a method of introducing heat into the pond, two systems existed in 1989. First is an aeration system. It consists of a 6 horsepower air compressor, 2" and 4" PVC piping, 1" nongalvanized black iron piping, and 28 air stone diffusers. Air is drawn into the compressor, heated to 100°F above ambient.

Originally, the hot air was sent to the pond through the 4" PVC piping. Once reaching the water, it was diverted 3 ways. The hot air was sent through two 1" water pipes that lie on the bottom of each side of the pond. Heat was conducted through the pipes to the pond. The pipes extended the length of the pond and rise above the surface to the atmosphere. The third diversion was made of 2" PVC extending the length of the pond and angling to the corner. Twenty-eight air stone diffusers were attached and allowed the direct diffusion of the hot air into the water (Fig. 2).

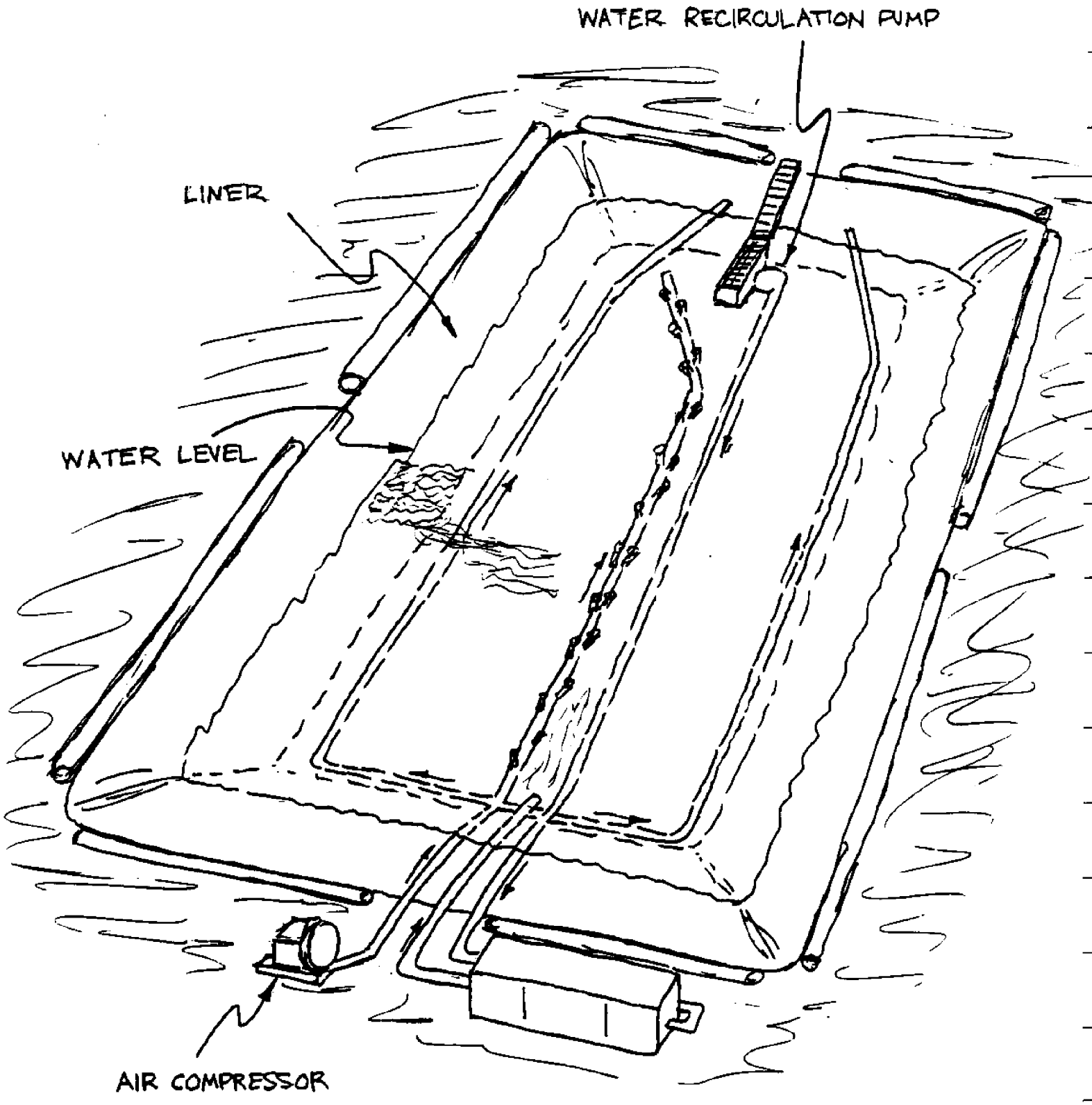
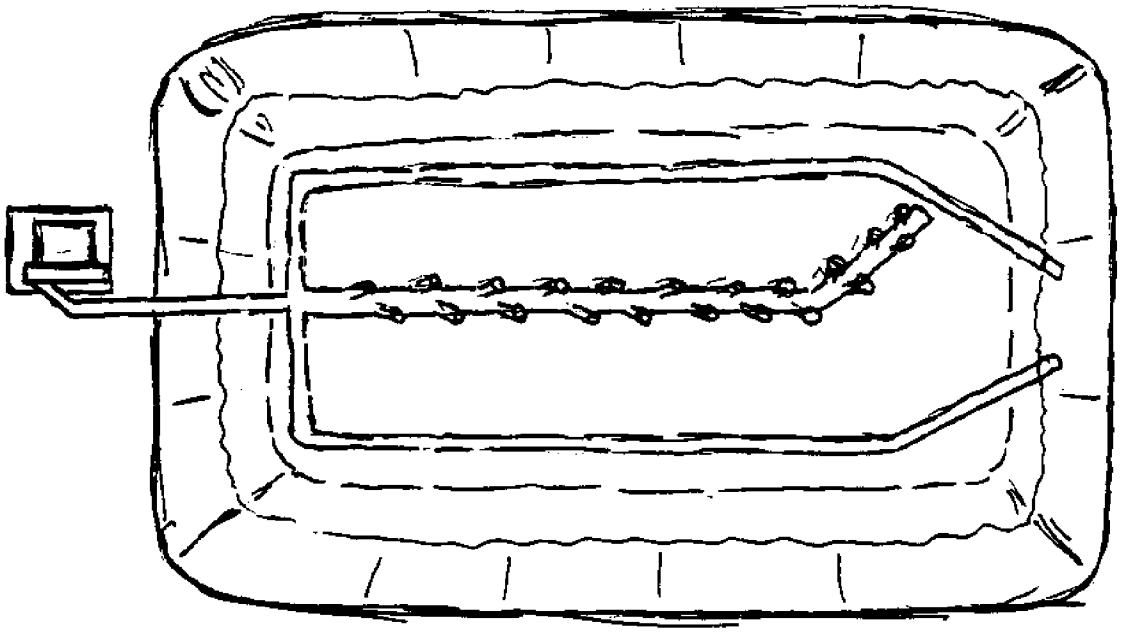
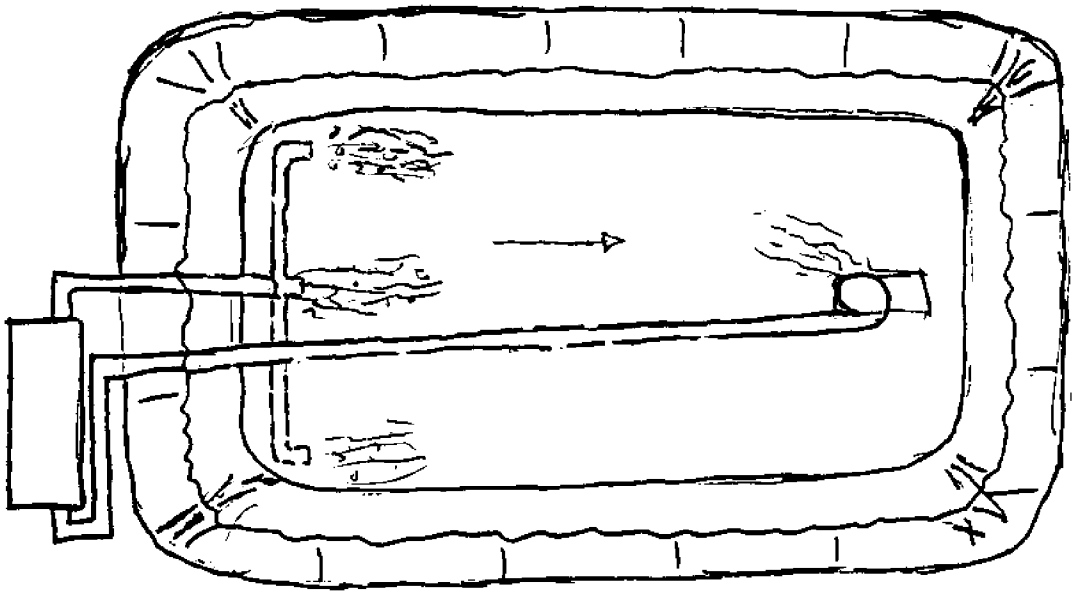


Fig. 1: Test Pond #4 at the Waddell Mariculture Research and Development Center, Bluffton, SC.



(a)



(b)

Fig. 2: Plan view of (a) heating and aeration and (b) water recirculation systems.

Between January and March several alterations were made to the heat conducting pipes to better utilize the energy generated by the compressor. These changes included adding two 1" heat exchanging pipes which run the length of the pond. The air is now channelled through all four of these pipes before being diffused through the air stones.

The second system used is a water recirculation system. A rebuilt 3/4 horsepower pump is located in the deeper end, 11' from the banking. Water is passed through 2" PVC piping, which runs the length of the pond and is fed through a water trough, or raceway. After passing through the 20' long raceway, the water is returned to the pond, completing the closed-system loop. The recirculation of water, aided by the diffusion of air into the pond, maintains a uniform temperature throughout (Fig. 2).

A polyethylene cover helps to maintain the temperature by preventing heat loss during the course of the day . The cover is made of bubble-mat concrete curing material, double-ply, in 20' by 70' sections. It is transluscent and has a manufacturers R-factor of 5.8 and covers approximately 90% of the pond. The sections are bonded together and firmly anchored to the pond walls to prevent it from being removed by the wind. To this date, the cover has withstood gales over 50 MPH.

APPROACH

As stated previously, the original intent of the project was to evaluate the heating efficiency of the pond's existing aeration system. It was felt that in order to do this as well as to create an analytical model of the pond that an on site visit to the Waddell Mariculture Center was essential. The purpose of this was to become familiar with the physical layout of the pond, to evaluate the present heating system, and to gather data necessary for the completion of an analytical model. Preparation for this on-site observation included the research and acquisition of an elbow flow meter and gauge, an open-channel flow meter, temperature measuring devices, and necessary equipment for the installation of measuring devices. While at the Waddell Center, flow measurements were made to determine the flow rate of air through the heat exchanging pipes with the flow meters. In addition, the temperatures throughout the pond, ambient conditions such as air temperature and wind velocities, flow patterns, and weather data were recorded.

Upon returning from the Waddell Center, and reoriented toward the goal of maintaining a water temperature of 73°F beginning on March first, the data obtained from the trip was evaluated. Based upon this, the heat transfer phenomena in the pond was modeled. Further experimentation was conducted regarding the heat transfer by the air diffused through the air stone, and the transmissivity of the cover. Analytical models were created to examine the benefits of the pond cover, determine the energy needed to artificially raise the pond temperature and

determine the energy needed to maintain this temperature. The analytical model allowed for the specification of the parameters of a heating system. Its economic feasibility could then be assessed, as well as the development of recommendations for heat transfer improvements.

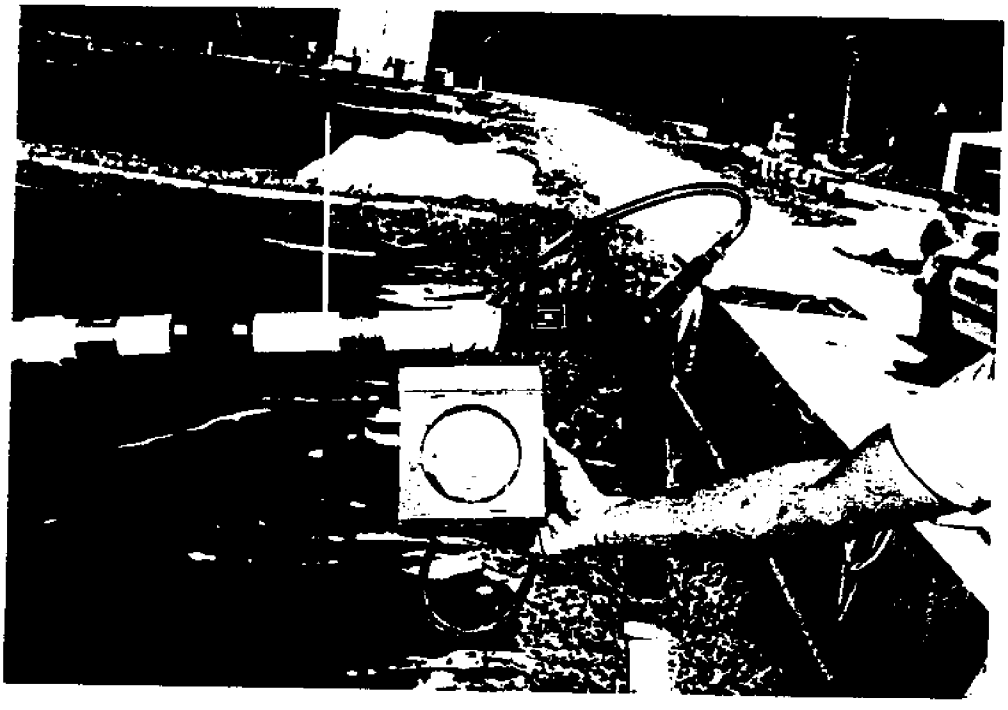
EXPERIMENTATION

Several experiments were performed to obtain knowledge and data regarding the parameters which affect the heat transfer to and from the test pond.

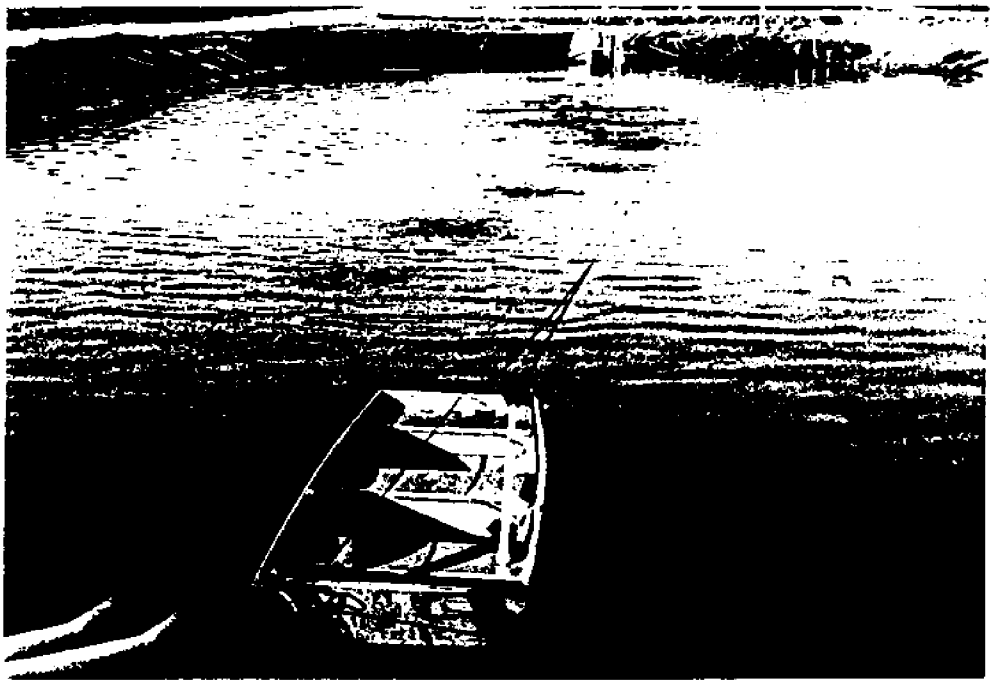
At the Waddell Mariculture Center an experiment was performed in order to evaluate the heat gained by the pond from the heat exchanging pipes. It was necessary to determine the mass flow rate and temperature of the air both entering and exiting the pond. The air flow entering the pond, from the compressor, was diverted and measured by an elbow flow meter and thermometers (Fig. 3). The pressure difference on each side of the elbow was measured and the corresponding flow, in cubic feet per minute, was read. A value of 150 cfm was obtained. The temperature of this flow measured 163°F.

The same procedure was used at the air exit, similarly attaching the elbow flow meter to the exiting pipes. The temperature of the air out of the system was the same as the water temperature, 60°F. The air exited the two heat exchanging pipes at a flow rate of 66 cfm., with the remainder passing through the air stones.

Another experiment was performed in order to understand the effects of the circulation of water and temperature distribution within the water. Additionally, the identification of this flow was necessary to determine the convection of water around the piping and under the cover. An open channel flow meter and an electronic temperature probe were used to measure the flow of water and temperature of the pond. After constructing a means to



(a)



(b)

Fig. 3: Methodology used to (a) obtain air flow rates and temperatures and (b) traverse pond to obtain water flow rates and temperatures.

ferry the length of the pond, these measurements were taken every 12', making 4 passes over the length of the pond (Fig. 3). The flowmeter consistently displayed very low values, on the order of 0.04 ft/sec. The temperatures throughout the pond did not vary more than one degree from 59°F.

Additional measurements were taken at the test pond in order to obtain information necessary to the development of an analytical model. The ground temperatures were measured below the water level of the pond, soil samples were gathered around the pond and wind velocities and air temperatures were recorded. This data was used to determine the conduction through the pond liner and to verify assumptions regarding the convective losses from the cover.

A laboratory experiment was performed which modeled the air stone portion of the aeration system. The goal was to determine whether heat transfer occurs from the hot air diffused through the air stones to the water. To accomplish this, two identical 50 gallon tubs were filled with 38°F sea water and covered with bubble mat material to reduce heat transfer at the surface. Hot air (73°F) was piped into one tub at a rate of approximately 30 cubic feet per minute and dispersed by an air stone. The other tub was the control, and did not receive air. The temperature of each were monitored and recorded until they reached air temperature (24 hours). Contrary to what was initially assumed, the temperatures of the two tubs increased identically over this period of time.

A final experiment was performed to determine the transmissivity of the pond cover at varying angles of incident. The transmissivity is the ratio of the solar energy which penetrates the cover to the total solar energy available. A pyronometer was mounted on a quarter sheet of plywood. The plywood was attached to a stand which allowed it and the pyronometer to tilt. The transmissivity of the cover was determined by placing a portion of the cover over the pyronometer and measuring the total available radiation on the side of cover facing the sun and behind the cover. This procedure was done with one layer of cover, and then two layers of cover, for incident angles from 0° to 90°. The average transmissivity over the possible range of incident angles at the Waddell Mariculture Center in February was used in the analytical models (Schubert, 1981).

THEORY

The following sections present the analytical expressions used to; examine the location and the magnitude of the heat loss from the test pond, determine the time required to raise the pond temperature from a specified unheated winter temperature to the pond temperature necessary for the survival of post larvae shrimp (73°F), and to determine the energy required to maintain the pond at this temperature during the months of March and April.

The conservation of energy equation, (Doblin, 1973) is the foundation from which the heat transfer calculations were performed. This equation states that the energy stored (Q_S) is equal to the energy gained (Q_G) minus energy loss (Q_L).

$$Q_S = Q_G - Q_L \tag{1}$$

The energy stored in the pond water can be expressed as;

$$Q_S = m c_p \frac{dT_p}{dt} \tag{2}$$

where: m = the mass of the fluid (lbm)

C_p = the specific heat of the fluid (Btu/lbm.°R)

$\frac{dT_p}{dt}$ = the derivative of the pond temperature with respect to the time (°F/sec).

This first order differential equation can be rapidly solved by numerical integration to obtain the pond temperature as a function of time.

The test pond receives heat energy by two means. It absorbs radiation from the sun, and heat is transferred by the aeration system, or;

$$Q_G = Q_{SUN} + Q_{COM} \quad (3)$$

where: Q_{SUN} = energy absorbed by the pond from the sun

Q_{COM} = energy absorbed by the pond from the aeration system.

The expression used to determine the solar energy absorbed by the pond (Q_{SUN}) is;

$$Q_{SUN} = AI_E \tau \alpha \quad (4)$$

where: I_E = total solar radiation at the earths surface (Btu/hr.ft^2)

τ = transmissivity of the cover (unitless)

α = absorbtivity of the pond (unitless)

θ = incident angle (degrees)

A = surface area of the pond (ft^2)

I_E , the total solar radiation at the earths surface is a combination of the beam radiation (I_b) and diffuse radiation (I_d). These quantities were determined by the expressions;

$$I_b = I_{ON}[\tau^{1/\cos z}\cos z] \tag{5}$$

$$I_d = I_{ON}[K_d * \cos z] \tag{5a}$$

where:

I_b = beam radiation from the sun (Btu/hr.ft^2)

I_d = diffuse radiation from the sun (Btu/hr.ft^2)

I_{ON} = extraterrestrial radiation on a normal surface (Btu/hr.ft^2)

τ = sky transmissivity (unitless)

z = zenith angle (rad)

K_d = the fraction of diffuse radiation (unitless)

The energy transferred into the pond by the aeration system through the pipes is;

$$Q_{COM} = \dot{m}\, c\, (T_{IN} - T_{OUT}). \tag{6}$$

where:

$\dot{m}$ = mass flow rate of the air (lbm/hr.)

c = specific heat (Btu/lbm.°R)

T_{IN} = temperature at the pipes inlet (°R).

