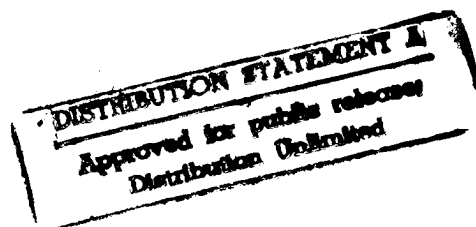
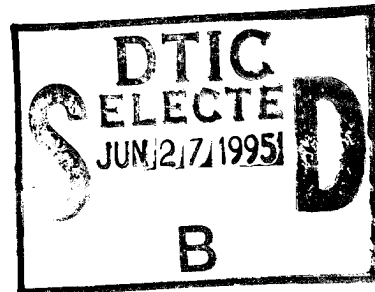


Thermal Design of an Antarctic Water Well

Virgil J. Lunardini and John Rand

March 1995

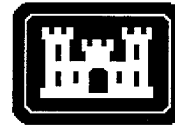


Abstract

The thermal and mechanical aspects of a potable water reservoir, formed at depth in a permanent snowfield in Antarctica, are detailed. The thermal model can be used for preliminary design, to predict reservoir size and depth, water temperature and mass, and energy requirements as a function of time. Predictions are made for the South Pole environment, but the model is valid for other permanent snowfields. The reservoir characteristics are influenced by the rate and timing of potable water removal during the lifetime of the reservoir.

For conversion of SI metric units to U.S./British customary units of measurement consult ASTM Standard E380-89a, *Standard Practice for Use of the International System of Units*, published by the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

Special Report 95-10



**U.S. Army Corps
of Engineers**
Cold Regions Research &
Engineering Laboratory

Thermal Design of an Antarctic Water Well

Virgil J. Lunardini and John Rand

March 1995

19950623 046

Prepared for
OFFICE OF THE CHIEF OF ENGINEERS

Approved for public release; distribution is unlimited.

DTIC QUALITY INSPECTED 5

PREFACE

This report was prepared by Virgil J. Lunardini, Mechanical Engineer, of the Applied Research Division, and John Rand, Mechanical Engineer, of the Programs and Resources Directorate, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL).

The manuscript was technically reviewed by Paul Richmond and Donald Haynes of USA CRREL.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.

Accession For		☒
NTIS GRA&I		☐
DTIC TAB		☐
Unannounced		
Justification		
By		
Distribution/		
Availability Codes		
Avail and/or		
Special		
Dist	A-1	

CONTENTS

	Page
Preface	ii
Nomenclature	v
Introduction	1
Physical and mathematical model of Rodriguez water well	3
Ice melt rate	3
Water mass balance	4
Water level	5
Water, air, and firn temperatures	6
Heat loss from water to firn/ice	7
Firn percolation	7
Ice melt coefficients	8
Computer program	8
Modelling results	8
Thermal design of South Pole Station new water well	9
Literature cited	13
Appendix A: Computer program for thermal design of Rodriguez water well	17
Appendix B: Old South Pole data	27
Appendix C: Requirements and numerical predictions for Rodriguez well at South Pole Station	33
Appendix D: Requirements and numerical predictions, South Pole Station water well, constant heat input rates	53
Abstract	71

ILLUSTRATIONS

Figure	
1. Camp Century water well equipment	2
2. Section of the pilot water well at Camp Century after the first test season	2
3. Section of the Camp Century water well after two seasons of operation	2
4. Second service well at Camp Century after two years of operation ...	3
5. Water-supply ice well, Camp Tuto, Greenland	4
6. 1972 development well at Old South Pole Station	5
7. Paraboloid geometry	5
8. Water well geometry	5

TABLES

	Page
Table	
1. Data and predictions of the transient behavior of South Pole Station water well	8
2. Performance of South Pole Station water well after 1704 hours	9
3. South Pole water well, base case A5	10
4. South Pole water well, potable water withdrawal 150%; base case A1	11
5. Constant heat input cases	12
6. Model predictions for Table 5 cases	13
7. South Pole water well predicted transient performance.....	14

NOMENCLATURE

Ab	= area of water/air interface = $\frac{\pi D^2}{4}$
A_i	= area of air/firn interface
A_L	= water percolation parameter
A_s	= surface area of water reservoir in contact with firn
c_p	= specific heat
D	= upper diameter of water volume
E	= energy
h_a, h_i, h_s	= convective coefficient for water/air; air/ice; water/ice
H, HW	= height of water in reservoir
HWB	= depth from firn surface to bottom of reservoir
k	= thermal conductivity
ℓ	= latent heat of fusion
ℓ_e	= effective latent heat of fusion
m	= mass
$\dot{m}_f$	= mass flow rate of water from boiler
$\dot{m}_\ell$	= mass flow rate of water loss to firn by percolation
$\dot{m}_m$	= mass flow rate of meltwater production
$\dot{m}_o$	= mass flow rate of potable water
MV	= volume of water in reservoir
p	= $\frac{\Omega^2 - 1}{2 \ln \Omega} - 1$
$\bar{q}$	= average heat flux from air to firn
q_s	= conduction heat loss from water to ice/firn
r	= radial distance from center of drill hole
r_o	= radius of initial drill hole
R	= radius of water cylinder
t	= time
T	= temperature
T_o	= initial firn temperature
T_s	= temperature of air/firn interface
T_{melt}	= temperature of meltwater
T_{wb}	= temperature of water leaving boiler
T_{ice}	= temperature distribution of firn/ice
V	= reservoir volume
V_a	= volume of air above reservoir
x, y	= Cartesian coordinates
α	= thermal diffusivity
β	= δ / r_o , dimensionless temperature disturbance
γ	= $\Delta D / \Delta H$, rate of change of reservoir diameter with respect to height
δ	= temperature penetration radius in firn/ice
θ	= $T - T_f$
θ_b	= $T_{wb} - T_f$
ρ	= density
ρ_s	= shut-off density of firn
σ	= r / r_o , dimensionless radius
τ	= dimensionless time, $\alpha_i t / r^2$
Ω	= δ / R , dimensionless penetration

Subscripts

a	= air
f	= freeze value
i	= ice/firn
w	= water

Thermal Design of an Antarctic Water Well

VIRGIL J. LUNARDINI AND JOHN RAND

INTRODUCTION

Itinerant travellers, visitors, or permanent inhabitants in areas of permanent snowfields such as Greenland or Antarctica face the same problem as Coleridge's (1798) ancient mariner,

Water, water, everywhere, and all the boards
did shrink;
water, water, everywhere, nor any drop to
drink.

Rather than the salty sea, for the polar denizen it is fresh water that is very abundant, but is in the wrong phase: it exists as either ice or snow. The ice or snow must first be changed to liquid water before it can be used. There are two broad methods by which this is done: gathering snow/ice in surface tanks with subsequent melting, or melting the snow/ice in place and storing it within the cavity so formed in the permanent ice cap. A summary of these methods has already been published by Mellor (1969). This report examines the preliminary engineering design of an in situ water reservoir for the refurbished research facility at the United States South Pole Station.

In situ water reservoirs were first designed and built by USACRREL in the early 1960s for Camp Tuto, Greenland (Schmitt and Rodriguez 1960; Russell 1965). They are commonly referred to as Rodriguez wells. The concept is simple and involves melting firn/ice at depth, thereby creating a reservoir of liquid water that can be pumped to the surface as needed. The insulating properties of firn/ice help to keep the water unfrozen, and the isolation of the water source tends to reduce contamination of the potable supply. Snow or ice is melted and stored in place at some depth below the surface of the ice cap, eliminating the need for mechanical handling of snow and for fabricated storage tanks. A hole is driven down into the snow and vertical advance is maintained until imper-

meable strata are intercepted or until refreezing meltwater forms its own impermeable barrier (Fig. 1). The melt then ponds and, after sufficient reserve capacity has been established in the well, pumping can begin to supply potable water to the surface. The development of the size and shape of the ponding cavity depends on the relative rates of melting and water removal by pumping and upon the rate of heat application to the pool: with a large heat supply and small pumping rate the cavity can grow laterally rapidly, but if the pool is overpumped, the cavity tends to develop rapidly downward due to the high temperature of the reservoir water.

On the ice cap in northern Greenland, initial ponding of the meltwater occurs at depths between 36.5 to 48 m (120 to 150 ft) (Mellor 1969). If heat is supplied to a central point at the base of the shaft, the pool forms a radially symmetric cavity. While the cavity is small, heat losses by conduction through the surrounding ice and by convection to the air above are minor. As the pool grows, the heat losses increase, until finally an equilibrium size may be reached, when all of the heat input is lost by conduction and convection and no new water can be produced unless the rate of heat supply or the pumping rate to storage is increased. Schmitt and Rodriguez (1960, 1963) report observations on cavity development in a well supplied with heat at the rate of 219,825 W (750,000 Btu/h). Figures 2 and 3 give an idea of the size and shape of the well after two years of operation at Camp Century, Greenland. The peculiar shape of the well is largely controlled by the rate of water removal and the rate of energy supplied to the well water. The water production efficiency was estimated at 59 lbm water per lbm of fuel. A shaft was steamed down and ponding developed at 42.5 to 49 m (140–160 ft). A special nozzle bubbled steam through the pool and also held a submersible electric pump that delivered water to the surface at a maximum rate of 1.58 L/s (25 gal/min). The

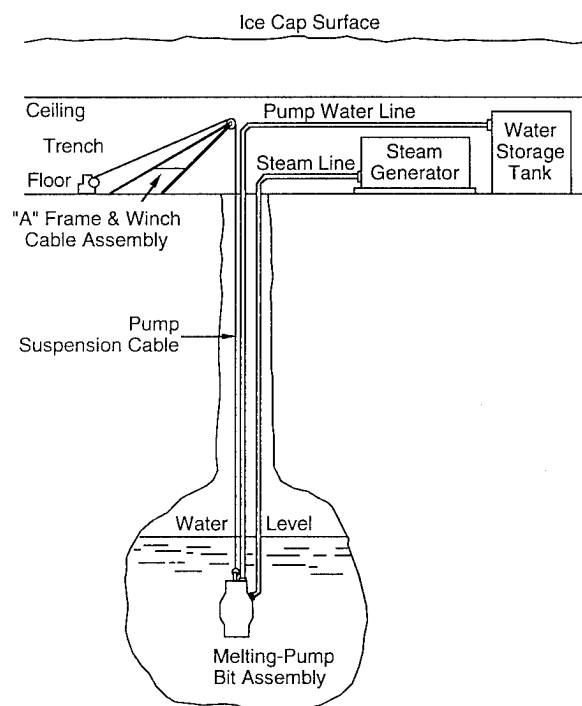


Figure 1. Camp Century water well equipment (from Clark 1965).

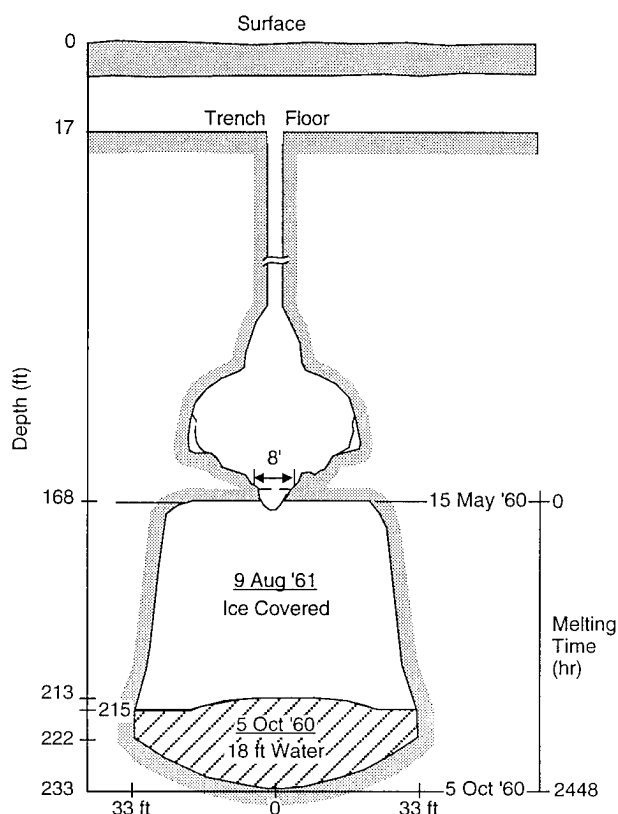


Figure 3. Section of the Camp Century water well after two seasons of operation (Schmitt and Rodriguez 1963).

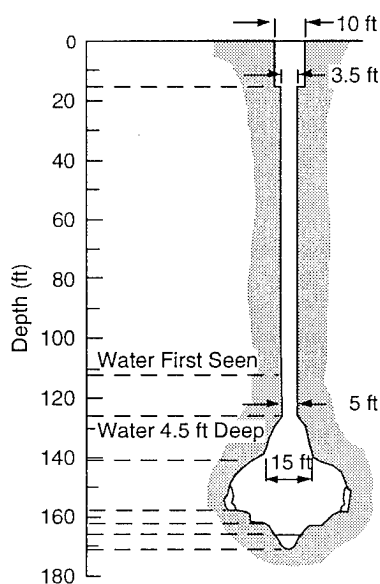


Figure 2. Section of the pilot water well at Camp Century after the first test season (Schmitt and Rodriguez 1963).

delivered water contained no detectable coliform bacteria and was delivered to the surface at an average temperature of 5.6°C (42°F). The steam generator was a coiled water tube, flash-type boiler capable of delivering about 219,825 W (750,000 Btu/h) and burning fuel oil at a maximum rate of 28.5 L (7 gal)/h. It produced 1.138 MPa (165 psig), 189.4°C (373°F) saturated steam at a rate of about 365 kg (800 lb)/h. The submersible pump had a capacity of 6435 L (1700 gal)/h pumping from 60-m (200-ft) depth, and 3860 L (1020 gal)/h from 150-m (500-ft) depth. A second well was also developed at Camp Century, as shown in Figure 4.

Combining observation with analysis of a well in an ice tunnel developed in 1962 at the under-ice camp at Camp Tuto, Greenland, Russell (1965) presented simplified engineering calculations and results for the relatively small heat input rate of approximately 73,275 W (250,000 Btu/h). The transient behavior of the well is shown in Figure 5. During May–June 1962, the well produced 5,315 L (1404 gal)/day of water, with a fuel consumption of 137 kg (302 lbm)/day, while delivering 2006 L (530 gal)/day of potable water. This gives an efficiency of 17.7 (39 lbm) water/lbm fuel.

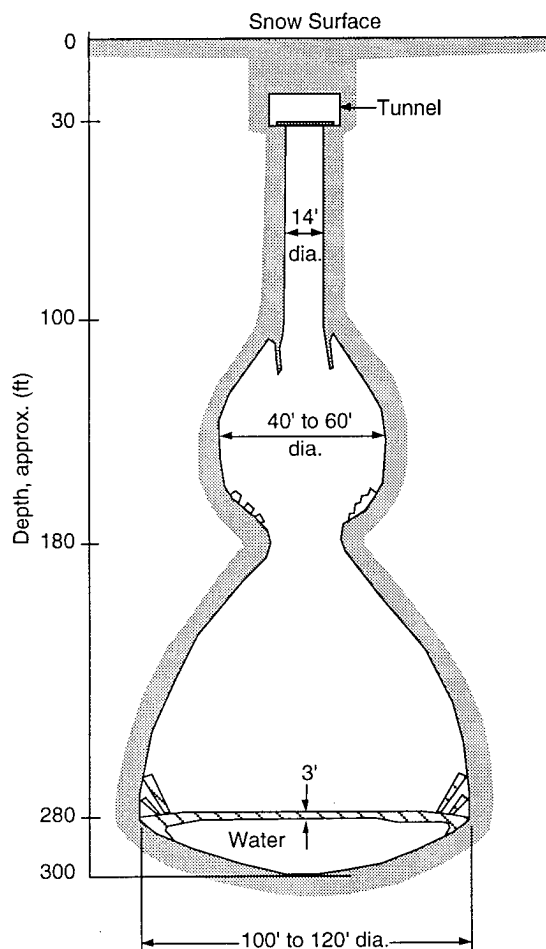


Figure 4. Second service well at Camp Century after two years of operation (from Mellor 1969).

The most recent example of a water well was developed for Old South Pole Station, Antarctica (Williams 1974). The transient behavior of the well geometry is shown in Figure 6. Complete details on the operation of this well are given in the tables of Appendix B. The significant aspect of this well is the ambient firn temperature of -51°C (-60°F), compared to a firn temperature of -28.9°C (-20°F) at Greenland sites. Despite the low temperature, the water well functioned well without significant adverse freezing problems. Its operation was halted due to a frozen fuel line at the surface boiler; the well was then shut down and abandoned after supplying about 416,400 liters (110,000 gallons) of potable water.

Despite the attractiveness of Rodriguez wells and their use over relatively long times, there has been very limited analysis of their thermal behavior. Tien (1960) presented a simplified analysis for spherical systems used as heat sinks but did not

account for the changing firn and air temperatures around the reservoir, nor did he include the effects of water withdrawal. If Rodriguez wells are to be used routinely it will be necessary to predict their thermal performance for use in the preliminary design of the wells. The following sections of this report deal with the preliminary engineering design of such wells.

PHYSICAL AND MATHEMATICAL MODEL OF RODRIGUEZ WATER WELL

The water well data from Greenland and the South Pole support an assumption that the shape of the water volume at any time can be modelled as parabolic (Williams 1974, Russell 1965). Thus, we assume the following geometric relations. Consider the volume of revolution shown in Figure 7, with a diameter D and a height H . The equation defining a parabolic volume is

$$y^2 = \frac{D^2}{4H} x. \quad (1)$$

The meaning of the symbols is given in the nomenclature list. It is easy to determine that the volume and surface area (exclusive of the upper horizontal surface) are

$$V = \frac{\pi}{8} D^2 H \quad \text{and} \quad (2)$$

$$A_s = \frac{2}{3} \pi D H. \quad (3)$$

If the height changes by a small amount, then the diameter will change by a corresponding amount to maintain the geometric relations:

$$\frac{\Delta D}{\Delta H} = \frac{D}{2H}. \quad (4)$$

Let us say that

$$\frac{\Delta D}{\Delta H} = \gamma \quad (5)$$

where γ is a constant that can be adjusted as required. Actually $\gamma = D/2H$ is close to unity for the present system, and a value of $\gamma = 1$ was used in the calculations. This agrees with the Greenland and South Pole data, which indicate that γ is close to unity.

Ice melt rate

The energy available to melt ice is the difference between the energy convected to the ice/water interface and the energy lost by conduction to the

Water Production on a Polar Ice Cap

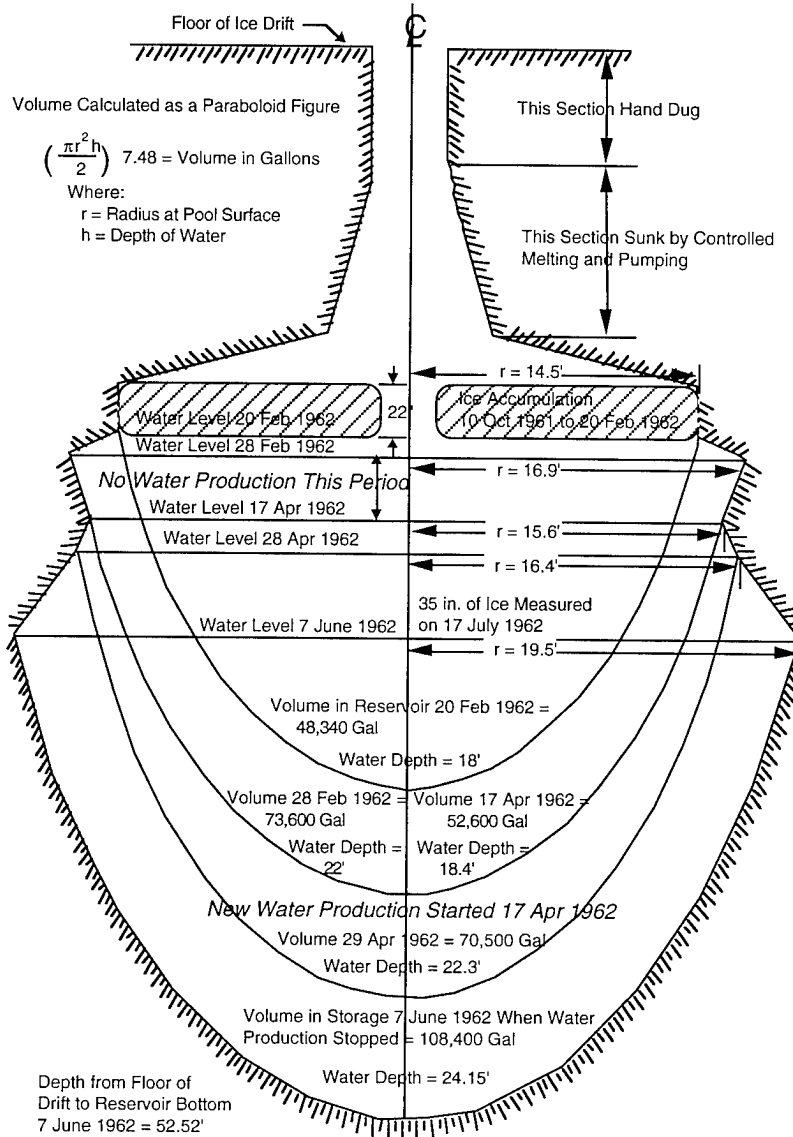


Figure 5. Water-supply ice well, Camp Tuto, Greenland (from Russell 1965).

surrounding firn or ice:

$$[h_s(T_w - T_f) - q_s] A_s \Delta t = \rho_i \ell_e \nabla V. \quad (6)$$

The energy lost to the ice, q_s , can be incorporated into the effective latent heat, ℓ_e , as will be described later (see eq 25). This is a reasonable approximation in view of the moving heat source represented by the sinking water reservoir. Using eq 2 through 6 leads to a relation for the rate of change of the height of the water in the reservoir:

$$\frac{\Delta H}{\Delta t} = \frac{16H[h_s(T_w - T_f) - q_s]}{3(2\gamma H + D)\rho_i \ell_e}. \quad (7)$$

Water mass balance

The amount of water in the reservoir at any time is controlled by the water produced by melt, the water lost to the surrounding firn by percolation, and the water withdrawn for use. The water circulated from the water well to the boiler to increase the water temperature will not affect the reservoir water mass balance. The water mass equation is

$$\frac{\Delta m_w}{\Delta t} = \frac{[h_s(T_w - T_f) - q_s] A_s}{\ell_e} - \dot{m}_o - \dot{m}_\ell \quad (8)$$

where

m_w = mass of water

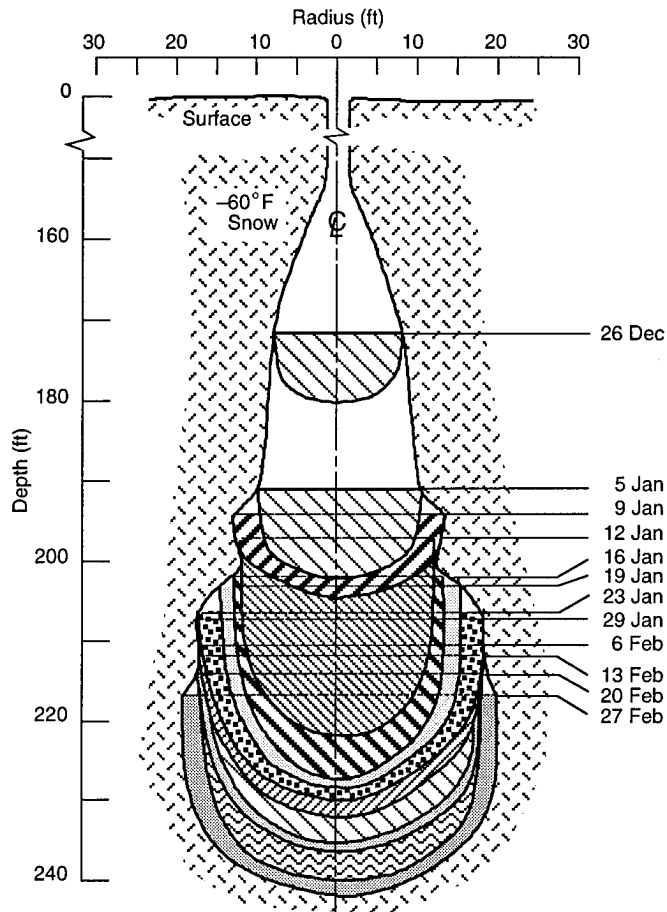


Figure 6. 1972 development well at Old South Pole Station (see Appendix A).

$\dot{m}_O$ = rate of withdrawal of usable water
 $\dot{m}_\ell$ = rate of loss of water due to percolation

Water level

A given volume of firn (or ice), after melt, will produce a different volume of water due to the density difference of firn and water. The new mass of water is calculated from eq 8 and the volume occupied by this water, V_w , can then be evaluated. With the new dimensions H_w , D_w , found by eq 5

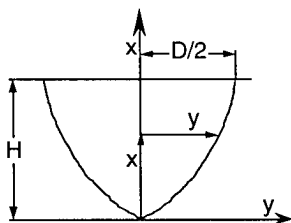


Figure 7. Paraboloid geometry.

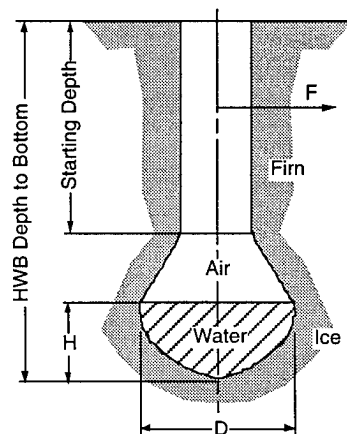


Figure 8. Water well geometry.

and 7, the final values of the height and diameter of the water reservoir are evaluated from the geometrical constraints of eq 1, 2, and 3:

$$H_f = \frac{\sqrt{8V_w H_n / \pi}}{D_n} \quad (9)$$

and

$$D_f = D_n \sqrt{H_f / H_n} \quad (10)$$

Water, air, and firm temperatures

The overall geometry of a well is shown in Figure 8. It is assumed that the water and air temperature vary only with time and not with position. Such a lumped approach is crude but reasonable for a preliminary engineering analysis. The conservation of mass and energy are used for the following derivations. The water temperature is governed by

$$\begin{aligned} -h_a A_b (T_w - T_a) - h_s A_s (T_w - T_f) = \\ \frac{d}{dt} [m_w c_{pw} (T_w - T_f)] + \dot{m}_f c_{pw} (T_w - T_{wb}) \\ + \dot{m}_o c_{pw} (T_w - T_f) - \dot{m}_m c_{pw} (T_{melt} - T_f) \\ - \dot{m}_\ell c_{pw} (T_{melt} - T_f) \end{aligned} \quad (11)$$

Since the meltwater is at the freezing temperature, the enthalpy fluxes associated with the mass fluxes $\dot{m}_m$ and $\dot{m}_\ell$ are zero. Using eq 8, the water temperature is then

$$\begin{aligned} m_w \frac{d\theta_w}{dt} = \dot{m}_f (\theta_b - \theta_w) \\ - h_s A_s \theta_w \left(\frac{1}{c_{pw}} + \frac{\theta_w}{\ell_e} - \frac{q_s}{\ell_e h_s} \right) \\ - \frac{h_a A_b (\theta_w - \theta_a)}{c_{pw}} \end{aligned} \quad (12)$$

where

$$\begin{aligned} \theta &= T - T_f \\ T_{wb} &= \text{boiler water temperature into reservoir} \\ A_b &= \pi D^2/4, \text{ area of water surface exposed to air} \\ T_a &= \text{air temperature above water} \\ h_a &= \text{convective coefficient between water and air.} \end{aligned}$$

The temperature of the air above the water is controlled by the energy flow from the water to the air and from the air to the surrounding firm/ice. The equation is

$$\begin{aligned} \rho_a c_{pa} V_a \frac{dT_a}{dt} = h_a A_b (T_w - T_a) \\ - h_i A_i (T_a - T_s) \end{aligned} \quad (13)$$

where

$$\begin{aligned} V_a &= \text{volume of air above water} \\ \rho_a, c_{pa} &= \text{density and specific heat of air} \\ h_i &= \text{convection coefficient between air and ice} \\ T_s &= \text{surface temperature of firm in contact with air.} \end{aligned}$$

The air density, in units of lbm/ft³, for air temperature °F, is given by the perfect gas equation:

$$\rho_a = \frac{39.685}{(T_a + 460)} \quad (14)$$

The air volume is continually increasing as the reservoir changes its dimensions. The temperature of the surrounding firm can be approximated by assuming that a uniform heat flux is imposed on the firm/air interface. The approximate solution is given by Lunardini (1986):

$$T = T_o + \frac{\bar{q} r_o (\beta - \sigma) \ln(\beta / \sigma)}{k_i (\beta - 1 + \ln \beta)} \quad (15)$$

where

$$\begin{aligned} \beta &= \delta / r_o, \text{ distance penetrated by temperature disturbance} \\ \sigma &= r / r_o \\ r_o &= \text{initial radius of air region (drill hole)} \\ k_i, \alpha_i &= \text{thermal conductivity and diffusivity of firm} \\ \bar{q} &= [k_i (T_a - T_s)]_{\text{avg}} = \text{temporal average value of heat flow from air to ice} \\ T_o &= \text{initial firm temperature.} \end{aligned}$$

The thermal penetration and the firm/air interface temperature are

$$\tau = \alpha_i \frac{t}{r_o^2} = \frac{\frac{5}{36} \beta^3 - \frac{1}{4} \beta + \frac{1}{9} + \left(\frac{1}{3} - \frac{\beta}{2} \right) \ln \beta}{\beta - 1 + \ln \beta} \quad (16)$$

and

$$T_s(t) = T_o + \frac{\bar{q} r_o (\beta - 1) \ln \beta}{k_i (\beta - 1 + \ln \beta)} \quad (17)$$

The overall radius of the air in contact with firm/ice increases with time, but this has been ignored. A correction could be made, altering r_o after each time step, with

$$r_o = \frac{A_i}{2\pi(HWB - H)} \quad (18)$$

where HWB is the depth to the bottom of the reservoir.

The firn thermal properties were assumed to be those of ice: $k_i = 7.27 \text{ W/m}^2 \text{ } ^\circ\text{C}$ (1.28 Btu/h-ft- $^\circ\text{F}$), $\alpha_i = 41.4 \text{ cm}^2$ (0.0446 ft 2)/h.

Heat loss from water to firn/ice

The energy delivered by convection to the ice is used to melt ice and to warm ice from the initial temperature T_o . The heat loss to warm the ice is quite difficult to calculate, but a simple quasi-steady approximation can be found (Lunardini 1991). Consider a cylinder of water of height H that melts the surrounding firn. The quasi-steady temperature in the ice (firn) is

$$T_{ice} = T_o + (T_f - T_o) \frac{\ln r / \delta}{\ln R / \delta} \quad (19)$$

where R is the instantaneous radius of the water cylinder and δ is the radius of the temperature disturbance. At any time the energy added to the ice to raise the firn temperature from T_o to T_{ice} is

$$E_T = \int_R^\delta 2\pi c_{pi} \rho_i H r (T_{ice} - T_o) dr \quad (20)$$

or

$$E_T = 2\pi \rho_i c_{pi} \frac{H(T_f - T_o)}{\ln \Omega} \frac{R^2}{2} p \quad (21)$$

$$p = \frac{\Omega^2 - 1}{2 \ln \Omega} - 1. \quad (22)$$

The ratio of the temperature disturbance to the thaw radius $\Omega = \delta/R$ can be approximated by a constant value of 4.5 (Lunardini 1991). The melt relation is

$$h_s(T_w - T_f)A = \rho_i \ell \frac{dV}{dt} + A \rho_i c_{pi} p (T_f - T_o) \frac{dR}{dt} \quad (23)$$

or

$$h_s(T_w - T_f) = \rho_i \ell \dot{R} + \rho_i c_{pi} (T_f - T_o) \dot{R} p. \quad (24)$$

This equation can be written as

$$h_s(T_w - T_f) = \rho_i \ell_e \frac{dR}{dt} \quad (25)$$

with the effective latent heat given by

$$\ell_e = \ell + c_{pi} p (T_f - T_o). \quad (26)$$

Thus, the equivalent latent heat to use in eq 6

incorporates the sensible heat loss to the surrounding firn. When ℓ_e is used, then q_s is zero since it is incorporated into the effective latent heat. Such an analysis is approximate and does not adequately handle the long-term equilibrium relation for the reservoir, but this will have little effect on the well design. The analysis also gives the conduction heat loss to the firn:

$$q_s = \rho_i c_{pi} (T_f - T_o) p \frac{dR}{dt} = \frac{(T_f - T_o)}{R \ln \Omega}. \quad (27)$$

Firn density

The variation of firn density with depth is based upon the measurements at the South Pole (Langway 1975). Curves were fitted as follows for density in gram/cc and z in meters:

$$\rho_i = 0.349 + 7.56 \times 10^{-3} z - 3.08 \times 10^{-5} z^2 \quad 0 < z < 97.5 \text{ m} \quad (28a)$$

$$\rho_i = 2.102 \times 10^{-3} z + 0.5885 \quad 97.5 < z < 158.5 \text{ m} \quad (28b)$$

$$\rho_i = 0.922 \quad z > 158.5 \text{ m} \quad (28c)$$

For density in lbm/ft 3 and vertical depth in feet:

$$\rho_i = 21.79 + 0.144 z - 0.17894 \times 10^{-4} z^2 \quad 0 < z < 320 \text{ ft} \quad (29a)$$

$$\rho_i = 0.04 z + 36.74 \quad 320 < z < 520 \text{ ft} \quad (29b)$$

$$\rho_i = 57.54 \quad z > 520 \text{ ft} \quad (29c)$$

The close-off density starts at about 0.72 g/cm 3 (45 lbm/ft 3) and is complete at 0.83 g/cm 3 (Langway 1975). The density of 0.72 g/cm 3 occurs at a depth of about 68 m (223 ft) and was used for all calculations. Below the shut-off density depth it is assumed that water will not percolate into the surrounding firn or ice. The ice reaches a maximum density of 0.922 g/cm 3 (57.54 lbm/ft 3) at a depth of 158.5 m (520 ft).

Firn percolation

It is well known that water will percolate into firn as long as the firn density is less than a shut-off value, noted as ρ_s . The rate of water percolation is assumed to be proportional to the difference between the firn density and the shut-off density, and the area of water in contact with the firn:

$$\dot{m}_\ell = A_s(\rho_s - \rho_i)A_L \quad (30)$$

where A_s is the area of the water volume in contact with the firn and ρ_i is the firn density. The parameter A_L depends upon the permeability of the firn and was deduced from the data available from the South Pole water well recorded in Appendix B.

Ice melt coefficients

Convective heat transfer coefficients between melting ice and water have been measured under certain conditions. Lunardini et al. (1986) found that the minimum coefficient for water flowing over a horizontal ice sheet was $h = 136.2 \text{ W/m}^2 \text{ }^\circ\text{C}$ (24 Btu/h-ft²-°F). This occurred when the mean water velocity was close to zero. Vanier (1967) and Tkachev (1953) measured coefficients for laminar flow near vertical ice surfaces, with bulk water temperatures from 0.5 to 4°C (33 to 39.2°F) and found h values from 125 to 175 W/m² °C (22 to 31 Btu/h-ft²-°F). Thus, it can be expected that minimum melt coefficients will be greater than about 136 W/m² °C (24 Btu/h-ft²-°F). Melt coefficients of 136 to 184.5 W/m² °C (24 to 32.5 Btu/h-ft²-°F) were used for most numerical calculations.

COMPUTER PROGRAM

The equations and concepts described in this section were incorporated into a numerical model to predict the transient behavior of a Rodriguez well. An explicit procedure was used for the time steps, and a 30-s time increment found to be sufficiently accurate. The complete program is listed in Appendix A.

Modelling results

Appendix B includes tables of the performance data actually recorded in 1972–73 at the U.S. South Pole Station. These data are plotted as Figure 6. Using the data of Williams (1974) (Table B2) and taking account of the firn density, volume of firn melted, and the water removed, it was possible to estimate the water lost due to percolation or re-freeze during 1704 h of operation, at depths from 45 to 74 m (150–242 ft). The volume of lost water was 188,267 L (49,735 gal).

The numerical model was tested and its parameters adjusted to predict the actual data as nearly as possible (see Table 1). The actual water withdrawal was quite complex, and the model assumed average daily withdrawal rates over various time periods. It was then possible to estimate the percolation coefficient by matching the model output to the transient South Pole data (see numerical output for 1711 h of operation listed in Appendix B). This gave a value of $A_L = 0.3$ for a predicted percolation loss of 173,600 L (45,859 gal).

The transient behavior of the development well was predicted by withdrawing water in a temporal fashion that reasonably closely matched the actual schedule. The results are compared in Tables 1 and 2. The agreement between the model and the data was excellent but, of course, this was enhanced by adjusting the model parameters, especially leakage coefficient A_L . The model is not particularly sensitive to the values of the convection coefficients. Since the model was able to predict the actual performance quite well, there is

Table 1. Data and predictions of the transient behavior of South Pole Station water well.

Date	Hours from start of water withdrawal	Reservoir diameter (ft)		Reservoir depth (ft)	
		Data	Model	Data	Model
26 Dec 1972	264	16.5	18.5	180.0	194.1
08 Jan 1973	576	26.0	24.0	202.8	210.0
20 Jan 1973	864	29.5	28.2	228.3	220.5
28 Jan 1973	1056	36.0	30.8	232.0	226.1
06 Feb 1973	1272	33.3	33.4	235.0	231.3
27 Feb 1973	1704	39.0	38.1	241.5	239.8

Model parameters: $h_s = 184 \text{ W/m}^2 \text{ }^\circ\text{C}$ (32.5 Btu/h-ft²-°F), TWB = 39.4°C (103°F), $A_L = 0.3$.

See Appendix B for complete numerical results.

Table 2. Performance of South Pole Station water well after 1704 hours.

	<i>South Pole Station water well data¹</i>	<i>Numerical model²</i>
Total energy used $\times 10^9$ Btu	0.73	0.716
Useful water withdrawal, gal	37,836	37,813
Water leakage, gal	49,735	45,859
Final water volume, gal	106,533	106,533
Depth to water bottom, ft	241.5	239.9
Water diameter, ft	39.0	38.1
Water depth, ft	23.9	25.0
Avg. energy input, Btu/hr	428,404	418,374
lbm water/lbm fuel	32.2	32.9
Run time, hr	1704	1712

¹From Williams (1974).

²See Appendix B for complete numerical results.

some confidence in using it for the design of the water well at the new South Pole Station.

Thermal design of South Pole Station new water well

The thermal performance of a Rodriguez water well depends strongly upon the volume and timing of the potable water removal. Hence a given installation can vary markedly with regard to water temperature and reservoir depth even if the energy input does not change significantly. The initial specifications for the new water well are given in Appendix C. They were modified as the analysis developed, but the basic requirements remain as follows:

- Drill initial well hole to about 45-m (150-ft) depth or until water starts to pool.
- Form an initial melt reservoir of approximately 56,781 L (15,000 gal) with no water withdrawal.
- Withdraw 2270 L (600 gal)/day of water during the winter (Feb–Sept) and 7570 L (2000 gal)/day during the summer (Oct–Jan).
- Maintain well for at least 5 years and preferably 10 years with a reservoir bottom depth not to exceed 152.5 m (500 ft).

The base case was finally chosen as follows:

- Start water withdrawal when reservoir reaches 45,525 L (12,000 gal).
- Winter withdrawal of water is 2270 L (600 gal)/day; summer withdrawal is 7570 L (2000 gal)/day.
- Boiler water temperature and flow rates set at 39.4°C (103°F) and 0.63 L/s (10 gal/min).
Constant energy input to water of 58,620–234,480 W (200,000–800,000 Btu/h).