T_{OUT} = temperature at the pipes inlet subtracted (°R).

The heat escapes from the pond by evaporation, radiation, and convection from the ponds surface, conduction through the pond liner and conduction through the cover.

According to Schubert (1981) and the ASHREA Applications Handbook (1975) the convection from the surface of a body of water exposed to the atmosphere is;

$$Q_{EVAP} = \dot{m}\, h_{fg} \tag{7}$$

where: $\dot{m}$ = pound mass of water evaporating from the pond's surface (lbm/hr)

h_{fg} = The heat of vaporization (Btu/lbm)

The expressions used to determine the heat transferred from the uncovered pond areas by convection and radiation are;

$$Q_{SCONV} = h\, A\, (T_p - T_a) \tag{8}$$

and

$$Q_{SRAD} = A\sigma\epsilon(T_p - T_a) \tag{9}$$

where:

Q_{SCONV} = heat transfer from the pond surface by convection (Btu/hr)

Q_{SRAD} = radiation from the pond surface (Btu/hr)

A = uncovered pond surface area (ft^2)

T_a = air temperature (°R)

T_p = pond temperature(°R)

h = convection coefficient of the cover (Btu/hr)

σ = Stefan-Boltzmann constant (Btu/hr.ft^2.°R^4)

ϵ = emissivity of the cover (unitless).

The heat transfer through the liner into the surrounding soil is;

$$Q_{LIN} = A_W K_L / X_L (T_p - T_g) \quad (10)$$

where: A_W = wetted area of the liner (ft^2)

X_L = liner thickness (ft)

T_p = pond temperature (°R)

T_g = ground temperature (approximately equal to mean air temperature (°R).

K_L = thermal conductivity of the polyethylene liner (Btu/hr.ft.°F)

Holman's (1986) expressions for conduction, radiation and convection were used to determine the heat transfer by conduction through the cover. The equations are;

$$Q_{COND} = A_C U_C (T_{C_2} - T_{C_1}) \quad (11)$$

$$Q_{CONV} = h_C A_A (T_A - T_{C_2}) \quad (12)$$

$$Q_{RAD} = A_C \sigma \epsilon (T_A^4 - T_{C_2}^4) \quad (13)$$

where : Q_{COND} = heat transferred from the cover by conduction (Btu/hr)

Q_{CONV} = heat transfer from the cover by convection (Btu/hr)

Q_{RAD} = radiation from the cover's surface (Btu/hr)

U_C = overall heat transfer coefficient through the

cover (Btu/hr.ft.^{2}.°F)

A_c = area of the cover (ft^2)

T_A = air temperature (°R)

T_{c_2} = outside cover temperature (°R)

T_{c_1} = inside cover temperature (°R)

h = convection coefficient of the cover (Btu/hr.ft^2.°F)

σ = Stefan-Boltzmann constant (Btu/hr.ft^2.°R^4)

ϵ = emissivity of the cover (no units).

The overall heat transfer coefficient for the cover was determined by modeling the cover as three layers of plastic with air sandwiched in between. The overall heat transfer coefficient (Holman,1986) of this model was calculated using the expression;

$$U_c = 1/\left[3\left(\frac{X_p}{K_p}\right) + 4\left(\frac{X_a}{K_a}\right)\right] \qquad (14)$$

where: X_p = thickness of on plastic layer (ft)

K_p = conduction coefficient of the plastic (Btu/hr.ft.°F)

X_a = thickness of an air layer (ft)

K_a = conduction coefficient of the air space (Btu/hr.ft.°F)

The following simplified convection equation was used to calculate the convection coefficient over the cover and the exposed pond surface (Schubert, 1981).

$$h = .99 + 0.21V \qquad (15)$$

where: h = convection coefficient (Btu/hr.ft.^{2}.°F)

V = velocity (ft/min)

T_{C_2}, the outside cover temperature, was determined using conservation of energy with no heat storage in the cover. For this restriction the conduction through the cover is equal to the radiation and convection from the cover surface. Or in equation form;

$$Q_{COND} = Q_{CONV} + Q_{RAD} \tag{16}$$

or

$$A_c U_c (T_{C_2} - T_{C_1}) = h_c * A_c (T_A - T_{C_2}) + A \sigma \epsilon (T_A^4 - T_{C_2}^4) \tag{16a}$$

Solving Eq. (14a) for Tc2 gives;

$$T_{C_2} = [T_{C_1} U_c + \sigma \epsilon (T_A^4 - T_{C_2}^4) + h_e T_{C_2}^4] / (h_c + U_c). \tag{17}$$

This single equation with 2 unknowns is solved iterativly using the computer programs shown in Appendix I and IV.

The total equation for the heat loss by partially covered test pond is;

$$Q_{LOSS} = Q_{LIN} + Q_{COND} + Q_{CONV} + Q_{EVAP} + Q_{RAD} \tag{18}$$

The expression for the heat loss from a pond with out a cover is Eq. (18) less the cover terms or;

$$Q_{LOSS} = Q_{CONV} + Q_{EVAP} + Q_{RAD} \tag{19}$$

The calculated hourly temperatures, which were used as input to the transient computer program (Appendix IV), were generated in the data program (Appendix III) using the equation;

$$T = T_M + DV/2 \sin(2\pi/24+1.54) \quad (20)$$

where: T = the calculated air temperature (°F)

T_M = the daily mean temperature (°F)

DV = the daily variation (°F)

APPLICATION OF THEORY

A steady state analytical model was created to compare the heat loss of the partially covered test pond with an uncovered pond, each at the same constant temperature.

Heat transfer from a partially covered pond occurs by evaporation, radiation, and convection from the exposed ponds surface, conduction through the pond liner, and conduction through the cover (Fig. 4). In an uncovered pond the heat escapes by convection, radiation from the ponds surface, and conduction through the liner. The steady state model solves Eqs. 7-19 and predicts the magnitudes of the various modes of heat transfer for constant atmospheric air and pond temperatures. The computer program, used to make these calculation, is in Appendix I.

A transient analytical model was created to determine the energy balance of a covered pond for varying atmospheric temperatures and magnitudes of solar energy. The energy balance consists of the energy gained, the energy lost, and the energy stored. This energy balance was manipulated to calculate the time required to raise the temperature of the pond from an initial temperature to the temperature of 73°F, the temperature necessary to sustain post larvae shrimp, for various artificial energy inputs.

The heat loss for the transient model was calculated in a fashion similar to the steady state model using Eqs. 7 - 19. It differs from the steady state model in that the heat loss was calculated with the assumption that the pond is completely covered. The steady state model calculates the heat loss from

Modes of Heat Transfer from Test Pond

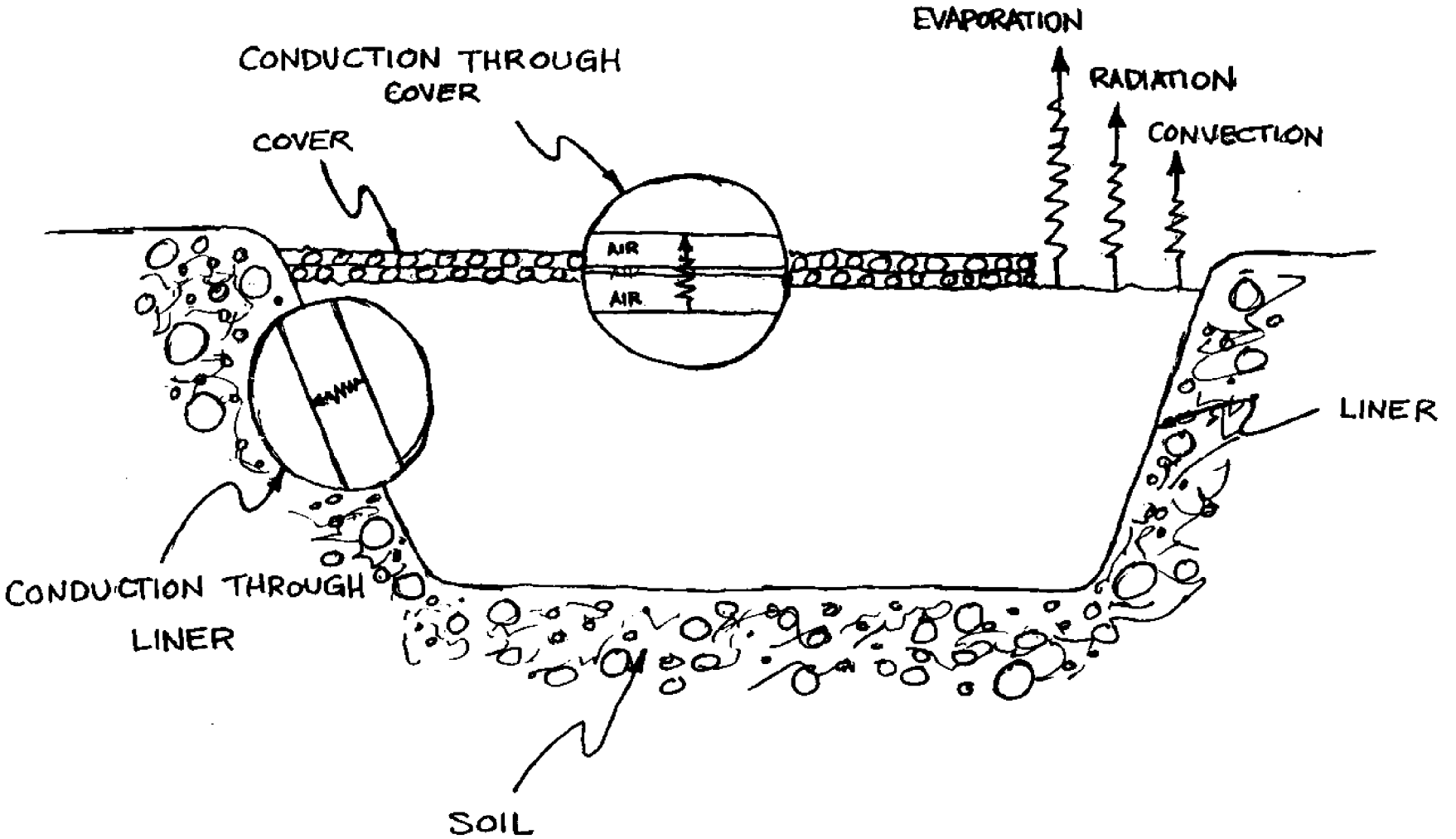


Fig. 4

covered and uncovered areas of the pond.

The amount of heat lost by the pond is largely dependent on the fluctuating outside air temperature and the availability of solar energy. To simulate the air temperature fluctuations, previously recorded data were obtained from the Beaufort U.S. Marine Station, located fifteen miles north of the Waddell Mariculture Center. With this information (Appendix II), an average of the daily temperature variation was determined and a mean monthly temperature confirmed. These quantities were used in Eq. 20 which serves to approximates the daily temperature as a sinusoidal function. The computer program in Appendix III uses the sinusoidal function to generates a data file of the approximated hourly air temperatures.

The energy is supplied to the pond by the sun and by the aeration system. The amount of energy available and absorbed in the pond was determined using Eqs. 4 - 5 given the latitude, date, and clearness index (the ratio of the daily radiation on earth to the daily extraterrestrial radiation) as input variables. With this information the variables which affect the availability of solar energy such as the time of sunrise and sunset, the declination angle (angle of the sun above the horizon) and the zenith angle (angle of the sun away from the line normal to the earths surface) are determined. The computer program in Appendix III also computes the solar energy available.

The energy supplied to the pond by the aeration system was determined from data obtained during the on-site observation of the test pond. With values for the mass flow rates and

temperatures in and out of the heat exchanging pipes, the energy was determined using Eq. 6.

Conservation of energy (Eq. 1) specifies that the energy supplied to the pond minus the heat loss from the pond is equal to the energy stored. The energy stored is expressed by Eq. 2. By numerically solving Eq. 2, the pond temperature as a function of the time was determined. The program in Appendix IV performs this numerical integration and creates an output file consisting of the energy losses and gains, and the pond temperature as a function of time.

DISCUSSION OF RESULTS

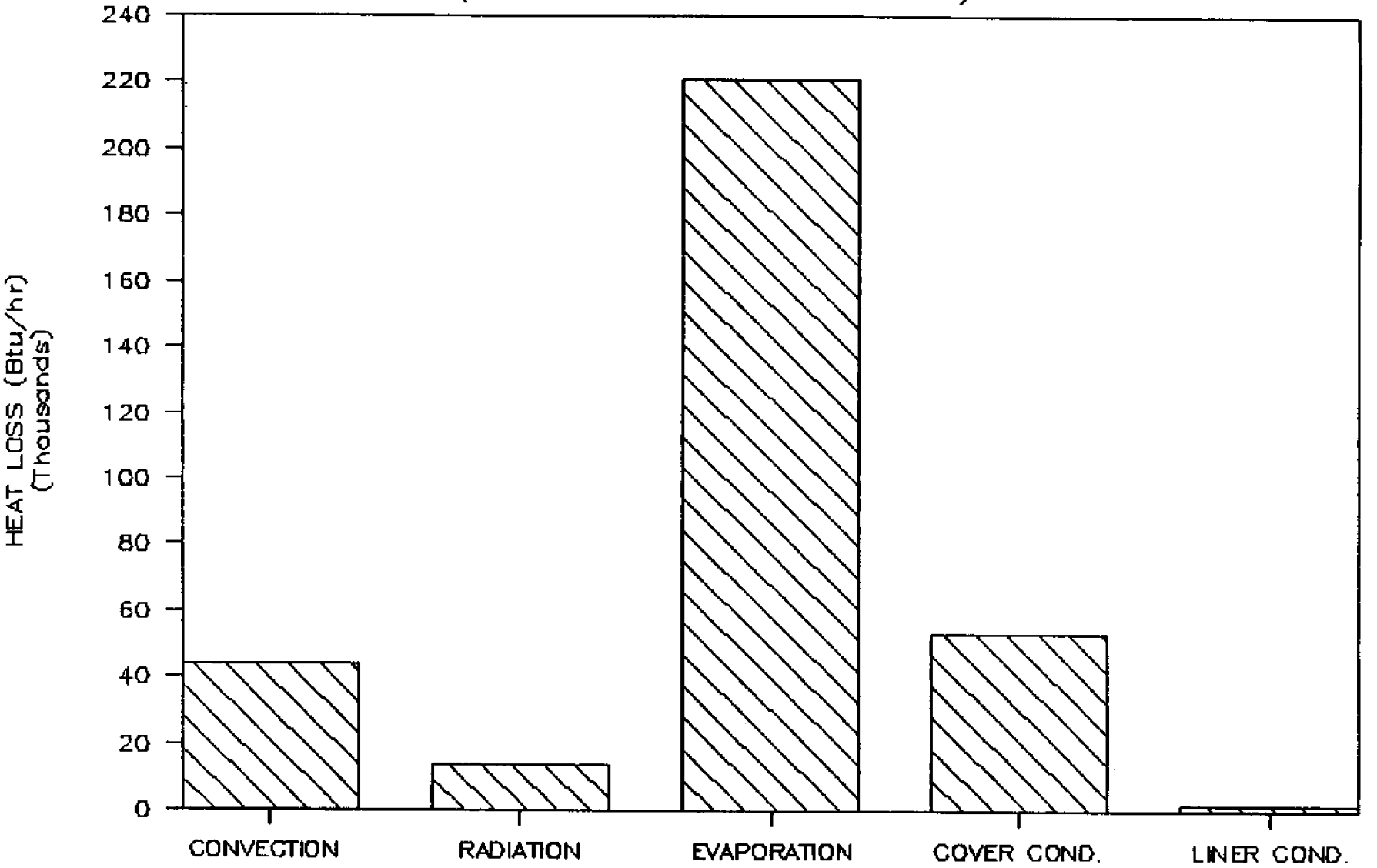
The steady state model provides a reasonable estimate of the energy loss by the various modes of heat transfer from the presently designed test pond for constant air and pond temperatures. Fig. 5 illustrates the amount of heat loss which occurs by evaporation, radiation and convection from the exposed pond surface, conduction through the pond liner, and conduction through the cover. These calculation were performed for constant 10 mph wind, a pond temperature of 73°F, and constant air temperature of 56°F (the mean temperature in Charleston S.C. in February). A comparison between the heat loss for the covered pond and an uncovered pond (see output in Appendix I) reveals the significance of the cover. With the previously stated wind velocities, and temperatures, an open pond loses heat at a rate of 3,588,000 Btu/hr. The loss from an covered pond is significantly less at 333,000 Btu/hr. In this instance, the cover was found to reduce heat loss by approximately 91%.

The amount of solar energy incidented on the test pond was found to have a significant effect on the amount of energy needed to further heat and maintain it. Of the total energy available only a fraction of it was absorbed. The fraction of energy absorbed was determined from the transmissivity of the cover and the absorbtivity of the pond water. With a cover transmissivity of .65 (determined experimentally) and a water absorbtivity of .9 (Schubert, 1981), the fraction absorbed was .58. Fig. 6 illustrates the calculated amount of solar energy absorbed by the pond over its entire area for a two day period in February.

The amount of energy supplied by the aeration system, made

STEADY STATE HEAT LOSS FROM TEST POND

(56 F AIR & 73 F POND TEMPERATURES)



MODES OF HEAT LOSS FROM 92% COVERED POND

Fig. 5

TOTAL CALCULATED SOLAR ENERGY

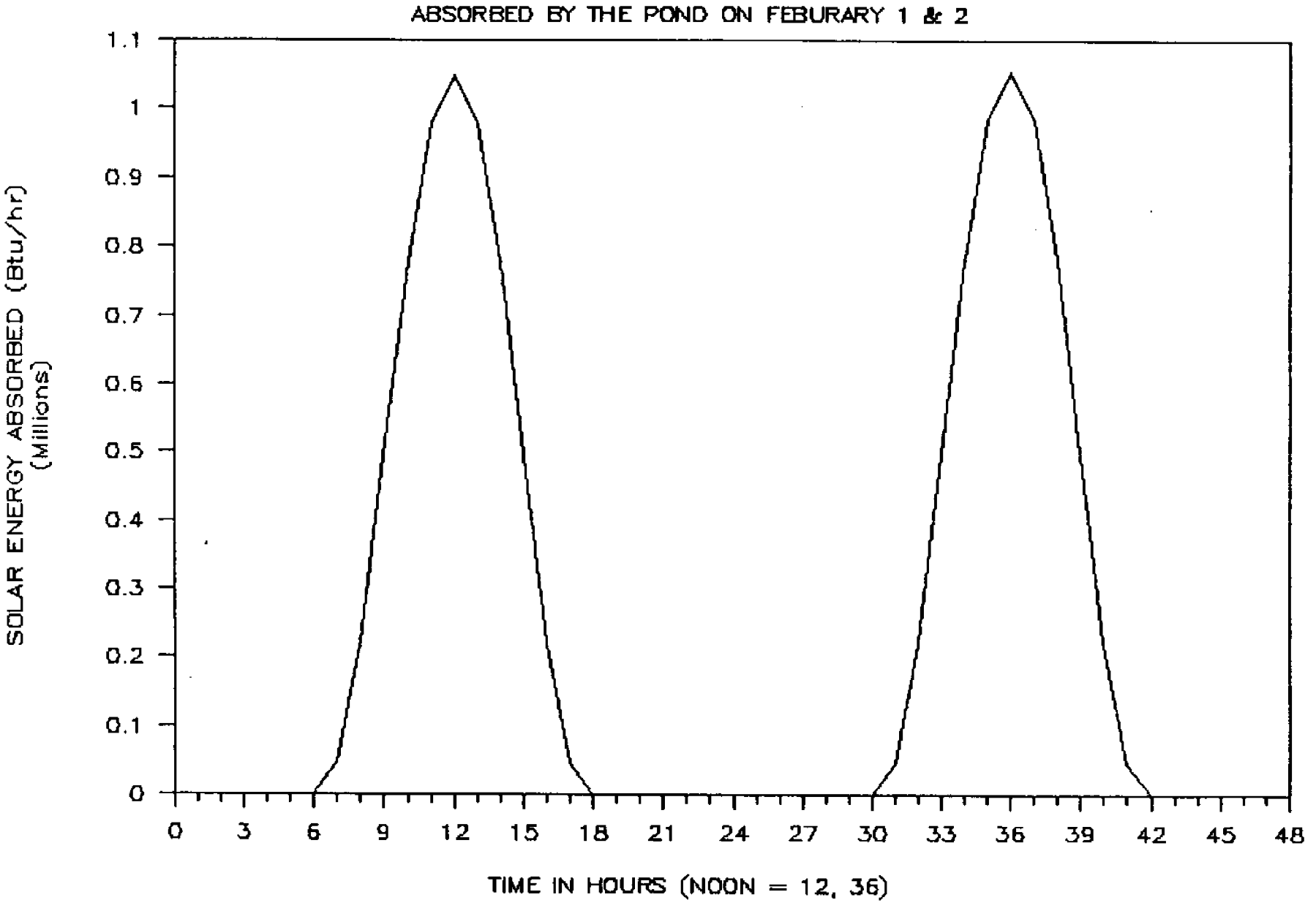


Fig. 6

up of the 6 horsepower compressor and the heat exchanging pipes, was found to have less of an effect on the heating of the pond than anticipated. The result from the air stone experiment indicated that the air bubbled through the airstones does not affect the temperature of the pond. This is primarily due to the large density difference of the water and the air. This density gradient restricts heat transfer.