Table 3 shows some of the results for base case A5 for a 10-year period. The complete computer outputs for cases A2 and A5 are in Appendix C. The model predicts that the reservoir depth will be 144 m (473 ft) after 10 years, which is acceptable. No attempt was made to optimize the performance since the energy input was to be obtained from waste heat. The average energy input is 97,309 W (332,000 Btu/h), which is well within the expected available waste heat flux. The effect of various parameters was examined to determine their sensitivity. Varying the convective coefficient from 142–284 W/m² °C (25–50 Btu/h-ft²-°F) caused the final reservoir depth to change from 145.4 to 142.2 m (477–466.5 ft). A coefficient of 184.5 W/m² °C (32.5 Btu/h-ft²-°F) was used for most predictions. This is well within the range to be expected for melting ice, as already noted. Decreasing the program time increment from 30 to 15 seconds changed the final depth by 51.8 cm (1.7 ft) and had little effect on other quantities, hence the runs were made with a 30-s time increment.

Table 4 shows the results for the base case with the water withdrawal increased by 50% (case A2) and the average heat input increased to 142,144 W (485,000 Btu/h) or 146% of the base case. This is a high heat input but within the range of possible waste heat values. The reservoir drops to 149 m (489 ft) after 10 years, which is still good performance.

The results just discussed were all obtained for a fixed outlet boiler water temperature and flow rate. This was in accordance with the initial requirements and assumed adequate energy input is available. However, it was recognized that the available energy might be limited, and in a second scenario the heat input rate was held at fixed values and the boiler water outlet temperature was allowed to fluctuate. It was felt that during the first year of formation and operation it might be necessary to rely on fuel oil with access to a minimum of waste heat. This scenario is detailed in

Table 3. South Pole water well, base case A5. Boiler water temperature = 39.4 °C (103°F); boiler flow rate = 2283 kg (5033 lbm)/h. Convective coefficient = 184.5 W/m² °C (32.5 Btu/h-ft²-°F); water percolation parameter A_L = 0.3.

Year	Time (hr)	TW (F)	MV (gal)	D (ft)	HW (ft)	HWB (ft)	Water top (ft)	Water use (gal/ day)	Fuel (gal/ season)
Startup	0.0	103.0	527	4.2	10.0	167.0	157.0	0	
	235.9	53.5	12,000	17.9	12.8	192.3	179.5	0	507
1	240.0	50.0	12,262	18.0	12.8	192.5	179.7	600	
	6,024.0	33.9	267,300	51.4	34.4	271.9	237.5		13,350
	6,120.0	33.8	266,800	51.4	34.3	272.4	238.1	2000	
	9,000.0	34.3	205,800	49.5	28.6	286.5	257.9		6,712
2	9,144.0	34.3	210,600	49.8	28.8	287.3	258.5	600	
	14,784.0	33.5	417,600	61.3	38.0	309.8	271.8		14,013
	14,856.0	33.4	416,800	61.2	37.9	310.0	272.1	2000	
	17,760.0	33.4	322,300	58.0	32.6	318.4	285.8		6,769
3	17,880.0	33.5	324,800	58.9	32.7	318.8	286.1	600	
	23,544.0	33.2	483,700	65.4	38.6	334.6	296.0		14,062
	23,592.0	33.1	483,300	65.4	38.6	334.7	296.1	2000	
	26,520.0	33.5	368,300	61.5	33.3	341.2	307.9		6,778
4	26,616.0	33.6	369,300	61.5	33.3	341.5	308.2	600	
	32,304.0	33.1	502,000	67.1	38.0	354.9	316.9		14,081
	32,328.0	33.1	502,500	67.1	38.0	354.9	316.9	2000	
	35,280.0	33.4	376,100	62.6	32.7	360.7	328.0		6,788
5	35,352.0	33.5	376,300	62.6	32.7	360.9	328.2	600	
	41,064.0	33.0	494,900	67.5	37.0	373.4	336.4		14,093
	41,232.0	32.9	488,600	67.3	36.8	373.7	336.9	2000	
	44,040.0	33.4	363,700	62.6	31.6	379.0	347.4		6,790
6	44,088.0	33.5	363,200	62.6	31.6	379.1	347.5	600	
	49,824.0	33.1	475,500	67.2	35.9	391.4	355.5		14,091
	49,968.0	32.9	470,100	67.0	35.9	391.6	355.7	2000	
	52,800.0	33.5	342,100	62.0	30.4	396.9	366.5		6,787
7	52,824.0	33.5	341,100	61.9	30.3	397.0	366.7	600	
	58,584.0	33.1	452,000	66.5	34.8	409.5	374.7		14,081
	58,704.0	33.0	447,700	66.4	34.6	409.7	375.1	2000	
	61,560.0	33.6	318,500	60.9	29.2	415.2	386.0		6,781
8	61,728.0	33.7	320,800	61.0	29.3	415.6	386.3	600	
	67,344.0	33.2	429,400	65.7	34.0	428.0	394.0		14,068
	67,440.0	33.0	426,300	65.6	33.8	428.3	394.5	2000	
	70,320.0	33.4	297,200	59.9	28.3	433.9	405.6		6,776
9	70,464.0	33.5	299,200	59.9	28.4	434.3	405.9	600	
	76,104.0	33.2	410,200	64.8	33.3	447.3	414.0		14,056
	76,176.0	33.1	408,400	64.7	33.3	447.4	414.1	2000	
	79,080.0	33.4	279,700	58.8	27.6	453.3	425.7		6775
10	79,200.0	33.5	281,200	58.9	27.7	453.7	426.0	600	
	84,864.0	33.3	395,600	64.0	32.9	467.0	434.1		14,057
	84,912.0	33.2	394,900	64.0	32.8	467.0	434.2	2000	
	87,840.0	33.5	266,500	57.9	27.0	473.2	446.2		6775

Total water withdrawn = 3,924,607 gallons

Total fuel consumed = 208,196 gallons

Table 4. South Pole water well, potable water withdrawal 150%; base case A2. Boiler water temperature = 39.4 °C (103°F); boiler flow rate = 3425 kg (7550 lbm)/h.

Year	Time (hr)	TW (F)	MV (gal)	D (ft)	HW (ft)	HWB (ft)	Water top (ft)	Water use (gal/ day)	Fuel (gal/ season)
1	240	53.3	12,300	18.0	12.8	192.6	179.8	900	
	6,024	34.2	423,100	59.6	40.5	283.0	242.5		19,500
	6,120	34.0	422,700	59.7	40.6	283.9	243.3	3,000	
	9,000	34.5	330,200	57.6	33.9	299.3	265.4		9,533
2	9,144	34.7	337,700	58.0	34.2	300.0	265.8	900	
	14,784	33.4	680,900	71.7	45.2	326.0	280.8		20,660
	14,856	33.3	680,000	71.1	45.1	326.2	281.1	3,000	
	17,760	33.5	541,300	68.4	39.4	335.2	295.8		9,645
3	17,880	33.7	545,300	68.6	39.5	335.7	296.2	900	
	23,544	33.1	821,700	77.5	46.7	353.7	307.0		20,817
	23,592	33.0	821,500	77.5	46.6	353.8	307.2	3,000	
	26,520	33.2	652,500	73.6	41.0	360.6	319.6		9,683
4	26,616	33.3	654,300	73.6	41.1	360.9	319.8	900	
	32,304	32.9	887,000	80.4	46.7	375.7	329.0		20,879
	32,328	32.9	887,900	80.4	46.8	375.7	328.9	3,000	
	35,280	33.1	698,700	76.1	41.1	381.5	340.4		9,701
5	35,352	33.2	699,000	76.1	41.2	381.7	340.5	900	
	41,064	32.9	903,700	81.8	46.0	394.9	348.9		20,906
	41,232	32.7	894,400	81.6	45.8	395.3	349.5	3,000	
	44,040	33.0	703,400	77.0	40.4	400.2	359.8		9,708
6	44,088	33.1	702,600	77.0	40.4	400.3	359.9	900	
	49,824	32.8	890,500	82.1	45.0	412.9	367.9		20,915
	49,968	32.7	882,500	82.0	44.8	413.2	368.4	3,000	
	52,800	33.0	683,400	77.0	39.3	418.0	378.7		9,710
7	52,824	33.0	681,800	77.0	39.2	418.0	378.8	900	
	58,584	32.8	860,800	81.8	43.8	430.4	386.6		20,913
	58,704	32.7	854,400	81.7	43.6	430.5	386.9	3,000	
	61,560	33.0	650,400	76.4	38.0	435.4	397.4		9,708
8	61,728	33.2	653,700	76.5	38.1	435.8	397.7	900	
	67,344	32.9	824,100	81.2	42.6	447.8	405.2		20,905
	67,440	32.8	819,400	81.1	42.5	448.0	405.5	3,000	
	70,320	33.1	612,900	75.4	36.7	452.9	416.2		9,704
9	70,464	33.3	615,300	75.5	36.8	453.3	416.5	900	
	76,104	32.9	786,500	80.3	41.5	465.6	424.1		20,892
	76,176	32.8	783,760	80.2	41.5	465.8	424.3	3,000	
	79,080	33.2	576,100	74.3	35.6	470.8	435.2		9,699
10	79,200	33.3	577,800	74.3	35.6	471.2	435.6	900	
	84,864	32.9	752,000	79.3	40.7	483.8	443.1		20,877
	84,912	32.9	751,000	79.3	40.7	483.9	443.2	3,000	
	86,592	33.0	627,800	75.8	37.2	486.7	449.5		9,693
	87,840	33.3	543,180	73.1	34.7	488.3	454.6		

Total water withdrawn = 5,886,865 gallons.

Total fuel consumed = 304,591 gallons.

Table 5. Constant heat input cases. Model parameters as in Appendix C. Except as noted, starting water depth is 51 m (167 ft).

Case	Initial start				Phase 2 start				First summer				First winter			
	Q^1 (10 ³ Btu/ h)	$\dot{m}_f$ (gal/min)	Time (h)	Water out (gal/day)	Q^1 (10 ³ Btu/ h)	$\dot{m}_f$ (gal/min)	Time (h)	Water out (gal/day)	Q^1 (10 ³ Btu/ h)	$\dot{m}_f$ (gal/min)	Time (h)	Water out (gal/day)	Q^1 (10 ³ Btu/ h)	$\dot{m}_f$ (gal/min)	Time (h)	Water out (gal/day)
Base case, year 1:																
9	400	10	0-168	0	400	15	168-384	1000	400	15	384-1488	1000	200	15	1488-7272	600
10	Same as 9 but uses 300,000 Btu/h in place of 200,000 after first summer.															
11	Same as 9 but 200,000 Btu/h for first winter and 300,000 afterwards.															
12	400	10	0-168	0	800	15	168-384	0	800	15	384-1488	600	200,000 subsequent years			
13	400	10	0-168	0	400	15	168-384	1000	400	15	384-1488	1000	200,000 W after year 1 300,000 S after year 1			
15	400	10	0-168	0	400	15	168-384	1000	400	15	384-1488	1000	250,000 W after year 1 300,000 S after year 1			

¹Nominal value; during water withdrawal the average energy input is less.

Table 6. Model predictions for Table 5 cases.

Case	Reservoir diam D (ft)	Start water height HW (ft)	Ice depth HWB (ft)	Final reservoir			Reservoir volume (gal)	Water delivered (gal)	Total fuel (gal)	Comments
				D	HW	HWB				
9	4.24	10	167	42.3	25.2	269.2	132,140	199,010	12,113	First year okay. Reservoir collapses at 421 days
10	4.24	10	167	45.2	20.5	516.3	122,637	3.59×10 ⁶	164,608	System runs for 10 years.
11	4.24	10	167	43.9	19.8	555.1	111,652	3.59×10 ⁶	160,592	10 years OK.
12	4.24	10	167	42.6	22.8	300.7	121,479 @	16,032 h		Reservoir dry at t = 823 days.
13	4.24	10	167	25.6 38.83	11.3 21.8	815.5 512.0	21,728 96,457	3.59×10 ⁶	128,467	10 yrs OK, but very deep. After 5 years.
Need more than 30,000 during summer										
15				45.5	25.3	664.1		3.73×10 ⁶	154,569	Depth = 493.5 after 6 years.

Appendix D along with complete computer results for cases 9, 10, 12 of Table 5.

Table 5 describes some cases examined, and Tables 6 and 7 denote the intermediate and final results for the reservoir thermal performance. The water well operating under scenario 1 only needed to perform adequately for the first year with a low heat input rate. After the first year it was expected that more waste heat would be available. Case 9, using the minimum energy available, illustrates some important performance characteristics of water wells. The well meets the one-year goal, but the combination of water withdrawal and energy input during the formation stage leads to high reservoir water temperatures and rapid sink rates. This is generally true if the water withdrawal is too rapid. Consequently, the reservoir drops more rapidly than was the case for the Appendix C predictions. For case 9, once a water withdrawal rate of 7570 L (2000 gal)/day was started in the second year, the reservoir sank rapidly and collapsed after 421 days of operation.

For case 10, the energy input was increased to 87,930 W (300,000 Btu/h), and the water well operated for 10 years. The final depth of 157.25 m (516 ft) exceeded the 144-m (473-ft) depth of the earlier case A5, but was still acceptable. Note that extreme depths can be attained if the water withdrawal rate is not matched to a proper energy input rate.

Case 10 is probably a reasonable preliminary design. During the first 62 days, 11,385 L (3008 gal) of fuel oil are consumed (14,233 L [3760 gal] at a boiler efficiency of 80%). After this time the energy is supplied by 87,930 W (300,000 Btu/h) of waste heat from the generators. At the end of 303 days, the reservoir is at 84.4 m (277 ft) and contains 1,018,276 L (269,000 gal) of water, having delivered 757,082 L (200,000 gal) of potable water.

In conclusion, the numerical model, although fairly crude, adequately predicts the performance of an actual antarctic water well and indicates that a Rodriguez water well at South Pole Station can operate for 10 years at a reasonable fuel consumption.

Table 7. South Pole water well predicted transient performance.

Case	Time phase	1000 Btu/h	Energy flow (gal/min)	Duration (h)	Rate water out (gal/day)	Temp. (°F)	Water reservoir Volume (gal)	Diameter (ft)	HW (ft)	HWB (ft)	Fuel (gal)	Water out (gal)	Total water out (gal)	Comments
9	1.0	400.0	10.0	0-168	0	54.5	12,332	17.7	13.4	190.2	488	0		
	2.0	400.0	15.0	168-384	1000	50.8	17,244	21.0	13.3	202.7	584	8,000		
	3.0	400.0	15.0	384-1488	1000	39.5	62,489	32.6	20.1	237.5	3,008	46,010		
	4.0	200.0	15.0	1488-7272	600	33.6	132,140	42.3	25.2	269.2	8,033	145,006		Reservoir collapse
	5.0	200.0	15.0	7272-10104	2000	88.5	1,442							
10	1.0	400.0	10.0	0-168	0	54.5	12,332	17.7	13.4	190.2	489	0		Energy in = 300,000, $t > 1488$ h
	2.0	400.0	15.0	168-384	1000	50.8	17,244	21.0	13.3	202.7	584	8,000		
	3.0	400.0	15.0	384-1488	1000	32.5	62,489	32.6	20.1	237.5	3,008	46,000		
	4.0	300.0	15.0	1488-7272	600	33.5	268,692	52.0	34.0	276.7	12,049	145,006		
	5.0	300.0	15.0	7272-80328	600/2000	34.7	122,637	45.2	20.5	516.3	148,483		3.59×10 ⁶	
11	1.0	400.0	10.0	0-168	0	54.5	12,332	17.7	13.4	190.2	489	0		Energy in = 300,000 $t > 7272$ h
	2.0	400.0	15.0	168-384	1000	50.8	17,244	21.0	13.3	202.7	584	8,000		
	3.0	400.0	15.0	384-1488	1000	32.5	62,489	32.6	20.1	237.5	3,008	46,000		
	4.0	200.0	15.0	1488-7272	600	33.6	132,140	42.3	25.2	269.2	8,033	145,006		
	5.0	300.0	15.0	7272-80328	600/2000	34.9	111,652	43.9	19.8	555.1	148,483		359×10 ⁶	
12	1.0	400.0	10.0	0-168	0	52.3	42,081	27.2	19.5	206.6	1,234	0		
	2.0	800.0	15.0	168-384	0	38.8	200,208	46.2	32.0	242.2	6,137	27,000		
	3.0	800.0	15.0	384-1488	600	33.0	214,266	48.9	30.5	259.0	8,033	144,608		
	4.0	200.0	15.0	1488-7272	600	55.9	5,460							Reservoir collapse
	5.0	200.0	15.0	7272-18504	600/2000									
13	1.0	400.0	10.0	0-168	0	54.5	12,332	17.7	13.4	190.2	488	0		Energy in alternates 200 W, 300 S
	2.0	400.0	15.0	168-384	1000	50.8	17,244	21.0	13.3	202.7	584	8,000		
	3.0	400.0	15.0	384-1488	1000	32.5	62,489	32.6	20.1	237.5	3,008	46,010		Note deep reservoir depth
	4.0	200.0	15.0	1488-7272	600	33.6	132,140	42.3	25.2	269.2	8,033	145,006		
	5.0	200W/300S	15.0	7272-80328	600/2000	44.4	21,728	25.6	11.3	815.5	116,357		3.59×10 ⁶	
15	1.0	400.0	10.0	0-168	0	54.5	12,332	17.7	13.4	190.2	489	0		Good case. Note final depth compared with case 13
	2.0	400.0	15.0	168-384	1000	50.8	17,244	21.0	13.3	202.7	584	8,000		
	3.0	400.0	15.0	384-1488	1000	32.5	62,489	32.6	20.1	237.5	3,008	46,010		
	4.0	200.0	15.0	1488-7272	600	33.6	132,140	42.3	25.2	269.2	8,033	145,006		
	5.0	250W/300S	15.0	7272-86112	600/2000	33.6	153,099	45.5	25.3	664.1	142,459		3.73×10 ⁶	

REFERENCES

- Awano, S. and S. Maita** (1963) Cold and hot water making equipment utilizing the exhaust gas energy of diesel engines coupled with electric generators. In *Symposium on Antarctic Logistics, Boulder, Colorado, 1962*. National Academy of Sciences, National Research Council, p. 254-280.
- Clark, E.F.** (1965) Camp Century—Evolution of concept and history of design, construction and performance. USACRREL Technical Report 174.
- Coleridge, S.T.** (1798) *The Rime of the Ancient Mariner*.
- Hoffmann, C.R. and C.E. Sherwood** (1966) Polar camp improvements—Water system using a hot-water snow melter. U.S. Naval Civil Engineering Laboratory, Technical Report 441.
- Langway, C.C.** (1975) Antarctic ice core studies. *Antarctic Journal*, July/Aug, pp. 152-153.
- Lunardini, V.J.** (1991) *Heat Transfer with Freezing and Thawing*. Amsterdam, New York: Elsevier Scientific Publishing Co., p. 247.
- Lunardini, V.J.** (1986) Condensing steam tunnel heat sinks. USA Cold Regions Research and Engineering Laboratory, Special Report 86-24.
- Lunardini, V.J., J.R. Zisson and Y.-C. Yen** (1986) Experimental determination of heat transfer coefficients in water flow over a horizontal ice sheet. USA Cold Regions Research and Engineering Laboratory, CRREL Report 86-3.
- Mellor, M.** (1969) Utilities on permanent snowfields. USA Cold Regions Research and Engineering Laboratory, Monograph III-A2d.
- Russell, F.L.** (1965) Water production in a polar ice cap by utilization of waste engine heat. USA Cold Regions Research and Engineering Laboratory, Technical Report 168.
- Smith, F.A.** (1963) An economical snow melting and central heat system. In *Symposium on Antarctic Logistics, Boulder, Colorado, 1962*. National Academy of Sciences, National Research Council, p. 210-214.
- Schmitt, R.P. and R. Rodriguez** (1960) Glacier water supply system. *Military Engineer*, 52(349).
- Schmitt, R.P. and R. Rodriguez** (1963) Glacier water supply and sewage disposal systems. In *Symposium on Antarctic Logistics, Boulder, Colorado, 1962*. National Academy of Sciences, National Research Council, p. 329-338.
- Schroeder, J.E.** (1951) Performance tests of an Aeroil portable snow melter at the Arctic Test Station, Point Barrow, Alaska. Port Hueneme, California: U.S. Naval Civil Engineering Research and Evaluation Laboratory.
- Tien, C.** (1960) Analysis of a sub-ice heat sink for cooling power plants. U.S. Army Snow, Ice and Permafrost Research Establishment (SIPRE) Research Report 60. (Available from USA Cold Regions Research and Engineering Laboratory.)
- Tinklepaugh, K.N.** (1953) Mark III Snow Melter. Port Hueneme, California: U.S. Naval Civil Engineering Research and Evaluation Laboratory.
- Tkachev, A.G.** (1953) Experimental investigation of heat exchange in melting. Atomic Energy Commission Translation 3405 (translated from a publication of the State Power Press, Moscow).
- U.S. Army Corps of Engineers, Eastern Ocean District** (1954) Operation and Maintenance Manual for USAF. AC&W Station N-33, New York.
- USAPRDC** (1959) Design and Construction of an Undersnow Camp on the Greenland Ice Cap. Vol. 3. Greenland Ice Cap Research Program. Vicksburg, Mississippi: U.S. Army Corps of Engineers.
- U.S. Navy** (1955) *Arctic Engineering*. Washington, D.C.: Bureau of Yards and Docks.
- Vanier, C.R.** (1967) Free convection melting of ice. Masters Thesis, Syracuse University.
- Williams, J.S.** (1974) Experimental development of potable water supply for new South Pole Station. Technical Note N-1328. Port Hueneme, California: Civil Engineering Laboratory, Naval Construction Battalion Center.

APPENDIX A: COMPUTER PROGRAM FOR THERMAL DESIGN OF RODRIGUEZ WATER WELL

```

C      $DECLARE
C      $DEBUG
Ccc    10 REM ***** DEM1 *****
CCC    REAL AB, AI, AIP, AL, ALPHAI, AS, ASP, B, BO, BP, BZ
CCC    REAL CPA, CPI, CPW, D, DELH, DEPTH, DF, DP, DT
CCC    REAL E, EF, EFI, EI, EIT, EK, EKT, EP, ESR, FB, FBP, FI, GAM
CCC    REAL H, HA, HB, HBN, HF, HI, HP, HS, HSO, HSN, HW, HWB, HWBP, HWP
CCC    REAL KI, LE, MF, MF1, MF2, MFA, MFS, MFW, MGO, MGW, MU, MUD, MUG
CCC    MUG1, MUG2, MUGA, MUGS, MUGW
CCC    REAL MUL, MW, MWG, MWGA, MWO, MWP, PI, PL, PLG, PLP, PLT, PM, PMG, PMP, PMT
CCC    REAL PRW, PRWT, Q, QB, QBC, QBC1, QBC2, QBC3, QBC4, QBC5
CCC    QI, QIT, QITI, QS, QT, QTT
CCC    REAL RA, RHOA, RHOI, RHOIM, RHOIS, RHOW, RO
CCC    REAL TA, TAP, TAU, TAUP, TF, TI, TICE, TIS, TP, TPI, TPIW, TPW, TS, TW, TWB
CCC    REAL TWP, TZ1, TZ2, TZ3, TZ3E, TZ4, TZ5, TZ6, VA, VAP, VW, VWP, ZP, ZPP, ZPS, ZS
      IMPLICIT DOUBLE PRECISION (A-H, K-M, O-Z)
      character PRNTR*12
      integer i, j, n

C
      PRNTR = 'OUTPUT.DAT'
      OPEN(9, FILE=PRNTR, STATUS='NEW')

C
CCC    FORMATION DELT = TZ3
      TZ3 = 168.0
      MGO = 12500.0
CCC    PHASE 1 1ST SUMMER DELT = TZ4+24
      TZ4 = 192.0
      MF1 = 7549.5
      QBC1 = 400000.0
      MUG1 = 1000.0
      TZ3E = 88000.0
CCC    PHASE 2 1ST SUMMER DELT = TZ5
      TZ5 = 1104.0
      MF2 = 7549.5
      MUG2 = 1000.0
      QBC2 = 400000.0
CCC    PHASE 3 1ST WINTER DELT = TZ6
      TZ6 = 5784.0
      QBC3 = 200000.0
CCC    2ND & SUB SUMMERS
      QBC4 = 300000.0
CCC    2ND & SUB WINTERS
      QBC5 = 250000.0

      AL = 0.30
      ALPHAI = .0446
      BO = 1.1
      CPA = .24
      CPI = .5
      CPW = 1.0
      DEPTH = 157.0
      DT = 8.333001E-03
      EIT = 0.0
      E = 0.0
      FI = 0.90
      GAM=1.0
      H = 10.0
      HA = 1.0
      HB = 60.0

```

HI = 1.0
 HS = 32.5
 HBN = 24.0
 HSN = 32.5
 HSO= 32.5
 J=1
 KI = 1.28

 MF = 5033.0
 MU = 0.0
 MUD=7549.5
 MWG=0.0
 MFS=7549.5
 MFW=5033.0
 MUGS=2000.0
 MUGW=600.00
 MGW=1106533.0
 N = 1
 OMEGA = 5.399
 PI = 3.141593
 PL = 0.0
 PM = 0.0
 PLT = 0.0
 PMT = 0.0
 PRWT = 0.0
 QBC=400000.0
 QS=0.0
 QT = 0.0
 QTT = 0.0
 QIT = 0.0
 RA = 1.5
 RHOIS = 45.0
 RHOIM = 57.54
 RHOW = 62.6
 RO = RA

CCC TIME PARAMETERS

TAUP=0.0
 TI = 0.0
 TIS = 0.0
 TP = 24.0
 TPI = 24.0
 CCC TPW = 240.0
 TPIW = 24.0
 TZ1=8760.0
 TZ2=8760.0

CCC TEMPERATURES

TF = 32.0
 TICE = -60.0
 TA = TICE
 TS = TICE
 TWB = 124.0
 TW = TWB

ZS = (.144-SQRT((.144)**2-4.0*(RHOIS-21.79)*.00017894))
 &/(2.0*.00017894)
 CCC

```

D = 2.82843*RO
MFA=MF
MW = PI * RA * RA * H * RHOW
MWO = MW
HWB=DEPTH+H
MWGA = MW / (.134 * RHOW)
LE = 144.0 + CPI * (TF - TICE) * OMEGA
AB = PI * D**2/4.0
HW = H
AS = 2.0*PI*D*H/3.0
VW=PI*D**2*H/8.0
AI = 2.0 * PI * RA * DEPTH
CCC gam=d/(2.0*h)
VA = PI * RA * RA * DEPTH
130 Write(9,3000)
3000 format(1x,'          ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION ')
140 Write(9,3001) TWB
3001 format(1x,' BOILER WATER TEMP  DEG F           = ',F9.2)
150 Write(9,3002) MF
3002 format(1x,' BOILER WATER FLOW RATE  lbm/hr       = ',F9.2)
160 Write(9,3003) HS
3003 format(1x,' CONVECTIVE COEFFICIENT  BTU/HR-FT2-F   = ',F9.2)
Write(9,3013) RA
3013 format(1x,' INITIAL DRILL RADIUS FT           = ',F9.2)
Write(9,3014) DEPTH
3014 format(1x,' DEPTH TO TOP OF WATER AT START  FT     = ',F9.2)
180 Write(9,3005) D
3005 format(1x,' INITIAL PARABOLIC WATER DIAMETER D  FT = ',F9.2)
191 Write(9,3007) HW
3007 format(1x,' INITIAL PARABOLIC WATER HEIGHT HW  FT = ',F9.2)
200 Write(9,3008) TW
3008 format(1x,' INITIAL WATER TEMP TW  DEG F         = ',F9.2)
201 Write(9,3009) TA
3009 format(1x,' INITIAL AIR TEMP TA  DEG F           = ',F9.2)
202 Write(9,3010) TS
3010 format(1x,' INITIAL ICE SURFACE TEMP TS  DEG F    = ',F9.2)
210 Write(9,3011) TICE
3011 format(1x,' AMBIENT ICE TEMP DEG F             = ',F9.2)
220 Write(9,3012) LE
3012 format(1x,' EFFECTIVE LATENT HEAT BTU/LB         = ',F9.2)

221 Write(9,*) 'TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT2,
& AIR VOL VA FT3 '
222 Write(9,*)
252 Write(9,*) '      TIME      TW      TA      TS      MW      D
&      HW      HWB      AI      VA'
253 Write(9,2001) TI, TW, TA, TS, MWGA, D, HW, HWB, AI, VA
3030 format(1x,F8.2, 3F7.2,F9.2,2F6.2,F7.2,2F7.2)
260 DO 1070, I=1,112500000
IF (MWG .GT. MGO) GOTO 1220
IF(TI .GT. TZ3) GOTO 1220
IF (J .EQ. 1 ) GOTO 280
400 IF(TI .LT. TAUP) GOTO 430
MF=MFA
MUG=0.0
MU=0.0
GOTO 280
430 MF=0.0
MUG=MUGA
MU=MUD

```

```

280  ZP = HWB-H/2.0
      IF(ZP .GT. 520.0) GO TO 289
      IF(ZP .GT. 320.0) GO TO 288
      RHOI=21.79 + 0.144*ZP - .00017894*ZP**2
      GO TO 291
288  RHOI = .04*ZP + 36.74
      GO TO 291
289  RHOI = RHOIM
291  DELH= 16.0*H*(HS*(TW-TF)-QS)*DT/(RHOI*LE*3.0*(2.0*GAM*H+D))
      HP = H+DELH
      DP = D+GAM*DELH
      HWBP=HWB+DELH
      ZPS=HWB-ZS
      IF(ZPS .GT. H)GOTO 282
      IF(HWB .GT. ZS)GOTO 281
      ASP=2.0*PI*D*H/3.0
      GO TO 283
281  ZPP=(ZS+HWB-H)/2.0
      ASP=2.0*PI*D*H*(1.0-(ZPS/H)**1.5)/3.0
      RHOI=21.79 + 0.144*ZPP - .00017894*ZPP**2
      GO TO 283
282  ASP=0.0
283  MUL = AL*ASP*(RHOIS - RHOI)
      IF(MF .EQ. 0.0) GOTO 284
      TWB = QBC/(CPW*MF) + TW
284  TWP=TW+(MF*(TWB-TW)-HS*AS*(TW-TF)*(1.0/CPW+(TW-TF)/LE-QS/(LE*HS))-
&HA*AB*(TW-TA)/CPW)*DT/MW
      MWP=MW+(((TW-TF)*HS-QS)*AS/LE-MU-MUL)*DT
      MWG = MWP / (.134 * RHOW)
      VWP = MWP / RHOW
      HF = SQRT(8.0*VWP*HP/PI)/DP
      DF = DP*SQRT(HF/HP)
      HW = HF
      EP = CPW * (TWB - TWP) * MF * DT
      E = E + EP
      PMP = MU*DT
      PM = PM + PMP
      PLP = MUL*DT
      PL = PL + PLP
      AIP = AI+PI*(DP**2-D**2)/4.0 + PI*DP*(HP-HF)
      VAP = VA + PI*(DP**2*HP-DF**2*HF)/8.0
      H = HF
      D = DF
CCC  gam=d/(2.0*h)
      TI = DT + TI
      Q = HI * (TA - TS)
      QI = Q * DT * AI
      QT = QT + Q * DT
      QIT = QIT + QI
      QB = QT / TI
      TAU = ALPHAI * TI / (RO ** 2)
      RHOA = 39.685 / (TA + 460.0)
      TAP = TA+(HA*AB*(TW-TA)+HI*AI*(TS-TA))*DT/(RHOA*VA*CPA)
418  FB=5.0*BO**3.0/36.0-BO/4.0+1.0/9.0+(1.0/3.0-BO/2.0)*LOG(BO)-
&TAU*(BO-1.0+LOG(BO))
      FBP = 5.0*(BO**2)/12.0 - .25-LOG(BO)/2.0+(1.0/3.0-BO/2.0)/BO-TAU*
&(1.0+1.0/BO)
      BP = BO - FB / FBP
      BZ = ABS(BP - BO)
      IF (BZ .lt. .0001) GOTO 425

```

```

BO = BP
GOTO 418
425  B = BP
BO = BP + .1
TS = TICE+QB*RO*(B-1.0)*LOG(B)/(KI*(B-1.0+LOG(B)))
IF (J .EQ. 1) GO TO 1031
IF (TI .gt. TPW) GOTO 1130
1028  IF (TI .gt. TP) GOTO 1131
GO TO 560
1031  IF (TI .gt. TP) GOTO 1128
CCC   IF (TI .gt. 0.0) GOTO 1130
560   continue
HWB = HWBP
TW = TWP
TA = TAP
MW = MWP
AS= 2.0*PI*D*H/3.0
AB = PI*D**2/4.0
AI = AIP
VA = VAP
IF (D .GT. 60.0) GOTO 1010
HS = HSO
GOTO 1040
1010  HS = HSN
CCC   HB = HBN
1040  IF (TW .LT. 32.0001) GOTO 1075
1041  IF (TI .GT. TZ2 ) GOTO 1220
IF (TI .GT. TZ1 ) GOTO 1220

1070  CONTINUE
GOTO 1760
1075  TW=32.0
GO TO 1041
1128  write(9,2001) TI, TWP, TAP, TS, MWG,D,HW,HWPB,AIP,VAP
TP = TP + TPI
TPW = TP
GOTO 560
1130  write(9,2001) TI, TWP, TAP, TS, MWG,D,HW,HWPB,AIP,VAP
2001  format(1x, F8.1, 3F7.2, F9.1, 2F6.2, F7.2, 2F9.2)
TPW = TPW + TPIW
GOTO 1028
1131  TP = TP + TPI
TAUP=TP+MUGA*.134*RHOW/MUD-TPI
GOTO 560
1220  Write(9,2001) TI, TWP, TAP, TS, MWG, D, HW, HWPB, AIP, VAP
2000  format(1x,6F9.2)
1280  Write(9,*)
EI = E- EIT
ESR = EI/(TI-TIS)
EIT = E
PRW = MW-MWO + PM
PRWT = PRWT+PRW
PLT = PLT+PL
PMT = PMT+PM
EKT = PRWT*19500.0/E
EK = PRW * 19500.0 / EI
PMG = PM/(.134*RHOW)
PM = 0.0
PLG = PL/(.134*RHOW)
PL = 0.0

```

```

MWO = MW
EF = E / 140000.0
EFI = EI / 140000.0
QITI = QIT- QTT
QTT = QIT
1340 Write(9,3040) E
3040 format(1x, '    TOTAL ENERGY INPUT  BTU           = ',E15.6)
Write(9,3041) EI
3041 format(1x, '    SEASONAL ENERGY INPUT BTU           = ',E15.6)

Write(9,3051) EFI
3051 format(1x, '    SEASONAL ENERGY INPUT  GAL FUEL       = ',F15.2)
Write(9,3042) ESR
3042 format(1x, '    SEASONAL ENERGY RATE  BTU/HR           = ',F15.2)
1370 Write(9,3050) EF
3050 format(1x, '    TOTAL ENERGY INPUT  GAL FUEL       = ',F15.2)
Write(9,3063) EKT
3063 format(1x, '    AVERAGE LB. WATER PER LB. FUEL       = ',F15.2)
1400 Write(9,3060) EK
3060 format(1x, '    SEASONAL LB. WATER PER LB. FUEL       = ',F15.2)
1401 Write(9,3070) QIT
3070 format(1x, '    ENERGY FROM AIR TO ICE  BTU           = ',E15.6)
Write(9,3071) QITI
3071 format(1x, '    SEASONAL ENERGY LOSS, AIR TO ICE  BTU = ',E15.6)
Write(9,3064) PMT/ (.134*RHOW)
3064 format(1x, '    TOTAL WATER WITHDRAWN  GAL           = ',F15.2)
Write(9,3061) PMG
3061 format(1x, '    SEASONAL WATER WITHDRAWN  GAL       = ',F15.2)
Write(9,3065) PLT/ (.134*RHOW)
3065 format(1x, '    TOTAL WATER LOSS  GAL           = ',F15.2)
Write(9,3062) PLG
3062 format(1x, '    SEASONAL WATER LOSS  GAL           = ',F15.2)

1430 Write(9,*)

```

```

IF (N .eq. 1) GOTO 1490
IF (N .EQ. 2) GOTO 1204
CCCC IF (N .EQ. 2) GOTO 1760
IF (N .EQ. 3) GOTO 1540
CCC ***** END OF YEAR 1 *****

CCC IF (N .EQ. 3) GOTO 1760
IF (N .EQ. 4) GOTO 1520
CCC IF (N .EQ. 4) GOTO 1760
IF (N .EQ. 5) GOTO 1500
CCC IF (N .EQ. 5) GOTO 1760
CCC ***** END OF YEAR 2 *****

CCC IF (N .EQ. 6) GOTO 1760

IF (N .EQ. 6) GOTO 1520
CCC IF (N .EQ. 7) GOTO 1760
IF (N .EQ. 7) GOTO 1500
CCC ***** END OF YEAR 3 *****

IF (N .EQ. 8) GOTO 1520
IF (N .EQ. 9) GOTO 1500
CCC ***** END OF YEAR 4 *****

```

```

        IF (N .EQ. 10) GOTO 1520
        IF (N .EQ. 11) GOTO 1500
CCC ***** END OF YEAR 5 *****

        IF (N .EQ. 12) GOTO 1760
        IF (N .EQ. 12) GOTO 1520

        IF (N .EQ. 13) GOTO 1500
CCC ***** END OF YEAR 6 *****

        IF (N .EQ. 14) GOTO 1520
        IF (N .EQ. 15) GOTO 1500
CCC ***** END OF YEAR 7 *****

        IF (N .EQ. 16) GOTO 1520
        IF (N .EQ. 17) GOTO 1500
CCC ***** END OF YEAR 8 *****

        IF (N .EQ. 18) GOTO 1520
        IF (N .EQ. 19) GOTO 1500
CCC ***** END OF YEAR 9 *****

        IF (N .EQ. 20) GOTO 1520
        IF (N .EQ. 21) GOTO 1500
CCC ***** END OF YEAR 10 *****

        IF (N .EQ. 22) GOTO 1760

1490  MGO = MGW
      MF = MF1
      MUGA = MUG1
      N = N + 1
      J = J+1
      JJ = 1
      MFA=MF
      TIS = TI
      TP=INT(TI/24.0)*24.0+TPI
      TZ1=TP+TZ4
      TZ2=TZ1+TZ5
      TZ3=TZ3E
      QBC = QBC1
      GOTO 1210
1500  MGO=MGW
      MUGA=MUGW
      MFA=MFS
      N=N+1
      MU=MUD
      TZ2=TZ1+2976.0
      TIS = TI
      QBC = QBC5
      GOTO 1553
1520  MGO=MGW
      MUGA=MUGS
      MFA=MFS
      N=N+1
      MU=MUD
      JJ = JJ+1
      TIS=TI

```

```

      TZ1=TZ2+5784.0
      QBC=QBC4
      GOTO 1551
1540  MGO=MGW
      MUGA=MUGW
      MFA=MFS
      N=N+1
      JJ = 1
      MU=MUD
      TIS=TI
      QBC=QBC3
      TZ2=TZ1+2976.0
      GOTO 1550

1204  MGO=MGW
      MF=MF2
      MUGA = MUG2
      N=N+1
      JJ = 1
      MFA=MF
      MU=MUD
      TIS = TI
      TZ1=TZ2+TZ6
      QBC = QBC2
      GOTO 1550
1210  MU=MUD
      TAUP=TP+MUGA*.134*RHOW/MUD-TPI
      TPIW=168.0
1550  Write(9,8000) JJ
8000  format(1x,'                                YEAR ',I3)
      Write(9,6000)
6000  format(1x,'                                STANDBY OR WATER WITHDRAWAL ')
      GO TO 1555
1551  Write(9,8000) JJ
      Write(9,6001)
6001  format(1x,'                                SUMMER WATER WITHDRAWAL ')
      GO TO 1555
1553  Write(9,8000) JJ
      Write(9,6002)
6002  format(1x,'                                WINTER WATER WITHDRAWAL ')
1555  Write(9,*)
1580  Write(9,4010) MFA
4010  format(1x,'BOILER WATER FLOW RATE lbm/hr                        = ',F9.2)
      Write(9,4011) TWB
4011  format(1x,'BOILER WATER TEMPERATURE DEG F                      = ',F9.2)
1610  Write(9,4020) MUGA
4020  format(1x,'WATER WITHDRAWAL GAL/DAY                            = ',F9.2)
      Write(9,4021) MUD/(8.04*RHOW)
4021  format(1x,'WITHDRAWAL FLOW RATE GAL/MIN                        = ',F9.2)
1640  Write(9,4030) HS
4030  format(1x,'CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F        = ',F9.2)
1672  WRITE(9,5050) TI
5050  FORMAT(1X,'START WITHDRAWAL AT HOUR                            = ',F9.2)
      Write(9,*)
      GO TO 400
1760  Write(9,*)
1790  Write(9,4050) E
4050  format(1x,' TOTAL ENERGY INPUT BTU                            = ',E15.6)
1820  Write(9,4060) E / 140000

```

```
4060 format(1x,'    TOTAL ENERGY INPUT  GAL FUEL      = ',F15.2)
1821 Write(9,4070) QIT
4070 format(1x,'    TOTAL ENERGY LOSS AIR TO ICE BTU  = ',E15.6)
1850 END
```

APPENDIX B: OLD SOUTH POLE DATA.
Numerical prediction of Old South Pole Station water well performance.