Since the bubbled air does not affect the temperature of the pond, the only heat transfer which occurred was from the heat exchanging pipes along the sides of the pond. The flow rates and temperatures collected at the inlet and outlets of these pipes indicated that the heat exchanging pipes were significantly long enough to allow for all possible heat transfer from the hot air to the pond to occur.

The amount of heat available to be transferred was found to be limited to size of the compressor. Of the 6 horsepower produced by the compressor, the analysis of the heat exchanging pipes indicated only half of this energy is actually available in the form of heat. As was previously indicated, the piping system was changed to allow more of the hot air to be circulated through the pond before being exited through the air stone diffusers. The new arrangement does allow more heat to be transferred; however, the size of the compressor still limits the energy available. Appendix IV displays the heat supplied by the original aeration system for varying pond and outside temperatures. It is shown that the aeration system has minimal effect on the overall heat balance of the pond.

The similarity of temperatures obtained from various

locations in the pond, indicated that the pond currents promoted a uniform mixing. However, since it was found that all of the heat which enters the heat exchanging pipes was transferred to the pond and the resulting amount was small compared to the heat loss of the pond, an in depth study of the effect of the pond circulation on the heat exchanging pipes was not required.

The amount of time required to raise the temperature of the pond from an initial value of 56°F, (the expected mean temperature in Febuary for any year) to the temperature of 73°F, (the temperature necessary to introduce post larve shrimp) for varying amounts of artifically added energy, are illustrated in Fig. 7. The bottom curve illustrates that without any artifically added heat, the energy from the sun is just enough to keep the pond at the Febuary monthly mean air temperature of 56 °F. The next curve illustrates that, if 100,000 Btu/hr are absorbed by the pond, 30 days are required to raise the pond temperature. Finally, the top curve illustrates, that if 200,000 Btu/hr are absorbed by the pond, 12 days are required to raise the temperature of the pond. The input to the computer program consisted of the sinusoidally generated atmspheric air temperatures (Fig. 8) and the fluctuating solar energy (Fig. 6).

TIME REQ'D TO RAISE POND TEMPERATURE

FOR VARYING AMOUNTS OF ADDED ENERGY

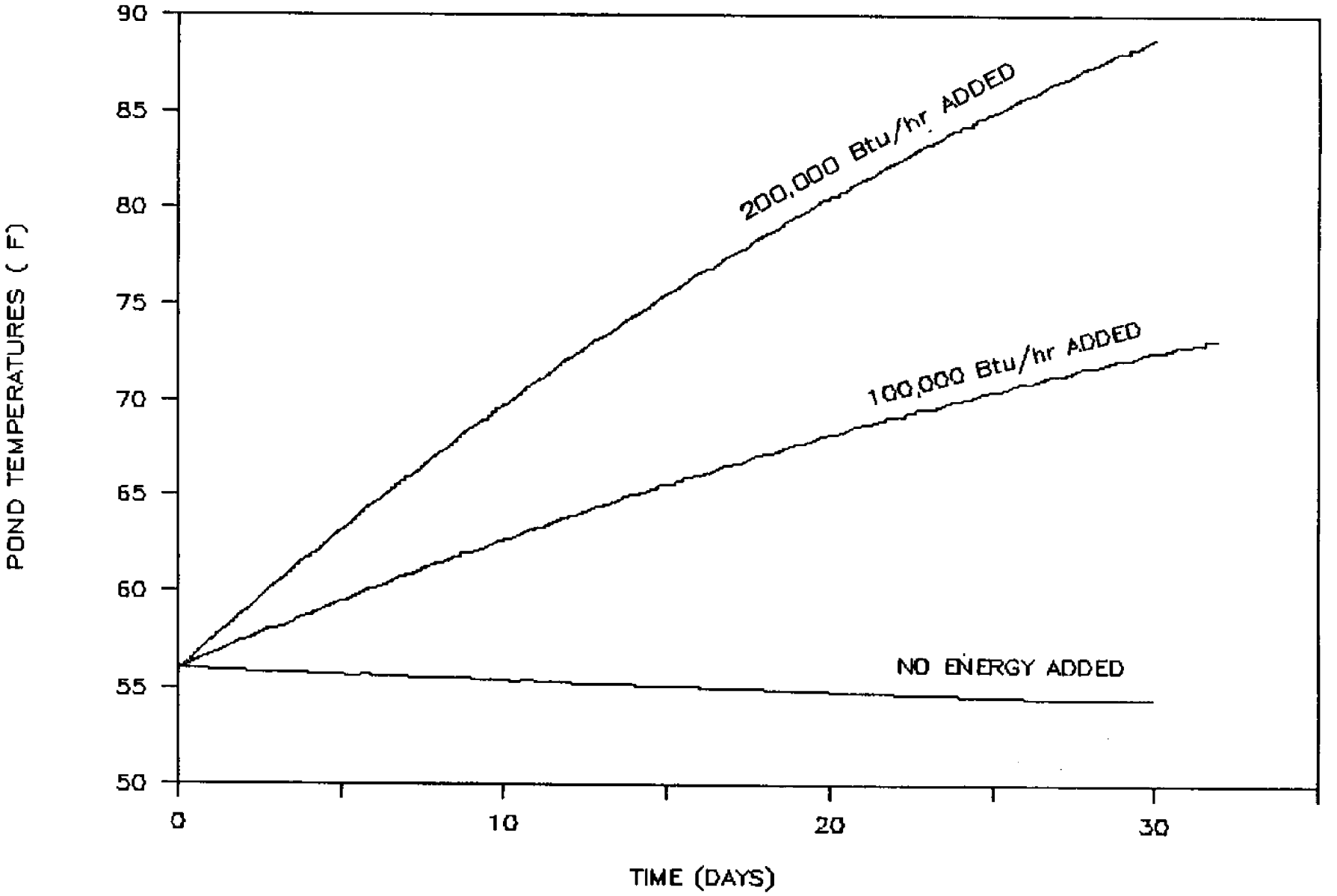


Fig. 7

APPROXIMATED DAILY AIR TEMPERATURES

(MEAN AIR TEMP. = 56, DAILY VAR. = 20)

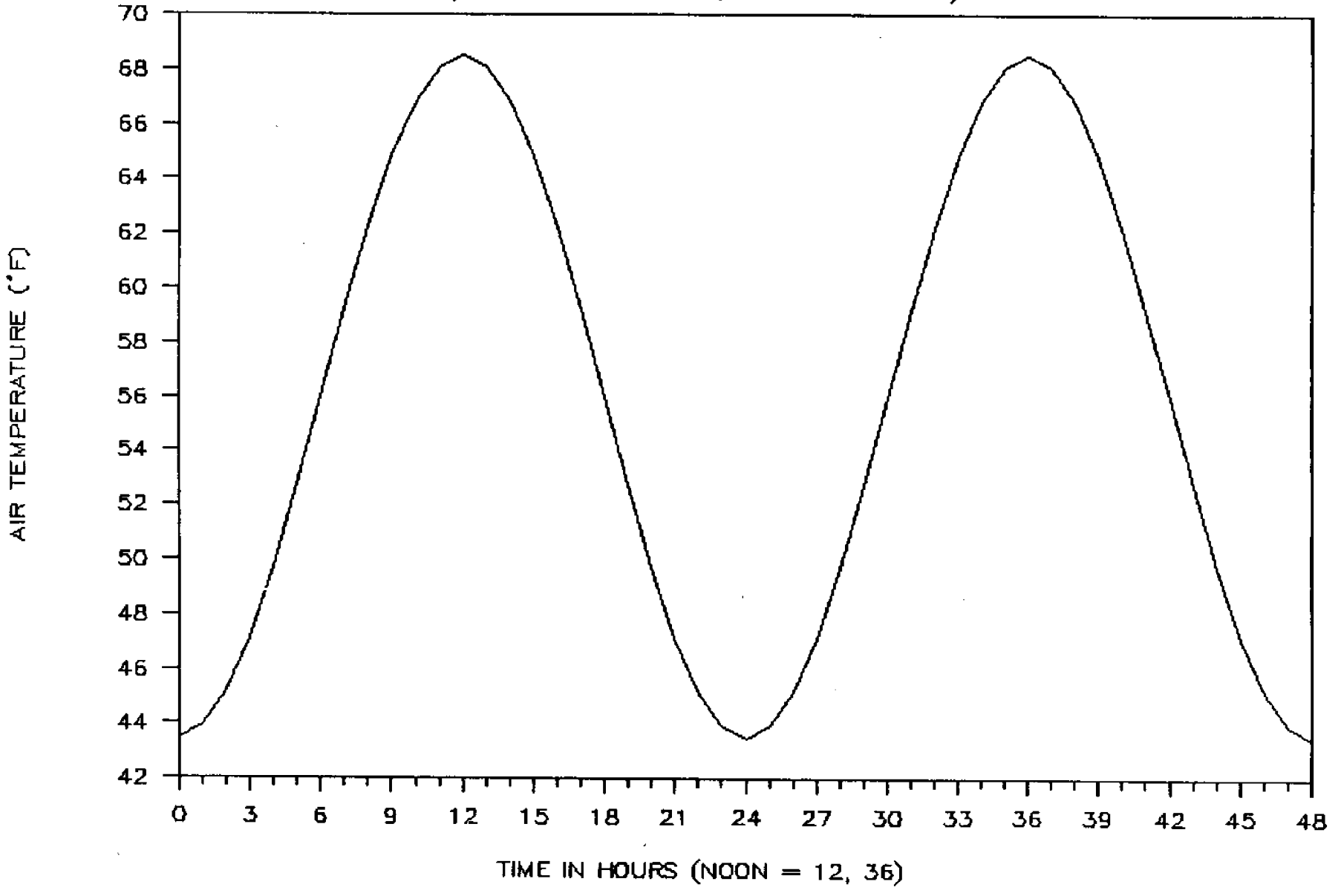


Fig. 8

CONCLUSIONS

The results of this research and analysis indicate that it is technically conceivable to raise the temperature of the test pond at the Waddell Mariculture Center from the estimated Febuary pond temperature of 56°F to 73°F before the first of March within a month, and maintain it at this operating temperature. A heating system that can effectively transfer at least 100,000 Btu/hr of energy to the pond water will accomplish this. The output from the boiler of such a heating system must be larger then 100,000 Btu/hr to account for any inefficiencies in the heating system. In choosing or designing this system, considerations should include the method and materials necessary to heat the water, the impact of the heating system on the marine life in the test pond, and the economic feasibility of such a system.

Specific considerations regarding the heating system include the number and type of heaters to be used, the total energy output, the method of heat exchange to be employed, and the type of fuel to use.

The use of two heaters should be considered. Each of them capable of maintaining the pond temperature individually. This would insure that the shrimp would not perish should one fail and also insure that sufficient energy is available during times of unusually high demands. In addition, portable or rental unit(s) might be advantageous since the heating system is only necessary for a 3 month period.

Another consideration is whether to heat the pond water by direct or indirect methods. A direct method could include the

use of a heat exchanger. With this method the pond water would pass directly over heated surfaces and then recirculated to the pond. An indirect method would be to circulate hot water through a closed system of pipes position in the pond. This could insure equal distribution of the heat but would increase the installation and maintenance costs. For either method, any ill effect on the marine life must be examined.

Finally the fuel used by the heating system must be considered. A natural gas or coal fired boiler is preferable over oil or gas fired units because the risk of contaminating the pond due to a spill or seepage is minimized.

In order to further develop artificial growing environments, the future use, improvement and implementation of the research, analytical models, and computer programs presented in this report is encouraged.

CITED LITERATURE

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APPENDIX I

Computer program that calculates the steady state heat loss with and without cover.

Sample output included.

```
*****************************************************************
*                                                               *
* THIS PROGRAM CALCULATES THE STEADY STATE HEAT LOSS FROM THE   *
*                                                               *
* TEST POND WITH AND WITHOUT A COVER FOR CONSTANT 10 MPH WIND,  *
* VARIABLE POND TEMPERATURES AND AIR TEMPERATURE OF.            *
*                                                               *
*                                                               *
*                                                               *
*****************************************************************

      REAL VELM,HH2O,EH2O
      REAL TP,TA,QCONV,QRAD
      REAL ATOT,MDOT,VEL
      REAL PW,PA,QEVAP,HFG
      REAL QLIN,HCOV
      REAL UW,AEX,ACOV
      REAL  AW,KC,X,UC
      REAL TC2,BOLT,ECOV
      REAL LCOND,CCOND
      REAL UL,AL,TG
      INTEGER J,I
      OPEN (4,FILE='SS.OUT',STATUS='NEW')
      DO 40 I=1,20
C          INPUT
      WRITE(*,*)'INPUT AVERAGE AIR TEMP'
      READ(*,'(F3.0)')TA
      TA=TA+459
      WRITE(*,*)'INPUT POND TEMP'
      READ(*,'(F3.0)')TP
      TP=TP+459
      ATOT=10800
      VELM=10
      HH2O=.99+0.21*VELM
      EH2O=1
      TP=73+459
C     GROUND TEMP APPROX = AVE TEMP
      TG=TA
      UW=.009
      AEX=840
      ACOV=ATOT-AEX
      AL=12480
      KC=0.0416
      X=0.014
      UC=.34
      TC2=TP
      UL=.0089
      BOLT=1.73*(10**(-9))
      ECOV=.94
      PW=.3631
      PA=.08854
      HFG=1000
      CCOND=0

*****  WITHOUT COVER  *****
C HEAT LOSS BY EVAPORTATION
      VEL = VELM*5280/60
      MDOT=ATOT*(95+0.425*VEL)/490*(PW-PA)
      QEVAP=MDOT*HFG
```

```
C BY CONVECTION
                QCONV=HH2O*ATOT*(TP-TA)

C BY RADIATION
                QRAD=ATOT*0.1713*EH2O*(((TP/100)**4)-((TA/100)**4))

C THROUGH LINNER
                LCOND = UL*AL*(TP-TG)
                TP=TP-459
                TA=TA-459
C OUTPUT
C PAUSE FOR PRINTER
                WRITE(*,*) ' '
                READ(*,'(F4.0)') DUM
                WRITE(*,*)'******* WITHOUT COVER *********'
   25           FORMAT(1X,A2,a5,A6,1A9,4A8)
   27           FORMAT(1X,F4.1,2F5.1,1F9.0,1F8.0,1F7.0,1F9.0,1F11.0)
                WRITE(*,25)'TA','TP','VEL',
     &          'QCONV','QRAD','MDOT','QEVAP','LCOND'
                WRITE(*,27)TA,TP,VELM,
     &          QCONV,QRAD,MDOT,QEVAP,lcond

C               WRITE TO FILE
                WRITE(4,*)'******* WITHOUT COVER *********'
                WRITE(4,25)'TA','TP','VEL',
     &          'QCONV','QRAD','MDOT','QEVAP','LCOND'
                WRITE(4,27)TA,TP,VELM,
     &          QCONV,QRAD,MDOT,QEVAP,lcond

*****  WITH COVER ******
                TP=TP+459
                TA=TA+459
                HCOV=.99+0.21*VELM

C HEAT LOSS BY EVAPORTATION EXPOSED AREA
                VEL = VELM*5280/60
                MDOT=AEX*(95+0.425*VEL)/490*(PW-PA)
                QEVAP=MDOT*HFG

C BY CONVECTION EXPOSED AREA
                QCONV=HH2O*AEX*(TP-TA)

C BY RADIATION EXPOSED AREA
                QRAD=AEX*0.1713*EH2O*(((TP/100)**4)-((TA/100)**4))

C CONDUCTION THROUGH LINNER
                LCOND = UL*AL*(TP-TG)

C CONDUCTION THROUGH COVER
C               INITIAL VALUES
                TC2=TP
C          DETERMINING TC2 BY ITERATION
           DO 15 J=1,20
                TC2=((TP*UC)+(0.1713*ECOV*((TA/100)**4-
     &          (TC2/100)**4))+HCOV*TA)/(HCOV+(UC))
C               ADJUST HCOV
  15       CONTINUE
               CCOND = UC*ACOV*(TP-TC2)
            IF (CCOND .LT. 0 .OR. CCOND .EQ. 0) CCOND = 0
                TC2=TC2-459
                TP=TP-459
```

```
                TA=TA-459

C               OUTPUT
                WRITE(*,*)' '
                WRITE(*,*)'******* WITH COVER *********'
   26           FORMAT(1X,A2,a5,A6,5A8,A9,A5)
   28           FORMAT(1X,F4.1,2F5.1,2F8.0,1F7.0,2F9.0,1F8.0,1F6.1)
                 WRITE(*,26)'TA','TP','VEL',
     &          'QCONV','QRAD','MDOT','QEVAP','CCOND','LCOND','TC2'
                 WRITE(*,28)TA,TP,VELM,
     &           QCONV,QRAD,MDOT,QEVAP,CCOND,LCOND,TC2
                 READ(*,'(F4.0)') DUM
                 WRITE(4,*)'******* WITH COVER *********'
                 WRITE(4,26)'TA','TP','VEL',
     &           'QCONV','QRAD','MDOT','QEVAP','CCOND','LCOND','TC2'
                 WRITE(4,28)TA,TP,VELM,
     &           QCONV,QRAD,MDOT,QEVAP,CCOND,LCOND,TC2
                 READ(*,'(F4.0)') DUM
   40          CONTINUE
               CLOSE(4)
                  END
```

SAMPLE OUTPUT FROM STEADY STATE COMPUTER PROGRAM

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
30.0 73.0 10.0 1434996. 424099. 2838. 2838166. 4776.

******* WITH COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP CCOND LCOND TC2
30.0 73.0 10.0 111611. 32985. 221. 220746. 133803. 4776. 33.5

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
35.0 73.0 10.0 1268136. 380165. 2838. 2838166. 4221.

******* WITH COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP CCOND LCOND TC2
35.0 73.0 10.0 98633. 29568. 221. 220746. 118300. 4221. 38.1

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
40.0 73.0 10.0 1101276. 334878. 2838. 2838166. 3665.

******* WITH COVER *********

TA TP VEL QCONV QRAD MDOT QEVAP CCOND LCOND TC2 40.0 73.0 10.0 85655

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
45.0 73.0 10.0 934416. 288208. 2838. 2838166. 3110.

******* WITH COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP CCOND LCOND TC2
45.0 73.0 10.0 72677. 22416. 221. 220746. 87252. 3110. 47.2

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
50.0 73.0 10.0 767556. 240128. 2838. 2838166. 2555.

******* WITH COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP CCOND LCOND TC2
50.0 73.0 10.0 59699. 18677. 221. 220746. 71706. 2555. 51.8

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
h) 56.0 73.0 10.0 567324. 180532. 2838. 2838166. 1888.

******* WITH COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP CCOND LCOND TC2
56.0 73.0 10.0 44125. 14041. 221. 220746. 53031. 1888. 57.3

******* WITHOUT COVER *********
TA TP VEL QCONV QRAD MDOT QEVAP LCOND
60.0 73.0 10.0 433836. 139627. 2838. 2838166. 1444.

******* WITH COVER *********

TA	TP	VEL	QCONV	QRAD	MDOT	QEVAP	CCOND	LCOND	TC2
60.0	73.0	10.0	33743.	10860.	221.	220746.	40569.	1444.	61.0

******* WITHOUT COVER *********

TA	TP	VEL	QCONV	QRAD	MDOT	QEVAP	LCOND
65.0	73.0	10.0	266976.	87148.	2838.	2838166.	889.

******* WITH COVER *********

TA	TP	VEL	QCONV	QRAD	MDOT	QEVAP	CCOND	LCOND	TC2
65.0	73.0	10.0	20765.	6778.	221.	220746.	24978.	889.	65.6

******* WITHOUT COVER *********

TA	TP	VEL	QCONV	QRAD	MDOT	QEVAP	LCOND
70.0	73.0	10.0	100116.	33146.	2838.	2838166.	333.