Table B1. Chronological operating record for South Pole experimental well (Williams 1974).

Date	Time	Water to storage		Drawdown (in.)	Calc. diam (ft)	Water temp		Depth		Fuel consumption (gal/h)
		(gal)	(ft ³)			In (°F)	Out (°F)	To bottom (ft)	Top of water (ft)	
12/24/72	1220	500	67	4	16					
	1845	500	67	4	16	80				
12/25/72	1245	500	67	6	13					
	2136	500	67	3.5	17					
	2218	500	67	4	16					
12/26/72	0001							180	171.5	
	1035	500	67	5.5						
	2230	600	80	Trouble measuring						
12/27/72	1635	795	106	5.5	17	100				
	2200							188.5	180	
12/28/72	0800							189.5		4
	0930	300	40	2	18					
	2010	300	40	1.375	21					
	2200									1.6
12/29/72	1010	500	67	2.25	21.4					2
12/30/72	0930	500	67	3	18.5					
	1300	Shut down to recover pump and remove ice.								
12/31/72										
01/01/73										
01/02/73	1300	Lowered pump and started circulation								
	2000	500	67	1.875	23.3	52				
01/03/73	0930					52	35			
	1040	500	67	2.375	20.7					
	1933	500	67	2.25	21.4					1.1
01/04/73	0830									1.5
	0940	500	67	2.625	19.8					
	1000					62				
	2400	500	67	3.5						
01/05/73	0045	500	67	2.375		82				
	0830					82				2
	1130							202	191	
	1300	Pulled pump to remove ice on bottom 50 ft								
01/07/73	1500	Lowered pump and regained circulation								
	1825	500	67	1.25	28.5			202.5	192	
	2330					116				4.5
01/08/73	0800					117		202.8	192.3	
	0920	500	67							
	1600					82				
	1650	500	67	1.5	26					
01/09/73	0000							204.8	193.7	2.8
	0900					72		205	194.2	2.7
	1018	500	67	1.75	24.2	110				
01/10/73	0000	Using steam to melt sides only								
	0900					80				3.3
	1033	500	67	1.5	26					5.0
	1400		42 s.m. ¹	0.875	27					5.0
01/11/73	0940	750	100	2.625	24			218	196.5	
01/12/73	0100		43					221.6	197.7	
	1214	750	100	Trouble with potentiometer						
	1715	750	100	Trouble with potentiometer						
	2330		40 s.m.	0.75	28.5					
01/13/73	1213		42 s.m.	1.25	22.7					
01/14/73	0130		35 s.m.	0.75	26.6					
	1100									5.0
	1400		37	1.5	19.4			226	199	
	1800	750	100	3.375	21.3	110				
01/15/73	1000	750	100	2.938	23.3	117		225	200	4.0
	1815	750	100	2.375	25.2	118	52 ^a	225.5	201	6.0

Table B1 (Cont'd).

Date	Time	Water to storage (gal) (ft ³)		Drawdown (in.)	Calc. diam. (ft)	Water temp In (°F) Out (°F)		Depth To bottom (ft) Top of water (ft)		Fuel consumption (gal/h)
01/16/73	0800							226.7	201.5	4.3
	1000	500	67	1.5	26.2					
	2300					126	60 ^a	227.3	202.1	
01/17/73	0800							226.1	202.6	4.0
	0930	Raised pump to repair broken hose								
	1730	Back on bottom				104	40	226.3	202.5	
01/18/73	1030					110	45	227.1	202.9	3.5
	1405	750	100	1.75	29.5					
	2300					110	42	228	203.1	
01/19/73	0800					110	42	228	203.2	4.8
	1700							228.1	203.2	
	2400	Added water heater				124	41			4.0
01/20/73	1100									5.0
	1350	750	100	1.75	29.5			228.3	203.9	
	2100					126	43			
01/21/73	0900					128	44			5.4
	1000							228.8	204.3	
	1900									6.3
01/22/73	0830	Disconnected water heater								5.4
	0915	750	100	1.625	30.7	86	42	229.5	205.3	
	1300					82				
	2200					80	38	229.9	205.7	
01/23/73	0830					80	37			2.7
	0935	750	100	1.25	35			230.4	206	
	2200							231.1		2.75
01/24/73	0830					84	36	231.9		3.0
	0930	750	100	1.25	35	60		231.9	206.4	
	2000					62	36	231.8	206.4	2.0
01/25/73	0935	750	100	1.25	35	62	35	231.8	206.6	
	2000					64	35	231.8	206.6	2.0
01/26/73	0940	750	100	1.312	34	64	36	231.8	206.8	
	1100					60	35			
	2100					57	34	231.8	206.8	
01/27/73	0930	750	100	1.375	33	54 ^b	34	231.8	206.9	1.3
	0950					105 ^a	35			
	2100					109	39	231.8	206.9	4.3
01/28/73	1030					110	40	231.9	207	
	1325	750	100	1.125	36					
	2230							232	207.2	4.3
01/29/73	1430	750	100	1.25	35	110	40	232.2	207.8	
01/30/73	0830							233.4	208.1	
	0900					70	40			
02/06/73	1330	1500	200	2.75	33.3	60	36	235	210.7	8 days/
02/07/73	1440	1200	160	2	35	59	35	236.25	212	535 gal
02/13/73	1030	1500	200	2.5	35	88	^d	236.5	212.75	2.8
02/15/73	1810	1500	200	2.5	35	64	34	237	213.5	9 days/
02/20/73	0630	1350	180	2	37	62	34	238	214.5	610 gal
02/24/73	1000	1500	200	2.5	35	72	34	240	216.5	3.1
02/26/73	0900	1500	200	2	39	69	33	241.25	217.25	6 days/
02/27/73	0930	1500	200	2	39	70	34	241.5	217.6	535 gal
03/03/73										3.7

¹Water pumped to snow melter for boiler make-up.

^aHigh temperature caused by short circuiting of water due to broken hose near pump intake.

^b9-psi steam pressure at Aerco Heater.

^c27-psi steam pressure at Aerco Heater.

^dBroken

^eAverage fuel for 2/5/73 to 3/3/73, inclusive = 6360 L (1680 gal)/26 days = 246 L (65 gal)/day.

Table B2. Data from South Pole well (Williams 1974).

Date	Total (h)	Water out (gal)	Total water	D	HW	HWB	TWB	TW
16 Dec 1972	24	0	0	4.24	10	153	80	
24 Dec	216	1500	1500	16				
25 Dec	240	1500	3000	13-16				
26 Dec	264	1100	4100		8.5	180		
27 Dec	288	795	4895	17	8.5	188.5	100	
28 Dec	312	600	5495	18-21		189.5		
29 Dec	336	500	5995	21.4				
30 Dec	360	500	6495	18.5				
02 Jan 1973	432	500	6995	23.3			52	
03 Jan	456	1000	7995	21.4			52	35
04 Jan	480	1000	8995	19.8			62	
05 Jan	504	500	9495		11.0	202	82	
07 Jan	552	500	9995	28.5			116	
08 Jan	576	1000	10995	26.0	10.5	202.8	82-117	
09 Jan	600	500	11495	24.2	10.8	205	110	
10 Jan	624	813	12308	27.0			80	
11 Jan	648	750	13058	24.0	21.5	218		
12 Jan	672	2123	15181	28.5				
13 Jan	696	315	15496	22.7				
14 Jan	720	1290	16786	21.3			110	
15 Jan	744	1500	18286	25.2	24.5	225.5	118	52
16 Jan	768	500	18786	26.2	25.2	227.3	126	60
17 Jan	792	0	18786		23.8	226.3		
18 Jan	816	750	19536	29.5	24.9	228.0	110	42
19 Jan	840						124	41
20 Jan	864	750	20286	29.5	24.4	228.3	126	43
21 Jan	888				24.5	228.8		
22 Jan	912	750	21036	30.7	24.2	229.9	86	42
23 Jan	936	750	21786	35.0	24.4	231.1		
24 Jan	960	750	22536	35.0	25.4	231.8	62-84	36
25 Jan	984	750	23286	35.0	25.2	231.8	63	35
26 Jan	1008	750	24036	34.0	25.0	231.8	57-64	35
27 Jan	1032	750	24786	33.0	25.0	231.8	54-109	34-39
28 Jan	1056	750	25536	36.0	24.8	232.0		
29 Jan	1080	750	26286	35.0	24.4	232.2	160	40
06 Feb	1272	1500	27786	33.3	24.3	235.0	60	36
07 Feb	1296	1200	28986	35.0	24.3	236.3	59	35
13 Feb	1440	1500	30486	35.0	23.75	236.5	88	—
15 Feb	1488	1500	31986	35.0	23.5	237.0	64	34
20 Feb	1584	1350	33336	37.0	23.5	238.0	62	34
24 Feb	1632	1500	34836	35.0	23.5	240.0	72	34
26 Feb	1680	1500	36336	39.0	24.0	241.3	69	33
27 Feb	1704	1500	37836	39.0	23.9	241.5	70	34

ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION

BOILER WATER TEMP DEG F = 103.00
 BOILER WATER FLOW RATE lbm/hr = 7549.50
 CONVECTIVE COEFFICIENT BTU/HR-FT2-F = 32.50
 INITIAL DRILL RADIUS FT = 1.50
 DEPTH TO TOP OF WATER AT START FT = 157.00
 INITIAL PARABOLIC WATER DIAMETER D FT = 4.24
 INITIAL PARABOLIC WATER HEIGHT HW FT = 10.00
 INITIAL WATER TEMP TW DEG F = 103.00
 INITIAL AIR TEMP TA DEG F = -60.00
 INITIAL ICE SURFACE TEMP TS DEG F = -60.00
 AMBIENT ICE TEMP DEG F = -60.00
 EFFECTIVE LATENT HEAT BTU/LB = 392.35
 TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT2, AIR VOL VA FT3

TIME	TW	TA	TS	MW	D	HW	HWB	AI	VA
0.0	103.00	-60.00	-60.00	527.5	4.24	10.00	167.00	1479.69	1109.77
24.0	75.12	-55.02	-58.23	1335.7	7.14	8.93	171.63	1621.59	1253.54
48.0	70.24	-52.20	-56.87	2297.2	9.23	9.19	175.24	1754.02	1430.20
72.0	66.45	-49.82	-55.58	3370.7	10.90	9.67	178.27	1882.94	1634.18
96.0	63.43	-47.79	-54.38	4523.6	12.31	10.19	180.92	2009.18	1860.43
120.0	60.97	-46.06	-53.27	5734.5	13.53	10.70	183.30	2132.96	2104.97
144.0	58.93	-44.56	-52.25	6989.3	14.61	11.18	185.45	2254.37	2364.66
168.0	57.21	-43.25	-51.31	8278.4	15.58	11.64	187.43	2373.47	2637.02
192.0	55.73	-42.08	-50.45	9595.7	16.47	12.07	189.27	2490.34	2920.02
216.0	54.45	-41.05	-49.65	10937.2	17.29	12.49	190.98	2605.08	3212.10
235.9	53.50	-40.27	-49.03	12066.0	17.93	12.81	192.33	2698.67	3460.21

TOTAL ENERGY INPUT BTU = 0.709905E+08
 SEASONAL ENERGY INPUT BTU = 0.709905E+08
 TOTAL ENERGY INPUT GAL FUEL = 507.07
 SEASONAL ENERGY INPUT GAL FUEL = 507.07
 AVERAGE LB. WATER PER LB. FUEL = 26.59
 SEASONAL LB. WATER PER LB. FUEL = 26.59
 ENERGY FROM AIR TO ICE BTU = 0.339972E+07
 SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.339972E+07
 TOTAL WATER WITHDRAWN GAL = 0.00
 SEASONAL WATER WITHDRAWN GAL = 0.00
 TOTAL WATER LOSS GAL = 7848.43
 SEASONAL WATER LOSS GAL = 7848.43

YEAR 1 STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 7549.50
 BOILER WATER TEMPERATURE DEG F = 103.00
 WATER WITHDRAWAL GAL/DAY = 610.00
 WITHDRAWAL FLOW RATE GAL/MIN = 15.00
 CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F = 32.50
 START WITHDRAWAL AT HOUR = 240.00

240.0	53.32	-40.11	-48.91	12299.1	18.05	12.88	192.60	2717.68	3511.67
264.0	52.83	-39.50	-48.26	13029.9	18.54	12.94	194.12	2843.90	3887.23
288.0	52.35	-38.96	-47.68	13794.9	19.00	13.03	195.58	2967.28	4261.22
312.0	51.87	-38.46	-47.16	14593.4	19.46	13.15	197.00	3088.01	4633.82
336.0	51.39	-38.00	-46.68	15424.7	19.91	13.28	198.37	3206.26	5005.15
360.0	50.92	-37.58	-46.24	16288.2	20.34	13.43	199.70	3322.17	5375.26
384.0	50.47	-37.19	-45.83	17175.2	20.77	13.59	200.99	3436.02	5745.06
408.0	50.02	-36.82	-45.45	18093.6	21.19	13.76	202.24	3547.74	6113.58
432.0	49.58	-36.43	-45.09	19043.6	21.60	13.93	203.45	3657.44	6480.89

456.0	49.15	-36.15	-44.76	20032.1	22.00	14.12	204.63	3764.97	6845.84
480.0	48.73	-35.83	-44.44	21051.0	22.40	14.31	205.77	3870.59	7209.41
504.0	48.32	-35.53	-44.14	22100.2	22.79	14.51	206.89	3974.37	7571.53
528.0	47.93	-35.25	-43.86	23179.5	23.18	14.72	207.97	4076.34	7932.11
552.0	47.54	-34.97	-43.59	24288.8	23.57	14.92	209.02	4176.57	8291.04
576.0	47.17	-34.70	-43.32	25428.2	23.95	15.13	210.04	4275.09	8648.22
600.0	46.81	-34.44	-43.07	26589.3	24.32	15.34	211.04	4372.09	9004.48
624.0	46.47	-34.19	-42.83	27780.4	24.69	15.56	212.01	4467.46	9358.74
648.0	46.13	-33.95	-42.60	29002.4	25.05	15.77	212.96	4561.26	9711.01
672.0	45.80	-33.71	-42.38	30262.1	25.41	15.99	213.88	4653.33	10060.08
696.0	45.49	-33.48	-42.16	31552.0	25.77	16.21	214.78	4743.87	10406.90
720.0	45.18	-33.25	-41.95	32872.1	26.13	16.43	215.66	4832.90	10751.35
744.0	44.88	-33.03	-41.74	34222.4	26.48	16.66	216.52	4920.45	11093.34
768.0	44.59	-32.81	-41.54	35603.3	26.83	16.88	217.35	5006.56	11432.77
792.0	44.31	-32.59	-41.35	37006.2	27.17	17.10	218.17	5091.37	11770.45
816.0	44.04	-32.38	-41.16	38440.0	27.51	17.33	218.97	5174.77	12105.35
840.0	43.78	-32.17	-40.97	39905.3	27.85	17.55	219.75	5256.81	12437.46
864.0	43.53	-31.96	-40.79	41409.4	28.19	17.78	220.51	5337.35	12765.58
888.0	43.28	-31.76	-40.61	42944.6	28.53	18.01	221.26	5416.54	13090.66
912.0	43.04	-31.56	-40.44	44511.2	28.86	18.24	221.99	5494.42	13412.60
936.0	42.81	-31.36	-40.27	46109.2	29.19	18.47	222.70	5571.00	13731.33
960.0	42.58	-31.16	-40.10	47734.6	29.52	18.70	223.40	5646.37	14047.33
984.0	42.37	-30.97	-39.93	49374.4	29.84	18.92	224.09	5720.79	14362.21
1008.0	42.16	-30.78	-39.77	51021.7	30.16	19.15	224.76	5794.37	14676.65
1032.0	41.96	-30.59	-39.61	52686.2	30.47	19.37	225.41	5866.98	14989.45
1056.0	41.77	-30.41	-39.45	54369.7	30.78	19.59	226.06	5938.64	15300.53
1080.0	41.58	-30.23	-39.29	56079.2	31.08	19.80	226.69	6009.22	15608.67
1104.0	41.40	-30.05	-39.14	57807.6	31.39	20.02	227.31	6078.86	15914.82
1128.0	41.22	-29.87	-38.99	59554.8	31.69	20.24	227.92	6147.57	16218.92
1152.0	41.05	-29.70	-38.84	61320.8	31.99	20.45	228.51	6215.38	16520.93
1176.0	40.89	-29.52	-38.69	63105.5	32.28	20.67	229.10	6282.29	16820.83
1200.0	40.73	-29.35	-38.55	64908.5	32.57	20.88	229.67	6348.33	17118.60
1224.0	40.58	-29.18	-38.41	66721.2	32.86	21.09	230.24	6413.63	17415.17
1248.0	40.43	-29.02	-38.26	68551.7	33.14	21.30	230.79	6478.09	17709.61
1272.0	40.29	-28.85	-38.12	70400.6	33.42	21.50	231.33	6541.75	18001.99
1296.0	40.15	-28.69	-37.99	72274.1	33.70	21.71	231.87	6604.50	18291.25
1320.0	40.01	-28.53	-37.85	74164.4	33.98	21.92	232.40	6666.47	18578.44
1344.0	39.88	-28.37	-37.71	76070.9	34.26	22.12	232.91	6727.68	18863.59
1368.0	39.75	-28.21	-37.58	77993.1	34.53	22.32	233.42	6788.16	19146.71
1392.0	39.63	-28.05	-37.45	79930.7	34.80	22.52	233.92	6847.91	19427.84
1416.0	39.50	-27.90	-37.32	81883.2	35.06	22.73	234.42	6906.96	19707.02
1440.0	39.39	-27.74	-37.19	83841.7	35.33	22.92	234.90	6965.43	19985.22
1464.0	39.27	-27.59	-37.06	85815.0	35.59	23.12	235.38	7023.25	20261.58
1488.0	39.16	-27.44	-36.93	87809.5	35.85	23.32	235.85	7080.30	20535.07
1512.0	39.06	-27.29	-36.81	89817.1	36.11	23.51	236.31	7136.71	20806.75
1536.0	38.95	-27.14	-36.68	91837.5	36.36	23.70	236.77	7192.51	21076.65
1560.0	38.85	-27.00	-36.56	93870.1	36.61	23.90	237.22	7247.71	21344.81
1584.0	38.75	-26.85	-36.44	95914.5	36.86	24.09	237.66	7302.32	21611.27
1608.0	38.65	-26.71	-36.32	97970.3	37.11	24.28	238.10	7356.36	21876.06
1632.0	38.56	-26.57	-36.20	100028.7	37.35	24.46	238.53	7409.94	22140.17
1656.0	38.47	-26.43	-36.08	102097.6	37.59	24.65	238.95	7462.97	22402.67
1680.0	38.38	-26.29	-35.96	104177.6	37.83	24.83	239.37	7515.49	22663.68
1704.0	38.29	-26.15	-35.85	106275.0	38.07	25.02	239.78	7567.38	22922.15
1711.8	38.10	-26.15	-35.81	106533.6	38.11	25.03	239.92	7589.71	23060.00

TOTAL ENERGY INPUT BTU	=	0.716172E+09
SEASONAL ENERGY INPUT BTU	=	0.645181E+09
TOTAL ENERGY INPUT GAL FUEL	=	5115.51
SEASONAL ENERGY INPUT GAL FUEL	=	4608.44
AVERAGE LB. WATER PER LB. FUEL	=	32.85

SEASONAL LB. WATER PER LB. FUEL	=	33.54
ENERGY FROM AIR TO ICE BTU	=	0.770895E+08
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.736897E+08
TOTAL WATER WITHDRAWN GAL	=	37813.19
SEASONAL WATER WITHDRAWN GAL	=	37813.19
TOTAL WATER LOSS GAL	=	45858.80
SEASONAL WATER LOSS GAL	=	38010.37

TOTAL ENERGY INPUT BTU	=	0.716172E+09
TOTAL ENERGY INPUT GAL FUEL	=	5115.51
TOTAL ENERGY LOSS AIR TO ICE BTU	=	0.770895E+08

APPENDIX C: REQUIREMENTS AND NUMERICAL PREDICTIONS FOR RODRIGUEZ WELL AT SOUTH POLE STATION

Constant Boiler Water Outlet Temperatures

Problem

Need to develop a water supply for South Pole Station.

Given

Water consumption rate

Summer months (Oct–Jan): $75 \text{ L (20 gal)}/\text{day} \times 100 \text{ people} = 7570 \text{ L (2000 gal)}/\text{day}$

Winter months (Feb–Sept): $115 \text{ L (30 gal)}/\text{day} \times 20 \text{ people} = 2270 \text{ L (600 gal)}/\text{day}$

Total annual consumption = $1,464,954 \text{ L (387,000 gal)}$.

Firm-ice transition is at about 115-m (377-ft) depth.

0.72 specific gravity is at about 73-m (240-ft) depth.

The pond should start at this depth or higher (assume 61 m, or 200 ft).

91-m (300-ft) depth temperature = $-51^{\circ}\text{C} (-60^{\circ}\text{F})$.

Refer to monthly temperature data.

Assume

That the desired initial melting rate is $757 \text{ L (200 gal)}/\text{h}$.

That the total volume (about 1 year consumption) of water is developed as soon as possible and then stored at $1.1^{\circ}\text{C} (34^{\circ}\text{F})$ until withdrawn.

That no water is taken from the well until the total annual volume is developed.

That the water collecting in the well will be at 34°F . Initially the return water temperature is higher but as soon as the pool gets large enough, the pool water remains close to 34°F .

That the rate of water circulation up the well and through the heat exchanger and back down is limited to $38\text{--}57 \text{ L (10--15 gal)}/\text{min}$ and flows through 2.54-cm (1-in.) ID flexible hose.

That the maximum water temperature cannot exceed 180°F in the water well loop.

Determine

How long will it take to develop the total volume?

What is the energy budget to develop the well?

Once the well is established, what is the energy requirement to maintain that capacity?

Assume that you want to continue on a daily basis to make an equal amount of water that is consumed for that day (i.e., summer months 2000 gal, winter months 600 gal), how much energy would be required to maintain that production rate while maintaining pool temperature at 34°F ?

Case A5

ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION

BOILER WATER TEMP DEG F = 103.00
 BOILER WATER FLOW RATE lbm/hr = 7549.50
 CONVECTIVE COEFFICIENT BTU/HR-FT²-F = 32.50
 INITIAL DRILL RADIUS FT = 1.50
 DEPTH TO TOP OF WATER AT START FT = 157.00
 INITIAL PARABOLIC WATER DIAMETER D FT = 4.24
 INITIAL PARABOLIC WATER HEIGHT HW FT = 10.00
 INITIAL WATER TEMP TW DEG F = 103.00
 INITIAL AIR TEMP TA DEG F = -60.00
 INITIAL ICE SURFACE TEMP TS DEG F = -60.00
 AMBIENT ICE TEMP DEG F = -60.00
 EFFECTIVE LATENT HEAT BTU/LB = 392.35
 TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT², AIR VOL VA FT³

TIME	TW	TA	TS	MW	D	HW	HWB	AI	VA
0.0	103.00	-60.00	-60.00	527.5	4.24	10.00	167.00	1479.69	1109.77
24.0	75.12	-55.02	-58.23	1335.7	7.14	8.93	171.63	1621.59	1253.54
48.0	70.24	-52.20	-56.87	2297.2	9.23	9.19	175.24	1754.02	1430.20
72.0	66.45	-49.82	-55.58	3370.7	10.90	9.67	178.27	1882.94	1634.18
96.0	63.43	-47.79	-54.38	4523.6	12.31	10.19	180.92	2009.18	1860.43
120.0	60.97	-46.06	-53.27	5734.5	13.53	10.70	183.30	2132.96	2104.97
144.0	58.93	-44.56	-52.25	6989.3	14.61	11.18	185.45	2254.37	2364.66
168.0	57.21	-43.25	-51.31	8278.4	15.58	11.64	187.43	2373.47	2637.02
192.0	55.73	-42.08	-50.45	9595.7	16.47	12.07	189.27	2490.34	2920.02
216.0	54.45	-41.05	-49.65	10937.2	17.29	12.49	190.98	2605.08	3212.10
235.9	53.50	-40.27	-49.03	12066.0	17.93	12.81	192.33	2698.67	3460.21

TOTAL ENERGY INPUT BTU = 0.709905E+08
 SEASONAL ENERGY INPUT BTU = 0.709905E+08
 TOTAL ENERGY INPUT GAL FUEL = 507.07
 SEASONAL ENERGY INPUT GAL FUEL = 507.07
 AVERAGE LB. WATER PER LB. FUEL = 26.59
 SEASONAL LB. WATER PER LB. FUEL = 26.59
 ENERGY FROM AIR TO ICE BTU = 0.339972E+07
 SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.339972E+07
 TOTAL WATER WITHDRAWN GAL = 0.00
 SEASONAL WATER WITHDRAWN GAL = 0.00
 TOTAL WATER LOSS GAL = 7848.43
 SEASONAL WATER LOSS GAL = 7848.43

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 5033.00
 WATER WITHDRAWAL GAL/DAY = 600.00
 WITHDRAWAL FLOW RATE GAL/MIN = 15.00
 CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
 START WITHDRAWAL AT HOUR = 240.00

240.0	50.04	-40.41	-48.92	12262.1	18.04	12.86	192.57	2716.49	3509.28
408.0	47.17	-38.63	-46.13	13728.3	19.50	12.32	200.18	3415.87	5726.77
576.0	45.89	-37.50	-44.68	16436.7	21.04	12.67	206.95	4035.25	7763.57
744.0	44.38	-36.57	-43.67	20208.0	22.64	13.45	212.92	4591.90	9679.01
912.0	42.92	-35.69	-42.84	24978.0	24.29	14.44	218.14	5093.23	11485.42
1080.0	41.60	-34.81	-42.10	30742.6	25.96	15.56	222.71	5543.89	13178.62
1248.0	40.47	-33.93	-41.40	37299.2	27.59	16.72	226.72	5952.08	14777.52
1416.0	39.54	-33.07	-40.73	44452.7	29.15	17.85	230.28	6325.55	16299.62
1584.0	38.75	-32.23	-40.08	52147.4	30.64	18.95	233.45	6668.54	17745.61
1752.0	38.11	-31.42	-39.45	60269.9	32.06	20.01	236.31	6985.81	19125.60

1920.0	37.56	-30.64	-38.84	65705.9	33.39	21.03	235.91	7261.65	20451.15
2028.0	37.10	-29.89	-38.25	77352.9	34.65	21.99	241.29	7559.66	21733.24
2256.0	36.72	-29.19	-37.68	86124.6	35.83	22.90	243.48	7822.88	22981.99
2424.0	36.38	-28.52	-37.13	94944.8	36.94	23.75	245.52	8073.81	24206.41
2592.0	36.10	-27.88	-36.60	103748.2	37.98	24.54	247.41	8314.55	25414.68
2760.0	35.86	-27.29	-36.09	112484.6	38.96	25.29	249.19	8546.81	26613.32
2928.0	35.64	-26.72	-35.61	121142.6	39.88	25.99	250.87	8771.55	27803.95
3096.0	35.45	-26.19	-35.14	129720.8	40.76	26.64	252.45	8989.50	28986.81
3264.0	35.29	-25.69	-34.69	138220.5	41.59	27.27	253.96	9201.26	30162.26
3432.0	35.10	-25.22	-34.27	146641.5	42.38	27.86	255.40	9407.36	31330.54
3600.0	35.00	-24.77	-33.86	154976.3	43.14	28.42	256.77	9608.33	32492.87
3768.0	34.88	-24.34	-33.47	163242.3	43.86	28.95	258.09	9804.39	33647.55
3936.0	34.77	-23.93	-33.09	171431.6	44.56	29.47	259.35	9995.96	34795.77
4104.0	34.67	-23.55	-32.73	179546.7	45.22	29.96	260.56	10183.36	35937.79
4272.0	34.57	-23.18	-32.38	187588.1	45.87	30.43	261.73	10366.85	37073.80
4440.0	34.49	-22.83	-32.05	195556.8	46.48	30.88	262.86	10546.68	38203.98
4608.0	34.41	-22.49	-31.73	203454.1	47.08	31.32	263.95	10723.07	39328.52
4776.0	34.33	-22.17	-31.42	211280.7	47.66	31.74	265.01	10896.20	40447.56
4944.0	34.26	-21.87	-31.13	219038.8	48.22	32.14	266.03	11066.26	41561.33
5112.0	34.20	-21.57	-30.84	226729.0	48.76	32.54	267.02	11233.41	42669.94
5280.0	34.14	-21.29	-30.57	234352.4	49.29	32.92	267.99	11397.81	43773.54
5448.0	34.08	-21.02	-30.30	241910.2	49.80	33.28	268.93	11559.58	44872.26
5616.0	34.03	-20.76	-30.05	249402.8	50.30	33.64	269.84	11718.84	45966.23
5784.0	33.98	-20.51	-29.80	256832.4	50.78	33.99	270.73	11875.72	47055.60
5952.0	33.93	-20.27	-29.56	264199.5	51.25	34.32	271.60	12030.32	48140.47
6024.0	33.91	-20.17	-29.46	267337.6	51.45	34.46	271.96	12095.91	48604.06

TOTAL ENERGY INPUT BTU	=	0.193989E+10
SEASONAL ENERGY INPUT BTU	=	0.186890E+10
TOTAL ENERGY INPUT GAL FUEL	=	13856.35
SEASONAL ENERGY INPUT GAL FUEL	=	13349.28
AVERAGE LB. WATER PER LB. FUEL	=	34.69
SEASONAL LB. WATER PER LB. FUEL	=	35.00
ENERGY FROM AIR TO ICE BTU	=	0.440438E+09
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.437038E+09
TOTAL WATER WITHDRAWN GAL	=	144600.58
SEASONAL WATER WITHDRAWN GAL	=	144600.58
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	31757.48

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	6048.00

6120.0	33.82	-20.14	-29.34	266897.5	51.48	34.36	272.42	12222.69	49763.99
6288.0	33.84	-20.15	-29.13	263275.5	51.40	34.00	273.18	12467.08	52106.66
6456.0	33.87	-20.17	-28.96	259669.2	51.32	33.64	273.96	12711.96	54446.72
6624.0	33.89	-20.20	-28.81	256079.9	51.23	33.29	274.74	12957.35	56784.24
6792.0	33.92	-20.25	-28.67	252498.0	51.14	32.94	275.53	13203.35	59120.13
6960.0	33.94	-20.30	-28.56	248914.3	51.05	32.60	276.32	13450.02	61455.33
7128.0	33.97	-20.37	-28.46	245329.0	50.95	32.25	277.13	13697.39	63789.84
7296.0	33.99	-20.45	-28.38	241757.2	50.84	31.91	277.93	13945.33	66121.68
7464.0	34.02	-20.54	-28.31	238200.0	50.74	31.57	278.75	14193.85	68450.89
7632.0	34.05	-20.64	-28.26	234648.4	50.63	31.24	279.57	14443.06	70778.42
7800.0	34.08	-20.74	-28.22	231094.0	50.51	30.91	280.40	14693.05	73105.23

7948.0	34.11	-20.85	-28.19	227537.1	50.39	30.58	281.23	14943.63	75431.35
8136.0	34.13	-20.97	-28.17	223993.9	50.26	30.25	282.08	15195.29	77754.81
8304.0	34.16	-21.10	-28.16	220465.3	50.13	29.93	282.93	15447.46	80075.68
8472.0	34.20	-21.23	-28.16	216943.0	50.00	29.61	283.79	15700.43	82394.90
8640.0	34.23	-21.36	-28.16	213427.0	49.86	29.29	284.66	15954.24	84712.50
8808.0	34.26	-21.50	-28.18	209901.4	49.72	28.97	285.53	16209.05	87030.45
8976.0	34.29	-21.64	-28.20	206391.2	49.57	28.66	286.42	16464.69	89345.83
9000.0	34.30	-21.66	-28.20	205888.5	49.55	28.62	286.54	16501.31	89676.77

TOTAL ENERGY INPUT BTU	=	0.287958E+10
SEASONAL ENERGY INPUT BTU	=	0.939686E+09
TOTAL ENERGY INPUT GAL FUEL	=	20568.39
SEASONAL ENERGY INPUT GAL FUEL	=	6712.04
AVERAGE LB. WATER PER LB. FUEL	=	33.89
SEASONAL LB. WATER PER LB. FUEL	=	32.23
ENERGY FROM AIR TO ICE BTU	=	0.767215E+09
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.326777E+09
TOTAL WATER WITHDRAWN GAL	=	391203.79
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	9024.00

9144.0	34.36	-21.65	-28.22	210609.4	49.89	28.88	287.36	16651.72	90751.02
9312.0	34.29	-21.61	-28.24	217917.7	50.38	29.30	288.31	16809.50	91792.12
9480.0	34.22	-21.57	-28.25	225145.7	50.86	29.70	289.23	16964.64	92826.47
9648.0	34.15	-21.53	-28.26	232294.6	51.32	30.09	290.13	17117.28	93860.19
9816.0	34.09	-21.49	-28.26	239365.1	51.77	30.47	291.00	17267.52	94887.38
9984.0	34.04	-21.44	-28.26	246359.5	52.21	30.84	291.85	17415.49	95910.13
10152.0	33.99	-21.39	-28.26	253278.6	52.64	31.19	292.67	17561.28	96928.68
10320.0	33.94	-21.34	-28.25	260123.5	53.05	31.53	293.48	17704.97	97942.98
10488.0	33.89	-21.29	-28.23	266895.6	53.46	31.87	294.26	17846.67	98953.18
10656.0	33.84	-21.24	-28.22	273595.4	53.85	32.19	295.03	17986.45	99959.36
10824.0	33.80	-21.19	-28.20	280216.9	54.24	32.50	295.78	18124.45	100962.62
10992.0	33.76	-21.14	-28.18	286777.5	54.61	32.81	296.52	18260.62	101961.09
11160.0	33.72	-21.09	-28.16	293269.9	54.98	33.10	297.24	18395.08	102955.82
11328.0	33.69	-21.03	-28.14	299695.3	55.34	33.39	297.94	18527.90	103946.89
11496.0	33.65	-20.98	-28.11	306054.7	55.69	33.67	298.63	18659.14	104934.39
11664.0	33.62	-20.92	-28.08	312348.8	56.03	33.95	299.30	18788.85	105918.37
11832.0	33.59	-20.87	-28.05	318579.6	56.37	34.21	299.96	18917.09	106898.95
12000.0	33.56	-20.81	-28.02	324747.7	56.70	34.47	300.61	19043.90	107876.18
12168.0	33.53	-20.76	-27.99	330854.1	57.02	34.72	301.25	19169.34	108850.12
12336.0	33.50	-20.70	-27.96	336899.7	57.33	34.97	301.88	19293.44	109820.84
12504.0	33.47	-20.65	-27.92	342885.0	57.64	35.21	302.49	19416.25	110788.40
12672.0	33.45	-20.59	-27.89	348812.0	57.95	35.45	303.09	19537.82	111752.89
12840.0	33.42	-20.54	-27.85	354681.1	58.24	35.68	303.69	19658.17	112714.35
13008.0	33.40	-20.48	-27.82	360493.2	58.53	35.90	304.27	19777.34	113672.84
13176.0	33.38	-20.43	-27.78	366249.1	58.82	36.12	304.84	19895.38	114628.42
13344.0	33.35	-20.37	-27.74	371949.3	59.10	36.34	305.41	20012.30	115581.13
13512.0	33.33	-20.32	-27.70	377595.5	59.37	36.55	305.96	20128.15	116531.05
13680.0	33.31	-20.27	-27.66	383188.1	59.64	36.76	306.51	20242.95	117478.22
13848.0	33.29	-20.21	-27.62	388727.8	59.91	36.96	307.05	20356.73	118422.68

14016.0	33.62	-20.12	-27.56	393608.5	60.15	37.14	307.56	20466.38	119348.58
14184.0	33.60	-20.06	-27.54	399106.6	60.40	37.33	308.07	20577.18	120282.41
14352.0	33.58	-20.01	-27.50	404356.2	60.65	37.51	308.58	20687.20	121215.06
14520.0	33.56	-19.96	-27.45	409567.1	60.89	37.69	309.08	20796.28	122144.36
14688.0	33.54	-19.91	-27.41	414731.5	61.13	37.87	309.58	20904.50	123071.29
14764.0	33.53	-19.88	-27.39	417661.7	61.27	37.97	309.86	20965.96	123599.92

TOTAL ENERGY INPUT BTU	=	0.484144E+10
SEASONAL ENERGY INPUT BTU	=	0.196186E+10
TOTAL ENERGY INPUT GAL FUEL	=	34581.72
SEASONAL ENERGY INPUT GAL FUEL	=	14013.32
AVERAGE LB. WATER PER LB. FUEL	=	32.24
SEASONAL LB. WATER PER LB. FUEL	=	29.83
ENERGY FROM AIR TO ICE BTU	=	0.154814E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.780929E+09
TOTAL WATER WITHDRAWN GAL	=	537206.81
SEASONAL WATER WITHDRAWN GAL	=	146003.02
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	14808.00

14856.0	33.43	-19.90	-27.37	416826.0	61.25	37.91	310.06	21034.81	124363.24
15024.0	33.43	-19.96	-27.33	411053.1	61.08	37.59	310.49	21220.05	124558.36
15192.0	33.45	-20.02	-27.30	405297.4	60.91	37.28	310.93	21405.89	124752.17
15360.0	33.47	-20.08	-27.27	399569.6	60.73	36.97	311.37	21592.55	124946.37
15528.0	33.50	-20.15	-27.24	393861.6	60.55	36.65	311.82	21780.09	125141.92
15696.0	33.52	-20.22	-27.22	388182.0	60.37	36.34	312.27	21968.48	125337.86
15864.0	33.54	-20.30	-27.21	382530.2	60.19	36.03	312.73	22157.71	125534.20
16032.0	33.40	-20.39	-27.20	377082.5	60.01	35.73	313.20	22349.05	125736.33
16200.0	33.26	-20.48	-27.19	371767.2	59.84	35.43	313.69	22542.02	125942.79
16368.0	33.28	-20.57	-27.19	366324.7	59.65	35.13	314.17	22734.78	126144.94
16536.0	33.30	-20.65	-27.18	360902.5	59.47	34.82	314.66	22928.49	126348.44
16704.0	33.31	-20.74	-27.19	355517.0	59.28	34.52	315.16	23123.04	126551.30
16872.0	33.33	-20.82	-27.19	350168.7	59.09	34.22	315.66	23318.44	126753.55
17040.0	33.36	-20.91	-27.20	344849.2	58.90	33.92	316.16	23514.78	126956.15
17208.0	33.38	-21.01	-27.21	339558.5	58.70	33.62	316.68	23712.05	127159.08
17376.0	33.40	-21.10	-27.23	334280.6	58.51	33.32	317.19	23910.42	127364.33
17544.0	33.42	-21.20	-27.25	329040.1	58.31	33.03	317.72	24109.70	127568.94
17712.0	33.44	-21.30	-27.27	323837.7	58.11	32.73	318.25	24309.91	127772.94
17760.0	33.45	-21.32	-27.27	322349.5	58.05	32.64	318.41	24367.35	1278403.55