******* WITH COVER *********

TA	TP	VEL	QCONV	QRAD	MDOT	QEVAP	CCOND	LCOND	TC2
70.0	73.0	10.0	7787						

FEBRUARY 1986

DATE	MAX/MIN	06L	12L	18L	00L
01	68/40	44	66	61	49
02	76/45	47	70	66	57
03	78/53	53	73	67	57
04	78/49	49	73	62	64
05	70/60	62	65	62	62
06	67/58	61	61	62	61
07	72/48	55	66	66	48
08	60/43	43	52	59	56
09	62/54	56	61	57	54
10	69/42	63	66	54	42
11	53/34	34	42	49	42
12	44/29	33	40	41	30
13	56/27	28	46	55	41
14	54/25	38	52	51	54
15	58/39	53	52	55	39
16	66/34	34	62	61	49
17	74/47	47	72	66	59
18	78/56	51	72	73	63
19	79/58	59	71	75	65
20	77/57	58	76	66	59
21	81/55	60	76	72	64
22	79/59	61	73	74	63
23	67/50	58	58	64	50
24	68/42	43	63	62	54
25	56/37	48	51	53	37
26	61/31	32	52	57	60
27	70/57	61	62	60	57
28	57/45	47	51	55	45

MARCH 1986

01	48/35	41	41	46	37
02	55/30	32	49	50	31
03	72/46	48	65	67	49
04	60/42	43	53	56	50
05	60/42	44	56	53	47
06	71/44	45	60	66	44
07	71/37	43	65	68	54
08	56/41	41	47	47	41
09	73/41	43	70	68	56
10	76/54	54	75	69	64
11	84/60	63	78	73	64
12	81/62	63	78	68	70
13	80/60	69	77	72	61
14	75/61	64	71	71	63
15	74/53	54	66	69	58

FEBRUARY 1987

DATE	MAX/MIN	06L	12L	18L	00L
01	61/31	31	57	54	52
02	60/52	54	56	59	53
03	69/46	50	62	63	52
04	63/45	49	58	52	50
05	56/44	49	52	56	44
06	55/41	44	49	54	55
07	55/40	51	53	53	40
08	68/34	35	60	63	49
09	50/32	35	49	47	32
10	58/29	30	53	49	42
11	64/35	36	58	56	49
12	74/46	47	69	70	53
13	64/40	42	61	54	43
14	69/39	40	59	63	43
15	63/40	40	61	56	50
16	50/35	46	48	39	35
17	48/34	34	42	46	41
18	50/38	40	45	49	44
19	56/39	42	48	50	40
20	57/36	37	53	48	46
21	46/41	42	43	45	45
22	49/40	43	43	47	49
23	61/40	46	57	57	40
24	56/36	37	53	51	48
25	57/48	48	54	52	49
26	51/40	48	50	40	47
27	45/42	44	42	42	45
28	67/47	58	64	63	63

MARCH 1987

01	71/57	67	68	67	57
02	64/43	46	57	62	43
03	70/37	39	66	64	44
04	65/40	45	60	60	42
05	57/36	38	51	49	47
06	63/38	39	56	52	49
07	66/48	53	61	60	60
08	73/60	61	69	66	60
09	68/54	59	63	61	54
10	56/39	55	49	42	39
11	53/32	33	45	47	45
12	48/35	41	44	45	35
13	60/33	35	55	58	42
14	60/36	36	57	54	41
15	70/37	38	66	63	53

FEBRUARY 1988

DATE	MAX/MIN	06L	12L	18L	00L
01	71/52	53	69	63	59
02	76/57	58	72	67	63
03	74/53	62	65	65	53
04	75/53	56	75	67	n/a
05	55/41	43	42	43	41
06	45/28	40	41	40	28
07	45/24	25	32	42	38
08	47/36	38	46	45	36
09	60/35	35	54	57	46
10	61/36	38	55	50	47
11	48/43	47	45	47	44
12	49/35	45	46	38	35
13	45/28	29	37	45	29
14	56/25	25	54	51	42
15	63/39	41	62	55	45
16	58/36	37	45	54	39
17	59/29	30	57	53	45
18	57/36	37	51	51	48
19	61/47	53	58	60	59
20	59/47	57	54	50	47
21	55/35	45	47	52	35
22	59/28	29	56	54	48
23	69/40	42	65	62	53
24	59/38	53	58	55	38
25	54/30	32	48	52	42
26	51/28	28	44	46	39
27	71/37	39	65	68	59
28	60/37	45	51	55	37
29	68/33	33	65	67	48

MARCH 1988

01	64/42	42	61	57	46
02	68/37	40	65	65	53
03	68/50	52	68	64	59
04	67/59	61	65	64	62
05	62/50	55	58	54	52
06	67/47	48	57	63	47
07	72/42	43	67	63	55
08	72/44	45	70	65	63
09	65/60	62	62	63	64
10	64/47	61	60	51	47
11	59/37	39	56	55	41
12	72/39	41	70	67	64
13	76/55	63	70	71	55
14	60/40	45	56	52	40
15	49/33	33	43	47	39

FEBRUARY 1989

DATE	MAX/MIN	06L	12L	18L	00L
01	n / a	na	na	na	na
02	79/62	62	77	72	62
03	84/59	63	78	73	62
04	78/56	62	72	60	56
05	73/54	55	62	64	60
06	77/58	58	65	68	67
07	75/60	61	75	69	62
08	62/45	50	53	58	45
09	49/30	37	45	48	30
10	52/25	28	45	48	29
11	62/26	27	52	58	46
12	70/40	41	63	64	44
13	74/42	45	72	68	60
14	78/59	64	74	72	64
15	80/57	63	76	71	64
16	85/54	55	78	72	58
17	58/38	48	45	41	38
18	39/37	37	38	38	37
19	48/36	36	43	47	43
20	66/42	43	53	60	58
21	73/58	67	73	63	58
22	62/43	58	56	57	44
23	43/29	39	42	34	32
24	44/27	28	36	40	28
25	51/23	26	43	49	36
26	68/34	40	59	64	54
27	71/53	56	69	62	63
28	64/50	60	60	61	50

MARCH 1989

01	57/45	46	53	49	46
02	49/46	47	48	47	49
03	66/49	50	55	62	57
04	62/55	55	59	60	58
05	78/58	59	72	71	67
06	78/54	63	74	69	55
07	54/36	45	52	42	36
08	36/33	34	36	35	35
09	46/35	35	41	46	40
10	61/35	35	53	58	42
11	66/36	37	58	58	47
12	85/42	50	74	79	55
13	69/50	55	61	66	52
14	79/46	47	73	67	62
15	80/56	56	76	65	65

FEBRUARY 1990

DATE	MAX/MIN	06L	12L	18L	00L
01	69/43	48	60	65	59
02	78/59	60	70	72	65
03	82/65	67	78	69	68
04	80/55	64	73	67	55
05	59/38	48	53	55	38
06	65/37	41	61	58	55
07	74/51	57	67	67	52
08	72/46	47	69	65	60
09	74/60	62	72	68	67
10	67/59	64	64	59	60
11	60/46	52	53	56	46
12	69/44	45	64	66	44
13	n /a	n/a	n/a	n/a	n/a
14	n /a	n/a	n/a	n/a	n/a
15	77/54	56	77	71	68
16	77/65	67	76	66	66
17	n /a	n/a	n/a	n/a	n/a
18	63/51	56	54	52	53
19	63/50	50	58	59	54
20	60/49	54	59	56	50
21	65/45	47	59	63	64
22	77/60	66	75	61	61
23	64/51	60	62	62	51
24	66/42	42	58	64	55
25	55/39	40	48	51	41
26	50/31	32	44	46	40
27	66/35	35	56	58	44
28	72/40	41	69	64	49

+ 3 DAY AVERAGE 19.56

MARCH 1990

01	62/46	47	61	57	51
02	64/49	53	64	61	60
03	70/50	62	64	61	51
04	69/45	47	69	58	52
05	68/44	44	66	61	52
06	73/46	49	71	64	52
07	54/47	50	50	52	48
08	50/43	44	47	50	50
09	66/51	51	64	63	60
10	79/55	57	75	68	56
11	80/53	54	77	72	64
12	86/55	55	81	74	65
13	85/55	57	81	72	64
14	78/55	56	77	73	68
15	80/66	67	74	74	70

APPENDIX II

Daily temperature data in South Carolina
from 1 Feb. 1986 - 15 Mar. 1990.

APPENDIX III

Computer program that;
(1) computes hourly air temperatures.
(2) computes solar energy available.
Sample output used in transient computer program (APPENDIX IV).

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                     C
C   THE FOLLOWING PROGRAM:                                            C
C       MODELS THE HOURLY TEMPERATURES                                C
C               ESTIMATES THE AVAILABLE SOLAR ENERGY                  C
C               CREATES A DATA FILE FOR EACH                          C
C                                                                     C
C                                                                     C
C                                                                     C
C                                                                     C
C                                                                     C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

      REAL LATD,WSS,ION
      REAL LATR,TSTEP
      REAL DECLR,HIE
      REAL W,IET,COSZ
      REAL ISC,DECLD,TSS
      REAL KT,KD,KB
      REAL TSR,T,DTEMP(24)
      REAL TILT,WA,EX
      REAL IETA,IEHB,IEHD
      REAL IETB,IETC,EXPON
      REAL TAUCC,WT,TIME
      REAL SUM,COSZZ
      REAL DV,TM
      INTEGER N,INC,REMDR
      INTEGER NINT,I,COEFF
      INTEGER MONTH,DAY,NDAY
      INTEGER PERIOD,COM
      INTEGER TI,J
      INTEGER START,STOP
      CHARACTER*12 FNAME
      DATA PI/3.1415926/

      OPEN(5,FILE='SOLAR.DAT',STATUS='NEW')
C     READ IN DATA
      CALL READ(MONTH,DAY,LATD,PERIOD)
      CALL DAYN(MONTH,DAY,NDAY)
C     LOOP FROM DATE SPECIFIED ON
      COM=NDAY
      PERIOD=PERIOD+NDAY
      DO 25 J=COM,PERIOD-1
         NDAY=NDAY+1
         CALL DECLIN(NDAY,DECLR,DECLD)
         CALL SUNSET(LATD,LATR,DECLR,WSS,TSS,TSR)
C     CALCULATE ENERGY AVAILABLE
C     MEAN TEMP.
         TM=56
C     DAILY VARIATION
         DV=25
         WT=2*PI/24
         TILT=0
         IETA=0
         IEHB=0
         IEHD=0
         HIE=0
         WA=0
C     CLEARNESS INDEX
```

```
            KT=.459
            START = INT(TSR)
            STOP = INT(TSS)
C           WRITE(*,'(3A10)')'IET','IEB','IED'
            WRITE(*,'(3A10)')'TIME','AIR TEMP','I-TOTAL'
            DO  10 I=-12,11
            ISC=429.6
C   EXTRATERESTRIAL ON NORMAL SURFACE
            ION=ISC*(1+.034*COS(2*PI/365*NDAY))
C   FRACTION DIFFUSE
            KD=KT*(.52+.45*COS(1.03*KT*PI+0.05))
C   FRACTION BEAM
            KB=KT*(.48-0.45*COS(1.03*PI*KT+0.05))
C   COSZZ=COSZ AT NOON
            SUM=(COS(LATR)*COS(DECLR))+SIN(LATR)*SIN(DECLR)
            IF(SUM.LT.0.001)THEN
                TAUCC=KB
            ELSE
                COSZZ=SUM
            EX=COSZZ/1.3
                TAUCC=KB**EX
            END IF
            IF (I.GE.START.AND.I.LE.STOP)THEN
               W=PI/12*I
C   TOTAL RADIATION ON HORI. SURFACE
            COSZ=(COS(LATR)*COS(DECLR))*COS(W)+SIN(LATR)*SIN(DECLR)
            IF (COSZ.LT.0.001) THEN
               IEHB=0
            ELSE
               EXPON=1/COSZ
               IEHB=TAUCC**EXPON*COSZ*ION
               END IF
               IEHD=ION*KD*COSZ*((1+COS(TILT))/2)
               IETA=IEHB+IEHD
            ELSE
               IETA=0
               IEHB=0
               IEHD=0
            END IF
    8  FORMAT(1X,A7,I2,A7,F12.2)
               HIE=HIE+IETA
C              WRITE(*,'(3F10.2)')IETA,IEHB,IEHD
C  CREATE A DAILY TEMP FILE
C              TM FOR CHARLESTON S.C. JAN 55.2 F
               TIME=I
               DTEMP(I)=TM+DV/2*SIN(WT*TIME+1.570796327)
               WRITE(5,20)I,DTEMP(I),IETA
               WRITE(*,20)I,DTEMP(I),IETA
   10       CONTINUE
   20         FORMAT (I5,2F15.2)
              WRITE (*,'(1X,A30,F12.2)')'TOTAL AVAILABLE ENERGY: ',HIE
C              NDAY=NDAY+1
   25  CONTINUE
             CLOSE (5)
          STOP
             END



C*****READ*****************; ***********************************
```

```
      SUBROUTINE READ(MONTH,DAY,LATD,PERIOD)
       INTEGER MONTH,DAY,INC,PERIOD
       REAL LATD,TILT

       WRITE (*,'(/A,/)')'INPUT DATA ARE:'
       WRITE (*,'(10X,A\)')'NUMBER OF MONTH:'
       READ (*,'(I4)') MONTH
       WRITE (*,'(10X,A\)')'DAY OF THE MONTH:  '
       READ (*,'(I4)') DAY
       WRITE (*,'(5X,A\)')'LATITUDE IN DEGREES:  ',
       READ (*,*) LATD
       WRITE (*,*) 'INPUT TIME PERIOD (IN DAYS) :'
       READ (*,*) PERIOD


   15  FORMAT (A12)
       END


C***** (DAYN) ***********************************************************


       SUBROUTINE DAYN(MONTH,DAY,NDAY)
       INTEGER MONTH, DAY, NDAY
       REAL DAYF
C       CALCULATE THE DAY OF THE YEAR
       DAYF=30.6*MONTH+DAY-30.2
       IF (MONTH-3) 6,4,4
    4  DAYF=DAYF-2.2
    6  CONTINUE
       NDAY=INT(DAYF)
       END

***** (DECLIN) ***********************************************************


       SUBROUTINE DECLIN(NDAY,DECLR,DECLD)
C   DETERMINE THE DECLINATION ANGLE
       REAL DECLR,DECLD
       INTEGER NDAY
       DATA PI/3.1415926/
       DECLR=-(23.45*2*PI/360)*COS(2*PI/365*(NDAY+10))

       DECLD=DECLR*360/(2*PI)
      END
C***** (SUNSET) *********************************************************


       SUBROUTINE SUNSET(LATD,LATR,DECLR,WSS,TSS,TSR)


C DETERMINE THE SUN'S ANGLE (WSS)
C       AND THE TIME OF SUNSET OR SUNRISE
       REAL LATD,WSS,TSR
       REAL LATR,TSTEP
       REAL TSS,DECLR
       DATA PI/3.1415926/
       LATR=LATD*2*PI/360
       TSS=ACOS(-TAN(LATR)*TAN(DECLR))*24/(2*PI)
       WSS=PI/12*TSS
       TSR=-TSS
```

END

TIME (hr)	AIR TEMP. (F)	AVAILABLE SOLAR ENERGY (Btu/hr.ft)
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	7.09
-4	62.25	34.31
-3	64.84	77.65
-2	66.83	122.14
-1	68.07	153.64
0	68.50	164.89
1	68.07	153.64
2	66.83	122.14
3	64.84	77.65
4	62.25	34.31
5	59.24	7.09
6	56.00	.00
7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	7.37
-4	62.25	34.78
-3	64.84	78.30
-2	66.83	122.88
-1	68.07	154.43
0	68.50	165.69
1	68.07	154.43
2	66.83	122.88
3	64.84	78.30
4	62.25	34.78
5	59.24	7.37
6	56.00	.00
7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00

-6	56.00	.00
-5	59.24	7.65
-4	62.25	35.25
-3	64.84	78.96
-2	66.83	123.64
-1	68.07	155.23
0	68.50	166.51
1	68.07	155.23
2	66.83	123.64
3	64.84	78.96
4	62.25	35.25
5	59.24	7.65
6	56.00	.00
7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	7.95
-4	62.25	35.73
-3	64.84	79.64
-2	66.83	124.40
-1	68.07	156.04
0	68.50	167.33
1	68.07	156.04
2	66.83	124.40
3	64.84	79.64
4	62.25	35.73
5	59.24	7.95
6	56.00	.00
7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	8.24
-4	62.25	36.22
-3	64.84	80.32
-2	66.83	125.18
-1	68.07	156.86
0	68.50	168.16
1	68.07	156.86
2	66.83	125.18
3	64.84	80.32
4	62.25	36.22
5	59.24	8.24
6	56.00	.00

7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	8.54
-4	62.25	36.72
-3	64.84	81.01
-2	66.83	125.96
-1	68.07	157.69
0	68.50	169.00
1	68.07	157.69
2	66.83	125.96
3	64.84	81.01
4	62.25	36.72
5	59.24	8.54
6	56.00	.00
7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	8.85
-4	62.25	37.23
-3	64.84	81.71
-2	66.83	126.75
-1	68.07	158.53
0	68.50	169.85
1	68.07	158.53
2	66.83	126.75
3	64.84	81.71
4	62.25	37.23
5	59.24	8.85
6	56.00	.00
7	52.76	.00
8	49.75	.00
9	47.16	.00
10	45.17	.00
11	43.93	.00
-12	43.50	.00
-11	43.93	.00
-10	45.17	.00
-9	47.16	.00
-8	49.75	.00
-7	52.76	.00
-6	56.00	.00
-5	59.24	9.15

APPENDIX IV

Transient computer program used to calculate pond temperatures as a function of time.

Output for 100,000 BTU/hr of energy added.

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                     C
C                                                                     C
C                                                                     C
C  DYNAMIC COMPUTER MODEL OF THE HEAT TRANSFER TO AND FROM            C
C     THE SOUTH CAROLINA TEST POND.                                   C
C                                                                     C
C                                                                     C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

C       VARIABLES
        REAL X,TP,TTEST
        REAL TIME(1000),Y(1000)
        REAL MCP,QGEN(1000)
        REAL TPDOT,TAF(1000)
        REAL KC,U,DAY
        REAL BOLT,ECOV,HCOV
        REAL TA,DT,AW,UW
        REAL LCOND,CCOND,TG
        REAL CONDC(1000),CONDL(1000)
        REAL QTOT(1000),VDOT
        REAL QSUN,QEVAP,QADD
        REAL VEL,VELM,PW,PA
        REAL AEX,MDOT,HFG
        REAL ATOT,ACOV,TC2
        REAL TAIR(1000),QSUNN(1000)
        REAL TAU, ALPHA,SUN
        INTEGER TFINAL,AN,STIME
        INTEGER I,J,STEP
        CHARACTER ANS
        REAL TIN,CVA,DENA
        DATA TAIR,QSUNN/2000*0.0/
        OPEN(11,FILE='SOLAR.DAT',STATUS='OLD')
        OPEN(21,FILE='OUTPUT.DAT',STATUS='NEW')
C  INITIAL CONDITIONS

        CALL INPUT(TP,TAIR,QSUNN,QADD,STIME,TFINAL,STEP,AN)
        DT=1
C  MASS * SPECIFIC HEAT
        MCP=3053635.2
        UW=.009
        ATOT=10880
        AW=12480
        UC=0.34
        TC2=TP
        TG=56+459
        TAU=.65
        ALPHA=.90
        BOLT=1.73*(10**(-9))
        ECOV=.94

C HEAT LOSS BY EVAPORTATION
        VELM=5
        HCOV=.99+0.21*VELM
        VEL = VELM*5280/60
        VDOT=3960
        DENA=0.0709
        CVA=0.1715
        WRITE(*,'(A27)')'HIT ^P FOR OUTPUT TO PRINTER'
```

```
C  DETERMINING THE OUTER COVER SURFACE TEMPERATURE
   9  FORMAT (1X,A20,I3,A2)
      STEP = 1
      WRITE(*,9) 'CHANGE TIME STEP ? <',STEP,'>'
      READ (*,'(A1)') ANS
      IF (ANS.EQ.'Y') THEN
        WRITE(*,5) 'ENTER TIME STEP IN HRS'
   5  FORMAT(A25)
        READ (*,'(I5)') STEP
      END IF

C  ENERGY BALANCE
      DO 20 I=1,TFINAL
            TIME(I)=I
            Y(I)=TP-459.7
            TAIR(I)=TAIR(I)+459.7

C  DETERMINING TC2 BY ITERATION
      DO 15 J=1,20
                TC2=((TP*UC)+(0.1713*ECOV*((TAIR(I)/100)**4-
     &     (TC2/100)**4))+HCOV*TAIR(I))/(HCOV+(UC))
   15 CONTINUE

C       ENERGY ABSORBED FROM THE SUN
           QSUNN(I)=QSUNN(I)*TAU*ALPHA*ATOT

C HEAT ADDED BY BLOWER
         TIN =((TAIR(I)-459)+(100))+459
         QGEN(I)=VDOT*DENA*CVA*(TIN-TP)

C CONDUCTION CONTRIBUTION THROUGH LINER
         LCOND = UW*AW*(TG-TP)
              IF (LCOND .GT. 0 .OR. LCOND .EQ. 0) LCOND = 0

C COVER CONDUCTION THROUGH COVER
         CCOND = UC*ATOT*(TC2-TP)
         IF (CCOND .GT. 0 .OR. CCOND .EQ. 0) CCOND = 0

C POND TEMPERATURE
            TPDOT=(QSUN+LCOND+CCOND+QGEN(I)+QADD)/MCP
            TP=TP+TPDOT*DT
            QTOT(I)=QSUNN(I)+LCOND+CCOND+QGEN(I)+QADD
            CONDL(I)=LCOND
            CONDC(I)=CCOND
            TAF(I)=TAIR(I)-459.7
   20 CONTINUE

C       OUTPUT
C      READ(*,'(F4.0)') DUM
C   25    FORMAT(1X,A3,1A5,1A10,A3,7A8)
C            WRITE(*,25) 'TA','DAY','TIME','TP',
C     &   'LCOND','CCOND','QGEN','QSUN',
C     &   'QADD','QTOT'
   25    FORMAT(1X,A3,1A5,1A10,A3,7A8)
            WRITE(21,25) 'TA','DAY','TIME','TP',
     &   'LCOND','CCOND','QGEN','QSUN',
     &   'QADD','QTOT'

         DO 40 I=0,TFINAL,STEP
          DAY=I/24+1
C       WRITE(*,'(1F5.0,1F4.0,I4,7F9.0)')TAF(I),DAY,I,Y(I),
```

```
C      &  CONDL(I),CONDC(I),QGEN(I),QSUNN(I),QADD,QTOT(I)
   26    FORMAT(1F5.2,1F4.0,I4,1F5.1,6F9.0)
         WRITE(21,26)TAF(I),DAY,I,Y(I),
     &   CONDL(I),CONDC(I),QGEN(I),QSUNN(I),QADD,QTOT(I)
C        WRITE(*,'(1F10.1)')'QADDED = ',QADD
C        WRITE(21,'(1F7.2,1F6.2,I5,2F15.1)')TAF(I),DAY,I,Y(I)
C     &     ,QTOT(I)
   40  CONTINUE
C        WRITE(*,25)'TA','DAY','TIME','TP',
C     &    'LCOND','CCOND','QGEN','QSUN',
C     &    'QADD','QTOT'
         READ(*,'(F4.0)') DUM
         CLOSE(11)
         CLOSE(21)
         STOP
             END

******INPUT*************************************************************

         SUBROUTINE INPUT(TP,TAIR,QSUNN,QADD,STIME,TFINAL,STEP,AN)


         REAL TP,TA,QADD
         REAL QSUN
         INTEGER AN,STIME,TFINAL
         INTEGER RE
         INTEGER STEP
         INTEGER INT
         REAL TAIR(725),QSUNN(725)
         REAL TWASTE(725),QWASTE(725)
         CHARACTER RES,ANS

         OPEN(11,FILE='SOLAR.DAT',STATUS='OLD')
         TP=52
         AN=0
   5  FORMAT(A25)
   8  FORMAT (1X,A28,F6.2,A2)
      WRITE(*,8)'CHANGE INITIAL POND TEMP ? <',TP,'>'
      READ (*,'(A1)') ANS
      IF (ANS.EQ.'Y') THEN
        WRITE(*,5)'ENTER INTITIAL POND TEMP'
        READ (*,'(F5.0)') TP
      END IF
      TP=TP+459.7
      TA=53.6
      QSUN=259
   7  FORMAT (1X,A28,F6.2,A2)
      WRITE(*,*) ' CONSTANT AIR TEMP(1) OR INPUT FILE(2)?'
      READ (*,'(I1)') AN
      IF (AN.EQ.1)THEN
      WRITE(*,8)'CHANGE AVE AIR TEMP ? <',TA,'>'
      READ (*,'(A1)') ANS
        IF (ANS.EQ.'Y') THEN
           WRITE(*,5)'ENTER AVE AIR TEMP'
           READ (*,'(F5.0)') TA
        END IF
      END IF
      WRITE(*,*) ' CONSTANT SUN ENERGY(1) OR INPUT FILE(2)?'
      READ (*,'(I1)') RE
      IF (RE.EQ.1)THEN
         WRITE(*,10)'CHANGE SUNS ENERGY INPUT ? <',QSUN,'>'
```

```
          READ (*,'(A1)') RES
          IF (RES.EQ.'Y') THEN
            WRITE(*,5) 'ENTER SUN ENERGY'
            READ (*,'(F5.0)') QSUN
          END IF
        END IF
         TSTART = 0
         WRITE (*,*)'ENTER DESIRED FINAL TIME IN DAYS (40 MAX):'
         READ(*,*) TFINAL
         TFINAL=TFINAL*24
         WRITE (*,*)'THE FINAL TIME IS ',TFINAL
    9  FORMAT (1X,A20,I3,A2)
         DO 99 I=1,TFINAL
           TAIR(I)=TA
           QSUNN(I)=QSUN
          IF ((AN.EQ.2).AND.(RE.EQ.2)) THEN
                READ(11,'(I7,2F15.2)') INT,TAIR(I),QSUNN(I)
          ELSE IF((AN.EQ.2).AND.(RE.EQ.1)) THEN
                READ(11,'(I7,2F15.2)') INT,TAIR(I),QWASTE(I)
          ELSE IF((AN.EQ.1).AND.(RE.EQ.2)) THEN
                READ(11,'(I7,2F15.2)') INT,TWASTE(I),QSUNN(I)
        END IF
C            WRITE(*,13) INT,TAIR(I),QSUNN(I),TWASTE(I),QWASTE(I)
   13   FORMAT(I7,4F15.2)
   99   CONTINUE
   10   FORMAT (1X,A28,F10.2,A2)
         QADD =200000
   11  FORMAT (1X,A34,F10.2,A2)
        WRITE(*,11) 'CHANGE ADDITIONAL ENERGY INPUT ? <',QADD,'>'
        READ (*,'(A1)') ANS
        IF (ANS.EQ.'Y') THEN
          WRITE(*,5) 'ENTER ADDED ENERGY'
          READ (*,'(F7.0)') QADD
        END IF
           CLOSE(11)
           END
```