TOTAL ENERGY INPUT BTU	=	0.578922E+10
SEASONAL ENERGY INPUT BTU	=	0.947776E+09
TOTAL ENERGY INPUT GAL FUEL	=	41351.54
SEASONAL ENERGY INPUT GAL FUEL	=	6769.83
AVERAGE LB. WATER PER LB. FUEL	=	31.24
SEASONAL LB. WATER PER LB. FUEL	=	26.11
ENERGY FROM AIR TO ICE BTU	=	0.199679E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.448646E+09
TOTAL WATER WITHDRAWN GAL	=	783802.51
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	39605.91

SEASONAL WATER LOSS GAL = 0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 5033.00
WATER WITHDRAWAL GAL/DAY = 600.00
WITHDRAWAL FLOW RATE GAL/MIN = 15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
START WITHDRAWAL AT HOUR = 17784.00

17980.0	33.53	-21.33	-27.29	324805.3	58.18	32.74	318.82	24463.72	163249.27
18048.0	33.50	-21.32	-27.31	330481.9	58.47	32.99	319.42	24582.13	164179.96
18216.0	33.48	-21.31	-27.33	336098.1	58.75	33.23	320.01	24699.35	165107.83
18384.0	33.45	-21.31	-27.34	341653.7	59.02	33.47	320.58	24815.41	166032.88
18552.0	33.43	-21.30	-27.36	347150.4	59.29	33.69	321.15	24930.35	166955.20
18720.0	33.40	-21.29	-27.37	352588.7	59.56	33.92	321.70	25044.19	167874.83
18888.0	33.38	-21.28	-27.38	357969.3	59.82	34.14	322.25	25156.97	168791.81
19056.0	33.64	-21.24	-27.39	363015.0	60.06	34.34	322.77	25266.56	169695.93
19224.0	33.70	-21.22	-27.40	368066.3	60.30	34.54	323.29	25375.67	170599.79
19392.0	33.68	-21.21	-27.41	373141.5	60.54	34.74	323.81	25484.43	171504.06
19560.0	33.65	-21.20	-27.42	378165.8	60.77	34.94	324.31	25592.29	172406.01
19728.0	33.63	-21.19	-27.42	383139.4	61.01	35.13	324.81	25699.26	173305.64
19896.0	33.60	-21.17	-27.43	388062.9	61.23	35.31	325.31	25805.37	174203.00
20064.0	33.58	-21.16	-27.43	392936.9	61.46	35.50	325.79	25910.62	175098.13
20232.0	33.56	-21.15	-27.43	397761.6	61.68	35.68	326.27	26015.05	175991.03
20400.0	33.54	-21.14	-27.43	402538.6	61.89	35.85	326.75	26118.68	176881.78
20568.0	33.52	-21.12	-27.43	407267.9	62.11	36.03	327.21	26221.53	177770.39
20736.0	33.50	-21.11	-27.44	411950.2	62.32	36.20	327.68	26323.60	178656.90
20904.0	33.48	-21.09	-27.43	416586.0	62.52	36.36	328.13	26424.92	179541.34
21072.0	33.46	-21.08	-27.43	421175.5	62.73	36.53	328.58	26525.51	180423.71
21240.0	33.44	-21.06	-27.43	425720.2	62.93	36.69	329.02	26625.38	181304.09
21408.0	33.42	-21.05	-27.43	430220.1	63.12	36.84	329.46	26724.55	182182.49
21576.0	33.41	-21.04	-27.43	434675.9	63.32	37.00	329.90	26823.04	183058.94
21744.0	33.39	-21.02	-27.42	439087.9	63.51	37.15	330.32	26920.85	183933.46
21912.0	33.37	-21.00	-27.42	443456.5	63.70	37.29	330.75	27018.00	184806.06
22080.0	33.36	-20.99	-27.41	447782.8	63.88	37.44	331.17	27114.51	185676.81
22248.0	33.34	-20.97	-27.41	452067.1	64.07	37.58	331.58	27210.39	186545.72
22416.0	33.33	-20.96	-27.40	456309.8	64.25	37.72	331.99	27305.66	187412.81
22584.0	33.31	-20.94	-27.40	460511.4	64.42	37.86	332.39	27400.31	188278.11
22752.0	33.30	-20.93	-27.39	464672.0	64.60	38.00	332.79	27494.37	189141.63
22920.0	33.28	-20.91	-27.38	468792.9	64.77	38.13	333.19	27587.86	190003.41
23088.0	33.27	-20.90	-27.38	472874.1	64.94	38.26	333.58	27680.77	190863.48
23256.0	33.26	-20.88	-27.37	476916.2	65.11	38.39	333.97	27773.12	191721.85
23424.0	33.24	-20.86	-27.36	480919.6	65.27	38.52	334.35	27864.93	192578.55
23592.0	33.23	-20.85	-27.36	484875.4	65.39	38.60	334.62	27930.17	193169.46

TOTAL ENERGY INPUT BTU = 0.775790E+10
SEASONAL ENERGY INPUT BTU = 0.196868E+10
TOTAL ENERGY INPUT GAL FUEL = 55413.56
SEASONAL ENERGY INPUT GAL FUEL = 14062.02
AVERAGE LB. WATER PER LB. FUEL = 29.79
SEASONAL LB. WATER PER LB. FUEL = 25.54
ENERGY FROM AIR TO ICE BTU = 0.295092E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.954135E+09
TOTAL WATER WITHDRAWN GAL = 929798.03
SEASONAL WATER WITHDRAWN GAL = 145995.52
TOTAL WATER LOSS GAL = 39605.91
SEASONAL WATER LOSS GAL = 0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	23568.00

23592.0	33.17	-20.87	-27.35	483395.8	65.39	38.58	334.72	27967.10	193618.43
23760.0	33.14	-20.93	-27.35	476512.0	65.18	38.28	335.06	28131.61	195747.87
23928.0	33.16	-21.00	-27.34	469612.3	64.96	37.97	335.39	28296.59	197876.38
24096.0	33.18	-21.06	-27.34	462745.2	64.75	37.66	335.73	28462.52	200006.95
24264.0	33.20	-21.13	-27.34	455919.7	64.53	37.36	336.07	28629.35	202138.64
24432.0	33.22	-21.20	-27.34	449135.3	64.31	37.05	336.42	28797.10	204271.41
24600.0	33.24	-21.27	-27.35	442400.5	64.10	36.75	336.77	28965.71	206404.29
24768.0	33.26	-21.34	-27.35	435706.9	63.87	36.44	337.13	29135.26	208538.26
24936.0	33.29	-21.42	-27.36	429046.4	63.65	36.14	337.50	29305.81	210674.28
25104.0	33.31	-21.49	-27.37	422419.5	63.42	35.83	337.87	29477.39	212812.37
25272.0	33.33	-21.57	-27.38	415842.4	63.20	35.53	338.24	29649.90	214950.66
25440.0	33.36	-21.65	-27.39	409315.5	62.97	35.23	338.63	29823.33	217088.91
25608.0	33.38	-21.73	-27.40	402822.0	62.74	34.92	339.01	29997.80	219229.06
25776.0	33.40	-21.81	-27.42	396378.6	62.50	34.62	339.41	30173.23	221369.14
25944.0	33.43	-21.89	-27.44	389961.3	62.27	34.32	339.81	30349.79	223512.11
26112.0	33.46	-21.97	-27.46	383594.5	62.03	34.02	340.21	30527.33	225655.00
26280.0	33.48	-22.05	-27.48	377278.6	61.79	33.72	340.62	30705.86	227797.81
26448.0	33.51	-22.14	-27.50	371005.3	61.55	33.42	341.04	30885.46	229941.52
26620.0	33.52	-22.17	-27.51	368319.1	61.45	33.29	341.22	30962.84	230861.78

TOTAL ENERGY INPUT BTU	=	0.870682E+10
SEASONAL ENERGY INPUT BTU	=	0.948923E+09
TOTAL ENERGY INPUT GAL FUEL	=	62191.59
SEASONAL ENERGY INPUT GAL FUEL	=	6778.02
AVERAGE LB. WATER PER LB. FUEL	=	29.01
SEASONAL LB. WATER PER LB. FUEL	=	22.61
ENERGY FROM AIR TO ICE BTU	=	0.346599E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.515067E+09
TOTAL WATER WITHDRAWN GAL	=	1176393.73
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 4
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	26544.00

26616.0	33.64	-22.18	-27.52	369317.7	61.50	33.32	341.49	31032.18	231537.80
26784.0	33.63	-22.18	-27.54	373943.8	61.71	33.51	341.97	31134.97	232406.32
26952.0	33.60	-22.19	-27.56	378528.7	61.92	33.69	342.44	31237.00	233272.95
27120.0	33.58	-22.19	-27.58	383065.8	62.12	33.87	342.91	31338.25	234137.48
27288.0	33.56	-22.19	-27.60	387555.2	62.32	34.05	343.37	31438.72	234999.93
27456.0	33.54	-22.20	-27.62	391997.4	62.52	34.22	343.82	31538.44	235860.31
27624.0	33.52	-22.20	-27.64	396393.0	62.71	34.39	344.27	31637.42	236718.66
27792.0	33.50	-22.20	-27.66	400742.6	62.90	34.56	344.71	31735.68	237575.02
27960.0	33.48	-22.21	-27.67	405046.2	63.09	34.72	345.15	31833.23	238429.38

28128.0	33.46	-22.21	-27.69	409305.2	63.28	34.88	345.58	31930.09239281.81
28296.0	33.44	-22.21	-27.71	413519.8	63.46	35.04	346.01	32026.28240132.32
28464.0	33.42	-22.21	-27.72	417690.3	63.64	35.19	346.43	32121.81240980.93
28632.0	33.41	-22.21	-27.73	421817.4	63.81	35.35	346.85	32216.68241827.67
28800.0	33.39	-22.21	-27.75	425901.1	63.99	35.49	347.26	32310.92242672.56
28968.0	33.37	-22.21	-27.76	429942.7	64.16	35.64	347.67	32404.55243515.64
29136.0	33.36	-22.22	-27.77	433942.4	64.33	35.78	348.07	32497.56244356.93
29304.0	33.34	-22.22	-27.78	437900.6	64.49	35.92	348.47	32589.98245196.44
29472.0	33.33	-22.22	-27.80	441817.7	64.66	36.06	348.86	32681.81246034.20
29640.0	33.31	-22.22	-27.81	445693.8	64.82	36.20	349.25	32773.06246870.23
29808.0	33.30	-22.22	-27.82	449530.3	64.98	36.33	349.64	32863.76247704.57
29976.0	33.28	-22.21	-27.83	453318.8	65.14	36.46	350.02	32953.96248538.21
30144.0	33.27	-22.21	-27.84	457076.4	65.29	36.59	350.39	33043.56249369.21
30312.0	33.26	-22.21	-27.84	460795.3	65.44	36.71	350.77	33132.63250198.57
30480.0	33.24	-22.21	-27.85	464475.5	65.59	36.84	351.14	33221.18251026.31
30648.0	33.23	-22.21	-27.86	468118.2	65.74	36.96	351.50	33309.22251852.46
30816.0	33.22	-22.21	-27.87	471723.5	65.89	37.08	351.86	33396.76252677.04
30984.0	33.21	-22.21	-27.88	475291.7	66.03	37.19	352.22	33483.81253500.06
31152.0	33.19	-22.21	-27.88	478823.3	66.18	37.31	352.58	33570.37254321.55
31320.0	33.18	-22.21	-27.89	482319.3	66.32	37.42	352.93	33656.45255141.50
31488.0	33.17	-22.20	-27.90	485777.8	66.45	37.54	353.28	33742.07255959.98
31656.0	33.16	-22.20	-27.90	489202.0	66.59	37.64	353.62	33827.23256776.97
31824.0	33.15	-22.20	-27.91	492591.1	66.73	37.75	353.96	33911.94257592.50
31992.0	33.14	-22.20	-27.91	495945.6	66.86	37.86	354.30	33996.21258406.60
32160.0	33.13	-22.20	-27.92	499265.4	66.99	37.96	354.64	34080.04259219.25
32304.0	33.12	-22.19	-27.92	502084.4	67.10	38.05	354.92	34151.55259914.70

TOTAL ENERGY INPUT BTU	=	0.106783E+11
SEASONAL ENERGY INPUT BTU	=	0.197147E+10
TOTAL ENERGY INPUT GAL FUEL	=	76273.51
SEASONAL ENERGY INPUT GAL FUEL	=	14081.92
AVERAGE LB. WATER PER LB. FUEL	=	27.94
SEASONAL LB. WATER PER LB. FUEL	=	23.21
ENERGY FROM AIR TO ICE BTU	=	0.451505E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.104906E+10
TOTAL WATER WITHDRAWN GAL	=	1322396.75
SEASONAL WATER WITHDRAWN GAL	=	146003.02
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 4
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	32328.00

32328.0	33.12	-22.19	-27.92	502551.7	67.12	38.07	354.97	34163.44260030.51
32496.0	33.02	-22.27	-27.93	495063.5	66.88	37.76	355.26	34318.77262121.38
32664.0	33.04	-22.33	-27.93	487483.1	66.64	37.45	355.55	34474.19264210.08
32832.0	33.07	-22.40	-27.94	479946.0	66.40	37.14	355.84	34630.62266301.07
33000.0	33.09	-22.46	-27.95	472468.8	66.16	36.84	356.14	34787.96268392.40
33168.0	33.11	-22.53	-27.96	465051.6	65.91	36.53	356.44	34946.22270484.06
33336.0	33.13	-22.60	-27.97	457686.1	65.66	36.22	356.75	35105.47272577.01
33504.0	33.15	-22.67	-27.99	450364.1	65.41	35.92	357.07	35265.78274672.23
33672.0	33.18	-22.74	-28.00	443086.3	65.16	35.61	357.39	35427.16276769.73
33840.0	33.20	-22.81	-28.01	435868.9	64.91	35.30	357.71	35589.53278867.53
34008.0	33.22	-22.88	-28.03	428712.1	64.65	35.00	358.05	35752.86280965.62

34176.0	33.25	-22.95	-28.05	421599.5	64.39	34.69	358.38	35917.34283065.96
34344.0	33.27	-23.03	-28.07	414547.3	64.13	34.39	358.73	36082.82285166.56
34512.0	33.30	-23.10	-28.09	407531.9	63.87	34.09	359.08	36249.52287270.39
34680.0	33.33	-23.18	-28.11	400577.5	63.61	33.78	359.43	36417.26289374.48
34848.0	33.35	-23.25	-28.13	393684.5	63.34	33.48	359.80	36586.06291478.83
35016.0	33.38	-23.33	-28.15	386844.7	63.08	33.18	360.17	36756.00293584.40
35184.0	33.41	-23.41	-28.17	380057.8	62.81	32.88	360.54	36927.10295691.18
35280.0	33.43	-23.45	-28.19	376190.0	62.65	32.70	360.76	37025.50296897.30

TOTAL ENERGY INPUT BTU	=	0.116286E+11
SEASONAL ENERGY INPUT BTU	=	0.950332E+09
TOTAL ENERGY INPUT GAL FUEL	=	83061.60
SEASONAL ENERGY INPUT GAL FUEL	=	6788.08
AVERAGE LB. WATER PER LB. FUEL	=	27.35
SEASONAL LB. WATER PER LB. FUEL	=	20.78
ENERGY FROM AIR TO ICE BTU	=	0.506604E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.550991E+09
TOTAL WATER WITHDRAWN GAL	=	1568999.96
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 5
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	35304.00

35352.0	33.54	-23.46	-28.20	376320.5	62.66	32.71	360.94	37077.04297433.20
35520.0	33.54	-23.46	-28.22	380449.6	62.84	32.87	361.37	37173.03298262.55
35688.0	33.52	-23.47	-28.24	384555.1	63.02	33.04	361.81	37268.49299090.76
35856.0	33.50	-23.48	-28.27	388616.5	63.20	33.20	362.23	37363.29299917.19
36024.0	33.48	-23.49	-28.29	392634.2	63.37	33.36	362.66	37457.43300741.84
36192.0	33.46	-23.50	-28.31	396608.6	63.54	33.52	363.07	37550.93301564.76
36360.0	33.44	-23.51	-28.33	400540.2	63.71	33.68	363.49	37643.81302385.95
36528.0	33.43	-23.51	-28.35	404429.1	63.87	33.83	363.89	37736.06303205.43
36696.0	33.41	-23.52	-28.37	408276.5	64.03	33.98	364.30	37827.72304023.25
36864.0	33.39	-23.53	-28.39	412082.6	64.19	34.12	364.70	37918.79304839.41
37032.0	33.38	-23.54	-28.41	415839.5	64.35	34.26	365.09	38009.33305654.92
37200.0	33.36	-23.54	-28.43	419563.9	64.51	34.40	365.48	38099.26306467.83
37368.0	33.35	-23.55	-28.44	423248.1	64.66	34.54	365.87	38188.62307279.14
37536.0	33.33	-23.56	-28.46	426893.1	64.81	34.68	366.25	38277.44308088.90
37704.0	33.32	-23.56	-28.48	430498.8	64.96	34.81	366.62	38365.73308897.09
37872.0	33.30	-23.57	-28.50	434065.8	65.11	34.94	367.00	38453.49309703.76
38040.0	33.29	-23.58	-28.51	437594.4	65.25	35.07	367.37	38540.74310508.92
38208.0	33.27	-23.58	-28.53	441084.7	65.40	35.19	367.73	38627.48311312.56
38376.0	33.26	-23.59	-28.54	444537.9	65.54	35.32	368.10	38713.72312114.75
38544.0	33.25	-23.60	-28.56	447954.0	65.67	35.44	368.45	38799.48312915.47
38712.0	33.24	-23.60	-28.57	451333.4	65.81	35.56	368.81	38884.76313714.76
38880.0	33.22	-23.61	-28.59	454676.4	65.95	35.68	369.16	38969.57314512.62
39048.0	33.21	-23.61	-28.60	457983.2	66.08	35.79	369.51	39053.92315309.07
39216.0	33.20	-23.62	-28.61	461254.9	66.21	35.90	369.85	39137.82316104.15
39384.0	33.19	-23.62	-28.63	464491.4	66.34	36.02	370.19	39221.27316897.86
39552.0	33.18	-23.63	-28.64	467693.2	66.47	36.12	370.53	39304.28317690.21
39720.0	33.17	-23.63	-28.65	470860.6	66.59	36.23	370.87	39386.87318481.22
39888.0	33.15	-23.64	-28.67	473993.6	66.72	36.34	371.20	39469.03319270.91
40056.0	33.14	-23.64	-28.68	477093.3	66.84	36.44	371.53	39550.77320059.30

40224.0	33.13	-23.65	-28.69	480159.8	66.96	36.54	371.85	39632.11320846.40
40392.0	33.12	-23.65	-28.70	483193.3	67.08	36.64	372.18	39713.05321632.23
40560.0	33.11	-23.65	-28.71	486186.3	67.20	36.74	372.50	39793.65322417.80
40728.0	33.10	-23.66	-28.72	489154.3	67.31	36.84	372.82	39873.80323201.10
40896.0	33.09	-23.66	-28.74	492091.3	67.43	36.93	373.13	39953.57323983.20
41064.0	33.09	-23.67	-28.75	494996.7	67.54	37.03	373.44	40032.97324764.09
41064.0	33.09	-23.67	-28.75	494996.7	67.54	37.03	373.44	40032.97324764.09

TOTAL ENERGY INPUT BTU	=	0.136017E+11
SEASONAL ENERGY INPUT BTU	=	0.197310E+10
TOTAL ENERGY INPUT GAL FUEL	=	97155.15
SEASONAL ENERGY INPUT GAL FUEL	=	14093.55
AVERAGE LB. WATER PER LB. FUEL	=	26.57
SEASONAL LB. WATER PER LB. FUEL	=	21.95
ENERGY FROM AIR TO ICE BTU	=	0.616602E+10
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.109998E+10
TOTAL WATER WITHDRAWN GAL	=	1715010.47
SEASONAL WATER WITHDRAWN GAL	=	146010.52
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 5
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	41088.00

41232.0	32.99	-23.73	-28.76	488677.0	67.33	36.78	373.72	40173.82326644.92
41400.0	33.01	-23.79	-28.77	480711.0	67.07	36.47	373.99	40324.94328707.09
41568.0	33.03	-23.86	-28.78	472812.6	66.80	36.15	374.26	40477.04330769.77
41736.0	33.05	-23.92	-28.79	464983.0	66.53	35.84	374.54	40630.13332832.96
41904.0	33.08	-23.98	-28.81	457213.9	66.26	35.53	374.83	40784.28334897.65
42072.0	33.10	-24.05	-28.82	449505.5	65.99	35.22	375.12	40939.51336963.82
42240.0	33.13	-24.12	-28.84	441841.8	65.72	34.91	375.41	41095.95339033.46
42408.0	33.15	-24.18	-28.86	434247.3	65.44	34.60	375.72	41253.43341103.58
42576.0	33.18	-24.25	-28.88	426722.3	65.17	34.29	376.03	41411.98343174.19
42744.0	33.20	-24.32	-28.89	419250.2	64.89	33.98	376.34	41571.73345247.23
42912.0	33.23	-24.39	-28.91	411847.4	64.60	33.67	376.66	41732.57347320.73
43080.0	33.26	-24.46	-28.93	404490.2	64.32	33.36	376.99	41894.71349397.66
43248.0	33.29	-24.53	-28.95	397202.9	64.03	33.05	377.33	42057.97351475.04
43416.0	33.32	-24.60	-28.97	389985.7	63.75	32.75	377.67	42222.39353552.86
43584.0	33.35	-24.67	-29.00	382830.5	63.46	32.44	378.02	42388.03355632.09
43752.0	33.38	-24.74	-29.02	375737.1	63.16	32.14	378.37	42554.91357712.73
43920.0	33.41	-24.81	-29.04	368690.1	62.87	31.83	378.74	42723.17359796.74
44040.0	33.43	-24.87	-29.06	363705.4	62.66	31.61	379.00	42844.07361284.91

TOTAL ENERGY INPUT BTU	=	0.145523E+11
SEASONAL ENERGY INPUT BTU	=	0.950602E+09
TOTAL ENERGY INPUT GAL FUEL	=	103945.16
SEASONAL ENERGY INPUT GAL FUEL	=	6790.01
AVERAGE LB. WATER PER LB. FUEL	=	26.13
SEASONAL LB. WATER PER LB. FUEL	=	19.84
ENERGY FROM AIR TO ICE BTU	=	0.673504E+10
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.569013E+09
TOTAL WATER WITHDRAWN GAL	=	1961606.18
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	39605.91

SEASONAL WATER LOSS GAL = 0.00

YEAR 6
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 5033.00
WATER WITHDRAWAL GAL/DAY = 600.00
WITHDRAWAL FLOW RATE GAL/MIN = 15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 25.00
START WITHDRAWAL AT HOUR = 44064.00

44088.0	33.52	-24.87	-29.07	363204.0	62.63	31.59	379.11	42881.26361695.84
44256.0	33.55	-24.88	-29.09	367085.7	62.80	31.76	379.54	42974.37362497.67
44424.0	33.53	-24.89	-29.12	370973.7	62.97	31.92	379.96	43067.19363299.34
44592.0	33.51	-24.90	-29.14	374819.1	63.14	32.08	380.38	43159.38364099.40
44760.0	33.49	-24.91	-29.16	378622.3	63.30	32.24	380.79	43250.96364897.87
44928.0	33.48	-24.92	-29.18	382383.7	63.46	32.40	381.20	43341.93365694.78
45096.0	33.46	-24.93	-29.21	386103.4	63.62	32.55	381.61	43432.30366490.12
45264.0	33.44	-24.94	-29.23	389782.5	63.77	32.70	382.00	43522.09367283.95
45432.0	33.42	-24.95	-29.25	393421.1	63.93	32.85	382.40	43611.32368076.27
45600.0	33.41	-24.96	-29.27	397019.6	64.08	32.99	382.79	43699.98368867.10
45768.0	33.39	-24.97	-29.29	400578.5	64.23	33.14	383.18	43788.10369656.46
45936.0	33.37	-24.98	-29.31	404097.8	64.37	33.27	383.56	43875.68370444.35
46104.0	33.36	-24.99	-29.33	407578.6	64.52	33.41	383.93	43962.74371230.82
46272.0	33.34	-25.00	-29.35	411021.0	64.66	33.54	384.31	44049.28372015.87
46440.0	33.33	-25.01	-29.37	414425.4	64.80	33.68	384.68	44135.31372799.53
46608.0	33.32	-25.02	-29.39	417792.2	64.94	33.81	385.04	44220.85373581.80
46776.0	33.30	-25.03	-29.40	421121.5	65.08	33.93	385.41	44305.89374362.69
46944.0	33.29	-25.03	-29.42	424414.3	65.21	34.06	385.77	44390.46375142.25
47112.0	33.27	-25.04	-29.44	427670.8	65.34	34.18	386.12	44474.56375920.47
47280.0	33.26	-25.05	-29.46	430891.2	65.47	34.30	386.47	44558.20376697.38
47448.0	33.25	-25.06	-29.48	434075.9	65.60	34.42	386.82	44641.38377472.99
47616.0	33.24	-25.07	-29.49	437225.1	65.73	34.53	387.16	44724.12378247.31
47784.0	33.22	-25.08	-29.51	440339.7	65.85	34.65	387.51	44806.42379020.36
47952.0	33.21	-25.08	-29.52	443419.8	65.98	34.76	387.84	44888.29379792.17
48120.0	33.20	-25.09	-29.54	446465.8	66.10	34.87	388.18	44969.74380562.74
48288.0	33.19	-25.10	-29.56	449478.0	66.22	34.98	388.51	45050.77381332.08
48456.0	33.18	-25.11	-29.57	452456.5	66.34	35.08	388.84	45131.40382100.21
48624.0	33.17	-25.12	-29.59	455402.2	66.45	35.19	389.17	45211.62382867.16
48792.0	33.16	-25.12	-29.60	458315.2	66.57	35.29	389.49	45291.45383632.92
48960.0	33.15	-25.13	-29.62	461195.9	66.68	35.39	389.81	45370.89384397.52
49128.0	33.14	-25.14	-29.63	464044.5	66.79	35.49	390.13	45449.95385160.97
49296.0	33.13	-25.15	-29.65	466861.1	66.91	35.59	390.44	45528.64385923.27
49464.0	33.12	-25.15	-29.66	469646.8	67.01	35.68	390.76	45606.95386684.46
49632.0	33.11	-25.16	-29.67	472401.4	67.12	35.78	391.06	45684.91387444.54
49800.0	33.10	-25.17	-29.69	475125.3	67.23	35.87	391.37	45762.51388203.51
49824.0	33.10	-25.17	-29.69	475511.9	67.24	35.89	391.42	45773.56388311.85

TOTAL ENERGY INPUT BTU = 0.165251E+11
SEASONAL ENERGY INPUT BTU = 0.197282E+10
TOTAL ENERGY INPUT GAL FUEL = 118036.71
SEASONAL ENERGY INPUT GAL FUEL = 14091.55
AVERAGE LB. WATER PER LB. FUEL = 25.56
SEASONAL LB. WATER PER LB. FUEL = 21.38
ENERGY FROM AIR TO ICE BTU = 0.785782E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.112278E+10
TOTAL WATER WITHDRAWN GAL = 2107601.69
SEASONAL WATER WITHDRAWN GAL = 145995.52
TOTAL WATER LOSS GAL = 39605.91
SEASONAL WATER LOSS GAL = 0.00

YEAR 6
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	49848.00

49968.0	32.99	-25.22	-29.70	470170.1	67.06	35.68	391.65	45891.71389881.76
50136.0	33.02	-25.28	-29.71	462030.5	66.78	35.36	391.91	46041.39391923.60
50304.0	33.04	-25.34	-29.73	453964.9	66.49	35.04	392.18	46192.11393965.99
50472.0	33.07	-25.40	-29.75	445967.2	66.20	34.72	392.45	46343.97396009.97
50640.0	33.09	-25.46	-29.76	438037.5	65.91	34.41	392.74	46496.98398055.53
50808.0	33.12	-25.53	-29.78	430160.1	65.62	34.09	393.02	46651.27400104.66
50976.0	33.15	-25.59	-29.80	422359.2	65.32	33.77	393.32	46806.69402154.36
51144.0	33.18	-25.65	-29.81	414635.2	65.03	33.46	393.62	46963.25404204.65
51312.0	33.20	-25.72	-29.83	406971.5	64.73	33.14	393.92	47121.08406257.46
51480.0	33.23	-25.78	-29.85	399384.6	64.43	32.83	394.24	47280.10408310.83
51648.0	33.26	-25.85	-29.87	391850.6	64.13	32.52	394.56	47440.49410367.72
51816.0	33.30	-25.91	-29.89	384393.9	63.82	32.20	394.88	47602.09412425.14
51984.0	33.33	-25.98	-29.91	377006.4	63.51	31.89	395.22	47764.99414484.07
52152.0	33.36	-26.05	-29.94	369696.6	63.20	31.58	395.56	47929.14416543.53
52320.0	33.40	-26.11	-29.96	362455.9	62.89	31.27	395.91	48094.63418604.47
52488.0	33.43	-26.18	-29.98	355268.9	62.57	30.96	396.27	48261.60420668.88
52656.0	33.47	-26.25	-30.00	348160.2	62.26	30.65	396.64	48429.88422733.78
52800.0	33.50	-26.31	-30.02	342132.7	61.98	30.39	396.96	48575.16424503.58

TOTAL ENERGY INPUT BTU	=	0.174754E+11
SEASONAL ENERGY INPUT BTU	=	0.950215E+09
TOTAL ENERGY INPUT GAL FUEL	=	124823.96
SEASONAL ENERGY INPUT GAL FUEL	=	6787.25
AVERAGE LB. WATER PER LB. FUEL	=	25.23
SEASONAL LB. WATER PER LB. FUEL	=	19.49
ENERGY FROM AIR TO ICE BTU	=	0.843320E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.575382E+09
TOTAL WATER WITHDRAWN GAL	=	2354197.40
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 7
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	52824.00

52824.0	33.50	-26.32	-30.03	341129.0	61.94	30.34	397.01	48599.51424799.14
52992.0	33.63	-26.32	-30.05	344896.5	62.10	30.52	397.44	48691.66425579.03
53160.0	33.60	-26.33	-30.08	348737.2	62.27	30.69	397.87	48783.98426360.57
53328.0	33.58	-26.34	-30.10	352535.4	62.44	30.86	398.30	48875.67427140.62
53496.0	33.56	-26.36	-30.12	356291.1	62.60	31.02	398.72	48966.73427919.18
53664.0	33.54	-26.37	-30.14	360004.4	62.76	31.19	399.13	49057.17428696.26
53832.0	33.52	-26.38	-30.17	363676.5	62.92	31.35	399.54	49147.02429471.90
54000.0	33.50	-26.39	-30.19	367307.5	63.08	31.50	399.95	49236.28430246.12
54168.0	33.48	-26.40	-30.21	370897.8	63.23	31.66	400.35	49324.96431018.92

54336.0	33.47	-26.41	-30.23	374447.8	63.38	31.81	400.74	49413.08431790.32
54504.0	33.45	-26.42	-30.25	377957.5	63.53	31.96	401.14	49500.65432560.34
54672.0	33.43	-26.43	-30.27	381428.1	63.68	32.10	401.52	49587.67433329.01
54840.0	33.42	-26.44	-30.29	384859.7	63.82	32.24	401.91	49674.17434096.33
55008.0	33.40	-26.45	-30.31	388252.6	63.96	32.38	402.28	49760.14434862.33
55176.0	33.38	-26.46	-30.33	391607.2	64.10	32.52	402.66	49845.60435627.02
55344.0	33.37	-26.47	-30.35	394923.7	64.24	32.65	403.03	49930.56436390.40
55512.0	33.35	-26.48	-30.37	398203.0	64.38	32.79	403.40	50015.03437152.52
55680.0	33.34	-26.49	-30.39	401445.3	64.51	32.92	403.76	50099.02437913.37
55848.0	33.32	-26.50	-30.41	404651.0	64.64	33.04	404.12	50182.53438672.98
56016.0	33.31	-26.50	-30.43	407820.4	64.77	33.17	404.47	50265.58439431.36
56184.0	33.30	-26.51	-30.44	410953.5	64.90	33.29	404.83	50348.17440188.51
56352.0	33.28	-26.52	-30.46	414043.2	65.03	33.41	405.18	50430.38440945.46
56520.0	33.27	-26.53	-30.48	417106.1	65.15	33.53	405.52	50512.08441700.23
56688.0	33.26	-26.54	-30.50	420134.2	65.28	33.65	405.86	50593.36442453.84
56856.0	33.24	-26.55	-30.51	423128.0	65.40	33.76	406.20	50674.21443206.29
57024.0	33.23	-26.56	-30.53	426087.4	65.52	33.87	406.54	50754.64443957.58
57192.0	33.22	-26.57	-30.55	429013.5	65.63	33.98	406.87	50834.66444707.75
57360.0	33.21	-26.58	-30.56	431906.2	65.75	34.09	407.20	50914.28445456.81
57528.0	33.20	-26.59	-30.58	434766.1	65.86	34.20	407.53	50993.51446204.77
57696.0	33.19	-26.59	-30.60	437593.3	65.98	34.30	407.85	51072.35446951.63
57864.0	33.18	-26.60	-30.61	440387.9	66.09	34.41	408.17	51150.80447697.41
58032.0	33.16	-26.61	-30.63	443151.0	66.20	34.51	408.49	51228.88448442.14
58200.0	33.15	-26.62	-30.64	445882.4	66.31	34.61	408.80	51306.59449185.82
58368.0	33.14	-26.63	-30.66	448582.7	66.41	34.70	409.12	51383.94449928.46
58536.0	33.13	-26.64	-30.67	451252.1	66.52	34.80	409.43	51460.93450670.07
58584.0	33.13	-26.64	-30.68	452009.0	66.55	34.83	409.51	51482.86450881.77

TOTAL ENERGY INPUT BTU	=	0.194468E+11
SEASONAL ENERGY INPUT BTU	=	0.197144E+10
TOTAL ENERGY INPUT GAL FUEL	=	138905.67
SEASONAL ENERGY INPUT GAL FUEL	=	14081.71
AVERAGE LB. WATER PER LB. FUEL	=	24.83
SEASONAL LB. WATER PER LB. FUEL	=	21.23
ENERGY FROM AIR TO ICE BTU	=	0.956088E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.112768E+10
TOTAL WATER WITHDRAWN GAL	=	2500200.42
SEASONAL WATER WITHDRAWN GAL	=	146003.02
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 7
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	58608.00

58704.0	33.03	-26.68	-30.69	447784.7	66.40	34.66	409.71	51579.78452149.44
58872.0	33.05	-26.74	-30.70	439595.8	66.10	34.34	409.98	51729.62454175.32
59040.0	33.08	-26.80	-30.72	431467.8	65.79	34.01	410.25	51880.68456203.67
59208.0	33.11	-26.85	-30.74	423422.1	65.49	33.69	410.52	52032.90458232.64
59376.0	33.13	-26.91	-30.75	415434.8	65.18	33.37	410.81	52186.47460265.19
59544.0	33.16	-26.97	-30.77	407530.1	64.87	33.04	411.10	52341.24462298.34
59712.0	33.19	-27.03	-30.79	399708.4	64.56	32.72	411.40	52497.21464332.09
59880.0	33.23	-27.09	-30.81	391953.0	64.25	32.40	411.70	52654.54466368.39
60048.0	33.26	-27.15	-30.83	384280.4	63.93	32.08	412.01	52813.11468405.25
60216.0	33.29	-27.22	-30.85	376666.7	63.61	31.76	412.33	52973.14470445.64

60384.0	33.33	-27.28	-30.87	369136.3	63.29	31.45	412.66	53134.46472486.58
60552.0	33.36	-27.34	-30.89	361681.1	62.97	31.13	413.00	53297.15474529.04
60720.0	33.40	-27.40	-30.91	354309.5	62.64	30.81	413.34	53461.18476572.04
60888.0	33.44	-27.46	-30.93	347013.0	62.31	30.50	413.69	53626.63478616.52
61056.0	33.47	-27.53	-30.95	339776.0	61.98	30.18	414.05	53793.64480664.48
61224.0	33.51	-27.59	-30.97	332623.2	61.65	29.87	414.42	53962.05482712.93
61392.0	33.55	-27.66	-30.99	325553.8	61.31	29.55	414.80	54131.90484761.84
61560.0	33.59	-27.72	-31.02	318560.7	60.97	29.24	415.19	54303.26486812.21
61560.0	33.59	-27.72	-31.02	318560.7	60.97	29.24	415.19	54303.26486812.21

TOTAL ENERGY INPUT BTU	=	0.203963E+11
SEASONAL ENERGY INPUT BTU	=	0.949462E+09
TOTAL ENERGY INPUT GAL FUEL	=	145687.54
SEASONAL ENERGY INPUT GAL FUEL	=	6781.87
AVERAGE LB. WATER PER LB. FUEL	=	24.58
SEASONAL LB. WATER PER LB. FUEL	=	19.49
ENERGY FROM AIR TO ICE BTU	=	0.101356E+11
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.574678E+09
TOTAL WATER WITHDRAWN GAL	=	2746803.62
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 8
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	61584.00

61728.0	33.73	-27.73	-31.04	320824.4	61.07	29.35	415.62	54407.27487759.23
61896.0	33.71	-27.74	-31.06	324717.6	61.24	29.54	416.07	54500.15488523.65
62064.0	33.68	-27.75	-31.09	328567.1	61.42	29.72	416.51	54592.36489286.64
62232.0	33.66	-27.76	-31.11	332372.5	61.59	29.90	416.94	54683.91490048.19
62400.0	33.63	-27.77	-31.13	336135.0	61.75	30.08	417.37	54774.82490808.36
62568.0	33.61	-27.78	-31.15	339854.7	61.92	30.25	417.80	54865.10491567.14
62736.0	33.59	-27.79	-31.17	343532.0	62.08	30.41	418.22	54954.76492324.54
62904.0	33.57	-27.80	-31.20	347167.3	62.24	30.58	418.63	55043.82493080.60
63072.0	33.55	-27.81	-31.22	350760.6	62.40	30.74	419.04	55132.29493835.32
63240.0	33.53	-27.82	-31.24	354313.2	62.55	30.90	419.44	55220.17494588.73
63408.0	33.51	-27.83	-31.26	357816.8	62.70	31.05	419.84	55307.56495341.82
63576.0	33.49	-27.84	-31.28	361288.5	62.85	31.21	420.24	55394.32496092.64
63744.0	33.47	-27.85	-31.30	364720.3	63.00	31.35	420.63	55480.55496842.20
63912.0	33.46	-27.86	-31.32	368112.3	63.15	31.50	421.01	55566.23497590.50
64080.0	33.44	-27.87	-31.34	371465.6	63.29	31.64	421.39	55651.40498337.57
64248.0	33.42	-27.88	-31.35	374780.3	63.43	31.78	421.77	55736.06499083.43
64416.0	33.41	-27.89	-31.37	378056.7	63.57	31.92	422.15	55820.21499828.07
64584.0	33.39	-27.90	-31.39	381295.4	63.71	32.06	422.51	55903.87500571.53
64752.0	33.38	-27.91	-31.41	384496.2	63.84	32.19	422.88	55987.04501313.81
64920.0	33.36	-27.92	-31.43	387660.4	63.97	32.32	423.24	56069.74502054.93
65088.0	33.35	-27.93	-31.45	390788.0	64.10	32.45	423.60	56151.98502794.91
65256.0	33.33	-27.93	-31.46	393879.4	64.23	32.58	423.95	56233.76503533.76
65424.0	33.32	-27.94	-31.48	396934.8	64.36	32.70	424.30	56315.10504271.49
65592.0	33.30	-27.95	-31.50	399954.5	64.49	32.82	424.65	56395.99505008.11
65760.0	33.29	-27.96	-31.52	402939.5	64.61	32.94	425.00	56476.45505743.65
65928.0	33.28	-27.97	-31.53	405889.7	64.73	33.06	425.34	56556.49506478.11
66096.0	33.26	-27.98	-31.55	408805.7	64.85	33.17	425.67	56636.11507211.52
66264.0	33.25	-27.99	-31.57	411687.6	64.97	33.28	426.01	56715.32507943.87

66432.0	33.24	-28.00	-31.58	414535.6	65.08	33.39	426.34	56794.13508675.17
66600.0	33.23	-28.00	-31.60	417350.7	65.20	33.50	426.67	56872.55509405.47
66768.0	33.22	-28.01	-31.62	420133.0	65.31	33.61	426.99	56950.57510134.75
66936.0	33.20	-28.02	-31.63	422874.5	65.42	33.71	427.31	57028.28510864.02
67104.0	33.19	-28.03	-31.65	425592.0	65.53	33.82	427.63	57105.55511591.31
67272.0	33.18	-28.04	-31.66	428277.5	65.64	33.92	427.95	57182.46512317.62
67344.0	33.18	-28.04	-31.67	429419.1	65.69	33.96	428.09	57215.31512628.61

TOTAL ENERGY INPUT BTU	=	0.223658E+11
SEASONAL ENERGY INPUT BTU	=	0.196953E+10
TOTAL ENERGY INPUT GAL FUEL	=	159755.61
SEASONAL ENERGY INPUT GAL FUEL	=	14068.07
AVERAGE LB. WATER PER LB. FUEL	=	24.29
SEASONAL LB. WATER PER LB. FUEL	=	21.33
ENERGY FROM AIR TO ICE BTU	=	0.112580E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.112244E+10
TOTAL WATER WITHDRAWN GAL	=	2892814.14
SEASONAL WATER WITHDRAWN GAL	=	146010.52
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 8
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	67368.00

67440.0	33.07	-28.07	-31.68	426374.0	65.57	33.84	428.25	57291.26513598.43
67608.0	33.09	-28.13	-31.69	418189.3	65.26	33.51	428.52	57442.10515612.37
67776.0	33.12	-28.18	-31.71	410081.2	64.94	33.18	428.79	57594.08517626.62
67944.0	33.15	-28.24	-31.73	402036.3	64.62	32.85	429.08	57747.46519644.42
68112.0	33.18	-28.30	-31.74	394078.8	64.30	32.52	429.37	57902.09521662.78
68280.0	33.22	-28.35	-31.76	386209.0	63.98	32.19	429.66	58057.99523681.68
68448.0	33.25	-28.41	-31.78	378418.6	63.66	31.87	429.97	58215.23525702.11
68616.0	33.29	-28.46	-31.80	370707.3	63.33	31.54	430.28	58373.84527724.03
68784.0	33.32	-28.52	-31.82	363059.7	63.00	31.21	430.60	58533.96529749.44
68952.0	33.36	-28.58	-31.83	355500.0	62.67	30.89	430.93	58695.43531775.35
69120.0	33.40	-28.64	-31.85	348020.2	62.33	30.57	431.27	58858.34533802.74
69288.0	33.44	-28.70	-31.87	340628.7	61.99	30.24	431.62	59022.65535830.60
69456.0	33.48	-28.76	-31.89	333316.8	61.65	29.92	431.97	59188.44537859.90
69624.0	33.52	-28.81	-31.91	326069.1	61.31	29.60	432.33	59355.86539892.62
69792.0	33.56	-28.87	-31.94	318901.8	60.96	29.28	432.71	59524.82541926.76
69960.0	33.60	-28.93	-31.96	311830.9	60.61	28.96	433.09	59695.22543960.32
70128.0	33.65	-28.99	-31.98	304840.7	60.26	28.64	433.48	59867.22545995.29
70296.0	33.37	-29.07	-32.00	298213.3	59.92	28.34	433.90	60042.76548038.03
70320.0	33.36	-29.08	-32.00	297258.3	59.87	28.30	433.96	60067.92548330.13

TOTAL ENERGY INPUT BTU	=	0.233145E+11
SEASONAL ENERGY INPUT BTU	=	0.948675E+09
TOTAL ENERGY INPUT GAL FUEL	=	166531.87
SEASONAL ENERGY INPUT GAL FUEL	=	6776.25
AVERAGE LB. WATER PER LB. FUEL	=	24.11
SEASONAL LB. WATER PER LB. FUEL	=	19.73
ENERGY FROM AIR TO ICE BTU	=	0.118283E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.570353E+09
TOTAL WATER WITHDRAWN GAL	=	3139417.34
SEASONAL WATER WITHDRAWN GAL	=	246603.21

TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 9
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	70344.00

70464.0	33.45	-29.09	-32.02	299211.7	59.96	28.40	434.36	60160.69549158.15
70632.0	33.81	-29.08	-32.05	302975.6	60.13	28.59	434.81	60252.85549901.18
70800.0	33.79	-29.09	-32.07	306915.5	60.31	28.79	435.27	60345.84550647.85
70968.0	33.76	-29.10	-32.09	310813.4	60.49	28.98	435.72	60438.14551393.24
71136.0	33.74	-29.11	-32.11	314666.3	60.67	29.17	436.17	60529.76552137.27
71304.0	33.71	-29.12	-32.13	318474.4	60.85	29.35	436.61	60620.70552879.98
71472.0	33.69	-29.13	-32.15	322238.2	61.02	29.53	437.05	60710.99553621.36
71640.0	33.66	-29.13	-32.17	325957.9	61.19	29.71	437.47	60800.64554361.44
71808.0	33.64	-29.14	-32.19	329634.5	61.35	29.88	437.90	60889.66555100.24
71976.0	33.62	-29.15	-32.21	333268.3	61.52	30.05	438.32	60978.07555837.78
72144.0	33.60	-29.16	-32.23	336859.6	61.68	30.22	438.73	61065.87556574.07
72312.0	33.57	-29.17	-32.25	340408.8	61.83	30.38	439.14	61153.09557309.13
72480.0	33.55	-29.18	-32.27	343916.0	61.99	30.54	439.54	61239.74558042.96
72648.0	33.53	-29.19	-32.29	347382.5	62.14	30.70	439.94	61325.82558775.60
72816.0	33.51	-29.20	-32.31	350808.2	62.29	30.85	440.33	61411.35559507.05
72984.0	33.50	-29.20	-32.33	354193.7	62.44	31.00	440.72	61496.34560237.34
73152.0	33.48	-29.21	-32.34	357539.2	62.59	31.15	441.11	61580.80560966.47
73320.0	33.46	-29.22	-32.36	360845.0	62.73	31.29	441.49	61664.74561694.45
73488.0	33.44	-29.23	-32.38	364112.1	62.87	31.43	441.87	61748.18562421.32
73656.0	33.43	-29.24	-32.40	367340.6	63.01	31.57	442.24	61831.12563147.07
73824.0	33.41	-29.25	-32.42	370531.0	63.15	31.71	442.61	61913.57563871.73
73992.0	33.39	-29.25	-32.43	373683.5	63.28	31.84	442.97	61995.54564595.31
74160.0	33.38	-29.26	-32.45	376798.4	63.41	31.97	443.33	62077.05565317.81
74328.0	33.36	-29.27	-32.47	379876.7	63.54	32.10	443.69	62158.09566039.27
74496.0	33.35	-29.28	-32.48	382918.4	63.67	32.23	444.04	62238.68566759.68
74664.0	33.33	-29.29	-32.50	385924.0	63.80	32.35	444.39	62318.83567479.07
74832.0	33.32	-29.30	-32.52	388893.9	63.93	32.47	444.74	62398.55568197.44
75000.0	33.31	-29.30	-32.53	391828.0	64.05	32.59	445.08	62477.84568914.80
75168.0	33.29	-29.31	-32.55	394727.5	64.17	32.71	445.42	62556.71569631.19
75336.0	33.28	-29.32	-32.57	397592.5	64.29	32.83	445.75	62635.17570346.59
75504.0	33.27	-29.33	-32.58	400423.2	64.41	32.94	446.09	62713.23571061.04
75672.0	33.25	-29.34	-32.60	403220.1	64.52	33.05	446.42	62790.89571774.53
75840.0	33.24	-29.35	-32.61	405983.2	64.64	33.16	446.74	62868.16572487.07
76008.0	33.23	-29.35	-32.63	408713.6	64.75	33.27	447.07	62945.06573198.69
76104.0	33.22	-29.36	-32.64	410259.2	64.81	33.33	447.25	62988.83573604.92

TOTAL ENERGY INPUT BTU	=	0.252824E+11
SEASONAL ENERGY INPUT BTU	=	0.196795E+10
TOTAL ENERGY INPUT GAL FUEL	=	180588.68
SEASONAL ENERGY INPUT GAL FUEL	=	14056.82
AVERAGE LB. WATER PER LB. FUEL	=	23.91
SEASONAL LB. WATER PER LB. FUEL	=	21.53
ENERGY FROM AIR TO ICE BTU	=	0.129413E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.111297E+10
TOTAL WATER WITHDRAWN GAL	=	3285412.86
SEASONAL WATER WITHDRAWN GAL	=	145995.52
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 9
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE 1bm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	76128.00

76176.0	33.12	-29.38	-32.64	408395.2	64.74	33.25	447.38	63043.53574280.71
76344.0	33.13	-29.43	-32.66	400262.9	64.42	32.91	447.65	63195.38576281.39
76512.0	33.17	-29.48	-32.67	392174.4	64.09	32.58	447.93	63348.52578285.04
76680.0	33.20	-29.54	-32.69	384176.9	63.77	32.24	448.22	63502.95580289.15
76848.0	33.23	-29.59	-32.71	376270.8	63.44	31.90	448.52	63658.67582293.72
77016.0	33.27	-29.64	-32.72	368447.9	63.11	31.57	448.82	63815.78584299.72
77184.0	33.31	-29.69	-32.74	360707.6	62.77	31.24	449.14	63974.29586307.14
77352.0	33.34	-29.75	-32.76	353034.7	62.43	30.91	449.46	64134.35588317.95
77520.0	33.38	-29.80	-32.78	345453.2	62.09	30.57	449.79	64295.81590329.17
77688.0	33.42	-29.86	-32.80	337955.3	61.75	30.24	450.13	64458.74592341.77
77856.0	33.46	-29.91	-32.81	330549.1	61.40	29.91	450.47	64623.11594354.75
78024.0	33.51	-29.96	-32.83	323226.1	61.06	29.59	450.83	64789.01596369.07
78192.0	33.55	-30.02	-32.85	315970.7	60.70	29.26	451.20	64956.59598386.72
78360.0	33.60	-30.07	-32.87	308799.3	60.35	28.93	451.57	65125.75600405.70
78528.0	33.62	-30.14	-32.89	301904.9	60.00	28.62	451.97	65297.58602427.65
78696.0	33.65	-30.20	-32.91	295130.6	59.65	28.30	452.37	65471.24604451.63
78864.0	33.68	-30.26	-32.93	288361.4	59.29	27.99	452.79	65646.03606475.25
79032.0	33.71	-30.31	-32.95	281669.8	58.93	27.67	453.21	65822.58608501.14
79080.0	33.74	-30.33	-32.96	279777.4	58.83	27.58	453.34	65873.31609079.77

TOTAL ENERGY INPUT BTU	=	0.262310E+11
SEASONAL ENERGY INPUT BTU	=	0.948581E+09
TOTAL ENERGY INPUT GAL FUEL	=	187364.26
SEASONAL ENERGY INPUT GAL FUEL	=	6775.58
AVERAGE LB. WATER PER LB. FUEL	=	23.77
SEASONAL LB. WATER PER LB. FUEL	=	20.02
ENERGY FROM AIR TO ICE BTU	=	0.135061E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.564743E+09
TOTAL WATER WITHDRAWN GAL	=	3532008.57
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 10
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE 1bm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	79104.00

79200.0	33.54	-30.34	-32.97	281208.2	58.89	27.67	453.68	65953.15609788.68
79368.0	33.51	-30.34	-32.99	285455.7	59.10	27.89	454.17	66048.54610523.47
79536.0	33.48	-30.35	-33.02	289651.9	59.30	28.11	454.65	66143.12611256.86
79704.0	33.46	-30.36	-33.04	293796.4	59.50	28.32	455.13	66236.91611988.84
79872.0	33.44	-30.36	-33.06	297889.7	59.69	28.53	455.60	66329.92612719.44
80040.0	33.41	-30.37	-33.08	301932.5	59.89	28.73	456.06	66422.18613448.68
80208.0	33.71	-30.37	-33.10	305650.6	60.06	28.91	456.50	66511.90614171.04
80376.0	33.74	-30.37	-33.11	309410.2	60.24	29.10	456.94	66601.53614893.93

80544.0	33.72	-30.38	-33.13	313165.0	60.41	29.28	457.38	66690.77615616.40
80712.0	33.69	-30.39	-33.15	316875.0	60.58	29.46	457.81	66779.37616337.68
80880.0	33.67	-30.39	-33.17	320540.8	60.75	29.64	458.24	66867.34617057.76
81048.0	33.64	-30.40	-33.19	324162.3	60.92	29.81	458.66	66954.68617776.66
81216.0	33.62	-30.41	-33.21	327740.8	61.08	29.98	459.07	67041.43618494.41
81384.0	33.60	-30.42	-33.23	331276.4	61.24	30.14	459.48	67127.59619211.02
81552.0	33.58	-30.42	-33.24	334769.5	61.40	30.30	459.88	67213.17619926.50
81720.0	33.56	-30.43	-33.26	338220.7	61.55	30.46	460.28	67298.19620640.87
81888.0	33.54	-30.44	-33.28	341629.9	61.71	30.62	460.68	67382.66621354.14
82056.0	33.52	-30.45	-33.30	344998.4	61.86	30.77	461.06	67466.58622066.33
82224.0	33.50	-30.46	-33.31	348326.3	62.00	30.92	461.45	67549.98622777.46
82392.0	33.48	-30.46	-33.33	351614.0	62.15	31.06	461.83	67632.87623487.53
82560.0	33.46	-30.47	-33.35	354854.0	62.29	31.20	462.21	67715.30624197.57
82728.0	33.45	-30.48	-33.36	358062.0	62.43	31.35	462.58	67797.18624905.56
82896.0	33.43	-30.49	-33.38	361231.8	62.57	31.48	462.95	67878.57625612.56
83064.0	33.41	-30.49	-33.40	364363.3	62.71	31.62	463.31	67959.49626318.57
83232.0	33.40	-30.50	-33.41	367456.8	62.84	31.75	463.67	68039.93627023.59
83400.0	33.38	-30.51	-33.43	370512.6	62.98	31.88	464.03	68119.92627727.63
83568.0	33.37	-30.52	-33.45	373531.0	63.11	32.01	464.38	68199.46628430.72
83736.0	33.35	-30.52	-33.46	376512.9	63.23	32.13	464.73	68278.56629132.86
83904.0	33.34	-30.53	-33.48	379458.6	63.36	32.25	465.07	68357.23629834.07
84072.0	33.32	-30.54	-33.49	382368.3	63.48	32.37	465.42	68435.48630534.35
84240.0	33.31	-30.55	-33.51	385242.5	63.61	32.49	465.76	68513.31631233.73
84408.0	33.29	-30.55	-33.52	388081.3	63.73	32.61	466.09	68590.73631932.20
84576.0	33.28	-30.56	-33.54	390885.7	63.85	32.72	466.42	68667.75632629.80
84744.0	33.27	-30.57	-33.55	393655.8	63.96	32.83	466.75	68744.38633326.52
84864.0	33.26	-30.57	-33.56	395613.7	64.04	32.91	466.98	68798.88633823.65

TOTAL ENERGY INPUT BTU	=	0.281990E+11
SEASONAL ENERGY INPUT BTU	=	0.196799E+10
TOTAL ENERGY INPUT GAL FUEL	=	201421.31
SEASONAL ENERGY INPUT GAL FUEL	=	14057.05
AVERAGE LB. WATER PER LB. FUEL	=	23.63
SEASONAL LB. WATER PER LB. FUEL	=	21.76
ENERGY FROM AIR TO ICE BTU	=	0.146097E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.110365E+10
TOTAL WATER WITHDRAWN GAL	=	3678011.58
SEASONAL WATER WITHDRAWN GAL	=	146003.02
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

YEAR 10
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	5033.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	25.00
START WITHDRAWAL AT HOUR	=	84888.00

84912.0	33.19	-30.58	-33.57	394910.8	64.02	32.88	467.07	68831.80634207.64
85080.0	33.16	-30.64	-33.58	386816.4	63.69	32.54	467.35	68984.57636198.12
85248.0	33.20	-30.68	-33.60	378763.6	63.36	32.20	467.64	69138.33638187.94
85416.0	33.23	-30.73	-33.61	370796.8	63.02	31.85	467.93	69293.46640179.10
85584.0	33.27	-30.78	-33.63	362924.2	62.69	31.51	468.23	69449.94642170.58
85752.0	33.31	-30.83	-33.64	355137.4	62.35	31.17	468.54	69607.84644163.36
85920.0	33.35	-30.88	-33.66	347420.6	62.01	30.83	468.86	69767.30646159.42
86088.0	33.39	-30.93	-33.68	339798.2	61.66	30.49	469.19	69928.18648155.76
86256.0	33.43	-30.98	-33.69	332262.0	61.32	30.16	469.52	70090.55650153.38
86424.0	33.47	-31.03	-33.71	324620.5	60.97	29.82	469.87	70254.38652151.24

86892.0	33.52	-31.08	-33.73	317464.5	60.61	29.45	470.34	70419.75	70419.75
86760.0	33.56	-31.13	-33.75	310179.5	60.26	29.15	470.50	70505.84	70505.84
86928.0	33.30	-31.20	-33.76	303256.4	59.91	28.83	470.97	70757.25	70757.25
87096.0	33.32	-31.25	-33.78	296301.0	59.56	28.51	471.36	70928.34	70928.34
87264.0	33.36	-31.30	-33.80	289423.2	59.20	28.18	471.77	71100.97	71100.97
87432.0	33.40	-31.35	-33.82	282633.2	58.84	27.86	472.18	71275.30	71275.30
87600.0	33.44	-31.40	-33.84	275923.6	58.47	27.54	472.60	71451.40	71451.40
87768.0	33.48	-31.46	-33.86	269294.3	58.10	27.22	473.04	71629.32	71629.32
87940.0	33.50	-31.48	-33.87	266501.1	57.95	27.08	473.23	71705.95	71705.95

TOTAL ENERGY INPUT BTU	=	0.291475E+11
SEASONAL ENERGY INPUT BTU	=	0.948529E+09
TOTAL ENERGY INPUT GAL FUEL	=	208196.52
SEASONAL ENERGY INPUT GAL FUEL	=	6775.21
AVERAGE LB. WATER PER LB. FUEL	=	23.52
SEASONAL LB. WATER PER LB. FUEL	=	20.26
ENERGY FROM AIR TO ICE BTU	=	0.151699E+11
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.560164E+09
TOTAL WATER WITHDRAWN GAL	=	3924607.29
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	39605.91
SEASONAL WATER LOSS GAL	=	0.00

TOTAL ENERGY INPUT BTU	=	0.291475E+11
TOTAL ENERGY INPUT GAL FUEL	=	208196.52
TOTAL ENERGY LOSS AIR TO ICE BTU	=	0.151699E+11

Case A2

ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION

BOILER WATER TEMP DEG F	=	103.00
BOILER WATER FLOW RATE lbm/hr	=	7549.50
CONVECTIVE COEFFICIENT BTU/HR-FT2-F	=	32.50
INITIAL DRILL RADIUS FT	=	1.50
DEPTH TO TOP OF WATER AT START FT	=	157.00
INITIAL PARABOLIC WATER DIAMETER D FT	=	4.24
INITIAL PARABOLIC WATER HEIGHT HW FT	=	10.00
INITIAL WATER TEMP TW DEG F	=	103.00
INITIAL AIR TEMP TA DEG F	=	-60.00
INITIAL ICE SURFACE TEMP TS DEG F	=	-60.00
AMBIENT ICE TEMP DEG F	=	-60.00
EFFECTIVE LATENT HEAT BTU/LB	=	392.35
TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT2, AIR VOL VA FT3		

TIME	TW	TA	TS	MW	D	HW	HWB	AI	VA
0.0	103.00	-60.00	-60.00	527.5	4.24	10.00	167.00	1479.69	1109.77
24.0	75.12	-55.02	-58.23	1335.7	7.14	8.93	171.63	1621.59	1253.54
48.0	70.24	-52.20	-56.87	2297.2	9.23	9.19	175.24	1754.02	1430.20
72.0	66.45	-49.82	-55.58	3370.7	10.90	9.67	178.27	1882.94	1634.18
96.0	63.43	-47.79	-54.38	4523.6	12.31	10.19	180.92	2009.18	1860.43
120.0	60.97	-46.06	-53.27	5734.5	13.53	10.70	183.30	2132.96	2104.97
144.0	58.93	-44.56	-52.25	6989.3	14.61	11.18	185.45	2254.37	2364.66
168.0	57.21	-43.25	-51.31	8278.4	15.58	11.64	187.43	2373.47	2637.02
192.0	55.73	-42.08	-50.45	9595.7	16.47	12.07	189.27	2490.34	2920.02
216.0	54.45	-41.05	-49.65	10937.2	17.29	12.49	190.98	2605.08	3212.10
235.9	53.50	-40.27	-49.03	12066.0	17.93	12.81	192.33	2698.67	3460.21

TOTAL ENERGY INPUT BTU	=	0.709905E+08
SEASONAL ENERGY INPUT BTU	=	0.709905E+08
TOTAL ENERGY INPUT GAL FUEL	=	507.07
SEASONAL ENERGY INPUT GAL FUEL	=	507.07
AVERAGE LB. WATER PER LB. FUEL	=	26.59
SEASONAL LB. WATER PER LB. FUEL	=	26.59
ENERGY FROM AIR TO ICE BTU	=	0.339972E+07
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.339972E+07
TOTAL WATER WITHDRAWN GAL	=	0.00
SEASONAL WATER WITHDRAWN GAL	=	0.00
TOTAL WATER LOSS GAL	=	7848.43
SEASONAL WATER LOSS GAL	=	7848.43

YEAR 1

STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	240.00

240.0	53.32	-40.11	-48.91	12299.1	18.05	12.68	192.60	2717.68	3511.67
408.0	51.23	-37.54	-45.71	16051.9	20.54	12.93	202.45	3596.12	6287.93
576.0	48.66	-35.91	-43.91	21594.1	22.93	14.01	210.71	4365.14	8916.54
744.0	46.27	-34.55	-42.59	28938.6	25.29	15.39	217.68	5046.47	11425.63
912.0	44.21	-33.28	-41.48	37782.5	27.60	16.92	223.56	5650.72	13791.21
1080.0	42.56	-32.08	-40.49	48032.1	29.79	18.46	228.63	6193.23	16042.44
1248.0	41.24	-30.96	-39.57	59343.5	31.85	19.96	233.03	6684.99	18187.73
1416.0	40.19	-29.90	-38.71	71527.2	33.78	21.39	236.83	7134.45	20238.28
1584.0	39.34	-28.91	-37.90	84351.0	35.58	22.74	240.34	7549.59	22203.00
1752.0	38.64	-27.98	-37.13	97607.4	37.25	24.00	243.45	7937.04	24106.58

1920.0	38.07	-27.12	-36.41	111120.1	38.80	25.18	246.28	8302.15	25972.20
2088.0	37.60	-26.32	-35.72	124739.9	40.25	26.28	248.87	8649.23	27806.33
2256.0	37.20	-25.58	-35.08	138349.6	41.59	27.30	251.28	8981.73	29625.15
2424.0	36.86	-24.90	-34.47	151904.3	42.84	28.24	253.52	9301.73	31432.72
2592.0	36.57	-24.26	-33.89	165393.8	44.02	29.12	255.62	9610.62	33229.31
2760.0	36.32	-23.67	-33.35	178811.6	45.13	29.95	257.60	9909.52	35015.21
2928.0	36.09	-23.11	-32.84	192152.7	46.19	30.74	259.47	10199.41	36790.74
3096.0	35.89	-22.59	-32.35	205413.0	47.19	31.48	261.24	10481.06	38556.19
3264.0	35.72	-22.10	-31.89	218592.3	48.14	32.19	262.94	10755.21	40311.97
3432.0	35.56	-21.65	-31.45	231688.2	49.05	32.86	264.55	11022.44	42058.35
3600.0	35.41	-21.21	-31.04	244691.0	49.92	33.50	266.10	11283.35	43796.57
3768.0	35.28	-20.81	-30.64	257617.8	50.76	34.12	267.59	11538.25	45525.04
3936.0	35.16	-20.42	-30.27	270459.0	51.57	34.71	269.01	11787.60	47244.93
4104.0	35.05	-20.05	-29.91	283216.5	52.34	35.28	270.39	12031.80	48956.60
4272.0	34.95	-19.70	-29.56	295889.7	53.09	35.82	271.72	12271.14	50660.24
4440.0	34.85	-19.37	-29.24	308479.1	53.81	36.35	273.00	12505.93	52356.11
4608.0	34.76	-19.06	-28.92	320985.3	54.51	36.86	274.25	12736.41	54044.41
4776.0	34.68	-18.76	-28.62	333408.0	55.19	37.35	275.45	12962.82	55725.32
4944.0	34.60	-18.47	-28.33	345749.9	55.85	37.83	276.62	13185.40	57399.14
5112.0	34.53	-18.20	-28.06	358010.8	56.49	38.29	277.75	13404.32	59066.00
5280.0	34.47	-17.94	-27.79	370191.4	57.11	38.74	278.86	13619.77	60726.10
5448.0	34.40	-17.68	-27.53	382292.6	57.71	39.17	279.93	13831.91	62379.60
5616.0	34.34	-17.44	-27.29	394314.3	58.30	39.59	280.98	14040.89	64026.63
5784.0	34.29	-17.21	-27.05	406259.1	58.87	40.00	282.00	14246.87	65667.43
5952.0	34.23	-16.99	-26.82	418127.1	59.42	40.40	283.00	14449.96	67302.12
6024.0	34.21	-16.90	-26.72	423189.6	59.66	40.57	283.42	14536.14	68000.84

TOTAL ENERGY INPUT BTU	=	0.280489E+10
SEASONAL ENERGY INPUT BTU	=	0.273390E+10
TOTAL ENERGY INPUT GAL FUEL	=	20034.91
SEASONAL ENERGY INPUT GAL FUEL	=	19527.84
AVERAGE LB. WATER PER LB. FUEL	=	37.30
SEASONAL LB. WATER PER LB. FUEL	=	37.58
ENERGY FROM AIR TO ICE BTU	=	0.556299E+09
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.554899E+09
TOTAL WATER WITHDRAWN GAL	=	216897.13
SEASONAL WATER WITHDRAWN GAL	=	216897.13
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	28144.25

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	6048.00

6120.0	34.05	-16.90	-26.60	422728.9	59.71	40.46	283.92	14700.05	69736.30
6288.0	34.07	-16.93	-26.41	417332.1	59.63	40.05	284.77	15012.97	73223.71
6456.0	34.09	-16.97	-26.25	411933.6	59.54	39.65	285.61	15326.43	76708.03
6624.0	34.11	-17.03	-26.11	406538.8	59.45	39.25	286.47	15640.49	80189.52
6792.0	34.14	-17.10	-25.99	401145.8	59.35	38.86	287.33	15955.17	83668.11
6960.0	34.17	-17.19	-25.89	395753.8	59.25	38.46	288.20	16270.46	87143.76
7128.0	34.19	-17.28	-25.81	390353.9	59.15	38.07	289.07	16586.51	90617.49
7296.0	34.22	-17.38	-25.74	384961.1	59.04	37.69	289.95	16903.14	94087.26
7464.0	34.25	-17.49	-25.69	379569.2	58.93	37.30	290.84	17220.47	97554.16
7632.0	34.27	-17.61	-25.65	374177.0	58.81	36.92	291.73	17538.53	101018.15
7800.0	34.30	-17.74	-25.62	368775.4	58.68	36.54	292.63	17857.40	104480.12

7968.0	34.33	-17.87	-25.80	363382.2	58.56	36.16	293.54	18176.99107938.39
8133.0	34.36	-18.01	-25.60	357987.8	58.42	35.79	294.45	18497.38111393.70
8304.0	34.39	-18.15	-25.60	352594.2	58.28	35.42	295.37	18818.63114646.21
8472.0	34.42	-18.30	-25.61	347200.9	58.14	35.05	296.30	19140.75118295.91
8640.0	34.46	-18.46	-25.64	341808.4	57.99	34.68	297.24	19463.79121742.84
8808.0	34.49	-18.61	-25.66	336416.9	57.84	34.32	298.18	19787.78125187.02
8976.0	34.52	-18.77	-25.70	331026.2	57.68	33.96	299.14	20112.74128628.47
9000.0	34.53	-18.80	-25.70	330257.2	57.65	33.90	299.27	20159.26129119.92

TOTAL ENERGY INPUT BTU	=	0.413961E+10
SEASONAL ENERGY INPUT BTU	=	0.133473E+10
TOTAL ENERGY INPUT GAL FUEL	=	29568.66
SEASONAL ENERGY INPUT GAL FUEL	=	9533.75
AVERAGE LB. WATER PER LB. FUEL	=	36.22
SEASONAL LB. WATER PER LB. FUEL	=	33.94
ENERGY FROM AIR TO ICE BTU	=	0.976039E+09
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.417740E+09
TOTAL WATER WITHDRAWN GAL	=	586794.43
SEASONAL WATER WITHDRAWN GAL	=	369897.31
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	9024.00

9144.0	34.63	-18.78	-25.73	337706.8	58.04	34.20	300.19	20353.12130723.34
9312.0	34.60	-18.76	-25.76	349352.3	58.62	34.69	301.26	20558.36132283.80
9480.0	34.53	-18.73	-25.79	360898.8	59.18	35.16	302.30	20760.38133838.07
9648.0	34.46	-18.70	-25.80	372347.0	59.73	35.62	303.31	20959.32135386.29
9816.0	34.40	-18.66	-25.82	383697.1	60.26	36.06	304.30	21155.32136928.56
9984.0	34.34	-18.63	-25.82	394952.1	60.77	36.49	305.27	21348.50138465.09
10152.0	34.28	-18.59	-25.83	406112.3	61.28	36.90	306.21	21539.00139995.96
10320.0	34.22	-18.55	-25.83	417178.9	61.77	37.31	307.12	21726.91141521.30
10488.0	34.17	-18.51	-25.83	428153.0	62.25	37.70	308.02	21912.34143041.24
10656.0	34.12	-18.47	-25.82	439035.1	62.72	38.08	308.90	22095.38144555.86
10824.0	34.08	-18.42	-25.81	449819.4	63.18	38.46	309.76	22276.20146066.29
10992.0	34.03	-18.38	-25.80	460523.8	63.63	38.82	310.60	22454.75147570.70
11160.0	33.99	-18.33	-25.78	471140.6	64.06	39.17	311.42	22631.18149070.15
11328.0	33.95	-18.28	-25.77	481671.1	64.49	39.52	312.22	22805.56150564.74
11496.0	33.91	-18.24	-25.75	492116.5	64.91	39.85	313.01	22977.96152054.58
11664.0	33.87	-18.19	-25.73	502477.0	65.32	40.18	313.79	23148.44153539.72
11832.0	33.84	-18.14	-25.70	512755.7	65.73	40.50	314.55	23317.07155020.32
12000.0	33.80	-18.09	-25.68	522952.6	66.12	40.81	315.29	23483.92156496.45
12168.0	33.77	-18.04	-25.65	533069.0	66.51	41.12	316.03	23649.04157968.19
12336.0	33.74	-17.99	-25.63	543105.8	66.89	41.42	316.75	23812.48159435.61
12504.0	33.71	-17.94	-25.60	553063.5	67.26	41.71	317.45	23974.29160898.78
12672.0	33.68	-17.89	-25.57	562944.7	67.63	42.00	318.15	24134.53162357.84
12840.0	33.65	-17.84	-25.54	572749.7	67.99	42.28	318.83	24293.24163812.83
13008.0	33.63	-17.79	-25.51	582479.3	68.34	42.56	319.51	24450.46165263.81
13176.0	33.60	-17.74	-25.47	592134.6	68.69	42.83	320.17	24606.23166710.88
13344.0	33.58	-17.69	-25.44	601715.8	69.03	43.09	320.82	24760.59168154.06
13512.0	33.55	-17.64	-25.40	611225.5	69.36	43.35	321.46	24913.60169593.48
13680.0	33.53	-17.59	-25.37	620663.8	69.69	43.60	322.09	25065.27171029.18
13848.0	33.51	-17.54	-25.33	630031.5	70.02	43.85	322.72	25215.65172461.23

14016.0	33.48	-17.49	-25.30	639329.6	70.34	44.10	323.33	25364.77173889.66
14184.0	33.46	-17.44	-25.26	648558.2	70.65	44.34	323.94	25512.65175314.56
14352.0	33.44	-17.39	-25.22	657711.0	70.96	44.57	324.53	25659.39176736.95
14520.0	33.42	-17.34	-25.19	666805.5	71.26	44.80	325.12	25804.91178154.96
14688.0	33.40	-17.29	-25.15	675833.8	71.56	45.03	325.70	25949.30179569.61
14784.0	33.39	-17.26	-25.13	680963.0	71.73	45.16	326.03	26031.30180376.47

TOTAL ENERGY INPUT BTU	=	0.703207E+10
SEASONAL ENERGY INPUT BTU	=	0.289246E+10
TOTAL ENERGY INPUT GAL FUEL	=	50229.08
SEASONAL ENERGY INPUT GAL FUEL	=	20660.41
AVERAGE LB. WATER PER LB. FUEL	=	34.57
SEASONAL LB. WATER PER LB. FUEL	=	32.22
ENERGY FROM AIR TO ICE BTU	=	0.198911E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.101307E+10
TOTAL WATER WITHDRAWN GAL	=	805798.96
SEASONAL WATER WITHDRAWN GAL	=	219004.53
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	14808.00

14856.0	33.27	-17.29	-25.11	680075.7	71.73	45.10	326.26	26120.82181525.63
15024.0	33.26	-17.36	-25.08	671850.8	71.56	44.76	326.74	26358.59184813.21
15192.0	33.28	-17.42	-25.05	663621.4	71.39	44.43	327.22	26596.97188099.60
15360.0	33.30	-17.49	-25.03	655420.1	71.22	44.10	327.71	26836.19191386.02
15528.0	33.31	-17.56	-25.01	647247.1	71.04	43.76	328.21	27076.24194672.47
15696.0	33.33	-17.64	-24.99	639102.2	70.86	43.43	328.71	27317.15197958.93
15864.0	33.34	-17.71	-24.98	630984.6	70.68	43.10	329.21	27558.92201245.37
16032.0	33.36	-17.79	-24.97	622895.9	70.50	42.76	329.72	27801.58204531.66
16200.0	33.38	-17.87	-24.97	614835.3	70.31	42.43	330.23	28045.13207818.35
16368.0	33.40	-17.96	-24.97	606794.2	70.13	42.10	330.75	28289.63211105.82
16536.0	33.41	-18.04	-24.97	598790.1	69.94	41.77	331.27	28535.00214392.32
16704.0	33.43	-18.13	-24.97	590813.7	69.75	41.44	331.80	28781.30217678.81
16872.0	33.45	-18.22	-24.98	582866.7	69.55	41.11	332.34	29028.56220965.34
17040.0	33.47	-18.31	-24.99	574948.5	69.36	40.79	332.88	29276.78224251.89
17208.0	33.49	-18.41	-25.01	567059.2	69.16	40.46	333.42	29525.99227538.45
17376.0	33.51	-18.50	-25.02	559199.1	68.96	40.13	333.97	29776.19230825.04
17544.0	33.53	-18.60	-25.04	551367.6	68.75	39.80	334.53	30027.40234111.63
17712.0	33.55	-18.70	-25.07	543566.7	68.54	39.48	335.09	30279.65237398.28
17760.0	33.56	-18.73	-25.07	541343.1	68.48	39.39	335.25	30351.92238337.33

TOTAL ENERGY INPUT BTU	=	0.838237E+10
SEASONAL ENERGY INPUT BTU	=	0.135030E+10
TOTAL ENERGY INPUT GAL FUEL	=	59874.10
SEASONAL ENERGY INPUT GAL FUEL	=	9645.02
AVERAGE LB. WATER PER LB. FUEL	=	33.50
SEASONAL LB. WATER PER LB. FUEL	=	27.90
ENERGY FROM AIR TO ICE BTU	=	0.257856E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.589452E+09
TOTAL WATER WITHDRAWN GAL	=	1175696.27
SEASONAL WATER WITHDRAWN GAL	=	369897.31
TOTAL WATER LOSS GAL	=	35992.68

SEASONAL WATER LOSS GAL = 0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE 15m/hr = 7549.50
WATER WITHDRAWAL GAL/DAY = 900.00
WITHDRAWAL FLOW RATE GAL/MIN = 15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
START WITHDRAWAL AT HOUR = 17764.00

17880.0	33.71	-18.72	-25.09	545385.0	68.64	39.50	335.71	30474.94239603.28
18048.0	33.68	-18.72	-25.11	554727.9	68.98	39.78	336.37	30628.22241005.77
18216.0	33.65	-18.71	-25.13	563995.3	69.31	40.06	337.03	30780.10242404.72
18384.0	33.63	-18.70	-25.15	573183.7	69.63	40.34	337.67	30930.59243800.02
18552.0	33.60	-18.70	-25.16	582295.5	69.95	40.61	338.30	31079.74245191.79
18720.0	33.58	-18.69	-25.18	591331.0	70.26	40.87	338.93	31227.58246580.07
18888.0	33.55	-18.68	-25.19	600291.1	70.57	41.13	339.54	31374.14247964.90
19056.0	33.53	-18.67	-25.20	609176.5	70.87	41.38	340.14	31519.46249346.34
19224.0	33.51	-18.66	-25.21	617988.2	71.17	41.63	340.74	31663.57250724.45
19392.0	33.48	-18.65	-25.22	626726.3	71.47	41.87	341.33	31806.51252099.44
19560.0	33.46	-18.64	-25.23	635393.2	71.75	42.11	341.91	31948.28253471.02
19728.0	33.44	-18.62	-25.24	643988.9	72.04	42.34	342.48	32088.91254839.16
19896.0	33.42	-18.61	-25.24	652514.3	72.32	42.57	343.04	32228.42256203.92
20064.0	33.40	-18.60	-25.25	660970.3	72.59	42.80	343.60	32366.84257565.34
20232.0	33.38	-18.59	-25.25	669356.8	72.86	43.02	344.15	32504.19258923.45
20400.0	33.37	-18.57	-25.26	677676.1	73.13	43.24	344.69	32640.51260276.34
20568.0	33.35	-18.56	-25.26	685928.4	73.39	43.45	345.22	32775.80261630.03
20736.0	33.33	-18.54	-25.26	694114.3	73.65	43.66	345.75	32910.10262978.57
20904.0	33.31	-18.53	-25.26	702234.6	73.91	43.87	346.27	33043.42264324.01
21072.0	33.30	-18.51	-25.26	710289.4	74.16	44.07	346.78	33175.79265666.36
21240.0	33.28	-18.50	-25.26	718280.8	74.41	44.27	347.29	33307.22267005.71
21408.0	33.27	-18.48	-25.26	726200.1	74.65	44.46	347.79	33437.80268343.04
21576.0	33.25	-18.47	-25.26	734065.4	74.89	44.66	348.29	33567.43269676.46
21744.0	33.24	-18.45	-25.25	741868.8	75.13	44.85	348.78	33696.19271007.01
21912.0	33.22	-18.44	-25.25	749610.3	75.37	45.03	349.27	33824.08272334.65
22080.0	33.21	-18.42	-25.25	757291.8	75.60	45.21	349.75	33951.14273659.50
22248.0	33.20	-18.40	-25.24	764913.4	75.83	45.39	350.22	34077.37274981.56
22416.0	33.18	-18.39	-25.24	772475.7	76.05	45.57	350.69	34202.80276300.87
22584.0	33.17	-18.37	-25.23	779979.4	76.28	45.75	351.15	34327.43277617.46
22752.0	33.16	-18.35	-25.22	787424.4	76.49	45.92	351.61	34451.28278931.36
22920.0	33.14	-18.34	-25.22	794812.6	76.71	46.09	352.06	34574.38280242.62
23088.0	33.13	-18.32	-25.21	802144.1	76.93	46.25	352.51	34696.72281551.28
23256.0	33.12	-18.30	-25.20	809419.5	77.14	46.42	352.96	34818.34282857.36
23424.0	33.11	-18.28	-25.20	816639.2	77.35	46.58	353.40	34939.23284160.89
23592.0	33.10	-18.27	-25.19	823762.0	77.49	46.69	353.71	35055.14285090.42