TA	DAY	TIME	TP	LCOND	CCOND	QGEN	QSUN	QADD	QTOT
.00	1.	0	.0	0.	0.	0.	0.	100000.	0.
43.50	1.	1	56.0	-79.	-41333.	4213.	0.	100000.	62802.
43.93	1.	2	56.0	-81.	-39982.	4233.	0.	100000.	64170.
45.17	1.	3	56.0	-83.	-35959.	4292.	0.	100000.	68250.
47.16	1.	4	56.1	-86.	-29461.	4386.	0.	100000.	74840.
49.75	1.	5	56.1	-89.	-20982.	4510.	0.	100000.	83440.
52.76	1.	6	56.1	-92.	-11114.	4654.	0.	100000.	93448.
56.00	1.	7	56.1	-95.	-485.	4808.	0.	100000.	104228.
59.24	1.	8	56.2	-99.	0.	4962.	45126.	100000.	149990.
62.25	1.	9	56.2	-103.	0.	5106.	218376.	100000.	323379.
64.84	1.	10	56.2	-107.	0.	5229.	494227.	100000.	599349.
66.83	1.	11	56.3	-110.	0.	5323.	777397.	100000.	882609.
68.07	1.	12	56.3	-114.	0.	5381.	977888.	100000.	1083154.
68.50	1.	13	56.4	-118.	0.	5400.	1049492.	100000.	1154774.
68.07	1.	14	56.4	-122.	0.	5378.	977888.	100000.	1083143.
66.83	1.	15	56.4	-126.	0.	5316.	777397.	100000.	882587.
64.84	1.	16	56.5	-130.	0.	5219.	494227.	100000.	599316.
62.25	1.	17	56.5	-134.	0.	5092.	218376.	100000.	323335.
59.24	1.	18	56.5	-138.	0.	4946.	45126.	100000.	149935.
56.00	1.	19	56.6	-141.	-1853.	4788.	0.	100000.	102794.
52.76	1.	20	56.6	-145.	-12694.	4631.	0.	100000.	91791.
49.75	1.	21	56.6	-149.	-22751.	4484.	0.	100000.	81585.
47.16	1.	22	56.6	-152.	-31398.	4358.	0.	100000.	72808.
45.17	1.	23	56.7	-154.	-38049.	4261.	0.	100000.	66058.
43.93	2.	24	56.7	-157.	-42213.	4200.	0.	100000.	61831.
43.50	2.	25	56.7	-159.	-43698.	4179.	0.	100000.	60321.
43.93	2.	26	56.7	-161.	-42345.	4199.	0.	100000.	61692.
45.17	2.	27	56.8	-163.	-38320.	4257.	0.	100000.	65774.
47.16	2.	28	56.8	-166.	-31820.	4352.	0.	100000.	72367.
49.75	2.	29	56.8	-169.	-23339.	4476.	0.	100000.	80968.
52.76	2.	30	56.8	-172.	-13470.	4619.	0.	100000.	90978.
56.00	2.	31	56.9	-175.	-2839.	4774.	0.	100000.	101760.
59.24	2.	32	56.9	-179.	0.	4928.	46909.	100000.	151658.
62.25	2.	33	56.9	-182.	0.	5072.	221368.	100000.	326257.
64.84	2.	34	57.0	-186.	0.	5195.	498364.	100000.	603372.
66.83	2.	35	57.0	-190.	0.	5289.	782107.	100000.	887205.
68.07	2.	36	57.0	-194.	0.	5347.	982916.	100000.	1088069.
68.50	2.	37	57.1	-198.	0.	5366.	1054584.	100000.	1159752.
68.07	2.	38	57.1	-202.	0.	5343.	982916.	100000.	1088058.
66.83	2.	39	57.1	-206.	0.	5282.	782107.	100000.	887183.
64.84	2.	40	57.2	-210.	0.	5185.	498364.	100000.	603339.
62.25	2.	41	57.2	-213.	0.	5058.	221368.	100000.	326213.
59.24	2.	42	57.2	-217.	0.	4912.	46909.	100000.	151603.
56.00	2.	43	57.3	-221.	-4203.	4754.	0.	100000.	100330.
52.76	2.	44	57.3	-225.	-15040.	4596.	0.	100000.	89332.
49.75	2.	45	57.3	-228.	-25093.	4450.	0.	100000.	79129.
47.16	2.	46	57.4	-231.	-33737.	4324.	0.	100000.	70356.
45.17	2.	47	57.4	-234.	-40384.	4227.	0.	100000.	63610.
43.93	3.	48	57.4	-236.	-44545.	4167.	0.	100000.	59386.
43.50	3.	49	57.4	-238.	-46028.	4145.	0.	100000.	57879.
43.93	3.	50	57.4	-240.	-44672.	4165.	0.	100000.	59253.
45.17	3.	51	57.5	-242.	-40644.	4223.	0.	100000.	63337.
47.16	3.	52	57.5	-245.	-34142.	4318.	0.	100000.	69931.
49.75	3.	53	57.5	-247.	-25660.	4442.	0.	100000.	78535.
52.76	3.	54	57.5	-250.	-15789.	4586.	0.	100000.	88546.
56.00	3.	55	57.6	-253.	-5157.	4740.	0.	100000.	99329.
59.24	3.	56	57.6	-257.	0.	4895.	48691.	100000.	153328.
62.25	3.	57	57.6	-261.	0.	5038.	224359.	100000.	329136.
64.84	3.	58	57.7	-265.	0.	5161.	502565.	100000.	607461.

66.83	3.	59	57.7	-269.	0.	5255.	786944.	100000.	891930.
68.07	3.	60	57.7	-272.	0.	5313.	988008.	100000.	1093049.
68.50	3.	61	57.8	-276.	0.	5332.	1059803.	100000.	1164859.
68.07	3.	62	57.8	-280.	0.	5310.	988008.	100000.	1093038.
66.83	3.	63	57.8	-284.	0.	5248.	786944.	100000.	891908.
64.84	3.	64	57.9	-288.	0.	5151.	502565.	100000.	607428.
62.25	3.	65	57.9	-292.	0.	5025.	224359.	100000.	329092.
59.24	3.	66	57.9	-296.	0.	4878.	48691.	100000.	153273.
56.00	3.	67	58.0	-300.	-6517.	4720.	0.	100000.	97904.
52.76	3.	68	58.0	-303.	-17350.	4563.	0.	100000.	86909.
49.75	3.	69	58.0	-306.	-27399.	4417.	0.	100000.	76711.
47.16	3.	70	58.1	-309.	-36040.	4291.	0.	100000.	67941.
45.17	3.	71	58.1	-312.	-42684.	4194.	0.	100000.	61198.
43.93	4.	72	58.1	-314.	-46841.	4133.	0.	100000.	56978.
43.50	4.	73	58.1	-316.	-48322.	4111.	0.	100000.	55474.
43.93	4.	74	58.1	-318.	-46963.	4131.	0.	100000.	56850.
45.17	4.	75	58.2	-320.	-42934.	4190.	0.	100000.	60936.
47.16	4.	76	58.2	-322.	-36430.	4285.	0.	100000.	67533.
49.75	4.	77	58.2	-325.	-27946.	4409.	0.	100000.	76138.
52.76	4.	78	58.2	-328.	-18074.	4552.	0.	100000.	86151.
56.00	4.	79	58.2	-331.	-7440.	4707.	0.	100000.	96936.
59.24	4.	80	58.3	-334.	0.	4861.	50600.	100000.	155127.
62.25	4.	81	58.3	-338.	0.	5005.	227414.	100000.	332081.
64.84	4.	82	58.3	-342.	0.	5128.	506893.	100000.	611678.
66.83	4.	83	58.4	-346.	0.	5222.	791781.	100000.	896657.
68.07	4.	84	58.4	-350.	0.	5280.	993163.	100000.	1098094.
68.50	4.	85	58.4	-354.	0.	5299.	1065022.	100000.	1169967.
68.07	4.	86	58.5	-358.	0.	5277.	993163.	100000.	1098083.
66.83	4.	87	58.5	-361.	0.	5215.	791781.	100000.	896635.
64.84	4.	88	58.6	-365.	0.	5118.	506893.	100000.	611645.
62.25	4.	89	58.6	-369.	0.	4992.	227414.	100000.	332037.
59.24	4.	90	58.6	-373.	0.	4845.	50600.	100000.	155072.
56.00	4.	91	58.7	-377.	-8796.	4687.	0.	100000.	95514.
52.76	4.	92	58.7	-380.	-19626.	4530.	0.	100000.	84524.
49.75	4.	93	58.7	-383.	-29671.	4384.	0.	100000.	74329.
47.16	4.	94	58.7	-386.	-38309.	4258.	0.	100000.	65563.
45.17	4.	95	58.8	-389.	-44949.	4161.	0.	100000.	58823.
43.93	5.	96	58.8	-391.	-49104.	4100.	0.	100000.	54606.
43.50	5.	97	58.8	-393.	-50581.	4079.	0.	100000.	53105.
43.93	5.	98	58.8	-395.	-49220.	4098.	0.	100000.	54483.
45.17	5.	99	58.8	-397.	-45188.	4157.	0.	100000.	58572.
47.16	5.	100	58.9	-399.	-38683.	4252.	0.	100000.	65171.
49.75	5.	101	58.9	-401.	-30197.	4376.	0.	100000.	73778.
52.76	5.	102	58.9	-404.	-20323.	4520.	0.	100000.	83792.
56.00	5.	103	58.9	-407.	-9689.	4674.	0.	100000.	94578.
59.24	5.	104	59.0	-410.	0.	4829.	52446.	100000.	156864.
62.25	5.	105	59.0	-414.	0.	4972.	230533.	100000.	335091.
64.84	5.	106	59.0	-418.	0.	5095.	511221.	100000.	615898.
66.83	5.	107	59.1	-422.	0.	5189.	796746.	100000.	901513.
68.07	5.	108	59.1	-426.	0.	5247.	998383.	100000.	1103204.
68.50	5.	109	59.1	-430.	0.	5266.	1070305.	100000.	1175142.
68.07	5.	110	59.2	-434.	0.	5244.	998383.	100000.	1103193.
66.83	5.	111	59.2	-437.	0.	5183.	796746.	100000.	901491.
64.84	5.	112	59.2	-441.	0.	5085.	511221.	100000.	615865.
62.25	5.	113	59.3	-445.	0.	4959.	230533.	100000.	335047.
59.24	5.	114	59.3	-449.	-190.	4812.	52446.	100000.	156619.
56.00	5.	115	59.3	-453.	-11040.	4655.	0.	100000.	93161.
52.76	5.	116	59.4	-456.	-21866.	4497.	0.	100000.	82175.
49.75	5.	117	59.4	-459.	-31908.	4351.	0.	100000.	71984.
47.16	5.	118	59.4	-462.	-40542.	4225.	0.	100000.	63222.
45.17	5.	119	59.4	-464.	-47179.	4128.	0.	100000.	56485.

43.93	6.	120	59.5	-466.	-51330.	4068.	0.	100000.	52271.
43.50	6.	121	59.5	-468.	-52805.	4046.	0.	100000.	50773.
43.93	6.	122	59.5	-470.	-51442.	4066.	0.	100000.	52154.
45.17	6.	123	59.5	-472.	-47408.	4125.	0.	100000.	56245.
47.16	6.	124	59.5	-474.	-40900.	4220.	0.	100000.	62846.
49.75	6.	125	59.5	-476.	-32413.	4344.	0.	100000.	71454.
52.76	6.	126	59.6	-479.	-22538.	4487.	0.	100000.	81470.
56.00	6.	127	59.6	-482.	-11902.	4642.	0.	100000.	92258.
59.24	6.	128	59.6	-485.	-1266.	4797.	54355.	100000.	157401.
62.25	6.	129	59.7	-489.	0.	4940.	233715.	100000.	338166.
64.84	6.	130	59.7	-493.	0.	5063.	515612.	100000.	620183.
66.83	6.	131	59.7	-497.	0.	5157.	801710.	100000.	906371.
68.07	6.	132	59.8	-501.	0.	5215.	1003665.	100000.	1108380.
68.50	6.	133	59.8	-505.	0.	5234.	1075651.	100000.	1180381.
68.07	6.	134	59.8	-508.	0.	5212.	1003665.	100000.	1108369.
66.83	6.	135	59.9	-512.	0.	5151.	801710.	100000.	906349.
64.84	6.	136	59.9	-516.	0.	5053.	515612.	100000.	620150.
62.25	6.	137	59.9	-520.	0.	4927.	233715.	100000.	338122.
59.24	6.	138	60.0	-524.	-2400.	4780.	54355.	100000.	156212.
56.00	6.	139	60.0	-528.	-13246.	4623.	0.	100000.	90849.
52.76	6.	140	60.0	-531.	-24068.	4465.	0.	100000.	79866.
49.75	6.	141	60.1	-534.	-34107.	4319.	0.	100000.	69678.
47.16	6.	142	60.1	-536.	-42737.	4193.	0.	100000.	60920.
45.17	6.	143	60.1	-539.	-49371.	4096.	0.	100000.	54187.
43.93	7.	144	60.1	-541.	-53520.	4036.	0.	100000.	49976.
43.50	7.	145	60.1	-543.	-54992.	4014.	0.	100000.	48480.
43.93	7.	146	60.1	-544.	-53626.	4034.	0.	100000.	49864.
45.17	7.	147	60.2	-546.	-49590.	4093.	0.	100000.	53957.
47.16	7.	148	60.2	-548.	-43081.	4188.	0.	100000.	60559.
49.75	7.	149	60.2	-550.	-34592.	4312.	0.	100000.	69169.
52.76	7.	150	60.2	-553.	-24716.	4456.	0.	100000.	79187.
56.00	7.	151	60.2	-556.	-14079.	4611.	0.	100000.	89976.
59.24	7.	152	60.3	-559.	-3441.	4765.	56328.	100000.	157093.
62.25	7.	153	60.3	-563.	0.	4908.	236961.	100000.	341307.
64.84	7.	154	60.3	-567.	0.	5032.	520068.	100000.	624533.
66.83	7.	155	60.4	-570.	0.	5126.	806738.	100000.	911294.
68.07	7.	156	60.4	-574.	0.	5184.	1009012.	100000.	1113621.
68.50	7.	157	60.4	-578.	0.	5203.	1081061.	100000.	1185686.
68.07	7.	158	60.5	-582.	0.	5180.	1009012.	100000.	1113610.
66.83	7.	159	60.5	-586.	0.	5119.	806738.	100000.	911272.
64.84	7.	160	60.6	-590.	0.	5022.	520068.	100000.	624500.
62.25	7.	161	60.6	-594.	0.	4895.	236961.	100000.	341263.
59.24	7.	162	60.6	-597.	-4572.	4749.	56328.	100000.	155908.
56.00	7.	163	60.7	-601.	-15414.	4591.	0.	100000.	88576.
52.76	7.	164	60.7	-604.	-26233.	4434.	0.	100000.	77597.
49.75	7.	165	60.7	-607.	-36267.	4288.	0.	100000.	67413.
47.16	7.	166	60.7	-610.	-44894.	4162.	0.	100000.	58658.
45.17	7.	167	60.7	-612.	-51525.	4065.	0.	100000.	51928.
43.93	8.	168	60.8	-614.	-55671.	4005.	0.	100000.	47720.
43.50	8.	169	60.8	-615.	-57140.	3983.	0.	100000.	46227.
43.93	8.	170	60.8	-617.	-55773.	4003.	0.	100000.	47613.
45.17	8.	171	60.8	-619.	-51735.	4062.	0.	100000.	51708.
47.16	8.	172	60.8	-621.	-45224.	4157.	0.	100000.	58313.
49.75	8.	173	60.8	-623.	-36733.	4281.	0.	100000.	66925.
52.76	8.	174	60.9	-625.	-26856.	4425.	0.	100000.	76944.
56.00	8.	175	60.9	-628.	-16217.	4579.	0.	100000.	87734.
59.24	8.	176	60.9	-631.	-5578.	4734.	58238.	100000.	156762.
62.25	8.	177	61.0	-635.	0.	4877.	240271.	100000.	344514.
64.84	8.	178	61.0	-639.	0.	5001.	524587.	100000.	628948.
66.83	8.	179	61.0	-643.	0.	5095.	811830.	100000.	916282.
68.07	8.	180	61.1	-647.	0.	5153.	1014358.	100000.	1118864.