TOTAL ENERGY INPUT BTU = 0.112968E+11
SEASONAL ENERGY INPUT BTU = 0.291442E+10
TOTAL ENERGY INPUT GAL FUEL = 80691.41
SEASONAL ENERGY INPUT GAL FUEL = 20817.31
AVERAGE LB. WATER PER LB. FUEL = 32.09
SEASONAL LB. WATER PER LB. FUEL = 28.03
ENERGY FROM AIR TO ICE BTU = 0.384632E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.126776E+10
TOTAL WATER WITHDRAWN GAL = 1394700.79
SEASONAL WATER WITHDRAWN GAL = 219004.53
TOTAL WATER LOSS GAL = 35992.68
SEASONAL WATER LOSS GAL = 0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	23568.00

23592.0	33.02	-18.29	-25.19	821502.2	77.50	46.67	353.83	35072.80	285736.44
23760.0	32.98	-18.35	-25.18	811545.5	77.29	46.35	354.19	35281.13	288924.27
23928.0	32.99	-18.42	-25.18	801522.9	77.08	46.03	354.54	35489.69	292109.10
24096.0	33.01	-18.48	-25.17	791544.4	76.87	45.71	354.91	35699.12	295294.65
24264.0	33.02	-18.55	-25.17	781610.3	76.66	45.39	355.27	35909.43	298480.92
24432.0	33.03	-18.61	-25.18	771720.0	76.44	45.07	355.64	36120.62	301667.87
24600.0	33.05	-18.69	-25.18	761874.8	76.22	44.75	356.02	36332.72	304855.54
24768.0	33.06	-18.75	-25.18	752074.3	76.00	44.42	356.40	36545.73	308043.90
24936.0	33.08	-18.82	-25.19	742309.9	75.78	44.10	356.78	36759.71	311233.91
25104.0	33.09	-18.89	-25.20	732599.0	75.56	43.78	357.17	36974.58	314423.63
25272.0	33.11	-18.97	-25.21	722932.5	75.34	43.46	357.57	37190.38	317613.98
25440.0	33.13	-19.04	-25.22	713311.9	75.11	43.14	357.97	37407.15	320805.02
25608.0	33.14	-19.12	-25.24	703736.6	74.88	42.82	358.37	37624.89	323996.72
25776.0	33.16	-19.19	-25.25	694206.9	74.65	42.50	358.78	37843.62	327189.05
25944.0	33.18	-19.27	-25.27	684723.0	74.42	42.18	359.19	38063.33	330382.02
26112.0	33.19	-19.35	-25.28	675264.3	74.19	41.86	359.61	38284.06	333575.60
26280.0	33.21	-19.43	-25.30	665892.6	73.95	41.55	360.03	38505.81	336769.83
26448.0	33.23	-19.51	-25.32	656547.3	73.72	41.23	360.46	38728.59	339964.67
26616.0	33.24	-19.55	-25.33	647256.1	73.61	41.09	360.64	38954.39	343134.07

TOTAL ENERGY INPUT BTU	=	0.126525E+11
SEASONAL ENERGY INPUT BTU	=	0.135574E+10
TOTAL ENERGY INPUT GAL FUEL	=	90375.26
SEASONAL ENERGY INPUT GAL FUEL	=	9683.84
AVERAGE LB. WATER PER LB. FUEL	=	31.24
SEASONAL LB. WATER PER LB. FUEL	=	24.21
ENERGY FROM AIR TO ICE BTU	=	0.453940E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.693080E+09
TOTAL WATER WITHDRAWN GAL	=	1764590.60
SEASONAL WATER WITHDRAWN GAL	=	369889.81
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 4
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	26544.00

26616.0	33.38	-19.55	-25.35	654385.3	73.68	41.13	360.92	38911.47	342343.29
26784.0	33.37	-19.55	-25.37	644232.8	73.93	41.35	361.44	39042.53	345646.07
26952.0	33.35	-19.55	-25.39	634026.8	74.17	41.56	361.96	39172.72	348950.35
27120.0	33.33	-19.55	-25.41	623755.2	74.41	41.77	362.47	39301.97	352249.75
27288.0	33.32	-19.56	-25.42	613419.2	74.65	41.97	362.97	39430.31	355546.28
27456.0	33.30	-19.56	-25.44	603016.3	74.88	42.17	363.46	39557.75	358839.98
27624.0	33.29	-19.56	-25.46	592550.2	75.11	42.37	363.95	39684.32	362130.88
27792.0	33.27	-19.56	-25.47	582020.6	75.34	42.56	364.44	39810.02	365419.03
27960.0	33.25	-19.56	-25.49	571427.5	75.56	42.76	364.92	39934.87	368704.43

28128.0	33.24	-19.56	-25.50	722772.9	75.78	42.94	365.39	40058.90353987.18
28296.0	33.23	-19.56	-25.52	730056.8	76.00	43.13	365.86	40182.12355267.27
28464.0	33.21	-19.56	-25.53	737279.9	76.22	43.31	366.32	40304.54356544.74
28632.0	33.20	-19.56	-25.54	744442.6	76.43	43.49	366.78	40426.19357819.63
28800.0	33.19	-19.55	-25.55	751545.1	76.64	43.66	367.23	40547.06359091.94
28968.0	33.17	-19.55	-25.57	758589.2	76.84	43.84	367.67	40667.19360361.75
29136.0	33.16	-19.55	-25.58	765574.9	77.05	44.01	368.12	40786.59361629.08
29304.0	33.15	-19.55	-25.59	772502.9	77.25	44.17	368.56	40905.26362893.94
29472.0	33.14	-19.55	-25.60	779373.6	77.45	44.34	368.99	41023.22364156.38
29640.0	33.12	-19.54	-25.61	786187.0	77.64	44.50	369.42	41140.49365416.40
29808.0	33.11	-19.54	-25.61	792945.0	77.84	44.66	369.84	41257.07366674.07
29976.0	33.10	-19.54	-25.62	799638.9	78.03	44.82	370.26	41373.03367930.36
30144.0	33.09	-19.54	-25.63	806286.5	78.22	44.97	370.68	41488.28369183.38
30312.0	33.08	-19.53	-25.64	812879.8	78.40	45.12	371.09	41602.88370434.11
30480.0	33.07	-19.53	-25.64	819418.6	78.59	45.27	371.50	41716.85371682.56
30648.0	33.06	-19.52	-25.65	825904.9	78.77	45.42	371.90	41830.19372928.80
30816.0	33.05	-19.52	-25.66	832338.3	78.95	45.57	372.30	41942.92374172.84
30984.0	33.04	-19.52	-25.66	838719.5	79.13	45.71	372.70	42055.04375414.69
31152.0	33.03	-19.51	-25.67	845049.0	79.30	45.85	373.09	42166.56376654.39
31320.0	33.02	-19.51	-25.67	851326.6	79.48	45.99	373.48	42277.50377891.94
31488.0	33.01	-19.50	-25.68	857554.2	79.65	46.13	373.87	42387.87379127.40
31656.0	33.00	-19.50	-25.68	863731.6	79.82	46.26	374.25	42497.67380360.79
31824.0	32.99	-19.49	-25.68	869859.2	79.98	46.40	374.63	42606.91381592.11
31992.0	32.98	-19.49	-25.69	875937.6	80.15	46.53	375.01	42715.60382821.40
32160.0	32.98	-19.48	-25.69	881966.6	80.31	46.66	375.38	42823.75384048.66
32304.0	32.97	-19.48	-25.69	887096.5	80.45	46.77	375.70	42916.03385099.03

TOTAL ENERGY INPUT BTU	=	0.155756E+11
SEASONAL ENERGY INPUT BTU	=	0.292309E+10
TOTAL ENERGY INPUT GAL FUEL	=	111254.45
SEASONAL ENERGY INPUT GAL FUEL	=	20879.19
AVERAGE LB. WATER PER LB. FUEL	=	30.14
SEASONAL LB. WATER PER LB. FUEL	=	25.38
ENERGY FROM AIR TO ICE BTU	=	0.596731E+10
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.142791E+10
TOTAL WATER WITHDRAWN GAL	=	1983587.63
SEASONAL WATER WITHDRAWN GAL	=	218997.03
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 4
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	32328.00

32328.0	32.97	-19.48	-25.69	887948.0	80.47	46.79	375.75	42931.37385273.94
32496.0	32.85	-19.55	-25.70	876975.5	80.24	46.47	376.05	43125.06388398.46
32664.0	32.86	-19.61	-25.70	865774.3	80.01	46.15	376.35	43318.12391515.31
32832.0	32.87	-19.67	-25.71	854629.3	79.77	45.83	376.65	43512.11394633.30
33000.0	32.89	-19.74	-25.72	843540.8	79.53	45.51	376.96	43707.02397752.44
33168.0	32.90	-19.80	-25.72	832510.1	79.29	45.19	377.27	43902.87400872.76
33336.0	32.91	-19.86	-25.73	821536.7	79.04	44.87	377.58	44099.68403994.23
33504.0	32.93	-19.93	-25.74	810612.1	78.80	44.55	377.90	44297.49407117.81
33672.0	32.94	-19.99	-25.76	799753.7	78.55	44.23	378.22	44496.23410241.55
33840.0	32.96	-20.06	-25.77	788952.6	78.30	43.91	378.55	44695.96413366.41
34008.0	32.97	-20.12	-25.78	778210.1	78.05	43.59	378.88	44896.69416492.40

34176.0	32.99	-20.19	-25.80	767516.9	77.80	43.27	379.22	45098.47419620.47
34344.0	33.01	-20.26	-25.81	756890.9	77.54	42.95	379.56	45301.23422748.68
34512.0	33.02	-20.33	-25.83	746323.4	77.29	42.63	379.91	45505.03425877.99
34680.0	33.04	-20.40	-25.85	735814.1	77.03	42.31	380.26	45709.87429008.37
34848.0	33.06	-20.47	-25.87	725364.3	76.77	41.99	380.61	45915.78432139.86
35016.0	33.07	-20.54	-25.89	714973.8	76.51	41.68	380.97	46122.77435272.42
35184.0	33.09	-20.62	-25.91	704642.8	76.25	41.36	381.34	46330.84438406.06
35280.0	33.10	-20.66	-25.92	698765.7	76.10	41.18	381.55	46450.24440197.17

TOTAL ENERGY INPUT BTU	=	0.169338E+11
SEASONAL ENERGY INPUT BTU	=	0.135818E+10
TOTAL ENERGY INPUT GAL FUEL	=	120955.73
SEASONAL ENERGY INPUT GAL FUEL	=	9701.28
AVERAGE LB. WATER PER LB. FUEL	=	29.48
SEASONAL LB. WATER PER LB. FUEL	=	21.87
ENERGY FROM AIR TO ICE BTU	=	0.672606E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.758746E+09
TOTAL WATER WITHDRAWN GAL	=	2353484.93
SEASONAL WATER WITHDRAWN GAL	=	369897.31
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 5
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	35304.00

35352.0	33.23	-20.66	-25.93	699068.9	76.11	41.18	381.73	46513.21440992.87
35520.0	33.24	-20.66	-25.95	705944.7	76.31	41.36	382.18	46632.59442230.43
35688.0	33.23	-20.67	-25.97	712802.3	76.52	41.54	382.63	46751.45443466.83
35856.0	33.21	-20.68	-25.99	719600.5	76.72	41.72	383.08	46869.57444700.86
36024.0	33.20	-20.68	-26.01	726339.9	76.91	41.90	383.52	46986.97445932.55
36192.0	33.18	-20.69	-26.03	733021.1	77.11	42.07	383.96	47103.64447161.93
36360.0	33.17	-20.69	-26.05	739644.5	77.30	42.24	384.39	47219.62448389.01
36528.0	33.16	-20.70	-26.06	746210.1	77.49	42.41	384.82	47334.90449613.82
36696.0	33.15	-20.70	-26.08	752719.9	77.68	42.57	385.24	47449.51450836.41
36864.0	33.14	-20.71	-26.10	759173.6	77.86	42.73	385.66	47563.46452056.79
37032.0	33.12	-20.71	-26.12	765563.2	78.04	42.89	386.07	47676.80453275.97
37200.0	33.11	-20.72	-26.13	771906.3	78.22	43.05	386.48	47789.45454492.01
37368.0	33.10	-20.72	-26.15	778194.6	78.40	43.20	386.89	47901.47455705.91
37536.0	33.09	-20.73	-26.16	784429.7	78.57	43.35	387.29	48012.87456917.73
37704.0	33.08	-20.73	-26.18	790611.4	78.75	43.50	387.69	48123.66458127.46
37872.0	33.07	-20.73	-26.19	796740.3	78.92	43.65	388.09	48233.86459335.13
38040.0	33.06	-20.74	-26.20	802816.7	79.09	43.80	388.48	48343.46460540.77
38208.0	33.05	-20.74	-26.22	808840.8	79.25	43.94	388.87	48452.49461744.39
38376.0	33.04	-20.74	-26.23	814814.1	79.42	44.08	389.25	48560.95462946.03
38544.0	33.03	-20.75	-26.24	820736.6	79.58	44.22	389.63	48668.85464145.70
38712.0	33.02	-20.75	-26.26	826608.7	79.74	44.36	390.01	48776.20465343.44
38880.0	33.01	-20.75	-26.27	832430.9	79.90	44.49	390.38	48883.00466539.25
39048.0	33.00	-20.76	-26.28	838203.0	80.06	44.62	390.75	48989.27467733.14
39216.0	32.99	-20.76	-26.29	843926.2	80.21	44.75	391.12	49095.02468925.17
39384.0	32.98	-20.76	-26.30	849602.2	80.37	44.88	391.48	49200.25470115.34
39552.0	32.98	-20.76	-26.31	855229.6	80.52	45.01	391.85	49304.97471303.66
39720.0	32.97	-20.76	-26.32	860809.3	80.67	45.14	392.20	49409.19472490.19
39888.0	32.96	-20.77	-26.33	866341.3	80.82	45.26	392.56	49512.92473674.89
40056.0	32.95	-20.77	-26.34	871827.2	80.96	45.38	392.91	49616.16474857.83

40224.0	32.94	-20.77	-26.35	877266.8	81.11	45.50	393.26	49718.93	476039.01
40392.0	32.94	-20.77	-26.36	882660.6	81.25	45.62	393.61	49821.22	477218.45
40560.0	32.93	-20.77	-26.37	888000.8	81.39	45.74	393.95	49923.10	478397.14
40728.0	32.92	-20.77	-26.38	893303.1	81.53	45.85	394.29	50024.46	479573.12
40896.0	32.91	-20.78	-26.39	898562.0	81.67	45.97	394.63	50125.38	480747.45
41064.0	32.91	-20.78	-26.40	903776.7	81.81	46.08	394.96	50225.86	481920.11
41064.0	32.91	-20.78	-26.40	903776.7	81.81	46.08	394.96	50225.86	481920.11

TOTAL ENERGY INPUT BTU	=	0.198607E+11
SEASONAL ENERGY INPUT BTU	=	0.292688E+10
TOTAL ENERGY INPUT GAL FUEL	=	141862.01
SEASONAL ENERGY INPUT GAL FUEL	=	20906.28
AVERAGE LB. WATER PER LB. FUEL	=	28.63
SEASONAL LB. WATER PER LB. FUEL	=	23.70
ENERGY FROM AIR TO ICE BTU	=	0.825511E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.152905E+10
TOTAL WATER WITHDRAWN GAL	=	2572489.46
SEASONAL WATER WITHDRAWN GAL	=	219004.53
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 5
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	41088.00

41232.0	32.78	-20.84	-26.40	894490.6	81.61	45.82	395.24	50399.30	484727.65
41400.0	32.80	-20.90	-26.41	882525.9	81.35	45.50	395.51	50584.06	487799.38
41568.0	32.81	-20.95	-26.42	870626.8	81.09	45.18	395.78	50769.78	490870.48
41736.0	32.83	-21.01	-26.44	858796.3	80.83	44.85	396.05	50956.49	493944.03
41904.0	32.84	-21.07	-26.45	847033.8	80.57	44.53	396.33	51144.21	497019.00
42072.0	32.85	-21.13	-26.46	835339.6	80.30	44.21	396.62	51332.95	500095.38
42240.0	32.87	-21.20	-26.47	823713.7	80.03	43.88	396.90	51522.70	503173.16
42408.0	32.88	-21.26	-26.49	812155.8	79.76	43.56	397.19	51713.50	506252.33
42576.0	32.90	-21.32	-26.50	800667.4	79.49	43.24	397.49	51905.35	509332.90
42744.0	32.92	-21.38	-26.52	789239.1	79.22	42.92	397.79	52098.30	512415.83
42912.0	32.93	-21.45	-26.54	777898.8	78.94	42.59	398.10	52292.29	515499.16
43080.0	32.95	-21.51	-26.55	766607.9	78.66	42.27	398.41	52487.37	518583.85
43248.0	32.97	-21.58	-26.57	755396.0	78.39	41.95	398.72	52683.56	521669.90
43416.0	32.98	-21.64	-26.59	744254.5	78.11	41.63	399.05	52880.86	524757.31
43584.0	33.00	-21.71	-26.61	733183.1	77.82	41.31	399.37	53079.30	527846.06
43752.0	33.02	-21.77	-26.63	722181.9	77.54	40.99	399.70	53278.89	530936.15
43920.0	33.04	-21.84	-26.65	711251.3	77.25	40.67	400.04	53479.64	534027.57
44040.0	33.05	-21.89	-26.67	703486.6	77.05	40.44	400.28	53623.75	536236.52

TOTAL ENERGY INPUT BTU	=	0.212199E+11
SEASONAL ENERGY INPUT BTU	=	0.135924E+10
TOTAL ENERGY INPUT GAL FUEL	=	151570.86
SEASONAL ENERGY INPUT GAL FUEL	=	9708.85
AVERAGE LB. WATER PER LB. FUEL	=	28.10
SEASONAL LB. WATER PER LB. FUEL	=	20.41
ENERGY FROM AIR TO ICE BTU	=	0.905437E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.799251E+09
TOTAL WATER WITHDRAWN GAL	=	2942386.77
SEASONAL WATER WITHDRAWN GAL	=	369897.31
TOTAL WATER LOSS GAL	=	35992.68

SEASONAL WATER LOSS GAL = 0.00

YEAR 6
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 7549.50
WATER WITHDRAWAL GAL/DAY = 900.00
WITHDRAWAL FLOW RATE GAL/MIN = 15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
START WITHDRAWAL AT HOUR = 44064.00

44088.0	33.15	-21.89	-26.67	702692.0	77.03	40.41	400.39	53668.04536844.44
44256.0	33.20	-21.90	-26.69	708929.4	77.21	40.58	400.81	53781.01538034.05
44424.0	33.18	-21.91	-26.71	715225.0	77.39	40.75	401.24	53893.86539223.51
44592.0	33.17	-21.91	-26.73	721465.1	77.57	40.92	401.65	54006.05540410.92
44760.0	33.16	-21.92	-26.75	727650.0	77.74	41.08	402.07	54117.60541596.31
44928.0	33.15	-21.93	-26.77	733780.1	77.92	41.24	402.48	54228.51542779.69
45096.0	33.13	-21.94	-26.79	739855.4	78.09	41.40	402.88	54338.81543961.07
45264.0	33.12	-21.95	-26.81	745877.6	78.26	41.55	403.28	54448.49545140.51
45432.0	33.11	-21.95	-26.83	751846.6	78.43	41.71	403.68	54557.58546318.01
45600.0	33.10	-21.96	-26.85	757762.9	78.59	41.86	404.08	54666.07547493.59
45768.0	33.09	-21.97	-26.87	763626.9	78.76	42.01	404.47	54773.99548667.28
45936.0	33.08	-21.98	-26.88	769438.6	78.92	42.15	404.85	54881.33549839.08
46104.0	33.07	-21.98	-26.90	775199.7	79.08	42.30	405.24	54988.12551009.04
46272.0	33.06	-21.99	-26.92	780910.0	79.24	42.44	405.62	55094.36552177.18
46440.0	33.05	-22.00	-26.93	786570.0	79.39	42.58	405.99	55200.05553343.50
46608.0	33.04	-22.00	-26.95	792180.2	79.55	42.72	406.36	55305.21554508.03
46776.0	33.03	-22.01	-26.96	797740.4	79.70	42.85	406.73	55409.84555670.77
46944.0	33.02	-22.02	-26.98	803252.3	79.85	42.99	407.10	55513.95556831.78
47112.0	33.01	-22.02	-27.00	808715.7	80.00	43.12	407.46	55617.56557991.06
47280.0	33.00	-22.03	-27.01	814131.1	80.14	43.25	407.82	55720.67559148.62
47448.0	32.99	-22.03	-27.02	819499.0	80.29	43.38	408.18	55823.28560304.49
47616.0	32.99	-22.04	-27.04	824819.1	80.43	43.50	408.53	55925.41561458.66
47784.0	32.98	-22.05	-27.05	830084.3	80.57	43.63	408.88	56027.10562612.17
47952.0	32.97	-22.05	-27.07	835312.1	80.71	43.75	409.23	56128.28563763.06
48120.0	32.96	-22.06	-27.08	840494.1	80.85	43.87	409.58	56229.00564912.33
48288.0	32.95	-22.06	-27.09	845630.6	80.99	43.99	409.92	56329.26566059.99
48456.0	32.95	-22.07	-27.11	850721.5	81.12	44.11	410.26	56429.07567206.05
48624.0	32.94	-22.07	-27.12	855768.4	81.26	44.22	410.60	56528.43568350.55
48792.0	32.93	-22.08	-27.13	860771.0	81.39	44.34	410.93	56627.36569493.49
48960.0	32.92	-22.08	-27.14	865729.9	81.52	44.45	411.26	56725.86570634.90
49128.0	32.92	-22.09	-27.16	870645.4	81.65	44.56	411.59	56823.94571774.78
49296.0	32.91	-22.09	-27.17	875517.3	81.78	44.67	411.92	56921.59572913.14
49464.0	32.90	-22.10	-27.18	880347.1	81.90	44.78	412.24	57018.84574050.02
49632.0	32.89	-22.10	-27.19	885134.8	82.03	44.89	412.56	57115.68575185.43
49800.0	32.89	-22.11	-27.20	889880.5	82.15	44.99	412.88	57212.12576319.37
49824.0	32.89	-22.11	-27.20	890555.0	82.17	45.01	412.93	57225.86576481.24

TOTAL ENERGY INPUT BTU = 0.241481E+11
SEASONAL ENERGY INPUT BTU = 0.292817E+10
TOTAL ENERGY INPUT GAL FUEL = 172486.33
SEASONAL ENERGY INPUT GAL FUEL = 20915.47
AVERAGE LB. WATER PER LB. FUEL = 27.44
SEASONAL LB. WATER PER LB. FUEL = 22.68
ENERGY FROM AIR TO ICE BTU = 0.106438E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.158946E+10
TOTAL WATER WITHDRAWN GAL = 3161391.29
SEASONAL WATER WITHDRAWN GAL = 219004.53
TOTAL WATER LOSS GAL = 35992.68
SEASONAL WATER LOSS GAL = 0.00

YEAR 6
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	49848.00

49968.0	32.76	-22.16	-27.21	882589.2	82.00	44.79	413.16	57369.38578819.56
50136.0	32.77	-22.21	-27.23	870156.9	81.72	44.47	413.41	57549.94581857.42
50304.0	32.79	-22.27	-27.24	857798.3	81.43	44.14	413.66	57731.54584896.76
50472.0	32.81	-22.33	-27.25	845517.3	81.15	43.81	413.92	57914.19587937.68
50640.0	32.82	-22.39	-27.27	833313.9	80.87	43.48	414.18	58097.91590980.17
50808.0	32.84	-22.44	-27.28	821188.5	80.58	43.16	414.45	58282.72594024.22
50976.0	32.85	-22.50	-27.30	809140.5	80.29	42.83	414.72	58468.63597069.81
51144.0	32.87	-22.56	-27.31	797171.4	80.00	42.50	415.00	58653.64600116.96
51312.0	32.89	-22.62	-27.33	785272.1	79.71	42.18	415.28	58843.63603166.61
51480.0	32.90	-22.68	-27.34	773460.2	79.41	41.85	415.57	59033.12606216.82
51648.0	32.92	-22.74	-27.36	761727.1	79.12	41.52	415.86	59223.56609268.55
51816.0	32.94	-22.80	-27.38	750072.6	78.82	41.20	416.16	59415.17612321.77
51984.0	32.96	-22.86	-27.40	738498.1	78.52	40.87	416.47	59607.97615376.51
52152.0	32.98	-22.93	-27.42	727003.1	78.22	40.55	416.77	59801.96618432.74
52320.0	33.00	-22.99	-27.44	715587.9	77.92	40.22	417.09	59997.18621490.46
52488.0	33.02	-23.05	-27.46	704232.6	77.61	39.90	417.41	60193.82624549.65
52656.0	33.04	-23.11	-27.48	692997.7	77.30	39.57	417.73	60391.32627610.31
52800.0	33.05	-23.17	-27.50	683414.3	77.04	39.29	418.02	60561.78630234.88

TOTAL ENERGY INPUT BTU	=	0.255076E+11
SEASONAL ENERGY INPUT BTU	=	0.135950E+10
TOTAL ENERGY INPUT GAL FUEL	=	182197.07
SEASONAL ENERGY INPUT GAL FUEL	=	9710.74
AVERAGE LB. WATER PER LB. FUEL	=	27.02
SEASONAL LB. WATER PER LB. FUEL	=	19.58
ENERGY FROM AIR TO ICE BTU	=	0.114659E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.822049E+09
TOTAL WATER WITHDRAWN GAL	=	3531281.10
SEASONAL WATER WITHDRAWN GAL	=	369889.81
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 7
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	52824.00

52824.0	33.06	-23.18	-27.50	681822.8	76.99	39.25	418.07	60590.28630672.41
52992.0	33.20	-23.18	-27.52	687618.2	77.16	39.41	418.47	60699.42631821.60
53160.0	33.19	-23.19	-27.54	693621.1	77.33	39.58	418.89	60809.34632975.54
53328.0	33.18	-23.20	-27.56	699570.1	77.50	39.74	419.30	60918.64634127.64
53496.0	33.17	-23.21	-27.58	705465.4	77.67	39.90	419.70	61027.33635277.90
53664.0	33.16	-23.21	-27.60	711306.7	77.84	40.06	420.10	61135.41636426.34
53832.0	33.14	-23.22	-27.62	717095.9	78.00	40.22	420.50	61242.91637573.01
54000.0	33.13	-23.23	-27.64	722832.7	78.16	40.37	420.89	61349.83638717.90
54168.0	33.12	-23.24	-27.66	728517.7	78.32	40.53	421.28	61456.18639861.05

54336.0	33.11	-23.25	-27.68	734151.3	78.48	40.68	421.67	61561.96641002.46
54504.0	33.10	-23.26	-27.70	739733.4	78.63	40.82	422.05	61667.20642142.15
54672.0	33.09	-23.27	-27.71	745265.7	78.79	40.97	422.43	61771.89643280.16
54840.0	33.08	-23.28	-27.73	750748.0	78.94	41.11	422.81	61876.05644416.49
55008.0	33.07	-23.28	-27.75	756180.8	79.09	41.25	423.18	61979.69645551.17
55176.0	33.06	-23.29	-27.77	761564.5	79.24	41.39	423.55	62082.80646684.21
55344.0	33.05	-23.30	-27.78	766899.0	79.38	41.53	423.91	62185.41647615.62
55512.0	33.04	-23.31	-27.80	772186.0	79.53	41.66	424.27	62287.52648945.45
55680.0	33.03	-23.32	-27.82	777425.2	79.67	41.79	424.63	62389.14650073.68
55848.0	33.02	-23.32	-27.83	782617.0	79.81	41.92	424.99	62490.27651200.35
56016.0	33.01	-23.33	-27.85	787762.0	79.95	42.05	425.34	62590.93652325.47
56184.0	33.00	-23.34	-27.87	792860.0	80.09	42.18	425.69	62691.12653449.05
56352.0	32.99	-23.35	-27.88	797903.8	80.23	42.30	426.04	62790.68654572.09
56520.0	32.99	-23.35	-27.90	802910.8	80.36	42.43	426.39	62890.16655692.66
56688.0	32.98	-23.36	-27.91	807872.6	80.49	42.55	426.73	62988.98656811.75
56856.0	32.97	-23.37	-27.93	812787.5	80.62	42.67	427.07	63087.36657929.37
57024.0	32.96	-23.37	-27.94	817661.6	80.75	42.78	427.40	63185.30659045.52
57192.0	32.95	-23.38	-27.96	822490.2	80.88	42.90	427.74	63282.61660160.24
57360.0	32.95	-23.39	-27.97	827275.3	81.01	43.01	428.07	63379.91661273.54
57528.0	32.94	-23.40	-27.98	832017.2	81.14	43.13	428.39	63476.58662385.44
57696.0	32.93	-23.40	-28.00	836716.2	81.26	43.24	428.72	63572.85663495.94
57864.0	32.92	-23.41	-28.01	841372.3	81.38	43.35	429.04	63668.71664605.04
58032.0	32.92	-23.42	-28.02	845986.9	81.50	43.46	429.36	63764.17665712.80
58200.0	32.91	-23.42	-28.04	850557.8	81.62	43.56	429.68	63859.24666819.20
58368.0	32.90	-23.43	-28.05	855091.5	81.74	43.67	430.00	63953.92667924.27
58536.0	32.90	-23.44	-28.06	859582.2	81.86	43.77	430.31	64048.22669028.01
58534.0	32.89	-23.44	-28.07	860857.7	81.89	43.80	430.40	64075.10669343.12

TOTAL ENERGY INPUT BTU	=	0.284355E+11
SEASONAL ENERGY INPUT BTU	=	0.292793E+10
TOTAL ENERGY INPUT GAL FUEL	=	203110.87
SEASONAL ENERGY INPUT GAL FUEL	=	20913.80
AVERAGE LB. WATER PER LB. FUEL	=	26.52
SEASONAL LB. WATER PER LB. FUEL	=	22.15
ENERGY FROM AIR TO ICE BTU	=	0.130868E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.162093E+10
TOTAL WATER WITHDRAWN GAL	=	3750278.13
SEASONAL WATER WITHDRAWN GAL	=	218997.03
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 7
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	58608.00

58704.0	32.77	-23.48	-28.08	854483.9	81.75	43.63	430.59	64191.63671226.36
58872.0	32.78	-23.53	-28.09	841798.5	81.45	43.30	430.84	64370.55674241.54
59040.0	32.79	-23.59	-28.10	829189.4	81.15	42.97	431.08	64550.55677256.13
59208.0	32.81	-23.64	-28.12	816666.3	80.85	42.63	431.34	64731.68680272.36
59376.0	32.83	-23.70	-28.13	804229.4	80.54	42.30	431.59	64913.95683290.22
59544.0	32.85	-23.75	-28.15	791878.4	80.24	41.97	431.86	65097.38686309.69
59712.0	32.86	-23.81	-28.17	779614.6	79.93	41.64	432.12	65281.99689330.79
59880.0	32.88	-23.87	-28.18	767423.9	79.62	41.31	432.40	65467.83692354.46
60048.0	32.90	-23.92	-28.20	755339.0	79.31	40.97	432.68	65654.84695378.75
60216.0	32.92	-23.98	-28.22	743336.4	79.00	40.64	432.96	65843.07698404.63

60364.0	32.94	-24.04	-28.23	701420.6	78.68	40.31	433.25	66032.63701432.07
60552.0	32.96	-24.10	-28.25	719584.4	78.37	39.98	433.54	66223.30704462.06
60720.0	32.98	-24.15	-28.27	707844.9	78.05	39.65	433.85	66415.30707492.64
60888.0	33.00	-24.21	-28.29	696193.5	77.73	39.32	434.15	66606.58710524.76
61056.0	33.02	-24.27	-28.31	684630.5	77.40	38.99	434.47	66803.17713558.41
61224.0	33.04	-24.33	-28.33	673156.1	77.08	38.66	434.78	66999.09716593.58
61392.0	33.07	-24.39	-28.35	661770.0	76.75	38.33	435.11	67196.35719630.26
61560.0	33.09	-24.45	-28.37	650473.6	76.42	38.01	435.44	67394.97722668.46
61560.0	33.09	-24.45	-28.37	650473.6	76.42	38.01	435.44	67394.97722668.46

TOTAL ENERGY INPUT BTU	=	0.297948E+11
SEASONAL ENERGY INPUT BTU	=	0.135924E+10
TOTAL ENERGY INPUT GAL FUEL	=	212819.75
SEASONAL ENERGY INPUT GAL FUEL	=	9708.88
AVERAGE LB. WATER PER LB. FUEL	=	26.19
SEASONAL LB. WATER PER LB. FUEL	=	19.20
ENERGY FROM AIR TO ICE BTU	=	0.139191E+11
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.832332E+09
TOTAL WATER WITHDRAWN GAL	=	4120175.43
SEASONAL WATER WITHDRAWN GAL	=	369897.31
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 8
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	61584.00

61728.0	33.25	-24.46	-28.39	653711.2	76.51	38.10	435.84	67515.92724062.47
61896.0	33.23	-24.47	-28.41	659611.3	76.69	38.27	436.26	67624.79725187.62
62064.0	33.22	-24.48	-28.43	665458.1	76.85	38.44	436.67	67733.05726311.06
62232.0	33.21	-24.49	-28.45	671250.5	77.02	38.61	437.08	67840.70727432.79
62400.0	33.19	-24.50	-28.47	676990.0	77.19	38.77	437.48	67947.74728552.85
62568.0	33.18	-24.51	-28.49	682676.7	77.35	38.94	437.88	68054.20729671.25
62736.0	33.17	-24.52	-28.51	688310.9	77.51	39.09	438.28	68160.08730788.01
62904.0	33.16	-24.53	-28.53	693893.2	77.67	39.25	438.67	68265.39731903.13
63072.0	33.15	-24.54	-28.55	699423.4	77.83	39.40	439.06	68370.13733016.64
63240.0	33.13	-24.54	-28.57	704903.1	77.98	39.56	439.44	68474.33734128.57
63408.0	33.12	-24.55	-28.59	710323.6	78.13	39.70	439.83	68578.03735239.90
63576.0	33.11	-24.56	-28.60	715702.8	78.28	39.85	440.20	68681.16736348.71
63744.0	33.10	-24.57	-28.62	721032.3	78.43	40.00	440.58	68783.76737455.97
63912.0	33.09	-24.58	-28.64	726312.1	78.58	40.14	440.95	68885.84738561.70
64080.0	33.08	-24.59	-28.66	731543.7	78.72	40.28	441.32	68987.42739665.95
64248.0	33.07	-24.60	-28.67	736727.0	78.87	40.42	441.68	69088.50740768.70
64416.0	33.06	-24.60	-28.69	741862.4	79.01	40.55	442.04	69189.09741869.99
64584.0	33.05	-24.61	-28.71	746950.4	79.15	40.69	442.40	69289.20742969.82
64752.0	33.04	-24.62	-28.72	751990.8	79.29	40.82	442.75	69388.83744068.19
64920.0	33.03	-24.63	-28.74	756985.3	79.42	40.95	443.11	69487.99745165.16
65088.0	33.02	-24.64	-28.76	761933.6	79.56	41.08	443.46	69586.69746260.72
65256.0	33.01	-24.65	-28.77	766836.1	79.69	41.20	443.80	69684.95747354.89
65424.0	33.01	-24.65	-28.79	771693.3	79.82	41.33	444.14	69782.75748447.68
65592.0	33.00	-24.66	-28.80	776505.1	79.95	41.45	444.48	69880.11749539.09
65760.0	32.99	-24.67	-28.82	781272.9	80.08	41.57	444.82	69977.04750629.17
65928.0	32.98	-24.68	-28.83	785996.6	80.21	41.69	445.16	70073.55751717.91
66096.0	32.97	-24.68	-28.85	790676.7	80.33	41.81	445.49	70169.64752805.33
66264.0	32.96	-24.69	-28.86	795313.4	80.46	41.92	445.82	70265.31753891.45

66432.0	32.96	-24.70	-28.88	799506.6	80.56	42.04	446.15	70360.57754976.26
66600.0	32.95	-24.71	-28.89	804457.9	80.70	42.15	446.47	70455.43756059.81
66768.0	32.94	-24.71	-28.91	808967.0	80.82	42.26	446.79	70549.90757142.09
66936.0	32.93	-24.72	-28.92	813425.7	80.94	42.37	447.11	70644.02758224.09
67104.0	32.93	-24.73	-28.94	817851.6	81.06	42.48	447.43	70737.71759303.88
67272.0	32.92	-24.74	-28.95	822236.1	81.17	42.59	447.74	70831.02760382.43
67344.0	32.92	-24.74	-28.95	824103.2	81.22	42.63	447.88	70870.90760844.31

TOTAL ENERGY INPUT BTU	=	0.327215E+11
SEASONAL ENERGY INPUT BTU	=	0.292671E+10
TOTAL ENERGY INPUT GAL FUEL	=	233724.85
SEASONAL ENERGY INPUT GAL FUEL	=	20905.10
AVERAGE LB. WATER PER LB. FUEL	=	25.81
SEASONAL LB. WATER PER LB. FUEL	=	21.94
ENERGY FROM AIR TO ICE BTU	=	0.155513E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.163220E+10
TOTAL WATER WITHDRAWN GAL	=	4339179.96
SEASONAL WATER WITHDRAWN GAL	=	219004.53
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 8
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	67368.00

67440.0	32.79	-24.77	-28.96	819472.0	81.11	42.50	448.03	70961.71762286.21
67608.0	32.80	-24.82	-28.98	806676.5	80.80	42.16	448.28	71140.62765280.57
67776.0	32.81	-24.88	-28.99	793961.3	80.48	41.83	448.52	71320.56768275.12
67944.0	32.83	-24.93	-29.01	781339.6	80.16	41.49	448.78	71501.71771271.30
68112.0	32.85	-24.98	-29.02	768811.1	79.85	41.15	449.04	71684.08774269.09
68280.0	32.87	-25.04	-29.04	756376.9	79.52	40.81	449.30	71867.68777268.51
68448.0	32.89	-25.09	-29.05	744036.8	79.20	40.47	449.57	72052.54780269.53
68616.0	32.91	-25.14	-29.07	731790.9	78.88	40.14	449.84	72238.66783272.14
68784.0	32.93	-25.20	-29.09	719639.5	78.55	39.80	450.13	72426.08786276.33
68952.0	32.95	-25.25	-29.10	707582.2	78.22	39.46	450.41	72614.79789282.07
69120.0	32.97	-25.31	-29.12	695611.7	77.89	39.13	450.70	72804.87792290.37
69288.0	33.00	-25.36	-29.14	683745.1	77.55	38.79	451.00	72996.25795299.24
69456.0	33.02	-25.42	-29.16	671973.8	77.22	38.46	451.31	73188.99798309.65
69624.0	33.04	-25.48	-29.18	660298.0	76.88	38.12	451.62	73383.11801321.59
69792.0	33.07	-25.53	-29.20	648718.0	76.54	37.79	451.94	73578.62804335.03
69960.0	33.09	-25.59	-29.22	637233.6	76.19	37.45	452.26	73775.56807349.96
70128.0	33.12	-25.65	-29.24	625846.0	75.85	37.12	452.60	73973.93810366.40
70296.0	33.14	-25.71	-29.26	614554.9	75.50	36.79	452.94	74173.77813384.31
70320.0	33.15	-25.71	-29.26	612949.7	75.45	36.74	452.98	74202.44813815.55

TOTAL ENERGY INPUT BTU	=	0.340801E+11
SEASONAL ENERGY INPUT BTU	=	0.135866E+10
TOTAL ENERGY INPUT GAL FUEL	=	243429.56
SEASONAL ENERGY INPUT GAL FUEL	=	9704.71
AVERAGE LB. WATER PER LB. FUEL	=	25.54
SEASONAL LB. WATER PER LB. FUEL	=	19.11
ENERGY FROM AIR TO ICE BTU	=	0.163855E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.834133E+09
TOTAL WATER WITHDRAWN GAL	=	4709077.27
SEASONAL WATER WITHDRAWN GAL	=	369897.31

TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 9
STANDEY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	70344.00

70464.0	33.31	-25.72	-29.28	615354.7	75.52	36.82	453.33	74308.07815029.30
70632.0	33.30	-25.73	-29.30	621277.9	75.69	37.00	453.76	74416.99815129.26
70800.0	33.28	-25.74	-29.32	627147.5	75.87	37.18	454.18	74525.27817227.63
70968.0	33.27	-25.75	-29.34	632962.7	76.04	37.36	454.60	74632.93818324.40
71136.0	33.25	-25.76	-29.36	638723.2	76.21	37.53	455.01	74739.96819419.59
71304.0	33.24	-25.76	-29.33	644429.6	76.37	37.70	455.42	74846.38820513.20
71472.0	33.22	-25.77	-29.39	650082.4	76.54	37.87	455.83	74952.21821608.25
71640.0	33.21	-25.78	-29.41	655681.5	76.70	38.03	456.23	75057.45822695.76
71808.0	33.20	-25.79	-29.43	661228.5	76.86	38.19	456.63	75162.11823784.75
71976.0	33.19	-25.80	-29.45	666723.4	77.02	38.35	457.02	75266.20824872.25
72144.0	33.17	-25.81	-29.47	672166.5	77.18	38.51	457.41	75369.74825958.26
72312.0	33.16	-25.82	-29.49	677558.4	77.33	38.66	457.80	75472.73827042.80
72480.0	33.15	-25.83	-29.50	682898.9	77.48	38.82	458.18	75575.18828125.88
72648.0	33.14	-25.83	-29.52	688189.8	77.63	38.96	458.56	75677.10829207.54
72816.0	33.13	-25.84	-29.54	693430.6	77.78	39.11	458.93	75778.50830287.78
72984.0	33.12	-25.85	-29.56	698622.4	77.93	39.26	459.30	75879.39831366.61
73152.0	33.11	-25.86	-29.57	703765.1	78.07	39.40	459.67	75979.77832444.06
73320.0	33.10	-25.87	-29.59	708858.7	78.21	39.54	460.04	76079.66833520.12
73488.0	33.08	-25.88	-29.61	713904.8	78.35	39.68	460.40	76179.06834594.84
73656.0	33.07	-25.88	-29.62	718903.3	78.49	39.81	460.76	76277.99835668.22
73824.0	33.07	-25.89	-29.64	723854.7	78.63	39.95	461.11	76376.44836740.28
73992.0	33.06	-25.90	-29.66	728751.0	78.77	40.08	461.47	76474.48837812.01
74160.0	33.05	-25.91	-29.67	733608.3	78.90	40.21	461.81	76572.01838881.43
74328.0	33.04	-25.92	-29.69	738420.7	79.03	40.34	462.16	76669.09839949.59
74496.0	33.03	-25.92	-29.70	743187.7	79.16	40.47	462.50	76765.73841016.48
74664.0	33.02	-25.93	-29.72	747909.7	79.29	40.59	462.85	76861.94842082.11
74832.0	33.01	-25.94	-29.73	752587.0	79.42	40.71	463.18	76957.72843146.51
75000.0	33.00	-25.95	-29.75	757219.4	79.55	40.83	463.52	77053.07844209.66
75168.0	32.99	-25.95	-29.76	761808.6	79.67	40.95	463.85	77148.01845271.61
75336.0	32.98	-25.96	-29.78	766354.4	79.80	41.07	464.18	77242.54846332.36
75504.0	32.98	-25.97	-29.79	770857.2	79.92	41.19	464.51	77336.66847391.91
75672.0	32.97	-25.98	-29.81	775317.2	80.04	41.30	464.83	77430.39848450.29
75840.0	32.96	-25.98	-29.82	779734.5	80.16	41.41	465.15	77523.72849507.50
76008.0	32.95	-25.99	-29.84	784110.5	80.27	41.52	465.47	77616.67850563.56
76104.0	32.95	-26.00	-29.84	786592.6	80.34	41.58	465.66	77669.62851166.52

TOTAL ENERGY INPUT BTU	=	0.370051E+11
SEASONAL ENERGY INPUT BTU	=	0.292492E+10
TOTAL ENERGY INPUT GAL FUEL	=	264321.83
SEASONAL ENERGY INPUT GAL FUEL	=	20892.27
AVERAGE LB. WATER PER LB. FUEL	=	25.26
SEASONAL LB. WATER PER LB. FUEL	=	21.96
ENERGY FROM AIR TO ICE BTU	=	0.180158E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.163030E+10
TOTAL WATER WITHDRAWN GAL	=	4928081.79
SEASONAL WATER WITHDRAWN GAL	=	219004.53
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 9
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	76128.00

76176.0	32.83	-26.02	-29.65	783760.3	80.27	41.51	465.78	77735.00852171.65
76344.0	32.82	-26.07	-29.86	770980.4	79.94	41.16	466.02	77914.72855148.04
76512.0	32.84	-26.12	-29.88	758250.8	79.62	40.82	466.28	78095.47858125.04
76680.0	32.86	-26.17	-29.89	745620.5	79.28	40.47	466.53	78277.48861103.59
76848.0	32.88	-26.22	-29.91	733090.6	78.95	40.13	466.80	78460.78864083.71
77016.0	32.91	-26.27	-29.93	720660.9	78.62	39.79	467.06	78645.39867065.37
77184.0	32.93	-26.32	-29.94	708331.6	78.28	39.44	467.34	78831.32870048.56
77352.0	32.95	-26.38	-29.96	696102.7	77.94	39.10	467.62	79018.59873033.28
77520.0	32.97	-26.43	-29.97	683974.1	77.60	38.76	467.90	79207.22876019.50
77688.0	33.00	-26.48	-29.99	671938.4	77.25	38.42	468.20	79397.28879008.20
77856.0	33.02	-26.53	-30.01	660012.5	76.91	38.08	468.50	79588.69881997.41
78024.0	33.04	-26.59	-30.03	648188.1	76.56	37.74	468.80	79781.53884988.09
78192.0	33.07	-26.64	-30.04	636465.2	76.21	37.40	469.12	79975.61887980.24
78360.0	33.09	-26.69	-30.06	624844.1	75.85	37.06	469.44	80171.55890973.82
78528.0	33.12	-26.75	-30.08	613324.6	75.50	36.72	469.76	80368.77893968.83
78696.0	33.15	-26.80	-30.10	601907.9	75.14	36.38	470.10	80567.50896963.27
78864.0	33.18	-26.86	-30.12	590593.7	74.78	36.04	470.44	80767.77899963.12
79032.0	33.20	-26.91	-30.14	579382.3	74.41	35.70	470.79	80969.59902962.35
79080.0	33.21	-26.93	-30.15	576197.7	74.31	35.61	470.89	81027.54903819.52

TOTAL ENERGY INPUT BTU	=	0.383630E+11
SEASONAL ENERGY INPUT BTU	=	0.135789E+10
TOTAL ENERGY INPUT GAL FUEL	=	274021.08
SEASONAL ENERGY INPUT GAL FUEL	=	9699.25
AVERAGE LB. WATER PER LB. FUEL	=	25.04
SEASONAL LB. WATER PER LB. FUEL	=	19.21
ENERGY FROM AIR TO ICE BTU	=	0.188465E+11
SEASONAL ENERGY LOSS. AIR TO ICE BTU	=	0.830732E+09
TOTAL WATER WITHDRAWN GAL	=	5297971.60
SEASONAL WATER WITHDRAWN GAL	=	369889.81
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 10
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	900.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	79104.00

79200.0	33.38	-26.93	-30.16	577837.4	74.35	35.66	471.19	81118.18904859.43
79368.0	33.37	-26.94	-30.18	583856.2	74.54	35.86	471.63	81227.64905935.74
79536.0	33.35	-26.95	-30.20	589823.6	74.72	36.05	472.07	81336.45907010.62
79704.0	33.34	-26.96	-30.22	595733.9	74.90	36.24	472.50	81444.60908083.96
79872.0	33.32	-26.96	-30.24	601587.6	75.08	36.42	472.93	81552.09909155.78
80040.0	33.30	-26.97	-30.26	607385.2	75.25	36.60	473.35	81658.95910226.11
80208.0	33.29	-26.98	-30.27	613126.8	75.42	36.78	473.77	81765.17911294.94
80376.0	33.27	-26.98	-30.28	618913.8	75.59	36.96	474.18	81870.78912342.32

80544.0	33.26	-27.00	-30.31	624446.5	75.76	37.13	474.59	81975.78913428.26
80712.0	33.25	-27.00	-30.33	630025.1	75.92	37.30	474.99	82080.19914492.77
80880.0	33.23	-27.01	-30.35	635550.1	76.08	37.46	475.40	82184.02915555.86
81048.0	33.22	-27.02	-30.36	641021.5	76.24	37.63	475.79	82287.27916617.55
81216.0	33.21	-27.03	-30.38	646440.9	76.40	37.79	476.19	82389.96917677.88
81384.0	33.19	-27.04	-30.40	651808.3	76.56	37.95	476.57	82492.10918736.84
81552.0	33.18	-27.04	-30.41	657124.0	76.71	38.10	476.96	82593.70919794.45
81720.0	33.17	-27.05	-30.43	662338.6	76.87	38.26	477.34	82694.76920850.73
81888.0	33.16	-27.06	-30.45	667602.1	77.02	38.41	477.72	82795.30921905.69
82056.0	33.15	-27.07	-30.46	672765.9	77.16	38.56	478.09	82895.32922959.35
82224.0	33.13	-27.08	-30.48	677880.0	77.31	38.70	478.46	82994.84924011.73
82392.0	33.12	-27.08	-30.50	682944.9	77.45	38.85	478.83	83093.85925062.84
82560.0	33.11	-27.09	-30.51	687952.7	77.60	38.99	479.20	83192.43926113.68
82728.0	33.10	-27.10	-30.53	692919.4	77.74	39.13	479.56	83290.47927162.27
82896.0	33.09	-27.11	-30.55	697839.3	77.88	39.26	479.92	83388.05928209.66
83064.0	33.08	-27.11	-30.56	702711.8	78.01	39.40	480.27	83485.16929255.83
83232.0	33.07	-27.12	-30.58	707537.3	78.15	39.53	480.62	83581.81930300.79
83400.0	33.06	-27.13	-30.59	712316.2	78.28	39.66	480.97	83678.01931344.57
83568.0	33.05	-27.14	-30.61	717048.4	78.41	39.79	481.32	83773.76932387.17
83736.0	33.04	-27.14	-30.62	721735.5	78.54	39.92	481.66	83869.08933428.62
83904.0	33.03	-27.15	-30.64	726377.2	78.67	40.04	482.00	83963.96934468.91
84072.0	33.02	-27.16	-30.65	730974.2	78.80	40.17	482.33	84058.43935508.08
84240.0	33.02	-27.17	-30.67	735526.6	78.93	40.29	482.67	84152.48936546.12
84408.0	33.01	-27.17	-30.68	740034.5	79.05	40.41	483.00	84246.11937583.04
84576.0	33.00	-27.18	-30.69	744499.3	79.17	40.53	483.33	84339.35938618.87
84744.0	32.99	-27.19	-30.71	748920.9	79.29	40.64	483.65	84432.18939653.61
84912.0	32.98	-27.19	-30.72	752053.0	79.38	40.73	483.89	84498.26940392.06

TOTAL ENERGY INPUT BTU	=	0.412858E+11
SEASONAL ENERGY INPUT BTU	=	0.292286E+10
TOTAL ENERGY INPUT GAL FUEL	=	254898.67
SEASONAL ENERGY INPUT GAL FUEL	=	20877.59
AVERAGE LB. WATER PER LB. FUEL	=	24.84
SEASONAL LB. WATER PER LB. FUEL	=	22.10
ENERGY FROM AIR TO ICE BTU	=	0.204674E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.162092E+10
TOTAL WATER WITHDRAWN GAL	=	5516968.63
SEASONAL WATER WITHDRAWN GAL	=	218997.03
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

YEAR 10
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
WATER WITHDRAWAL GAL/DAY	=	3000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	84888.00

84912.0	32.90	-27.21	-30.72	751002.3	79.35	40.70	483.97	84537.90940965.16
85080.0	32.85	-27.26	-30.74	738317.7	79.02	40.35	484.23	84719.01943926.24
85248.0	32.88	-27.31	-30.75	725623.4	78.68	40.00	484.48	84900.89946886.74
85416.0	32.90	-27.35	-30.77	713034.4	78.34	39.65	484.74	85084.10949846.71
85584.0	32.92	-27.40	-30.78	700550.7	77.99	39.30	485.01	85268.65952812.12
85752.0	32.94	-27.45	-30.80	688172.2	77.65	38.95	485.29	85454.58955776.96
85920.0	32.97	-27.50	-30.81	675899.4	77.30	38.60	485.57	85641.89958743.21
86088.0	32.99	-27.55	-30.83	663731.7	76.95	38.25	485.85	85830.60961710.86
86256.0	33.02	-27.60	-30.85	651661.8	76.60	37.90	486.15	86020.79964680.90
86424.0	33.04	-27.65	-30.86	639706.9	76.24	37.55	486.45	86212.38967651.33

86592.0	33.07	-27.70	-30.88	627858.3	75.88	37.21	486.76	86405.44970623.12
86760.0	33.09	-27.75	-30.90	616107.7	75.52	36.86	487.07	86600.03973597.25
86928.0	33.12	-27.80	-30.91	604472.1	75.16	36.52	487.39	86796.10976571.72
87096.0	33.15	-27.85	-30.93	592943.3	74.79	36.17	487.72	86993.70979547.51
87264.0	33.18	-27.90	-30.95	581522.2	74.42	35.83	488.06	87192.86982524.62
87432.0	33.21	-27.95	-30.97	570208.5	74.05	35.48	488.40	87393.61985503.01
87600.0	33.24	-28.01	-30.99	559002.3	73.67	35.14	488.76	87595.97988482.68
87768.0	33.27	-28.06	-31.00	547903.8	73.30	34.80	489.12	87799.97991463.60
87840.0	33.28	-28.08	-31.01	543180.3	73.13	34.65	489.28	87887.91992741.52

TOTAL ENERGY INPUT BTU	=	0.426429E+11
SEASONAL ENERGY INPUT BTU	=	0.135706E+10
TOTAL ENERGY INPUT GAL FUEL	=	304591.93
SEASONAL ENERGY INPUT GAL FUEL	=	9693.26
AVERAGE LB. WATER PER LB. FUEL	=	24.66
SEASONAL LB. WATER PER LB. FUEL	=	19.41
ENERGY FROM AIR TO ICE BTU	=	0.212921E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.824695E+09
TOTAL WATER WITHDRAWN GAL	=	5886865.93
SEASONAL WATER WITHDRAWN GAL	=	369897.31
TOTAL WATER LOSS GAL	=	35992.68
SEASONAL WATER LOSS GAL	=	0.00

TOTAL ENERGY INPUT BTU	=	0.426429E+11
TOTAL ENERGY INPUT GAL FUEL	=	304591.93
TOTAL ENERGY LOSS AIR TO ICE BTU	=	0.212921E+11

APPENDIX D: REQUIREMENTS AND NUMERICAL PREDICTIONS, SOUTH POLE STATION WATER WELL, CONSTANT HEAT INPUT RATES.

Scenario No. 1.

Initial startup

Energy rate available: $Q_{bc} = 400,000 \text{ Btu/h}$
Boiler flow rate: $\dot{m}_f = 10 \text{ gal/min}$
Water withdrawal rate: $\dot{m}_o = 0 \text{ gal/day}$
Time: 0–5 days (0–120 h)

Second phase—5–14 days (120–336 h)

Energy rate available: $Q_{bc} = 800,000 \text{ Btu/h}$
Boiler flow rate: $\dot{m}_f = 10 \text{ gal/min}$
Water withdrawal rate: $\dot{m}_o = \text{variable (0–1000 gal/day)}$
Time: 120–336 h

Third phase—15–60 days

Energy rate available: $Q_{bc} = 800,000 \text{ Btu/h}$
Boiler flow rate: $\dot{m}_f = 15 \text{ gal/min}$
Water withdrawal rate: $\dot{m}_o = 600\text{--}1000 \text{ gal/day}$
Time: 336–1440 h

Fourth phase—61–300 days

Energy rate available: $Q_{bc} = 200,000 \text{ Btu/h}$
Boiler flow rate: $\dot{m}_f = 15 \text{ gal/min}$
Water withdrawal rate: $\dot{m}_o = 600 \text{ gal/day}$
Time: 1441–7200 h

Scenario No. 2

Phase 1—Same

Phase 2—Same

Phase 3—Same

Phase 4

Energy rate available: $Q_{bc} = 400,000 \text{ Btu/h}$
Boiler flow rate: $\dot{m}_f = 15 \text{ gal/min}$
Water withdrawal rate: $\dot{m}_o = 600 \text{ gal/day}$
Time: 61–300 days

Case 9

ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION

BOILER WATER TEMP DEG F = 124.00
 BOILER WATER FLOW RATE lbm/hr = 5033.00
 CONVECTIVE COEFFICIENT BTU/HR-FT²-F = 32.50
 INITIAL DRILL RADIUS FT = 1.50
 DEPTH TO TOP OF WATER AT START FT = 157.00
 INITIAL PARABOLIC WATER DIAMETER D FT = 4.24
 INITIAL PARABOLIC WATER HEIGHT HW FT = 10.00
 INITIAL WATER TEMP TW DEG F = 124.00
 INITIAL AIR TEMP TA DEG F = -60.00
 INITIAL ICE SURFACE TEMP TS DEG F = -60.00
 AMBIENT ICE TEMP DEG F = -60.00
 EFFECTIVE LATENT HEAT BTU/LB = 392.35
 TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT², AIR VOL VA FT³

TIME	TW	TA	TS	MW	D	HW	HWB	AI	VA
0.0	124.00	-60.00	-60.00	527.5	4.24	10.00	167.00	1479.69	1109.77
24.0	88.17	-51.53	-56.96	2530.8	9.19	10.24	174.30	1703.72	1362.60
48.0	73.47	-48.01	-54.92	4404.0	11.67	11.03	178.42	1880.60	1649.00
72.0	66.21	-45.53	-53.27	6148.0	13.41	11.67	181.51	2038.04	1952.38
96.0	61.72	-43.63	-51.88	7793.6	14.76	12.20	184.06	2183.60	2266.90
120.0	58.60	-42.10	-50.70	9362.8	15.89	12.65	186.26	2320.67	2589.26
144.0	56.27	-40.84	-49.67	10871.5	16.86	13.06	188.22	2451.14	2917.26
168.0	54.45	-39.76	-48.77	12331.9	17.71	13.42	190.00	2576.21	3249.36
170.8	54.26	-39.65	-48.67	12500.0	17.80	13.46	190.19	2590.54	3288.43

TOTAL ENERGY INPUT BTU = 0.683269E+08
 SEASONAL ENERGY INPUT BTU = 0.683269E+08
 SEASONAL ENERGY INPUT GAL FUEL = 488.05
 SEASONAL ENERGY RATE BTU/HR = 400017.12
 TOTAL ENERGY INPUT GAL FUEL = 488.05
 AVERAGE LB. WATER PER LB. FUEL = 28.66
 SEASONAL LB. WATER PER LB. FUEL = 28.66
 ENERGY FROM AIR TO ICE BTU = 0.273713E+07
 SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.273713E+07
 TOTAL WATER WITHDRAWN GAL = 0.00
 SEASONAL WATER WITHDRAWN GAL = 0.00
 TOTAL WATER LOSS GAL = 6779.04
 SEASONAL WATER LOSS GAL = 6779.04

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 7549.50
 BOILER WATER TEMPERATURE DEG F = 133.73
 WATER WITHDRAWAL GAL/DAY = 1000.00
 WITHDRAWAL FLOW RATE GAL/MIN = 15.00
 CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
 START WITHDRAWAL AT HOUR = 170.81

192.0	52.97	-38.84	-47.96	13753.1	18.48	13.75	191.63	2696.70	3584.39
360.0	51.10	-36.66	-44.84	16707.3	20.72	13.28	201.39	3616.64	6595.73
384.0	50.75	-36.47	-44.57	17244.4	21.02	13.32	202.65	3736.64	7004.14

TOTAL ENERGY INPUT BTU = 0.150049E+09
 SEASONAL ENERGY INPUT BTU = 0.817220E+08
 SEASONAL ENERGY INPUT GAL FUEL = 583.73
 SEASONAL ENERGY RATE BTU/HR = 383326.59
 TOTAL ENERGY INPUT GAL FUEL = 1071.78
 AVERAGE LB. WATER PER LB. FUEL = 26.94

SEASONAL LB. WATER PER LB. FUEL	=	25.50
ENERGY FROM AIR TO ICE BTU	=	0.841014E+07
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.567301E+07
TOTAL WATER WITHDRAWN GAL	=	7994.62
SEASONAL WATER WITHDRAWN GAL	=	7994.62
TOTAL WATER LOSS GAL	=	16184.68
SEASONAL WATER LOSS GAL	=	9405.64

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	103.74
WATER WITHDRAWAL GAL/DAY	=	1000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	384.00

528.0	48.55	-35.55	-43.30	21002.5	22.75	13.85	209.56	4406.39	9356.55
696.0	46.16	-34.69	-42.28	26369.9	24.67	14.79	216.39	5094.46	11915.34
864.0	44.13	-33.89	-41.46	32781.4	26.53	15.89	222.16	5697.54	14280.92
1032.0	42.47	-33.11	-40.75	40059.3	28.31	17.05	227.09	6231.37	16479.09
1200.0	41.16	-32.36	-40.09	47934.7	29.98	18.19	231.36	6711.53	18547.53
1368.0	40.11	-31.63	-39.48	56301.0	31.55	19.30	235.11	7147.61	20502.00
1488.0	39.49	-31.12	-39.05	62488.9	32.61	20.05	237.53	7437.03	21841.34

TOTAL ENERGY INPUT BTU	=	0.571198E+09
SEASONAL ENERGY INPUT BTU	=	0.421149E+09
SEASONAL ENERGY INPUT GAL FUEL	=	3008.21
SEASONAL ENERGY RATE BTU/HR	=	381473.80
TOTAL ENERGY INPUT GAL FUEL	=	4079.99
AVERAGE LB. WATER PER LB. FUEL	=	33.21
SEASONAL LB. WATER PER LB. FUEL	=	35.44
ENERGY FROM AIR TO ICE BTU	=	0.574433E+08
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.490331E+08
TOTAL WATER WITHDRAWN GAL	=	54004.92
SEASONAL WATER WITHDRAWN GAL	=	46010.30
TOTAL WATER LOSS GAL	=	35634.03
SEASONAL WATER LOSS GAL	=	19449.35

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	92.47
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	1488.01

1536.0	35.22	-31.43	-38.92	63382.7	32.78	20.13	238.06	7508.93	22208.93
1704.0	35.06	-31.06	-38.50	65824.5	33.21	20.36	239.42	7697.33	23178.16
1872.0	34.96	-30.72	-38.13	68357.4	33.65	20.60	240.74	7879.41	24121.13
2040.0	34.86	-30.40	-37.79	70946.2	34.08	20.84	242.01	8056.22	25044.42
2208.0	34.77	-30.10	-37.48	73548.5	34.50	21.08	243.24	8228.57	25953.71
2376.0	34.69	-29.83	-37.19	76125.5	34.91	21.32	244.43	8397.28	26854.40
2544.0	34.61	-29.58	-36.91	78651.4	35.30	21.54	245.58	8562.93	27750.28
2712.0	34.54	-29.35	-36.66	81124.1	35.67	21.75	246.70	8725.75	28641.88
2880.0	34.47	-29.13	-36.43	83545.9	36.03	21.96	247.78	8885.92	29529.40
3048.0	34.41	-28.92	-36.20	85917.7	36.38	22.15	248.83	9043.57	30412.96

3216.0	34.35	-28.73	-36.00	88240.9	36.72	22.34	249.86	9198.84	31292.70
3384.0	34.29	-28.56	-35.80	90516.6	37.04	22.51	250.86	9351.85	32168.75
3552.0	34.24	-28.39	-35.61	92745.7	37.35	22.68	251.84	9502.71	33041.21
3720.0	34.19	-28.23	-35.44	94922.1	37.65	22.85	252.79	9651.63	33911.20
3888.0	34.14	-28.09	-35.27	97062.4	37.95	23.00	253.72	9798.52	34776.87
4056.0	34.10	-27.95	-35.11	99159.7	38.23	23.15	254.63	9943.54	35639.28
4224.0	34.06	-27.82	-34.96	101214.9	38.50	23.30	255.52	10086.79	36498.53
4392.0	34.02	-27.69	-34.82	103229.0	38.77	23.44	256.39	10228.35	37354.72
4560.0	33.98	-27.58	-34.68	105202.5	39.03	23.57	257.24	10368.27	38207.91
4728.0	33.95	-27.47	-34.55	107137.0	39.28	23.70	258.08	10506.65	39058.22
4896.0	33.91	-27.36	-34.42	109033.1	39.52	23.82	258.90	10643.52	39905.71
5064.0	33.88	-27.26	-34.31	110891.5	39.75	23.94	259.70	10778.96	40750.45
5232.0	33.85	-27.17	-34.19	112712.9	39.98	24.06	260.49	10913.01	41592.52
5400.0	33.82	-27.08	-34.08	114498.0	40.21	24.17	261.27	11045.73	42431.97
5568.0	33.79	-27.00	-33.98	116248.0	40.42	24.28	262.03	11177.18	43268.90
5736.0	33.76	-26.92	-33.88	117963.2	40.63	24.38	262.79	11307.39	44103.35
5904.0	33.74	-26.84	-33.78	119644.5	40.84	24.48	263.52	11436.41	44935.39
6072.0	33.71	-26.77	-33.69	121292.5	41.04	24.57	264.25	11564.28	45765.06
6240.0	33.69	-26.71	-33.60	122907.4	41.23	24.67	264.97	11691.03	46592.42
6408.0	33.67	-26.64	-33.52	124490.6	41.42	24.76	265.67	11816.71	47417.54
6576.0	33.64	-26.58	-33.44	126042.3	41.61	24.84	266.37	11941.36	48240.46
6744.0	33.62	-26.52	-33.36	127563.2	41.79	24.93	267.05	12065.00	49061.23
6912.0	33.60	-26.47	-33.29	129053.7	41.97	25.01	267.73	12187.67	49879.91
7080.0	33.58	-26.42	-33.21	130514.2	42.14	25.08	268.39	12309.39	50696.51
7248.0	33.56	-26.37	-33.14	131937.9	42.30	25.16	269.05	12430.29	51512.10
7272.0	33.56	-26.36	-33.13	132140.0	42.33	25.17	269.15	12447.48	51628.31

TOTAL ENERGY INPUT BTU	=	0.169577E+10
SEASONAL ENERGY INPUT BTU	=	0.112457E+10
SEASONAL ENERGY INPUT GAL FUEL	=	8032.66
SEASONAL ENERGY RATE BTU/HR	=	194428.45
TOTAL ENERGY INPUT GAL FUEL	=	12112.65
AVERAGE LB. WATER PER LB. FUEL	=	31.89
SEASONAL LB. WATER PER LB. FUEL	=	31.22
ENERGY FROM AIR TO ICE BTU	=	0.472327E+09
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.414884E+09
TOTAL WATER WITHDRAWN GAL	=	199010.48
SEASONAL WATER WITHDRAWN GAL	=	145005.56
TOTAL WATER LOSS GAL	=	36495.45
SEASONAL WATER LOSS GAL	=	861.42

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	60.05
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	7272.00

7416.0	33.56	-26.54	-33.09	125932.3	41.86	24.52	269.66	12635.00	53242.55
7584.0	33.69	-26.81	-33.05	117001.2	41.14	23.59	270.28	12878.18	55343.74
7752.0	33.83	-27.10	-33.04	108179.0	40.38	22.64	270.95	13127.69	57449.97
7920.0	33.99	-27.42	-33.06	99485.5	39.58	21.67	271.67	13383.92	59559.34
8088.0	34.18	-27.75	-33.10	90926.4	38.72	20.69	272.44	13647.57	61672.00
8256.0	34.41	-28.11	-33.15	82499.3	37.81	19.69	273.29	13919.55	63789.06
8424.0	34.67	-28.49	-33.23	74202.7	36.84	18.66	274.20	14200.99	65911.63
8592.0	34.99	-28.89	-33.33	66052.7	35.78	17.61	275.21	14493.05	68038.95
8760.0	35.39	-29.32	-33.44	58057.9	34.62	16.53	276.33	14797.29	70171.18

8928.0	35.88	-29.78	-33.58	50237.6	33.35	15.41	277.58	15115.68	72307.61
9096.0	36.51	-30.27	-33.73	42595.9	31.93	14.26	279.00	15451.05	74449.48
9264.0	37.36	-30.79	-33.90	35139.3	30.31	13.05	280.63	15807.34	76598.06
9432.0	38.56	-31.35	-34.09	27885.3	28.43	11.78	282.56	16190.18	78753.66
9600.0	40.39	-31.96	-34.30	20869.9	26.16	10.41	284.92	16608.24	80914.56
9768.0	43.54	-32.63	-34.53	14117.6	23.28	8.89	287.97	17077.56	83080.95
9936.0	50.54	-33.41	-34.79	7635.4	19.19	7.08	292.41	17634.97	85254.31
10104.0	88.54	-34.52	-35.08	1442.1	10.35	4.60	303.44	18456.83	87429.22

Case 10

ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION

BOILER WATER TEMP DEG F = 124.00
 BOILER WATER FLOW RATE lbm/hr = 5033.00
 CONVECTIVE COEFFICIENT BTU/HR-FT2-F = 32.50
 INITIAL DRILL RADIUS FT = 1.50
 DEPTH TO TOP OF WATER AT START FT = 157.00
 INITIAL PARABOLIC WATER DIAMETER D FT = 4.24
 INITIAL PARABOLIC WATER HEIGHT HW FT = 10.00
 INITIAL WATER TEMP TW DEG F = 124.00
 INITIAL AIR TEMP TA DEG F = -60.00
 INITIAL ICE SURFACE TEMP TS DEG F = -60.00
 AMBIENT ICE TEMP DEG F = -60.00
 EFFECTIVE LATENT HEAT BTU/LB = 392.35
 TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT2, AIR VOL VA FT3

TIME	TW	TA	TS	MW	D	HW	HWB	AI	VA
0.0	124.00	-60.00	-60.00	527.5	4.24	10.00	167.00	1479.69	1109.77
24.0	88.17	-51.53	-56.96	2530.8	9.19	10.24	174.30	1703.72	1362.60
48.0	73.47	-48.01	-54.92	4404.0	11.67	11.03	178.42	1880.60	1649.00
72.0	66.21	-45.53	-53.27	6148.0	13.41	11.67	181.51	2038.04	1952.38
96.0	61.72	-43.63	-51.88	7793.6	14.76	12.20	184.06	2183.60	2266.90
120.0	58.60	-42.10	-50.70	9362.8	15.89	12.65	186.26	2320.67	2589.26
144.0	56.27	-40.84	-49.67	10871.5	16.86	13.06	188.22	2451.14	2917.26
168.0	54.45	-39.76	-48.77	12331.9	17.71	13.42	190.00	2576.21	3249.36
168.0	54.45	-39.76	-48.77	12331.9	17.71	13.42	190.00	2576.21	3249.36

TOTAL ENERGY INPUT BTU = 0.672036E+08
 SEASONAL ENERGY INPUT BTU = 0.672036E+08
 SEASONAL ENERGY INPUT GAL FUEL = 480.03
 SEASONAL ENERGY RATE BTU/HR = 400017.36
 TOTAL ENERGY INPUT GAL FUEL = 480.03
 AVERAGE LB. WATER PER LB. FUEL = 28.73
 SEASONAL LB. WATER PER LB. FUEL = 28.73
 ENERGY FROM AIR TO ICE BTU = 0.267174E+07
 SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.267174E+07
 TOTAL WATER WITHDRAWN GAL = 0.00
 SEASONAL WATER WITHDRAWN GAL = 0.00
 TOTAL WATER LOSS GAL = 6637.45
 SEASONAL WATER LOSS GAL = 6637.45

YEAR 1 STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 7549.50
 BOILER WATER TEMPERATURE DEG F = 133.92
 WATER WITHDRAWAL GAL/DAY = 1000.00
 WITHDRAWAL FLOW RATE GAL/MIN = 15.00
 CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F = 32.50
 START WITHDRAWAL AT HOUR = 168.00

192.0	54.19	-39.23	-48.05	12672.2	18.09	13.21	191.62	2722.79	3697.48
360.0	51.70	-37.03	-45.08	16055.9	20.52	13.01	201.77	3646.83	6648.69
384.0	51.28	-36.84	-44.81	16638.5	20.83	13.08	203.06	3766.95	7050.69

TOTAL ENERGY INPUT BTU = 0.149602E+09
 SEASONAL ENERGY INPUT BTU = 0.823982E+08
 SEASONAL ENERGY INPUT GAL FUEL = 588.56
 SEASONAL ENERGY RATE BTU/HR = 381473.79
 TOTAL ENERGY INPUT GAL FUEL = 1068.58
 AVERAGE LB. WATER PER LB. FUEL = 27.46

SEASONAL LB. WATER PER LB. FUEL	=	26.42
ENERGY FROM AIR TO ICE BTU	=	0.831495E+07
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.564321E+07
TOTAL WATER WITHDRAWN GAL	=	8999.57
SEASONAL WATER WITHDRAWN GAL	=	8999.57
TOTAL WATER LOSS GAL	=	15626.93
SEASONAL WATER LOSS GAL	=	8989.48

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	104.26
WATER WITHDRAWAL GAL/DAY	=	1000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	384.00

528.0	48.78	-35.87	-43.55	20626.8	22.65	13.72	210.08	4435.93	9370.40
696.0	46.23	-34.95	-42.51	26211.3	24.63	14.74	216.96	5120.96	11897.66
864.0	44.11	-34.11	-41.67	32820.0	26.53	15.91	222.73	5719.70	14234.02
1032.0	42.43	-33.29	-40.93	40234.8	28.34	17.10	227.64	6249.69	16410.52
1200.0	41.11	-32.50	-40.25	48239.2	30.03	18.25	231.89	6725.97	18458.10
1368.0	40.06	-31.74	-39.61	56708.7	31.61	19.37	235.62	7158.62	20394.94
1488.0	39.44	-31.22	-39.17	62952.0	32.67	20.12	238.03	7445.96	21724.09

TOTAL ENERGY INPUT BTU	=	0.570751E+09
SEASONAL ENERGY INPUT BTU	=	0.421149E+09
SEASONAL ENERGY INPUT GAL FUEL	=	3008.21
SEASONAL ENERGY RATE BTU/HR	=	381473.80
TOTAL ENERGY INPUT GAL FUEL	=	4076.79
AVERAGE LB. WATER PER LB. FUEL	=	33.66
SEASONAL LB. WATER PER LB. FUEL	=	35.86
ENERGY FROM AIR TO ICE BTU	=	0.574624E+08
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.491474E+08
TOTAL WATER WITHDRAWN GAL	=	55009.87
SEASONAL WATER WITHDRAWN GAL	=	46010.30
TOTAL WATER LOSS GAL	=	33988.43
SEASONAL WATER LOSS GAL	=	18361.50

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	92.42
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	1488.01

1536.0	37.24	-31.25	-39.02	64900.8	32.99	20.35	238.75	7534.03	22141.04
1704.0	36.78	-30.60	-38.49	72183.3	34.09	21.19	240.96	7793.13	23338.53
1872.0	36.42	-29.98	-37.99	79472.9	35.13	21.98	242.99	8038.28	24503.13
2040.0	36.11	-29.40	-37.50	86719.8	36.09	22.72	244.87	8272.03	25644.25
2208.0	35.85	-28.84	-37.03	93874.4	37.00	23.40	246.63	8496.44	26770.05
2376.0	35.62	-28.32	-36.58	100909.5	37.85	24.04	248.29	8713.00	27885.71
2544.0	35.43	-27.84	-36.15	107828.7	38.65	24.63	249.85	8922.57	28992.24
2712.0	35.25	-27.37	-35.74	114636.8	39.41	25.19	251.33	9125.83	30090.16
2880.0	35.10	-26.94	-35.35	121339.9	40.13	25.72	252.73	9323.37	31180.01
3048.0	34.96	-26.53	-34.98	127941.9	40.81	26.21	254.07	9515.69	32262.19

3216.0	34.84	-26.14	-34.62	134446.9	41.46	26.69	255.36	9703.20	33337.10
3384.0	34.73	-25.77	-34.28	140858.5	42.09	27.14	256.59	9886.27	34405.08
3552.0	34.63	-25.42	-33.95	147179.5	42.68	27.56	257.77	10065.21	35466.43
3720.0	34.53	-25.08	-33.64	153406.0	43.26	27.97	258.91	10240.43	36522.45
3888.0	34.45	-24.76	-33.34	159556.8	43.81	28.37	260.01	10411.97	37571.46
4056.0	34.37	-24.46	-33.05	165626.1	44.34	28.74	261.07	10580.17	38614.64
4224.0	34.29	-24.17	-32.77	171616.6	44.86	29.10	262.10	10745.21	39652.24
4392.0	34.22	-23.90	-32.50	177530.4	45.35	29.45	263.09	10907.28	40684.45
4560.0	34.16	-23.63	-32.25	183369.2	45.83	29.79	264.06	11066.53	41711.44
4728.0	34.10	-23.38	-32.00	189136.0	46.30	30.11	264.99	11223.14	42733.45
4896.0	34.04	-23.14	-31.76	194832.2	46.75	30.42	265.90	11377.22	43750.60
5064.0	33.99	-22.90	-31.53	200459.6	47.19	30.72	266.79	11528.91	44763.07
5232.0	33.94	-22.68	-31.31	206019.9	47.61	31.01	267.65	11678.31	45770.98
5400.0	33.89	-22.47	-31.10	211514.2	48.02	31.30	268.50	11825.54	46774.47
5568.0	33.85	-22.26	-30.89	216944.9	48.42	31.57	269.32	11970.69	47773.70
5736.0	33.81	-22.06	-30.69	222312.9	48.81	31.84	270.12	12113.86	48768.76
5904.0	33.77	-21.87	-30.50	227619.7	49.19	32.09	270.90	12255.12	49759.79
6072.0	33.73	-21.69	-30.31	232866.5	49.57	32.34	271.67	12394.55	50746.87
6240.0	33.70	-21.51	-30.13	238054.1	49.93	32.59	272.42	12532.23	51730.11
6408.0	33.66	-21.34	-29.96	243184.6	50.28	32.82	273.15	12668.23	52709.62
6576.0	33.63	-21.17	-29.79	248258.7	50.62	33.05	273.87	12802.60	53685.50
6744.0	33.60	-21.01	-29.62	253277.4	50.96	33.28	274.58	12935.42	54657.83
6912.0	33.57	-20.86	-29.46	258241.7	51.29	33.50	275.27	13066.72	55626.68
7080.0	33.54	-20.71	-29.31	263152.2	51.61	33.71	275.95	13196.57	56592.13
7248.0	33.51	-20.57	-29.16	268002.5	51.93	33.92	276.61	13325.09	57555.25
7272.0	33.51	-20.54	-29.14	268692.3	51.97	33.95	276.71	13343.33	57692.44