68.50	8.	181	61.1	-650.	0.	5172.	1086535.	100000. 1191056.
68.07	8.	182	61.1	-654.	0.	5149.	1014358.	100000. 1118853.
66.83	8.	183	61.2	-658.	0.	5088.	811830.	100000. 916260.
64.84	8.	184	61.2	-662.	0.	4991.	524587.	100000. 628915.
62.25	8.	185	61.2	-666.	0.	4864.	240271.	100000. 344470.
59.24	8.	186	61.3	-670.	-6705.	4718.	58238.	100000. 155580.
56.00	8.	187	61.3	-673.	-17545.	4560.	0.	100000. 86342.
52.76	8.	188	61.3	-676.	-28359.	4403.	0.	100000. 75367.
49.75	8.	189	61.3	-679.	-38391.	4257.	0.	100000. 65187.
47.16	8.	190	61.4	-682.	-47014.	4131.	0.	100000. 56435.
45.17	8.	191	61.4	-684.	-53642.	4034.	0.	100000. 49709.
43.93	9.	192	61.4	-686.	-57785.	3974.	0.	100000. 45503.
43.50	9.	193	61.4	-687.	-59252.	3952.	0.	100000. 44013.
43.93	9.	194	61.4	-689.	-57882.	3972.	0.	100000. 45402.
45.17	9.	195	61.4	-690.	-53842.	4031.	0.	100000. 49499.
47.16	9.	196	61.5	-692.	-47329.	4126.	0.	100000. 56105.
49.75	9.	197	61.5	-694.	-38837.	4250.	0.	100000. 64719.
52.76	9.	198	61.5	-697.	-28958.	4394.	0.	100000. 74739.
56.00	9.	199	61.5	-699.	-18319.	4549.	0.	100000. 85531.
59.24	9.	200	61.6	-703.	-7678.	4704.	60275.	100000. 156597.
62.25	9.	201	61.6	-706.	0.	4847.	243581.	100000. 347722.
64.84	9.	202	61.6	-710.	0.	4970.	529169.	100000. 633430.
66.83	9.	203	61.7	-714.	0.	5064.	816986.	100000. 921336.
68.07	9.	204	61.7	-718.	0.	5122.	1019768.	100000. 1124173.
68.50	9.	205	61.7	-722.	0.	5141.	1092009.	100000. 1196429.
68.07	9.	206	61.8	-725.	0.	5119.	1019768.	100000. 1124162.
66.83	9.	207	61.8	-729.	0.	5058.	816986.	100000. 921314.
64.84	9.	208	61.8	-733.	0.	4960.	529169.	100000. 633397.
62.25	9.	209	61.9	-737.	0.	4834.	243581.	100000. 347678.
59.24	9.	210	61.9	-741.	-8802.	4687.	60275.	100000. 155419.
56.00	9.	211	61.9	-744.	-19638.	4530.	0.	100000. 84148.
52.76	9.	212	62.0	-747.	-30449.	4372.	0.	100000. 73176.
49.75	9.	213	62.0	-750.	-40477.	4226.	0.	100000. 62999.
47.16	9.	214	62.0	-752.	-49097.	4101.	0.	100000. 54251.
45.17	9.	215	62.0	-754.	-55722.	4004.	0.	100000. 47528.
43.93	10.	216	62.0	-756.	-59862.	3944.	0.	100000. 43325.
43.50	10.	217	62.0	-758.	-61326.	3922.	0.	100000. 41838.
43.93	10.	218	62.1	-759.	-59954.	3942.	0.	100000. 43229.
45.17	10.	219	62.1	-761.	-55912.	4001.	0.	100000. 47328.
47.16	10.	220	62.1	-763.	-49398.	4096.	0.	100000. 53936.
49.75	10.	221	62.1	-764.	-40904.	4220.	0.	100000. 62551.
52.76	10.	222	62.1	-767.	-31024.	4364.	0.	100000. 72573.
56.00	10.	223	62.2	-769.	-20383.	4519.	0.	100000. 83367.
59.24	10.	224	62.2	-773.	-9742.	4674.	62311.	100000. 156471.
62.25	10.	225	62.2	-776.	0.	4817.	247018.	100000. 351059.
64.84	10.	226	62.2	-780.	0.	4940.	533752.	100000. 637913.
66.83	10.	227	62.3	-784.	0.	5034.	822205.	100000. 926455.
								68.07 10. 228 6
68.50	10.	229	62.3	-791.	0.	5111.	1097546.	100000. 1201866.
68.07	10.	230	62.4	-795.	0.	5089.	1025242.	100000. 1129536.
66.83	10.	231	62.4	-799.	0.	5028.	822205.	100000. 926434.
64.84	10.	232	62.4	-803.	0.	4930.	533752.	100000. 637880.
62.25	10.	233	62.5	-807.	-769.	4804.	247018.	100000. 350246.
59.24	10.	234	62.5	-810.	-10861.	4657.	62311.	100000. 155297.
56.00	10.	235	62.5	-814.	-21694.	4500.	0.	100000. 81993.
52.76	10.	236	62.6	-817.	-32501.	4343.	0.	100000. 71024.
49.75	10.	237	62.6	-820.	-42526.	4197.	0.	100000. 60851.
47.16	10.	238	62.6	-822.	-51143.	4071.	0.	100000. 52106.
45.17	10.	239	62.6	-824.	-57765.	3974.	0.	100000. 45386.
43.93	11.	240	62.6	-825.	-61902.	3914.	0.	100000. 41186.
43.50	11.	241	62.7	-827.	-63364.	3892.	0.	100000. 39701.

43.93	11.	242	62.7	-828.	-61990.	3913.	0.	100000.	41094.
45.17	11.	243	62.7	-830.	-57946.	3972.	0.	100000.	45196.
47.16	11.	244	62.7	-831.	-51430.	4067.	0.	100000.	51805.
49.75	11.	245	62.7	-833.	-42935.	4191.	0.	100000.	60422.
52.76	11.	246	62.7	-836.	-33053.	4335.	0.	100000.	70446.
56.00	11.	247	62.8	-838.	-22411.	4489.	0.	100000.	81240.
59.24	11.	248	62.8	-841.	-11768.	4644.	64348.	100000.	156383.
62.25	11.	249	62.8	-845.	-1889.	4788.	250455.	100000.	352509.
64.84	11.	250	62.9	-848.	0.	4911.	538398.	100000.	642461.
66.83	11.	251	62.9	-852.	0.	5005.	827424.	100000.	931577.
68.07	11.	252	62.9	-856.	0.	5063.	1030716.	100000.	1134923.
68.50	11.	253	63.0	-860.	0.	5082.	1103083.	100000.	1207306.
68.07	11.	254	63.0	-864.	0.	5060.	1030716.	100000.	1134912.
66.83	11.	255	63.0	-867.	0.	4998.	827424.	100000.	931555.
64.84	11.	256	63.1	-871.	0.	4901.	538398.	100000.	642428.
62.25	11.	257	63.1	-875.	-2792.	4775.	250455.	100000.	351563.
59.24	11.	258	63.1	-879.	-12881.	4628.	64348.	100000.	155217.
56.00	11.	259	63.2	-882.	-23710.	4471.	0.	100000.	79879.
52.76	11.	260	63.2	-885.	-34514.	4313.	0.	100000.	68914.
49.75	11.	261	63.2	-888.	-44535.	4167.	0.	100000.	58744.
47.16	11.	262	63.2	-890.	-53149.	4042.	0.	100000.	50002.
45.17	11.	263	63.2	-892.	-59768.	3945.	0.	100000.	43285.
43.93	12.	264	63.3	-893.	-63903.	3885.	0.	100000.	39089.
43.50	12.	265	63.3	-895.	-65362.	3863.	0.	100000.	37606.
43.93	12.	266	63.3	-896.	-63986.	3883.	0.	100000.	39001.
45.17	12.	267	63.3	-898.	-59940.	3943.	0.	100000.	43105.
47.16	12.	268	63.3	-899.	-53422.	4038.	0.	100000.	49716.
49.75	12.	269	63.3	-901.	-44926.	4162.	0.	100000.	58334.
52.76	12.	270	63.3	-903.	-35043.	4306.	0.	100000.	68359.
56.00	12.	271	63.4	-906.	-24400.	4461.	0.	100000.	79155.
59.24	12.	272	63.4	-909.	-13756.	4615.	66385.	100000.	156336.
62.25	12.	273	63.4	-912.	-3875.	4759.	253956.	100000.	353927.
64.84	12.	274	63.5	-915.	0.	4882.	543108.	100000.	647075.
66.83	12.	275	63.5	-919.	0.	4976.	832643.	100000.	936700.
68.07	12.	276	63.5	-923.	0.	5034.	1036253.	100000.	1140364.
68.50	12.	277	63.6	-927.	0.	5053.	1108685.	100000.	1212811.
68.07	12.	278	63.6	-931.	0.	5031.	1036253.	100000.	1140353.
66.83	12.	279	63.6	-935.	0.	4970.	832643.	100000.	936678.
64.84	12.	280	63.7	-938.	0.	4872.	543108.	100000.	647042.
62.25	12.	281	63.7	-942.	-4775.	4746.	253956.	100000.	352984.
59.24	12.	282	63.7	-946.	-14861.	4599.	66385.	100000.	155177.
56.00	12.	283	63.8	-949.	-25686.	4442.	0.	100000.	77806.
52.76	12.	284	63.8	-952.	-36488.	4285.	0.	100000.	66845.
49.75	12.	285	63.8	-955.	-46506.	4139.	0.	100000.	56678.
47.16	12.	286	63.8	-957.	-55117.	4013.	0.	100000.	47940.
45.17	12.	287	63.8	-958.	-61732.	3916.	0.	100000.	41226.
43.93	13.	288	63.8	-960.	-65865.	3856.	0.	100000.	37032.
43.50	13.	289	63.9	-961.	-67322.	3835.	0.	100000.	35552.
43.93	13.	290	63.9	-963.	-65943.	3855.	0.	100000.	36949.
45.17	13.	291	63.9	-964.	-61896.	3914.	0.	100000.	41055.
47.16	13.	292	63.9	-965.	-55376.	4009.	0.	100000.	47667.
49.75	13.	293	63.9	-967.	-46879.	4133.	0.	100000.	56287.
52.76	13.	294	63.9	-969.	-36994.	4277.	0.	100000.	66314.
56.00	13.	295	64.0	-972.	-26350.	4432.	0.	100000.	77111.
59.24	13.	296	64.0	-975.	-15705.	4587.	68485.	100000.	156393.
62.25	13.	297	64.0	-978.	-5823.	4731.	257456.	100000.	355386.
64.84	13.	298	64.0	-981.	0.	4854.	547882.	100000.	651754.
66.83	13.	299	64.1	-985.	0.	4948.	837990.	100000.	941952.
68.07	13.	300	64.1	-989.	0.	5006.	1041790.	100000.	1145807.
68.50	13.	301	64.1	-993.	0.	5025.	1114349.	100000.	1218381.
68.07	13.	302	64.	-997.	0.	5003.	1041790.	100000.	1145797.

66.83	13.	303	64.2	-1000.	0.	4941.	837990.	100000.	941931.
64.84	13.	304	64.2	-1004.	0.	4844.	547882.	100000.	651722.
62.25	13.	305	64.3	-1008.	-6719.	4718.	257456.	100000.	354446.
59.24	13.	306	64.3	-1012.	-16802.	4571.	68485.	100000.	155242.
56.00	13.	307	64.3	-1015.	-27624.	4414.	0.	100000.	75775.
52.76	13.	308	64.4	-1018.	-38423.	4257.	0.	100000.	64816.
49.75	13.	309	64.4	-1020.	-48438.	4111.	0.	100000.	54653.
47.16	13.	310	64.4	-1022.	-57045.	3985.	0.	100000.	45918.
45.17	13.	311	64.4	-1024.	-63658.	3888.	0.	100000.	39207.
43.93	14.	312	64.4	-1025.	-67788.	3828.	0.	100000.	35015.
43.50	14.	313	64.4	-1026.	-69243.	3807.	0.	100000.	33538.
43.93	14.	314	64.4	-1028.	-67862.	3827.	0.	100000.	34937.
45.17	14.	315	64.5	-1029.	-63813.	3886.	0.	100000.	39045.
47.16	14.	316	64.5	-1030.	-57292.	3981.	0.	100000.	45659.
49.75	14.	317	64.5	-1032.	-48793.	4105.	0.	100000.	54281.
52.76	14.	318	64.5	-1034.	-38907.	4249.	0.	100000.	64308.
56.00	14.	319	64.5	-1036.	-28261.	4404.	0.	100000.	75107.
59.24	14.	320	64.6	-1039.	-17615.	4559.	70586.	100000.	156490.
62.25	14.	321	64.6	-1042.	-7732.	4703.	261020.	100000.	356949.
64.84	14.	322	64.6	-1046.	0.	4826.	552656.	100000.	656436.
66.83	14.	323	64.6	-1050.	0.	4920.	843336.	100000.	947207.
68.07	14.	324	64.7	-1054.	0.	4978.	1047391.	100000.	1151316.
68.50	14.	325	64.7	-1057.	0.	4997.	1120014.	100000.	1223954.
68.07	14.	326	64.7	-1061.	0.	4975.	1047391.	100000.	1151305.
66.83	14.	327	64.8	-1065.	0.	4914.	843336.	100000.	947185.
64.84	14.	328	64.8	-1069.	0.	4816.	552656.	100000.	656403.
62.25	14.	329	64.9	-1073.	-8626.	4690.	261020.	100000.	356012.
59.24	14.	330	64.9	-1076.	-18706.	4543.	70586.	100000.	155347.
56.00	14.	331	64.9	-1079.	-29525.	4386.	0.	100000.	73782.
52.76	14.	332	64.9	-1082.	-40320.	4229.	0.	100000.	62827.
49.75	14.	333	65.0	-1084.	-50332.	4083.	0.	100000.	52667.
47.16	14.	334	65.0	-1086.	-58937.	3957.	0.	100000.	43935.
45.17	14.	335	65.0	-1088.	-65547.	3861.	0.	100000.	37226.
43.93	15.	336	65.0	-1089.	-69674.	3801.	0.	100000.	33037.
43.50	15.	337	65.0	-1090.	-71127.	3779.	0.	100000.	31562.
43.93	15.	338	65.0	-1092.	-69744.	3800.	0.	100000.	32964.
45.17	15.	339	65.0	-1093.	-65693.	3859.	0.	100000.	37073.
47.16	15.	340	65.0	-1094.	-59170.	3954.	0.	100000.	43689.
49.75	15.	341	65.1	-1096.	-50670.	4078.	0.	100000.	52312.
52.76	15.	342	65.1	-1098.	-40784.	4222.	0.	100000.	62341.
56.00	15.	343	65.1	-1100.	-30136.	4377.	0.	100000.	73141.
59.24	15.	344	65.1	-1103.	-19489.	4532.	72750.	100000.	156690.
62.25	15.	345	65.1	-1106.	-9604.	4676.	264648.	100000.	358614.
64.84	15.	346	65.2	-1109.	-1114.	4799.	557493.	100000.	660069.
66.83	15.	347	65.2	-1113.	0.	4893.	848682.	100000.	952463.
68.07	15.	348	65.2	-1117.	0.	4951.	1052993.	100000.	1156827.
68.50	15.	349	65.3	-1121.	0.	4970.	1125679.	100000.	1229528.
68.07	15.	350	65.3	-1124.	0.	4948.	1052993.	100000.	1156816.
66.83	15.	351	65.3	-1128.	0.	4887.	848682.	100000.	952441.
64.84	15.	352	65.4	-1132.	-1789.	4789.	557493.	100000.	659361.
62.25	15.	353	65.4	-1136.	-10492.	4663.	264648.	100000.	357683.
59.24	15.	354	65.4	-1139.	-20569.	4516.	72750.	100000.	155558.
56.00	15.	355	65.5	-1142.	-31385.	4359.	0.	100000.	71832.
52.76	15.	356	65.5	-1145.	-42176.	4202.	0.	100000.	60881.
49.75	15.	357	65.5	-1147.	-52185.	4056.	0.	100000.	50723.
47.16	15.	358	65.5	-1149.	-60787.	3931.	0.	100000.	41994.
45.17	15.	359	65.5	-1151.	-67395.	3834.	0.	100000.	35289.
43.93	16.	360	65.6	-1152.	-71519.	3774.	0.	100000.	31103.
43.50	16.	361	65.6	-1153.	-72970.	3753.	0.	100000.	29630.
43.93	16.	362	65.6	-1154.	-71585.	3773.	0.	100000.	31034.
45.17	16.	363	65.6	-1155.	-67533.	3832.	0.	100000.	35144.

47.16	16.	364	65.6	-1157.	-61009.	3927.	0.	100000.	41762.
49.75	16.	365	65.6	-1158.	-52507.	4051.	0.	100000.	50386.
52.76	16.	366	65.6	-1160.	-42619.	4196.	0.	100000.	60416.
56.00	16.	367	65.6	-1162.	-31971.	4351.	0.	100000.	71217.
59.24	16.	368	65.7	-1165.	-21323.	4505.	74914.	100000.	156932.
62.25	16.	369	65.7	-1168.	-11437.	4649.	268340.	100000.	360385.
64.84	16.	370	65.7	-1171.	-2945.	4772.	562330.	100000.	662986.
66.83	16.	371	65.8	-1175.	0.	4867.	854029.	100000.	957720.
68.07	16.	372	65.8	-1179.	0.	4925.	1058594.	100000.	1162340.
68.50	16.	373	65.8	-1183.	0.	4944.	1131343.	100000.	1235104.
68.07	16.	374	65.9	-1186.	0.	4921.	1058594.	100000.	1162329.
66.83	16.	375	65.9	-1190.	0.	4860.	854029.	100000.	957699.
64.84	16.	376	65.9	-1194.	-3618.	4763.	562330.	100000.	662281.
62.25	16.	377	66.0	-1198.	-12318.	4636.	268340.	100000.	359460.
59.24	16.	378	66.0	-1201.	-22392.	4490.	74914.	100000.	155811.
56.00	16.	379	66.0	-1204.	-33205.	4333.	0.	100000.	69924.
52.76	16.	380	66.0	-1207.	-43993.	4176.	0.	100000.	58976.
49.75	16.	381	66.1	-1209.	-53999.	4030.	0.	100000.	48822.
47.16	16.	382	66.1	-1211.	-62598.	3904.	0.	100000.	40095.
45.17	16.	383	66.1	-1212.	-69203.	3808.	0.	100000.	33393.
43.93	17.	384	66.1	-1213.	-73325.	3748.	0.	100000.	29209.
43.50	17.	385	66.1	-1214.	-74774.	3726.	0.	100000.	27739.
43.93	17.	386	66.1	-1215.	-73387.	3747.	0.	100000.	29144.
45.17	17.	387	66.1	-1216.	-69333.	3806.	0.	100000.	33257.
47.16	17.	388	66.1	-1218.	-62807.	3901.	0.	100000.	39876.
49.75	17.	389	66.2	-1219.	-54304.	4025.	0.	100000.	48502.
52.76	17.	390	66.2	-1221.	-44415.	4169.	0.	100000.	58533.
56.00	17.	391	66.2	-1223.	-33766.	4325.	0.	100000.	69335.
59.24	17.	392	66.2	-1226.	-23117.	4479.	77141.	100000.	157279.
62.25	17.	393	66.2	-1229.	-13229.	4623.	272032.	100000.	362197.
64.84	17.	394	66.3	-1232.	-4736.	4746.	567231.	100000.	666009.
66.83	17.	395	66.3	-1235.	0.	4841.	859439.	100000.	963044.
68.07	17.	396	66.3	-1239.	0.	4899.	1064258.	100000.	1167918.
68.50	17.	397	66.4	-1243.	0.	4918.	1137071.	100000.	1240746.
68.07	17.	398	66.4	-1247.	0.	4895.	1064258.	100000.	1167907.
66.83	17.	399	66.4	-1251.	0.	4834.	859439.	100000.	963022.
64.84	17.	400	66.5	-1255.	-5407.	4737.	567231.	100000.	665306.
62.25	17.	401	66.5	-1258.	-14104.	4610.	272032.	100000.	361280.
59.24	17.	402	66.5	-1261.	-24175.	4464.	77141.	100000.	156169.
56.00	17.	403	66.6	-1264.	-34985.	4307.	0.	100000.	68058.
52.76	17.	404	66.6	-1267.	-45771.	4150.	0.	100000.	57112.
49.75	17.	405	66.6	-1269.	-55774.	4004.	0.	100000.	46961.
47.16	17.	406	66.6	-1271.	-64370.	3878.	0.	100000.	38238.
45.17	17.	407	66.6	-1272.	-70972.	3782.	0.	100000.	31538.
43.93	18.	408	66.6	-1273.	-75092.	3722.	0.	100000.	27357.
43.50	18.	409	66.6	-1274.	-76538.	3701.	0.	100000.	25888.
43.93	18.	410	66.7	-1275.	-75150.	3721.	0.	100000.	27296.
45.17	18.	411	66.7	-1276.	-71093.	3780.	0.	100000.	31411.
47.16	18.	412	66.7	-1277.	-64567.	3876.	0.	100000.	38031.
49.75	18.	413	66.7	-1279.	-56063.	4000.	0.	100000.	46658.
52.76	18.	414	66.7	-1280.	-46172.	4144.	0.	100000.	56691.
56.00	18.	415	66.7	-1283.	-35522.	4299.	0.	100000.	67494.
59.24	18.	416	66.7	-1285.	-24872.	4454.	79305.	100000.	157603.
62.25	18.	417	66.8	-1288.	-14983.	4598.	275787.	100000.	364113.
64.84	18.	418	66.8	-1291.	-6489.	4721.	572132.	100000.	669073.
66.83	18.	419	66.8	-1295.	0.	4815.	864913.	100000.	968433.
68.07	18.	420	66.9	-1298.	0.	4873.	1069923.	100000.	1173498.
68.50	18.	421	66.9	-1302.	0.	4892.	1142800.	100000.	1246390.
68.07	18.	422	66.9	-1306.	0.	4870.	1069923.	100000.	1173487.
66.83	18.	423	67.0	-1310.	-440.	4809.	864913.	100000.	967972.
64.84	18.	424	67.0	-1314.	-7157.	4711.	572132.	100000.	668373.

62.25	18.	425	67.0	-1317.	-15851.	4585.	275787.	100000.	363203.
59.24	18.	426	67.1	-1320.	-25919.	4439.	79305.	100000.	156505.
56.00	18.	427	67.1	-1323.	-36726.	4282.	0.	100000.	66232.
52.76	18.	428	67.1	-1326.	-47509.	4124.	0.	100000.	55290.
49.75	18.	429	67.1	-1328.	-57509.	3979.	0.	100000.	45142.
47.16	18.	430	67.1	-1329.	-66103.	3853.	0.	100000.	36421.
45.17	18.	431	67.1	-1331.	-72702.	3757.	0.	100000.	29724.
43.93	19.	432	67.2	-1332.	-76820.	3697.	0.	100000.	25545.
43.50	19.	433	67.2	-1333.	-78264.	3676.	0.	100000.	24079.
43.93	19.	434	67.2	-1334.	-76874.	3696.	0.	100000.	25489.
45.17	19.	435	67.2	-1335.	-72816.	3755.	0.	100000.	29605.
47.16	19.	436	67.2	-1336.	-66288.	3851.	0.	100000.	36227.
49.75	19.	437	67.2	-1337.	-57782.	3975.	0.	100000.	44855.
52.76	19.	438	67.2	-1339.	-47891.	4119.	0.	100000.	54889.
56.00	19.	439	67.2	-1341.	-37240.	4274.	0.	100000.	65693.
59.24	19.	440	67.3	-1343.	-26588.	4429.	81533.	100000.	158031.
62.25	19.	441	67.3	-1346.	-16699.	4573.	279542.	100000.	366070.
64.84	19.	442	67.3	-1349.	-8203.	4696.	577033.	100000.	672176.
66.83	19.	443	67.3	-1353.	-1702.	4790.	870323.	100000.	972059.
68.07	19.	444	67.4	-1356.	0.	4849.	1075588.	100000.	1179080.
68.50	19.	445	67.4	-1360.	0.	4868.	1148528.	100000.	1252036.
68.07	19.	446	67.4	-1364.	0.	4845.	1075588.	100000.	1179069.
66.83	19.	447	67.5	-1368.	-2150.	4784.	870323.	100000.	971589.
64.84	19.	448	67.5	-1372.	-8865.	4687.	577033.	100000.	671483.
62.25	19.	449	67.5	-1375.	-17556.	4560.	279542.	100000.	365171.
59.24	19.	450	67.6	-1378.	-27621.	4414.	81533.	100000.	156948.
56.00	19.	451	67.6	-1381.	-38425.	4257.	0.	100000.	64450.
52.76	19.	452	67.6	-1383.	-49206.	4100.	0.	100000.	53511.
49.75	19.	453	67.6	-1385.	-59203.	3954.	0.	100000.	43366.
47.16	19.	454	67.6	-1387.	-67794.	3829.	0.	100000.	34648.
45.17	19.	455	67.7	-1388.	-74391.	3732.	0.	100000.	27953.
43.93	20.	456	67.7	-1389.	-78507.	3672.	0.	100000.	23776.
43.50	20.	457	67.7	-1390.	-79949.	3651.	0.	100000.	22312.
43.93	20.	458	67.7	-1391.	-78557.	3671.	0.	100000.	23724.
45.17	20.	459	67.7	-1392.	-74498.	3731.	0.	100000.	27841.
47.16	20.	460	67.7	-1393.	-67968.	3826.	0.	100000.	34466.
49.75	20.	461	67.7	-1394.	-59461.	3950.	0.	100000.	43095.
52.76	20.	462	67.7	-1396.	-49569.	4095.	0.	100000.	53130.
56.00	20.	463	67.7	-1398.	-38917.	4250.	0.	100000.	63936.
59.24	20.	464	67.8	-1400.	-28264.	4405.	83824.	100000.	158565.
62.25	20.	465	67.8	-1403.	-18373.	4548.	283361.	100000.	368133.
64.84	20.	466	67.8	-1406.	-9877.	4672.	581997.	100000.	675386.
66.83	20.	467	67.8	-1409.	-3374.	4766.	875796.	100000.	975779.
68.07	20.	468	67.9	-1413.	0.	4824.	1081252.	100000.	1184664.
68.50	20.	469	67.9	-1417.	0.	4843.	1154320.	100000.	1257747.
68.07	20.	470	67.9	-1420.	0.	4821.	1081252.	100000.	1184653.
66.83	20.	471	68.0	-1424.	-3820.	4760.	875796.	100000.	975311.
64.84	20.	472	68.0	-1428.	-10532.	4662.	581997.	100000.	674699.
62.25	20.	473	68.0	-1431.	-19221.	4536.	283361.	100000.	367244.
59.24	20.	474	68.1	-1434.	-29284.	4390.	83824.	100000.	157496.
56.00	20.	475	68.1	-1437.	-40085.	4233.	0.	100000.	62710.
52.76	20.	476	68.1	-1439.	-50862.	4076.	0.	100000.	51774.
49.75	20.	477	68.1	-1441.	-60857.	3930.	0.	100000.	41631.
47.16	20.	478	68.1	-1443.	-69446.	3805.	0.	100000.	32916.
45.17	20.	479	68.2	-1444.	-76041.	3708.	0.	100000.	26224.
43.93	21.	480	68.2	-1445.	-80154.	3648.	0.	100000.	22049.
43.50	21.	481	68.2	-1446.	-81594.	3627.	0.	100000.	20588.
43.93	21.	482	68.2	-1447.	-80200.	3647.	0.	100000.	22001.
45.17	21.	483	68.2	-1447.	-76139.	3707.	0.	100000.	26121.
47.16	21.	484	68.2	-1448.	-69608.	3802.	0.	100000.	32746.
49.75	21.	485	68.2	-1450.	-61100.	3926.	0.	100000.	41376.

52.76	21.	486	68.2	-1451.	-51207.	4071.	0.	100000.	51413.
56.00	21.	487	68.2	-1453.	-40554.	4226.	0.	100000.	62219.
59.24	21.	488	68.3	-1455.	-29900.	4381.	86116.	100000.	159141.
62.25	21.	489	68.3	-1458.	-20009.	4525.	287243.	100000.	370302.
64.84	21.	490	68.3	-1461.	-11511.	4648.	587026.	100000.	678702.
66.83	21.	491	68.3	-1464.	-5007.	4742.	881270.	100000.	979541.
68.07	21.	492	68.4	-1468.	-997.	4801.	1086917.	100000.	1189253.
68.50	21.	493	68.4	-1472.	0.	4820.	1160048.	100000.	1263396.
68.07	21.	494	68.4	-1476.	-1221.	4797.	1086917.	100000.	1189018.
66.83	21.	495	68.5	-1479.	-5449.	4736.	881270.	100000.	979078.
64.84	21.	496	68.5	-1483.	-12158.	4639.	587026.	100000.	678023.
62.25	21.	497	68.5	-1486.	-20845.	4513.	287243.	100000.	369425.
59.24	21.	498	68.6	-1489.	-30904.	4366.	86116.	100000.	158088.
56.00	21.	499	68.6	-1492.	-41703.	4209.	0.	100000.	61014.
52.76	21.	500	68.6	-1494.	-52478.	4052.	0.	100000.	50080.
49.75	21.	501	68.6	-1496.	-62470.	3907.	0.	100000.	39941.
47.16	21.	502	68.6	-1498.	-71056.	3781.	0.	100000.	31228.
45.17	21.	503	68.6	-1499.	-77648.	3685.	0.	100000.	24538.
43.93	22.	504	68.7	-1500.	-81759.	3625.	0.	100000.	20366.
43.50	22.	505	68.7	-1500.	-83197.	3604.	0.	100000.	18906.
43.93	22.	506	68.7	-1501.	-81802.	3624.	0.	100000.	20321.
45.17	22.	507	68.7	-1502.	-77740.	3684.	0.	100000.	24442.
47.16	22.	508	68.7	-1503.	-71207.	3779.	0.	100000.	31069.
49.75	22.	509	68.7	-1504.	-62698.	3903.	0.	100000.	39701.
52.76	22.	510	68.7	-1505.	-52804.	4047.	0.	100000.	49738.
56.00	22.	511	68.7	-1507.	-42150.	4203.	0.	100000.	60546.
59.24	22.	512	68.7	-1509.	-31495.	4358.	88407.	100000.	159760.
62.25	22.	513	68.8	-1512.	-21603.	4502.	291126.	100000.	372513.
64.84	22.	514	68.8	-1515.	-13104.	4625.	591990.	100000.	681996.
66.83	22.	515	68.8	-1518.	-6599.	4719.	886808.	100000.	983410.
68.07	22.	516	68.8	-1522.	-2587.	4778.	1092645.	100000.	1193314.
68.50	22.	517	68.9	-1526.	-1268.	4797.	1165777.	100000.	1267780.
68.07	22.	518	68.9	-1529.	-2807.	4774.	1092645.	100000.	1193083.
66.83	22.	519	68.9	-1533.	-7033.	4713.	886808.	100000.	982954.
64.84	22.	520	69.0	-1537.	-13741.	4616.	591990.	100000.	681329.
62.25	22.	521	69.0	-1540.	-22425.	4490.	291126.	100000.	371651.
59.24	22.	522	69.0	-1543.	-32482.	4343.	88407.	100000.	158726.
56.00	22.	523	69.1	-1545.	-43278.	4186.	0.	100000.	59363.
52.76	22.	524	69.1	-1548.	-54050.	4029.	0.	100000.	48432.
49.75	22.	525	69.1	-1549.	-64039.	3884.	0.	100000.	38295.
47.16	22.	526	69.1	-1551.	-72623.	3758.	0.	100000.	29585.
45.17	22.	527	69.1	-1552.	-79213.	3662.	0.	100000.	22897.
43.93	23.	528	69.1	-1553.	-83322.	3602.	0.	100000.	18727.
43.50	23.	529	69.1	-1553.	-84758.	3581.	0.	100000.	17270.
43.93	23.	530	69.1	-1554.	-83361.	3601.	0.	100000.	18686.
45.17	23.	531	69.1	-1555.	-79297.	3661.	0.	100000.	22809.
47.16	23.	532	69.1	-1555.	-72764.	3756.	0.	100000.	29437.
49.75	23.	533	69.2	-1557.	-64254.	3881.	0.	100000.	38070.
52.76	23.	534	69.2	-1558.	-54358.	4025.	0.	100000.	48109.
56.00	23.	535	69.2	-1560.	-43703.	4180.	0.	100000.	58918.
59.24	23.	536	69.2	-1562.	-33047.	4335.	90698.	100000.	160424.
62.25	23.	537	69.2	-1564.	-23154.	4479.	295008.	100000.	374769.
64.84	23.	538	69.3	-1567.	-14654.	4603.	597018.	100000.	685400.
66.83	23.	539	69.3	-1571.	-8147.	4697.	892281.	100000.	987260.
68.07	23.	540	69.3	-1574.	-4134.	4755.	1098310.	100000.	1197357.
68.50	23.	541	69.3	-1578.	-2814.	4774.	1171505.	100000.	1271887.
68.07	23.	542	69.4	-1581.	-4351.	4752.	1098310.	100000.	1197129.
66.83	23.	543	69.4	-1585.	-8575.	4691.	892281.	100000.	986812.
64.84	23.	544	69.4	-1589.	-15280.	4593.	597018.	100000.	684743.
62.25	23.	545	69.5	-1592.	-23962.	4467.	295008.	100000.	373922.
59.24	23.	546	69.5	-1595.	-34016.	4321.	90698.	00000.	159409.

56.00	23.	547	69.5	-1597.	-44810.	4164.	0.	100000.	57757.
52.76	23.	548	69.5	-1599.	-55579.	4007.	0.	100000.	46828.
49.75	23.	549	69.6	-1601.	-65566.	3861.	0.	100000.	36694.
47.16	23.	550	69.6	-1602.	-74147.	3736.	0.	100000.	27986.
45.17	23.	551	69.6	-1603.	-80735.	3640.	0.	100000.	21301.
43.93	24.	552	69.6	-1604.	-84842.	3580.	0.	100000.	17133.
43.50	24.	553	69.6	-1605.	-86277.	3559.	0.	100000.	15677.
43.93	24.	554	69.6	-1605.	-84878.	3579.	0.	100000.	17096.
45.17	24.	555	69.6	-1606.	-80813.	3639.	0.	100000.	21220.
47.16	24.	556	69.6	-1607.	-74278.	3734.	0.	100000.	27849.
49.75	24.	557	69.6	-1608.	-65767.	3859.	0.	100000.	36484.
52.76	24.	558	69.6	-1609.	-55870.	4003.	0.	100000.	46523.
56.00	24.	559	69.6	-1611.	-45214.	4158.	0.	100000.	57333.
59.24	24.	560	69.7	-1613.	-34558.	4313.	93053.	100000.	161196.
62.25	24.	561	69.7	-1616.	-24664.	4457.	298955.	100000.	377133.
64.84	24.	562	69.7	-1618.	-16163.	4581.	602110.	100000.	688910.
66.83	24.	563	69.7	-1622.	-9655.	4675.	897755.	100000.	991154.
68.07	24.	564	69.8	-1625.	-5640.	4733.	1103975.	100000.	1201443.
68.50	24.	565	69.8	-1629.	-4319.	4752.	1177233.	100000.	1276039.
68.07	24.	566	69.8	-1632.	-5854.	4730.	1103975.	100000.	1201219.
66.83	24.	567	69.9	-1636.	-10075.	4669.	897755.	100000.	990713.
64.84	24.	568	69.9	-1639.	-16778.	4572.	602110.	100000.	688264.
62.25	24.	569	69.9	-1642.	-25458.	4446.	298955.	100000.	376300.
59.24	24.	570	69.9	-1645.	-35510.	4299.	93053.	100000.	160198.
56.00	24.	571	70.0	-1648.	-46301.	4142.	0.	100000.	56194.
52.76	24.	572	70.0	-1650.	-57068.	3986.	0.	100000.	45268.
49.75	24.	573	70.0	-1652.	-67053.	3840.	0.	100000.	35136.
47.16	24.	574	70.0	-1653.	-75632.	3715.	0.	100000.	26430.
45.17	24.	575	70.0	-1654.	-82217.	3618.	0.	100000.	19747.
43.93	25.	576	70.0	-1655.	-86322.	3558.	0.	100000.	15582.
43.50	25.	577	70.0	-1655.	-87755.	3537.	0.	100000.	14127.
43.93	25.	578	70.0	-1656.	-86355.	3558.	0.	100000.	15548.
45.17	25.	579	70.0	-1656.	-82288.	3617.	0.	100000.	19673.
47.16	25.	580	70.1	-1657.	-75752.	3713.	0.	100000.	26304.
49.75	25.	581	70.1	-1658.	-67240.	3837.	0.	100000.	34939.
52.76	25.	582	70.1	-1659.	-57343.	3982.	0.	100000.	44980.
56.00	25.	583	70.1	-1661.	-46685.	4137.	0.	100000.	55791.
59.24	25.	584	70.1	-1663.	-36028.	4292.	95408.	100000.	162010.
62.25	25.	585	70.1	-1665.	-26132.	4436.	302964.	100000.	379603.
64.84	25.	586	70.2	-1668.	-17630.	4559.	607138.	100000.	692399.
66.83	25.	587	70.2	-1671.	-11121.	4654.	903292.	100000.	995154.
68.07	25.	588	70.2	-1675.	-7105.	4712.	1109703.	100000.	1205635.
68.50	25.	589	70.2	-1678.	-5782.	4731.	1182962.	100000.	1280233.
68.07	25.	590	70.3	-1682.	-7316.	4709.	1109703.	100000.	1205415.
66.83	25.	591	70.3	-1685.	-11536.	4648.	903292.	100000.	994719.
64.84	25.	592	70.3	-1689.	-18237.	4551.	607138.	100000.	691764.
62.25	25.	593	70.4	-1692.	-26914.	4425.	302964.	100000.	378784.
59.24	25.	594	70.4	-1695.	-36963.	4278.	95408.	100000.	161029.
56.00	25.	595	70.4	-1697.	-47752.	4121.	0.	100000.	54673.
52.76	25.	596	70.4	-1699.	-58516.	3964.	0.	100000.	43749.
49.75	25.	597	70.4	-1701.	-68499.	3819.	0.	100000.	33620.
47.16	25.	598	70.5	-1702.	-77075.	3694.	0.	100000.	24917.
45.17	25.	599	70.5	-1703.	-83659.	3597.	0.	100000.	18236.
43.93	26.	600	70.5	-1703.	-87762.	3537.	0.	100000.	14072.
43.50	26.	601	70.5	-1704.	-89193.	3516.	0.	100000.	12620.
43.93	26.	602	70.5	-1704.	-87791.	3537.	0.	100000.	14042.
45.17	26.	603	70.5	-1705.	-83723.	3596.	0.	100000.	18169.
47.16	26.	604	70.5	-1706.	-77186.	3692.	0.	100000.	24801.
49.75	26.	605	70.5	-1706.	-68673.	3816.	0.	100000.	33437.
52.76	26.	606	70.5	-1708.	-58774.	3961.	0.	100000.	43479.
56.00	26.	607	70.5	-1709.	-48116.	4116.	0.	100000.	54291.

59.24	26.	608	70.5	-1711.	-37458.	4271.	97827.	100000.	162929.
62.25	26.	609	70.6	-1714.	-27562.	4415.	306911.	100000.	382051.
64.84	26.	610	70.6	-1716.	-19059.	4539.	612230.	100000.	695994.
66.83	26.	611	70.6	-1720.	-12548.	4633.	908766.	100000.	999131.
68.07	26.	612	70.6	-1723.	-8531.	4691.	1115368.	100000.	1209805.
68.50	26.	613	70.7	-1726.	-7206.	4711.	1188690.	100000.	1284468.
68.07	26.	614	70.7	-1730.	-8738.	4688.	1115368.	100000.	1209588.
66.83	26.	615	70.7	-1733.	-12956.	4627.	908766.	100000.	998704.
64.84	26.	616	70.8	-1737.	-19655.	4530.	612230.	100000.	695369.
62.25	26.	617	70.8	-1740.	-28330.	4404.	306911.	100000.	381245.
59.24	26.	618	70.8	-1742.	-38377.	4258.	97827.	100000.	161965.
56.00	26.	619	70.8	-1745.	-49163.	4101.	0.	100000.	53193.
52.76	26.	620	70.9	-1747.	-59926.	3944.	0.	100000.	42272.
49.75	26.	621	70.9	-1748.	-69905.	3798.	0.	100000.	32145.
47.16	26.	622	70.9	-1749.	-78480.	3673.	0.	100000.	23444.
45.17	26.	623	70.9	-1750.	-85062.	3577.	0.	100000.	16765.
43.93	27.	624	70.9	-1751.	-89163.	3517.	0.	100000.	12603.
43.50	27.	625	70.9	-1751.	-90592.	3496.	0.	100000.	11153.
43.93	27.	626	70.9	-1752.	-89188.	3517.	0.	100000.	12576.
45.17	27.	627	70.9	-1752.	-85119.	3576.	0.	100000.	16705.
47.16	27.	628	70.9	-1753.	-78581.	3672.	0.	100000.	23338.
49.75	27.	629	70.9	-1754.	-70067.	3796.	0.	100000.	31975.
52.76	27.	630	70.9	-1755.	-60168.	3940.	0.	100000.	42018.
56.00	27.	631	70.9	-1756.	-49509.	4096.	0.	100000.	52830.
59.24	27.	632	71.0	-1758.	-38850.	4251.	100182.	100000.	163825.
62.25	27.	633	71.0	-1761.	-28952.	4395.	310984.	100000.	384666.
64.84	27.	634	71.0	-1763.	-20448.	4518.	617258.	100000.	699565.
66.83	27.	635	71.0	-1766.	-13937.	4613.	914240.	100000.	1003149.
68.07	27.	636	71.1	-1770.	-9919.	4671.	1120969.	100000.	1213952.
68.50	27.	637	71.1	-1773.	-8592.	4691.	1194355.	100000.	1288680.
68.07	27.	638	71.1	-1777.	-10122.	4668.	1120969.	100000.	1213738.
66.83	27.	639	71.1	-1780.	-14338.	4607.	914240.	100000.	1002728.
64.84	27.	640	71.2	-1783.	-21035.	4510.	617258.	100000.	698950.
62.25	27.	641	71.2	-1786.	-29708.	4384.	310984.	100000.	383874.
59.24	27.	642	71.2	-1789.	-39753.	4238.	100182.	100000.	162878.
56.00	27.	643	71.2	-1791.	-50537.	4081.	0.	100000.	51753.
52.76	27.	644	71.3	-1793.	-61297.	3924.	0.	100000.	40834.
49.75	27.	645	71.3	-1795.	-71274.	3778.	0.	100000.	30709.
47.16	27.	646	71.3	-1796.	-79847.	3653.	0.	100000.	22011.
45.17	27.	647	71.3	-1797.	-86426.	3557.	0.	100000.	15334.
43.93	28.	648	71.3	-1797.	-90526.	3497.	0.	100000.	11174.
43.50	28.	649	71.3	-1798.	-91953.	3476.	0.	100000.	9726.
43.93	28.	650	71.3	-1798.	-90548.	3497.	0.	100000.	11151.
45.17	28.	651	71.3	-1798.	-86478.	3556.	0.	100000.	15280.
47.16	28.	652	71.3	-1799.	-79939.	3652.	0.	100000.	21914.
49.75	28.	653	71.3	-1800.	-71423.	3776.	0.	100000.	30553.
52.76	28.	654	71.3	-1801.	-61523.	3921.	0.	100000.	40597.
56.00	28.	655	71.3	-1802.	-50864.	4076.	0.	100000.	51410.
59.24	28.	656	71.4	-1804.	-40204.	4231.	102664.	100000.	164887.
62.25	28.	657	71.4	-1807.	-30306.	4375.	314994.	100000.	387257.
64.84	28.	658	71.4	-1809.	-21801.	4499.	622350.	100000.	703239.
66.83	28.	659	71.4	-1812.	-15289.	4593.	919777.	100000.	1007270.
68.07	28.	660	71.5	-1815.	-11269.	4652.	1126633.	100000.	1218201.
68.50	28.	661	71.5	-1819.	-9941.	4671.	1200083.	100000.	1292994.
68.07	28.	662	71.5	-1822.	-11469.	4649.	1126633.	100000.	1217991.
66.83	28.	663	71.6	-1826.	-15683.	4588.	919777.	100000.	1006856.
64.84	28.	664	71.6	-1829.	-22378.	4490.	622350.	100000.	702634.
62.25	28.	665	71.6	-1832.	-31049.	4365.	314994.	100000.	386478.
59.24	28.	666	71.6	-1834.	-41092.	4218.	102664.	100000.	163956.
56.00	28.	667	71.7	-1837.	-51874.	4061.	0.	100000.	50351.
52.76	28.	668	71.7	-1838.	-62631.	3905.	0.	100000.	39435.

49.75	28.	669	71.7	-1840.	-72607.	3759.	0.	100000.	29312.
47.16	28.	670	71.7	-1841.	-81177.	3634.	0.	100000.	20616.
45.17	28.	671	71.7	-1842.	-87755.	3538.	0.	100000.	13941.
43.93	29.	672	71.7	-1842.	-91852.	3478.	0.	100000.	9783.
43.50	29.	673	71.7	-1843.	-93278.	3457.	0.	100000.	8336.
43.93	29.	674	71.7	-1843.	-91872.	3478.	0.	100000.	9763.
45.17	29.	675	71.7	-1843.	-87800.	3537.	0.	100000.	13894.
47.16	29.	676	71.7	-1844.	-81260.	3633.	0.	100000.	20529.
49.75	29.	677	71.7	-1845.	-72744.	3757.	0.	100000.	29169.
52.76	29.	678	71.7	-1846.	-62843.	3902.	0.	100000.	39213.
56.00	29.	679	71.7	-1847.	-52183.	4057.	0.	100000.	50027.
59.24	29.	680	71.8	-1849.	-41522.	4212.	105083.	100000.	165924.
62.25	29.	681	71.8	-1851.	-31623.	4356.	319067.	100000.	389950.
64.84	29.	682	71.8	-1854.	-23117.	4480.	627442.	100000.	706951.
66.83	29.	683	71.8	-1857.	-16603.	4574.	925187.	100000.	1011302.
68.07	29.	684	71.9	-1860.	-12582.	4633.	1132234.	100000.	1222425.
68.50	29.	685	71.9	-1863.	-11253.	4652.	1205684.	100000.	1297220.
68.07	29.	686	71.9	-1867.	-12780.	4630.	1132234.	100000.	1222218.
66.83	29.	687	71.9	-1870.	-16993.	4569.	925187.	100000.	1010894.
64.84	29.	688	72.0	-1873.	-23685.	4472.	627442.	100000.	706355.
62.25	29.	689	72.0	-1876.	-32354.	4346.	319067.	100000.	389183.
59.24	29.	690	72.0	-1878.	-42394.	4200.	105083.	100000.	165009.
56.00	29.	691	72.0	-1881.	-53174.	4043.	0.	100000.	48988.
52.76	29.	692	72.1	-1882.	-63930.	3886.	0.	100000.	38074.
49.75	29.	693	72.1	-1884.	-73903.	3740.	0.	100000.	27953.
47.16	29.	694	72.1	-1885.	-82471.	3615.	0.	100000.	19259.
45.17	29.	695	72.1	-1886.	-89047.	3519.	0.	100000.	12586.
43.93	30.	696	72.1	-1886.	-93143.	3459.	0.	100000.	8430.
43.50	30.	697	72.1	-1886.	-94567.	3438.	0.	100000.	6985.
43.93	30.	698	72.1	-1887.	-93159.	3459.	0.	100000.	8413.
45.17	30.	699	72.1	-1887.	-89086.	3518.	0.	100000.	12545.
47.16	30.	700	72.1	-1887.	-82545.	3614.	0.	100000.	19182.
49.75	30.	701	72.1	-1888.	-74028.	3738.	0.	100000.	27822.
52.76	30.	702	72.1	-1889.	-64126.	3883.	0.	100000.	37868.
56.00	30.	703	72.1	-1891.	-53465.	4038.	0.	100000.	48683.
59.24	30.	704	72.1	-1892.	-42804.	4194.	107565.	100000.	167063.
62.25	30.	705	72.2	-1895.	-32904.	4338.	323141.	100000.	392680.
64.84	30.	706	72.2	-1897.	-24397.	4461.	632534.	100000.	710701.
66.83	30.	707	72.2	-1900.	-17882.	4556.	930661.	100000.	1015435.
68.07	30.	708	72.2	-1903.	-13860.	4614.	1137835.	100000.	1226686.
68.50	30.	709	72.3	-1906.	-12530.	4633.	1211349.	100000.	1301546.
68.07	30.	710	72.3	-1910.	-14055.	4611.	1137835.	100000.	1226482.
66.83	30.	711	72.3	-1913.	-18266.	4550.	930661.	100000.	1015033.
64.84	30.	712	72.4	-1916.	-24957.	4453.	632534.	100000.	710114.
62.25	30.	713	72.4	-1919.	-33623.	4327.	323141.	100000.	391926.
59.24	30.	714	72.4	-1921.	-43662.	4181.	107565.	100000.	166163.
56.00	30.	715	72.4	-1924.	-54439.	4024.	0.	100000.	47661.
52.76	30.	716	72.4	-1925.	-65193.	3867.	0.	100000.	36749.
49.75	30.	717	72.5	-1927.	-75164.	3722.	0.	100000.	26631.
47.16	30.	718	72.5	-1928.	-83730.	3597.	0.	100000.	17939.
45.17	30.	719	72.5	-1928.	-90304.	3501.	0.	100000.	11268.
43.93	31.	720	72.5	-1929.	-94398.	3441.	0.	100000.	7114.
43.50	31.	721	72.5	-1929.	-95821.	3420.	0.	100000.	5670.
43.93	31.	722	72.5	-1929.	-94412.	3441.	0.	100000.	7099.
45.17	31.	723	72.5	-1929.	-90338.	3500.	0.	100000.	11233.
47.16	31.	724	72.5	-1930.	-83795.	3596.	0.	100000.	17871.
49.75	31.	725	72.5	-1930.	-75278.	3720.	0.	100000.	26512.
52.76	31.	726	72.5	-1931.	-65375.	3865.	0.	100000.	36558.
56.00	31.	727	72.5	-1933.	-54713.	4020.	0.	100000.	47375.
59.24	31.	728	72.5	-1935.	-44051.	4175.	109984.	100000.	168174.
62.25	31.	729	72.5	-1937.	-34150.	4320.	327278.	100000.	395511.

64.84	31.	730	72.6	-1939.	-25642.	4443.	637626.	100000.	714487.
66.83	31.	731	72.6	-1942.	-19127.	4538.	936135.	100000.	1019604.
68.07	31.	732	72.6	-1945.	-15103.	4596.	1143373.	100000.	1230920.
68.50	31.	733	72.6	-1948.	-13772.	4615.	1216950.	100000.	1305845.
68.07	31.	734	72.7	-1952.	-15295.	4593.	1143373.	100000.	1230719.
66.83	31.	735	72.7	-1955.	-19505.	4532.	936135.	100000.	1019208.
64.84	31.	736	72.7	-1958.	-26194.	4435.	637626.	100000.	713909.
62.25	31.	737	72.8	-1961.	-34858.	4309.	327278.	100000.	394768.
59.24	31.	738	72.8	-1963.	-44895.	4163.	109984.	100000.	167289.
56.00	31.	739	72.8	-1965.	-55670.	4006.	0.	100000.	46371.
52.76	31.	740	72.8	-1967.	-66422.	3850.	0.	100000.	35461.
49.75	31.	741	72.8	-1968.	-76391.	3704.	0.	100000.	25345.
47.16	31.	742	72.8	-1969.	-84955.	3579.	0.	100000.	16655.
45.17	31.	743	72.8	-1970.	-91527.	3483.	0.	100000.	9986.
43.93	32.	744	72.8	-1970.	-95620.	3423.	0.	100000.	5833.
43.50	32.	745	72.8	-1970.	-97041.	3402.	0.	100000.	4391.
43.93	32.	746	72.8	-1971.	-95631.	3423.	0.	100000.	5821.
45.17	32.	747	72.8	-1971.	-91556.	3482.	0.	100000.	9956.
47.16	32.	748	72.8	-1971.	-85012.	3578.	0.	100000.	16595.
49.75	32.	749	72.9	-1972.	-76493.	3703.	0.	100000.	25237.
52.76	32.	750	72.9	-1973.	-66590.	3847.	0.	100000.	35285.
56.00	32.	751	72.9	-1974.	-55927.	4003.	0.	100000.	46101.
59.24	32.	752	72.9	-1976.	-45264.	4158.	112530.	100000.	169448.
62.25	32.	753	72.9	-1978.	-35363.	4302.	331415.	100000.	398377.
64.84	32.	754	72.9	-1980.	-26854.	4426.	642654.	100000.	718245.
66.83	32.	755	73.0	-1983.	-20338.	4520.	941545.	100000.	1023744.
68.07	32.	756	73.0	-1986.	-16313.	4579.	1148910.	100000.	1235190.
68.50	32.	757	73.0	-1989.	-14980.	4598.	1222487.	100000.	1310116.
68.07	32.	758	73.0	-1992.	-16502.	4576.	1148910.	100000.	1234991.
66.83	32.	759	73.1	-1996.	-20710.	4515.	941545.	100000.	1023354.
64.84	32.	760	73.1	-1999.	-27397.	4418.	642654.	100000.	717676.
62.25	32.	761	73.1	-2001.	-36060.	4292.	331415.	100000.	397646.
59.24	32.	762	73.1	-2004.	-46095.	4146.	112530.	100000.	168577.
56.00	32.	763	73.2	-2006.	-56868.	3989.	0.	100000.	45115.
52.76	32.	764	73.2	-2008.	-67618.	3832.	0.	100000.	34207.
49.75	32.	765	73.2	-2009.	-77585.	3687.	0.	100000.	24093.
47.16	32.	766	73.2	-2010.	-86147.	3562.	0.	100000.	15405.
45.17	32.	767	73.2	-2010.	-92718.	3466.	0.	100000.	8737.
43.93	33.	768	73.2	-2011.	-96809.	3406.	0.	100000.	4586.
43.50	33.	769	73.2	-2011.	-98229.	3385.	0.	100000.	3146.
43.93	33.	770	73.2	-2011.	-96817.	3406.	0.	100000.	4577.
45.17	33.	771	73.2	-2011.	-92741.	3465.	0.	100000.	8713.
47.16	33.	772	73.2	-2011.	-86197.	3561.	0.	100000.	15353.
49.75	33.	773	73.2	-2012.	-77677.	3685.	0.	100000.	23996.
52.76	33.	774	73.2	-2013.	-67773.	3830.	0.	100000.	34044.
56.00	33.	775	73.2	-2014.	-57110.	3985.	0.	100000.	44862.
59.24	33.	776	73.2	-2016.	-46446.	4141.	115012.	100000.	170691.
62.25	33.	777	73.3	-2018.	-36544.	4285.	335552.	100000.	401275.
64.84	33.	778	73.3	-2020.	-28035.	4408.	647746.	100000.	722099.
66.83	33.	779	73.3	-2023.	-21517.	4503.	946955.	100000.	1027918.
68.07	33.	780	73.3	-2026.	-17492.	4562.	1154447.	100000.	1239492.
68.50	33.	781	73.4	-2029.	-16157.	4581.	1228025.	100000.	1314420.
68.07	33.	782	73.4	-2032.	-17678.	4559.	1154447.	100000.	1239296.
66.83	33.	783	73.4	-2035.	-21884.	4498.	946955.	100000.	1027534.
64.84	33.	784	73.4	-2038.	-28569.	4401.	647746.	100000.	721539.
62.25	33.	785	73.5	-2041.	-37230.	4275.	335552.	100000.	400556.
59.24	33.	786	73.5	-2043.	-47263.	4129.	115012.	100000.	169834.
56.00	33.	787	73.5	-2045.	-58035.	3972.	0.	100000.	43892.
52.76	33.	788	73.5	-2047.	-68782.	3815.	0.	100000.	32986.
49.75	33.	789	73.5	-2048.	-78747.	3670.	0.	100000.	22874.
47.16	33.	790	73.5	-2049.	-87308.	3545.	0.	100000.	14188.

45.17	33.	791	73.5	-2050.	-93877.	3449.	0.	100000.	7522.
43.93	34.	792	73.5	-2050.	-97966.	3389.	0.	100000.	3373.
43.50	34.	793	73.6	-2050.	-99385.	3368.	0.	100000.	1934.
43.93	34.	794	73.6	-2050.	-97972.	3389.	0.	100000.	3367.
45.17	34.	795	73.6	-2050.	-93894.	3448.	0.	100000.	7504.
47.16	34.	796	73.6	-2050.	-87349.	3544.	0.	100000.	14145.
49.75	34.	797	73.6	-2051.	-78828.	3669.	0.	100000.	22789.
52.76	34.	798	73.6	-2052.	-68924.	3813.	0.	100000.	32838.
56.00	34.	799	73.6	-2053.	-58259.	3969.	0.	100000.	43656.
59.24	34.	800	73.6	-2055.	-47595.	4124.	117558.	100000.	172032.
62.25	34.	801	73.6	-2057.	-37692.	4268.	339689.	100000.	404209.
64.84	34.	802	73.6	-2059.	-29182.	4392.	652838.	100000.	725989.
66.83	34.	803	73.7	-2062.	-22663.	4486.	952301.	100000.	1032063.
68.07	34.	804	73.7	-2065.	-18637.	4545.	1159921.	100000.	1243765.
68.50	34.	805	73.7	-2068.	-17301.	4564.	1233498.	100000.	1318694.
68.07	34.	806	73.7	-2071.	-18820.	4542.	1159921.	100000.	1243572.
66.83	34.	807	73.8	-2074.	-23025.	4481.	952301.	100000.	1031684.
64.84	34.	808	73.8	-2077.	-29709.	4384.	652838.	100000.	725436.
62.25	34.	809	73.8	-2079.	-38368.	4258.	339689.	100000.	403500.
59.24	34.	810	73.8	-2082.	-48399.	4112.	117558.	100000.	171189.
56.00	34.	811	73.9	-2084.	-59169.	3955.	0.	100000.	42703.
52.76	34.	812	73.9	-2085.	-69914.	3799.	0.	100000.	31799.
49.75	34.	813	73.9	-2087.	-79878.	3653.	0.	100000.	21689.
47.16	34.	814	73.9	-2087.	-88437.	3528.	0.	100000.	13004.
45.17	34.	815	73.9	-2088.	-95004.	3432.	0.	100000.	6341.
43.93	35.	816	73.9	-2088.	-99092.	3372.	0.	100000.	2193.
43.50	35.	817	73.9	-2088.	-100509.	3352.	0.	100000.	755.
43.93	35.	818	73.9	-2088.	-99095.	3372.	0.	100000.	2189.
45.17	35.	819	73.9	-2088.	-95016.	3432.	0.	100000.	6328.
47.16	35.	820	73.9	-2088.	-88470.	3528.	0.	100000.	12969.
49.75	35.	821	73.9	-2089.	-79949.	3652.	0.	100000.	21614.
52.76	35.	822	73.9	-2090.	-70043.	3797.	0.	100000.	31664.
56.00	35.	823	73.9	-2091.	-59379.	3952.	0.	100000.	42483.
59.24	35.	824	73.9	-2092.	-48714.	4108.	120104.	100000.	173405.
62.25	35.	825	73.9	-2094.	-38810.	4252.	343826.	100000.	407174.
64.84	35.	826	74.0	-2097.	-30299.	4376.	657866.	100000.	729846.
66.83	35.	827	74.0	-2099.	-23780.	4470.	957648.	100000.	1036239.
68.07	35.	828	74.0	-2102.	-19752.	4529.	1165331.	100000.	1248006.
68.50	35.	829	74.0	-2105.	-18415.	4548.	1238972.	100000.	1322999.
68.07	35.	830	74.1	-2108.	-19933.	4526.	1165331.	100000.	1247816.
66.83	35.	831	74.1	-2111.	-24136.	4465.	957648.	100000.	1035865.
64.84	35.	832	74.1	-2114.	-30819.	4368.	657866.	100000.	729301.
62.25	35.	833	74.1	-2117.	-39476.	4242.	343826.	100000.	406476.
59.24	35.	834	74.2	-2119.	-49505.	4096.	120104.	100000.	172575.
56.00	35.	835	74.2	-2121.	-60273.	3939.	0.	100000.	41545.
52.76	35.	836	74.2	-2123.	-71017.	3783.	0.	100000.	30643.
49.75	35.	837	74.2	-2124.	-80978.	3637.	0.	100000.	20535.
47.16	35.	838	74.2	-2125.	-89536.	3512.	0.	100000.	11852.
45.17	35.	839	74.2	-2125.	-96101.	3416.	0.	100000.	5190.
43.93	36.	840	74.2	-2125.	-100188.	3357.	0.	100000.	1044.
43.50	36.	841	74.2	-2125.	-101604.	3336.	0.	100000.	-393.
43.93	36.	842	74.2	-2125.	-100189.	3357.	0.	100000.	1043.
45.17	36.	843	74.2	-2125.	-96109.	3416.	0.	100000.	5182.
47.16	36.	844	74.2	-2126.	-89562.	3512.	0.	100000.	11824.
49.75	36.	845	74.2	-2126.	-81040.	3636.	0.	100000.	20471.
52.76	36.	846	74.2	-2127.	-71134.	3781.	0.	100000.	30521.
56.00	36.	847	74.2	-2128.	-60468.	3937.	0.	100000.	41341.
59.24	36.	848	74.3	-2129.	-49803.	4092.	122650.	100000.	174810.
62.25	36.	849	74.3	-2131.	-39898.	4236.	348027.	100000.	410234.
64.84	36.	850	74.3	-2134.	-31387.	4360.	662894.	100000.	733734.
66.83	36.	851	74.3	-2136.	-24866.	4455.	962994.	100000.	1040446.