TOTAL ENERGY INPUT BTU	=	0.225761E+10
SEASONAL ENERGY INPUT BTU	=	0.168686E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12049.01
SEASONAL ENERGY RATE BTU/HR	=	291642.87
TOTAL ENERGY INPUT GAL FUEL	=	16125.80
AVERAGE LB. WATER PER LB. FUEL	=	33.92
SEASONAL LB. WATER PER LB. FUEL	=	34.01
ENERGY FROM AIR TO ICE BTU	=	0.585515E+09
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.528052E+09
TOTAL WATER WITHDRAWN GAL	=	200015.43
SEASONAL WATER WITHDRAWN GAL	=	145005.56
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	574.98

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.25
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	7272.00

7416.0	33.44	-20.58	-29.02	265185.6	51.86	33.65	277.22	13518.85	59422.77
7584.0	33.47	-20.65	-28.90	259245.9	51.63	33.18	277.82	13739.72	61652.21
7752.0	33.51	-20.73	-28.80	253337.0	51.40	32.72	278.43	13962.13	63883.05
7920.0	33.54	-20.83	-28.71	247473.8	51.17	32.25	279.04	14185.96	66113.25
8088.0	33.58	-20.93	-28.64	241657.3	50.93	31.79	279.67	14411.26	68342.85
8256.0	33.62	-21.05	-28.58	235878.8	50.68	31.33	280.32	14638.12	70572.77
8424.0	33.66	-21.17	-28.54	230129.8	50.43	30.87	280.97	14866.67	72803.95
8592.0	33.70	-21.31	-28.51	224419.3	50.18	30.42	281.64	15096.88	75035.45
8760.0	33.74	-21.45	-28.49	218746.9	49.91	29.96	282.32	15328.79	77267.21

8928.0	33.79	-21.59	-28.48	213122.0	49.65	29.51	283.01	15562.38	79498.30
9096.0	33.84	-21.75	-28.49	207536.4	49.37	29.05	283.72	15797.78	81729.68
9264.0	33.88	-21.91	-28.50	201982.5	49.09	28.60	284.44	16035.13	83962.31
9432.0	33.94	-22.08	-28.52	196461.4	48.80	28.15	285.18	16274.49	86196.24
9600.0	33.99	-22.25	-28.54	190989.8	48.51	27.70	285.93	16515.76	88429.48
9768.0	34.04	-22.43	-28.58	185569.2	48.20	27.25	286.70	16759.04	90662.09
9936.0	34.10	-22.62	-28.62	180183.7	47.89	26.81	287.49	17004.53	92896.01
10104.0	34.16	-22.81	-28.67	174850.9	47.58	26.36	288.30	17252.18	95129.31
10248.0	34.22	-22.97	-28.72	170295.3	47.29	25.98	289.00	17466.48	97046.39

TOTAL ENERGY INPUT BTU	=	0.306821E+10
SEASONAL ENERGY INPUT BTU	=	0.810598E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.98
SEASONAL ENERGY RATE BTU/HR	=	272377.63
TOTAL ENERGY INPUT GAL FUEL	=	21915.78
AVERAGE LB. WATER PER LB. FUEL	=	32.86
SEASONAL LB. WATER PER LB. FUEL	=	29.91
ENERGY FROM AIR TO ICE BTU	=	0.905263E+09
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.319748E+09
TOTAL WATER WITHDRAWN GAL	=	446618.64
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.96
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	10248.01

10272.0	34.23	-23.00	-28.73	169547.3	47.25	25.92	289.12	17502.28	97364.95
10440.0	34.27	-23.00	-28.79	174996.5	47.66	26.28	290.03	17650.98	98323.55
10608.0	34.20	-23.00	-28.84	180411.5	48.07	26.64	290.92	17797.71	99279.63
10776.0	34.14	-23.01	-28.88	185736.5	48.47	26.98	291.78	17942.16	100232.25
10944.0	34.08	-23.01	-28.92	190989.8	48.85	27.31	292.62	18084.29	101179.59
11112.0	34.02	-23.01	-28.96	196165.1	49.22	27.63	293.44	18224.28	102122.75
11280.0	33.97	-23.00	-28.99	201263.7	49.58	27.94	294.24	18362.22	103061.83
11448.0	33.92	-23.00	-29.02	206288.2	49.93	28.23	295.02	18498.22	103996.98
11616.0	33.87	-22.99	-29.05	211239.8	50.27	28.52	295.78	18632.35	104928.30
11784.0	33.83	-22.98	-29.07	216120.2	50.61	28.80	296.52	18764.69	105855.87
11952.0	33.79	-22.97	-29.09	220930.9	50.93	29.06	297.24	18895.32	106779.82
12120.0	33.75	-22.96	-29.11	225673.3	51.25	29.32	297.95	19024.31	107700.21
12288.0	33.71	-22.95	-29.12	230348.6	51.55	29.58	298.64	19151.70	108617.14
12456.0	33.67	-22.93	-29.13	234958.9	51.85	29.82	299.32	19277.58	109530.72
12624.0	33.64	-22.92	-29.14	239505.2	52.15	30.06	299.99	19402.00	110441.02
12792.0	33.61	-22.90	-29.15	243988.9	52.43	30.29	300.64	19525.01	111348.11
12960.0	33.58	-22.88	-29.15	248411.0	52.71	30.51	301.28	19646.65	112252.08
13128.0	33.55	-22.87	-29.16	252772.5	52.98	30.72	301.91	19766.98	113152.97
13296.0	33.52	-22.85	-29.16	257075.5	53.25	30.94	302.53	19886.04	114050.90
13464.0	33.49	-22.83	-29.16	261320.5	53.51	31.14	303.13	20003.88	114945.92
13632.0	33.46	-22.81	-29.16	265508.7	53.77	31.34	303.73	20120.53	115838.08
13800.0	33.44	-22.79	-29.16	269641.2	54.02	31.53	304.31	20236.03	116727.46
13968.0	33.41	-22.77	-29.15	273718.6	54.26	31.72	304.88	20350.41	117614.10
14136.0	33.39	-22.75	-29.15	277742.7	54.50	31.91	305.45	20463.72	118498.08
14304.0	33.37	-22.73	-29.14	281706.0	54.73	32.09	306.01	20576.06	119380.43
14472.0	33.35	-22.70	-29.13	285625.8	54.96	32.26	306.55	20687.31	120259.25

14640.0	33.33	-22.68	-29.13	289494.8	55.19	32.43	307.09	20797.58	121135.57
14808.0	33.31	-22.66	-29.12	293313.4	55.41	32.60	307.62	20906.89	122009.41
14976.0	33.29	-22.64	-29.11	297083.4	55.63	32.76	308.15	21015.28	122880.87
15144.0	33.27	-22.62	-29.10	300805.3	55.84	32.92	308.66	21122.76	123749.98
15312.0	33.25	-22.59	-29.08	304479.7	56.05	33.07	309.17	21229.36	124616.77
15480.0	33.23	-22.57	-29.07	308107.5	56.25	33.23	309.67	21335.11	125481.30
15648.0	33.22	-22.55	-29.06	311689.1	56.45	33.37	310.16	21440.03	126343.59
15816.0	33.20	-22.53	-29.05	315226.1	56.65	33.52	310.65	21544.13	127203.71
15984.0	33.18	-22.50	-29.03	318718.7	56.84	33.66	311.13	21647.45	128061.70
16032.0	33.18	-22.50	-29.03	319708.5	56.90	33.70	311.27	21676.83	128306.45

TOTAL ENERGY INPUT BTU	=	0.475474E+10
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.63
SEASONAL ENERGY RATE BTU/HR	=	291585.49
TOTAL ENERGY INPUT GAL FUEL	=	33962.42
AVERAGE LB. WATER PER LB. FUEL	=	31.37
SEASONAL LB. WATER PER LB. FUEL	=	28.65
ENERGY FROM AIR TO ICE BTU	=	0.161759E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.712331E+09
TOTAL WATER WITHDRAWN GAL	=	592621.66
SEASONAL WATER WITHDRAWN GAL	=	146003.02
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	72.92
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	16032.00

16152.0	33.11	-22.56	-29.02	316086.3	56.76	33.48	311.58	21798.94	129648.59
16320.0	33.14	-22.66	-29.01	308793.6	56.46	33.05	312.00	21987.41	131782.62
16488.0	33.17	-22.76	-29.01	301566.4	56.16	32.63	312.43	22177.39	133917.27
16656.0	33.20	-22.87	-29.01	294406.8	55.85	32.20	312.88	22368.94	136052.62
16824.0	33.23	-22.98	-29.01	287306.5	55.54	31.78	313.33	22562.16	138189.61
16992.0	33.27	-23.09	-29.02	280257.6	55.23	31.36	313.79	22757.15	140329.23
17160.0	33.31	-23.20	-29.03	273269.4	54.91	30.93	314.27	22953.89	142470.52
17328.0	33.34	-23.32	-29.05	266341.9	54.58	30.51	314.76	23152.42	144613.46
17496.0	33.38	-23.44	-29.07	259484.3	54.25	30.08	315.26	23352.73	146757.10
17664.0	33.42	-23.57	-29.09	252689.0	53.92	29.66	315.77	23554.93	148902.42
17832.0	33.46	-23.70	-29.12	245948.1	53.58	29.24	316.29	23759.14	151050.40
18000.0	33.51	-23.83	-29.15	239263.0	53.23	28.81	316.83	23965.42	153201.06
18168.0	33.55	-23.96	-29.18	232650.3	52.88	28.39	317.38	24173.69	155352.44
18336.0	33.60	-24.09	-29.22	226111.4	52.52	27.97	317.95	24384.00	157504.56
18504.0	33.65	-24.23	-29.26	219630.3	52.16	27.55	318.53	24596.57	159659.40
18672.0	33.70	-24.37	-29.30	213224.4	51.79	27.13	319.13	24811.32	161815.00
18840.0	33.76	-24.51	-29.35	206870.4	51.41	26.71	319.74	25028.53	163974.33
19008.0	33.81	-24.66	-29.39	200593.3	51.02	26.29	320.37	25248.06	166134.44
19008.0	33.81	-24.66	-29.39	200593.3	51.02	26.29	320.37	25248.06	166134.44

TOTAL ENERGY INPUT BTU	=	0.556533E+10
SEASONAL ENERGY INPUT BTU	=	0.810595E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.97
SEASONAL ENERGY RATE BTU/HR	=	272377.69
TOTAL ENERGY INPUT GAL FUEL	=	39752.38

AVERAGE LB. WATER PER LB. FUEL	=	30.55
SEASONAL LB. WATER PER LB. FUEL	=	25.73
ENERGY FROM AIR TO ICE BTU	=	0.200610E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.388506E+09
TOTAL WATER WITHDRAWN GAL	=	839224.86
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 4
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.55
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	19008.00

19176.0	33.90	-24.69	-29.44	203540.7	51.22	26.47	321.08	25387.76167198.58
19344.0	33.85	-24.70	-29.49	208024.2	51.51	26.75	321.78	25513.05168079.12
19512.0	33.81	-24.72	-29.53	212441.3	51.80	27.02	322.47	25636.83168956.66
19680.0	33.77	-24.74	-29.57	216793.1	52.08	27.28	323.14	25759.14169831.28
19848.0	33.73	-24.75	-29.61	221080.4	52.35	27.53	323.80	25880.05170703.02
20016.0	33.70	-24.77	-29.65	225305.2	52.61	27.78	324.45	25999.60171571.98
20184.0	33.66	-24.78	-29.69	229468.4	52.87	28.01	325.08	26117.84172438.20
20352.0	33.63	-24.79	-29.73	233570.9	53.12	28.24	325.70	26234.82173301.75
20520.0	33.60	-24.80	-29.76	237613.9	53.37	28.47	326.31	26350.58174162.67
20688.0	33.57	-24.81	-29.79	241598.4	53.61	28.68	326.91	26465.16175021.02
20856.0	33.54	-24.82	-29.82	245525.1	53.85	28.89	327.50	26578.59175876.85
21024.0	33.51	-24.83	-29.85	249395.7	54.08	29.10	328.08	26690.92176730.23
21192.0	33.48	-24.84	-29.88	253210.9	54.30	29.30	328.65	26802.18177581.19
21360.0	33.46	-24.85	-29.91	256971.6	54.53	29.49	329.21	26912.40178429.80
21528.0	33.43	-24.86	-29.93	260678.7	54.74	29.68	329.76	27021.61179276.09
21696.0	33.41	-24.86	-29.96	264332.8	54.95	29.87	330.30	27129.85180120.09
21864.0	33.39	-24.87	-29.98	267935.6	55.16	30.05	330.83	27237.13180961.89
22032.0	33.36	-24.88	-30.01	271487.4	55.37	30.22	331.36	27343.50181801.50
22200.0	33.34	-24.88	-30.03	274989.3	55.57	30.39	331.88	27448.96182638.96
22368.0	33.32	-24.89	-30.05	278441.9	55.76	30.56	332.39	27553.56183474.33
22536.0	33.30	-24.89	-30.07	281845.7	55.95	30.72	332.89	27657.31184307.62
22704.0	33.28	-24.90	-30.09	285202.3	56.14	30.88	333.38	27760.23185138.91
22872.0	33.27	-24.90	-30.10	288512.1	56.33	31.03	333.87	27862.36185968.21
23040.0	33.25	-24.91	-30.12	291775.7	56.51	31.18	334.35	27963.70186795.56
23208.0	33.23	-24.91	-30.14	294994.1	56.68	31.33	334.83	28064.29187620.99
23376.0	33.21	-24.91	-30.15	298167.4	56.86	31.47	335.30	28164.12188444.53
23544.0	33.20	-24.92	-30.17	301297.2	57.03	31.61	335.76	28263.24189266.24
23712.0	33.18	-24.92	-30.18	304383.8	57.20	31.75	336.22	28361.67190086.24
23880.0	33.17	-24.92	-30.20	307427.9	57.36	31.88	336.67	28459.39190904.37
24048.0	33.15	-24.92	-30.21	310430.0	57.52	32.01	337.11	28556.44191720.65
24216.0	33.14	-24.92	-30.22	313390.5	57.68	32.14	337.55	28652.82192535.09
24384.0	33.13	-24.93	-30.23	316310.8	57.84	32.26	337.99	28748.55193347.76
24552.0	33.11	-24.93	-30.24	319191.1	57.99	32.38	338.42	28843.65194158.66
24720.0	33.10	-24.93	-30.25	322032.0	58.14	32.50	338.84	28938.13194967.83
24792.0	33.09	-24.93	-30.26	323237.5	58.21	32.55	339.02	28978.44195314.09

TOTAL ENERGY INPUT BTU	=	0.725187E+10
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.67
SEASONAL ENERGY RATE BTU/HR	=	291585.95
TOTAL ENERGY INPUT GAL FUEL	=	51799.05

AVERAGE LB. WATER PER LB. FUEL	=	29.50
SEASONAL LB. WATER PER LB. FUEL	=	26.05
ENERGY FROM AIR TO ICE BTU	=	0.280688E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.800779E+09
TOTAL WATER WITHDRAWN GAL	=	985220.38
SEASONAL WATER WITHDRAWN GAL	=	145995.52
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 4
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	72.83
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	24792.00

24888.0	33.02	-24.98	-30.26	320277.1	58.09	32.39	339.24	29068.13	196326.84
25056.0	33.05	-25.07	-30.28	312349.7	57.74	31.97	339.61	29245.99	198414.89
25224.0	33.08	-25.17	-30.29	304504.3	57.39	31.54	339.99	29425.54	200504.04
25392.0	33.12	-25.27	-30.31	296734.8	57.04	31.12	340.38	29606.88	202595.33
25560.0	33.15	-25.37	-30.33	289033.6	56.68	30.70	340.78	29790.12	204689.73
25728.0	33.19	-25.47	-30.35	281401.6	56.32	30.27	341.20	29975.32	206787.26
25896.0	33.23	-25.58	-30.37	273855.6	55.95	29.85	341.62	30162.40	208885.94
26064.0	33.27	-25.68	-30.40	266396.5	55.58	29.43	342.06	30351.39	210985.78
26232.0	33.31	-25.79	-30.42	259016.6	55.20	29.00	342.51	30542.42	213087.76
26400.0	33.36	-25.90	-30.45	251716.7	54.82	28.58	342.97	30735.54	215191.88
26568.0	33.40	-26.01	-30.48	244481.3	54.43	28.16	343.45	30930.96	217300.10
26736.0	33.45	-26.13	-30.52	237335.7	54.03	27.74	343.94	31128.52	219409.48
26904.0	33.50	-26.24	-30.55	230281.0	53.63	27.32	344.45	31328.28	221520.03
27072.0	33.56	-26.36	-30.59	223301.5	53.23	26.90	344.97	31530.47	223633.70
27240.0	33.61	-26.48	-30.63	216414.4	52.81	26.48	345.51	31735.00	225748.54
27408.0	33.67	-26.60	-30.67	209596.5	52.39	26.06	346.07	31942.16	227867.48
27576.0	33.73	-26.72	-30.71	202873.0	51.96	25.64	346.64	32151.82	229987.59
27744.0	33.79	-26.84	-30.75	196245.2	51.53	25.22	347.24	32364.06	232108.87
27768.0	33.80	-26.86	-30.76	195302.0	51.46	25.16	347.32	32394.63	232412.50

TOTAL ENERGY INPUT BTU	=	0.806246E+10
SEASONAL ENERGY INPUT BTU	=	0.810595E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.97
SEASONAL ENERGY RATE BTU/HR	=	272377.68
TOTAL ENERGY INPUT GAL FUEL	=	57589.02
AVERAGE LB. WATER PER LB. FUEL	=	28.94
SEASONAL LB. WATER PER LB. FUEL	=	23.95
ENERGY FROM AIR TO ICE BTU	=	0.322444E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.417559E+09
TOTAL WATER WITHDRAWN GAL	=	1231823.58
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 5
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.54
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00

CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
 START WITHDRAWAL AT HOUR = 27768.00

27912.0	33.90	-26.89	-30.79	197316.0	51.59	25.30	347.89	32511.05233316.42
28080.0	33.86	-26.90	-30.84	201478.3	51.85	25.57	348.57	32630.65234157.06
28248.0	33.81	-26.92	-30.88	205577.7	52.11	25.83	349.22	32748.87234995.03
28416.0	33.77	-26.94	-30.92	209614.8	52.36	26.09	349.87	32865.74235830.36
28584.0	33.74	-26.96	-30.96	213591.6	52.61	26.33	350.50	32981.36236663.13
28752.0	33.70	-26.97	-31.00	217508.7	52.85	26.57	351.12	33095.71237493.39
28920.0	33.67	-26.99	-31.03	221367.0	53.09	26.80	351.73	33208.87238321.18
29088.0	33.63	-27.01	-31.07	225167.6	53.32	27.03	352.33	33320.86239146.56
29256.0	33.60	-27.02	-31.10	228911.4	53.54	27.25	352.91	33431.73239969.56
29424.0	33.57	-27.04	-31.14	232599.0	53.76	27.46	353.49	33541.50240790.23
29592.0	33.54	-27.05	-31.17	236232.2	53.98	27.67	354.06	33650.22241608.63
29760.0	33.52	-27.07	-31.20	239811.3	54.19	27.87	354.61	33757.92242424.80
29928.0	33.49	-27.08	-31.24	243329.3	54.39	28.07	355.16	33864.70243239.76
30096.0	33.47	-27.09	-31.27	246803.2	54.59	28.26	355.70	33970.45244051.58
30264.0	33.44	-27.11	-31.30	250225.5	54.79	28.44	356.23	34075.26244861.29
30432.0	33.42	-27.12	-31.32	253597.6	54.98	28.62	356.75	34179.17245668.94
30600.0	33.40	-27.13	-31.35	256920.0	55.17	28.80	357.27	34282.19246474.55
30768.0	33.37	-27.14	-31.38	260193.6	55.36	28.97	357.77	34384.36247278.17
30936.0	33.35	-27.16	-31.41	263419.0	55.54	29.14	358.27	34485.69248079.83
31104.0	33.33	-27.17	-31.43	266596.8	55.72	29.30	358.77	34586.21248879.55
31272.0	33.31	-27.18	-31.46	269728.3	55.90	29.46	359.25	34685.95249677.40
31440.0	33.29	-27.19	-31.48	272814.0	56.07	29.61	359.73	34784.91250473.39
31608.0	33.28	-27.20	-31.51	275854.5	56.24	29.76	360.20	34883.13251267.55
31776.0	33.26	-27.21	-31.53	278850.6	56.40	29.91	360.67	34980.61252059.92
31944.0	33.24	-27.22	-31.55	281802.7	56.56	30.06	361.13	35077.38252850.52
32112.0	33.22	-27.23	-31.58	284712.0	56.72	30.20	361.58	35173.47253639.41
32280.0	33.21	-27.24	-31.60	287578.9	56.88	30.33	362.03	35268.87254426.58
32448.0	33.19	-27.25	-31.62	290404.2	57.03	30.47	362.47	35363.62255212.09
32616.0	33.18	-27.26	-31.64	293188.3	57.18	30.60	362.91	35457.72255995.95
32784.0	33.16	-27.27	-31.66	295931.6	57.33	30.72	363.34	35551.19256778.19
32952.0	33.15	-27.28	-31.68	298635.4	57.47	30.85	363.76	35644.05257558.84
33120.0	33.14	-27.29	-31.70	301299.9	57.62	30.97	364.19	35736.32258337.94
33288.0	33.12	-27.30	-31.72	303925.7	57.76	31.09	364.60	35827.99259115.49
33456.0	33.11	-27.31	-31.73	306505.5	57.89	31.21	365.01	35919.16259892.52
33552.0	33.10	-27.31	-31.74	307967.0	57.97	31.27	365.25	35970.97260335.29

TOTAL ENERGY INPUT BTU	=	0.974899E+10
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.63
SEASONAL ENERGY RATE BTU/HR	=	291585.08
TOTAL ENERGY INPUT GAL FUEL	=	69635.66
AVERAGE LB. WATER PER LB. FUEL	=	28.28
SEASONAL LB. WATER PER LB. FUEL	=	25.09
ENERGY FROM AIR TO ICE BTU	=	0.405802E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.833585E+09
TOTAL WATER WITHDRAWN GAL	=	1377834.10
SEASONAL WATER WITHDRAWN GAL	=	146010.52
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 5
 STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	72.84
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00

CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT²-F = 32.50
 START WITHDRAWAL AT HOUR = 3352.00

33624.0	33.03	-27.34	-31.75	306033.0	57.88	31.17	365.41	36034.04261036.07
33792.0	33.06	-27.43	-31.77	297861.8	57.51	30.73	365.77	36208.97263093.60
33960.0	33.09	-27.52	-31.79	289773.0	57.12	30.30	366.13	36385.79265153.26
34128.0	33.13	-27.61	-31.81	281765.4	56.73	29.87	366.51	36564.65267216.24
34296.0	33.18	-27.71	-31.84	273840.1	56.34	29.44	366.90	36745.62269282.54
34464.0	33.22	-27.80	-31.86	266013.9	55.94	29.01	367.31	36928.62271350.19
34632.0	33.26	-27.90	-31.89	258287.7	55.54	28.58	367.72	37113.70273419.20
34800.0	33.31	-27.99	-31.91	250654.0	55.13	28.14	368.16	37300.99275490.53
34968.0	33.36	-28.09	-31.94	243113.5	54.71	27.71	368.60	37490.54277564.19
35136.0	33.41	-28.19	-31.97	235650.9	54.29	27.28	369.06	37682.56279642.16
35304.0	33.46	-28.29	-32.00	228291.3	53.86	26.85	369.54	37876.92281721.45
35472.0	33.52	-28.39	-32.04	221036.0	53.42	26.43	370.03	38073.68283802.10
35640.0	33.58	-28.49	-32.07	213869.4	52.98	26.00	370.54	38273.07285886.04
35808.0	33.64	-28.60	-32.10	206808.6	52.53	25.57	371.07	38475.01287971.32
35976.0	33.71	-28.70	-32.14	199830.6	52.07	25.15	371.62	38679.82290060.89
36144.0	33.78	-28.81	-32.18	192960.3	51.61	24.72	372.19	38887.35292151.77
36312.0	33.85	-28.92	-32.22	186191.2	51.14	24.30	372.77	39097.78294244.97
36480.0	33.93	-29.03	-32.26	179532.4	50.66	23.87	373.38	39311.14296339.48
36528.0	33.95	-29.06	-32.27	177641.6	50.52	23.75	373.56	39372.73296939.17

TOTAL ENERGY INPUT BTU	=	0.105596E+11
SEASONAL ENERGY INPUT BTU	=	0.810595E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.97
SEASONAL ENERGY RATE BTU/HR	=	272377.63
TOTAL ENERGY INPUT GAL FUEL	=	75425.62
AVERAGE LB. WATER PER LB. FUEL	=	27.91
SEASONAL LB. WATER PER LB. FUEL	=	23.46
ENERGY FROM AIR TO ICE BTU	=	0.448328E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.425258E+09
TOTAL WATER WITHDRAWN GAL	=	1624437.30
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 6
 STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.69
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	36528.00

36648.0	34.05	-29.08	-32.30	179054.9	50.60	23.86	374.05	39472.09297702.27
36816.0	34.00	-29.10	-32.33	183220.4	50.87	24.16	374.75	39591.61298513.66
36984.0	33.95	-29.11	-32.37	187320.7	51.14	24.44	375.43	39709.67299322.54
37152.0	33.91	-29.13	-32.41	191349.3	51.40	24.72	376.10	39826.39300129.96
37320.0	33.86	-29.14	-32.45	195323.2	51.65	24.99	376.75	39941.70300933.98
37488.0	33.82	-29.16	-32.48	199235.3	51.90	25.24	377.39	40055.70301735.65
37656.0	33.78	-29.17	-32.52	203086.7	52.14	25.49	378.02	40168.44302535.02
37824.0	33.75	-29.19	-32.55	206878.3	52.37	25.74	378.63	40279.97303332.12
37992.0	33.71	-29.20	-32.59	210610.8	52.60	25.97	379.24	40390.32304126.99
38160.0	33.68	-29.22	-32.62	214286.0	52.83	26.20	379.83	40499.54304919.70
38328.0	33.64	-29.23	-32.65	217904.4	53.05	26.42	380.41	40607.66305710.29
38496.0	33.61	-29.24	-32.68	221467.0	53.26	26.64	380.98	40714.73306498.79
38664.0	33.58	-29.26	-32.71	224974.7	53.47	26.85	381.54	40820.76307285.24

38832.0	33.55	-29.27	-32.74	228428.1	53.68	27.05	382.09	40925.80308069.68
39000.0	33.53	-29.28	-32.77	231828.8	53.88	27.25	382.64	41029.88308852.16
39168.0	33.50	-29.30	-32.80	235177.4	54.08	27.44	383.17	41133.02309632.71
39336.0	33.47	-29.31	-32.83	238474.6	54.27	27.63	383.70	41235.25310411.37
39504.0	33.45	-29.32	-32.86	241721.3	54.46	27.81	384.21	41336.60311188.18
39672.0	33.43	-29.34	-32.89	244918.0	54.64	27.99	384.72	41437.09311963.15
39840.0	33.40	-29.35	-32.91	248066.3	54.82	28.16	385.23	41536.75312736.34
40008.0	33.38	-29.36	-32.94	251166.4	55.00	28.33	385.72	41635.60313507.77
40176.0	33.36	-29.37	-32.97	254219.3	55.17	28.50	386.21	41733.67314277.48
40344.0	33.34	-29.38	-32.99	257225.7	55.34	28.66	386.69	41830.97315045.50
40512.0	33.32	-29.40	-33.02	260185.9	55.51	28.81	387.16	41927.52315811.85
40680.0	33.30	-29.41	-33.04	263093.2	55.67	28.96	387.63	42023.42316577.55
40848.0	33.28	-29.42	-33.06	265964.5	55.83	29.11	388.09	42118.54317340.67
41016.0	33.27	-29.43	-33.09	268792.1	55.99	29.26	388.54	42212.98318102.22
41184.0	33.25	-29.44	-33.11	271576.7	56.15	29.40	388.99	42306.75318862.21
41352.0	33.23	-29.45	-33.13	274318.7	56.30	29.53	389.44	42399.86319620.68
41520.0	33.22	-29.46	-33.16	277019.5	56.45	29.67	389.87	42492.33320377.65
41688.0	33.20	-29.47	-33.18	279679.2	56.59	29.80	390.31	42584.18321133.16
41856.0	33.19	-29.49	-33.20	282298.6	56.73	29.93	390.73	42675.43321887.22
42024.0	33.17	-29.50	-33.22	284878.2	56.87	30.05	391.15	42766.08322639.86
42192.0	33.16	-29.51	-33.24	287418.4	57.01	30.17	391.57	42856.15323391.09
42360.0	33.15	-29.51	-33.25	289209.5	57.11	30.26	391.87	42920.14323926.85

TOTAL ENERGY INPUT BTU	=	0.122461E+11
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.63
SEASONAL ENERGY RATE BTU/HR	=	291585.06
TOTAL ENERGY INPUT GAL FUEL	=	87472.26
AVERAGE LB. WATER PER LB. FUEL	=	27.50
SEASONAL LB. WATER PER LB. FUEL	=	24.98
ENERGY FROM AIR TO ICE BTU	=	0.532039E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.837110E+09
TOTAL WATER WITHDRAWN GAL	=	1770447.82
SEASONAL WATER WITHDRAWN GAL	=	146010.52
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 6
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	72.89
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	42312.00

42360.0	33.09	-29.53	-33.26	288423.7	57.07	30.21	391.98	42958.14324326.25
42528.0	33.10	-29.61	-33.28	280205.7	56.67	29.77	392.34	43133.44326362.38
42696.0	33.14	-29.70	-33.30	272058.0	56.26	29.33	392.71	43310.74328401.25
42864.0	33.19	-29.78	-33.33	264002.0	55.85	28.88	393.09	43490.27330443.43
43032.0	33.23	-29.86	-33.35	256054.5	55.43	28.44	393.49	43671.94332486.95
43200.0	33.28	-29.95	-33.37	248216.5	55.00	27.99	393.90	43855.82334531.80
43368.0	33.33	-30.03	-33.40	240480.4	54.57	27.55	394.33	44042.03336578.95
43536.0	33.39	-30.12	-33.43	232846.9	54.14	27.11	394.77	44230.65338628.41
43704.0	33.44	-30.21	-33.45	225300.8	53.69	26.67	395.23	44421.88340682.14
43872.0	33.50	-30.30	-33.48	217867.3	53.24	26.23	395.70	44615.59342737.18
44040.0	33.57	-30.39	-33.51	210547.7	52.78	25.79	396.20	44811.86344793.52
44208.0	33.63	-30.48	-33.54	203326.3	52.32	25.35	396.71	45010.92346853.14
44376.0	33.70	-30.57	-33.57	196220.4	51.84	24.91	397.24	45212.72348914.03

44544.0	33.77	-30.67	-33.61	189206.8	51.36	24.47	397.79	45417.55350979.18
44712.0	33.85	-30.76	-33.64	182310.7	50.87	24.04	398.36	45625.31353045.58
44880.0	33.93	-30.86	-33.67	175525.4	50.37	23.61	398.96	45836.17355114.24
45048.0	34.02	-30.95	-33.71	168860.2	49.86	23.17	399.58	46050.16357184.16
45216.0	34.11	-31.05	-33.74	162307.6	49.35	22.74	400.22	46267.49359256.29
45288.0	34.15	-31.09	-33.76	159523.7	49.12	22.56	400.51	46361.77360146.29

TOTAL ENERGY INPUT BTU	=	0.130567E+11
SEASONAL ENERGY INPUT BTU	=	0.810595E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.96
SEASONAL ENERGY RATE BTU/HR	=	272377.55
TOTAL ENERGY INPUT GAL FUEL	=	93262.22
AVERAGE LB. WATER PER LB. FUEL	=	27.26
SEASONAL LB. WATER PER LB. FUEL	=	23.59
ENERGY FROM AIR TO ICE BTU	=	0.574332E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.422932E+09
TOTAL WATER WITHDRAWN GAL	=	2017051.03
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 7
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.89
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	45288.00

45384.0	34.26	-31.11	-33.78	160415.9	49.17	22.64	400.92	46445.38360779.43
45552.0	34.20	-31.12	-33.81	164720.6	49.47	22.97	401.66	46566.67361565.70
45720.0	34.14	-31.13	-33.85	168955.5	49.76	23.29	402.39	46686.33362349.55
45888.0	34.09	-31.14	-33.88	173121.8	50.04	23.59	403.09	46804.43363131.02
46056.0	34.03	-31.15	-33.92	177220.3	50.31	23.89	403.79	46921.03363910.17
46224.0	33.98	-31.17	-33.95	181252.3	50.58	24.18	404.46	47036.19364687.04
46392.0	33.93	-31.18	-33.98	185219.0	50.84	24.45	405.12	47149.96365461.69
46560.0	33.89	-31.19	-34.01	189121.0	51.09	24.72	405.77	47262.40366234.15
46728.0	33.85	-31.20	-34.04	192960.4	51.34	24.98	406.40	47373.55367004.49
46896.0	33.81	-31.21	-34.08	196737.8	51.58	25.23	407.02	47483.47367772.74
47064.0	33.77	-31.23	-34.11	200454.5	51.82	25.48	407.63	47592.20368538.96
47232.0	33.73	-31.24	-34.13	204111.3	52.05	25.71	408.23	47699.78369303.17
47400.0	33.69	-31.25	-34.16	207709.1	52.27	25.94	408.82	47806.24370065.43
47568.0	33.66	-31.26	-34.19	211249.6	52.49	26.16	409.39	47911.63370825.78
47736.0	33.63	-31.27	-34.22	214733.4	52.71	26.38	409.95	48015.98371584.25
47904.0	33.60	-31.28	-34.25	218161.5	52.92	26.59	410.51	48119.33372340.88
48072.0	33.57	-31.29	-34.27	221534.8	53.12	26.79	411.05	48221.70373095.71
48240.0	33.54	-31.30	-34.30	224854.0	53.32	26.99	411.59	48323.13373848.77
48408.0	33.51	-31.32	-34.33	228120.7	53.52	27.18	412.12	48423.65374600.11
48576.0	33.49	-31.33	-34.35	231335.4	53.71	27.36	412.64	48523.29375349.75
48744.0	33.46	-31.34	-34.38	234499.0	53.90	27.55	413.15	48622.06376097.72
48912.0	33.44	-31.35	-34.40	237612.4	54.08	27.72	413.65	48720.00376844.07
49080.0	33.42	-31.36	-34.43	240676.0	54.26	27.89	414.15	48817.13377588.80
49248.0	33.39	-31.37	-34.45	243691.4	54.44	28.06	414.63	48913.47378331.98
49416.0	33.37	-31.38	-34.48	246659.0	54.61	28.22	415.11	49009.05379073.61
49584.0	33.35	-31.39	-34.50	249579.7	54.78	28.38	415.59	49103.89379813.73
49752.0	33.33	-31.40	-34.52	252454.2	54.94	28.54	416.05	49198.00380552.36
49920.0	33.31	-31.41	-34.54	255282.8	55.11	28.69	416.51	49291.41381289.53
50088.0	33.29	-31.42	-34.57	258067.2	55.26	28.83	416.97	49384.13382025.27

50256.0	33.28	-31.43	-34.59	260807.5	55.42	28.98	417.42	49476.19	382759.61
50424.0	33.26	-31.44	-34.61	263504.6	55.57	29.11	417.86	49567.59	383492.57
50592.0	33.24	-31.45	-34.63	266159.0	55.72	29.25	418.30	49658.37	384224.18
50760.0	33.23	-31.46	-34.65	268771.3	55.87	29.38	418.73	49748.52	384954.44
50928.0	33.21	-31.47	-34.67	271342.7	56.01	29.51	419.15	49838.07	385683.41
51072.0	33.20	-31.48	-34.69	273514.4	56.13	29.62	419.51	49914.37	386307.21

TOTAL ENERGY INPUT BTU	=	0.147432E+11
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.67
SEASONAL ENERGY RATE BTU/HR	=	291585.91
TOTAL ENERGY INPUT GAL FUEL	=	105308.89
AVERAGE LB. WATER PER LB. FUEL	=	27.03
SEASONAL LB. WATER PER LB. FUEL	=	25.22
ENERGY FROM AIR TO ICE BTU	=	0.657240E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.829078E+09
TOTAL WATER WITHDRAWN GAL	=	2163046.54
SEASONAL WATER WITHDRAWN GAL	=	145995.52
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 7
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	72.94
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	51072.00

51096.0	33.20	-31.48	-34.69	273873.5	56.15	29.64	419.57	49927.04	386411.09
51264.0	33.14	-31.56	-34.71	265703.4	55.74	29.18	419.94	50103.68	388429.87
51432.0	33.19	-31.64	-34.73	257566.0	55.31	28.72	420.32	50282.11	390450.22
51600.0	33.24	-31.71	-34.76	249543.3	54.89	28.27	420.71	50462.75	392471.74
51768.0	33.29	-31.79	-34.78	241636.4	54.45	27.81	421.12	50645.65	394494.43
51936.0	33.35	-31.86	-34.80	233829.5	54.01	27.35	421.54	50831.02	396520.25
52104.0	33.40	-31.94	-34.83	226139.6	53.56	26.90	421.97	51018.80	398547.22
52272.0	33.46	-32.02	-34.85	218543.5	53.10	26.44	422.43	51209.26	400578.30
52440.0	33.53	-32.10	-34.88	211066.2	52.64	25.99	422.90	51402.28	402610.51
52608.0	33.59	-32.18	-34.90	203709.1	52.17	25.54	423.39	51597.94	404643.85
52776.0	33.66	-32.26	-34.93	196464.5	51.70	25.09	423.90	51796.40	406679.29
52944.0	33.74	-32.34	-34.96	189333.4	51.21	24.64	424.43	51997.75	408716.81
53112.0	33.82	-32.42	-34.98	182300.9	50.72	24.19	424.99	52202.24	410758.39
53280.0	33.90	-32.50	-35.01	175392.0	50.21	23.74	425.56	52409.75	412801.04
53448.0	33.98	-32.59	-35.04	168600.3	49.70	23.29	426.16	52620.47	414845.76
53616.0	34.08	-32.67	-35.07	161934.9	49.18	22.85	426.78	52834.45	416891.52
53784.0	34.18	-32.76	-35.10	155388.4	48.65	22.40	427.43	53051.87	418939.29
53952.0	34.28	-32.85	-35.14	148946.0	48.10	21.96	428.11	53273.04	420991.04
54048.0	34.34	-32.90	-35.15	145330.7	47.79	21.71	428.51	53400.97	422162.95

TOTAL ENERGY INPUT BTU	=	0.155538E+11
SEASONAL ENERGY INPUT BTU	=	0.810595E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.96
SEASONAL ENERGY RATE BTU/HR	=	272377.48
TOTAL ENERGY INPUT GAL FUEL	=	111098.85
AVERAGE LB. WATER PER LB. FUEL	=	26.86
SEASONAL LB. WATER PER LB. FUEL	=	23.90
ENERGY FROM AIR TO ICE BTU	=	0.699018E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.417785E+09

TOTAL WATER WITHDRAWN GAL	=	2409649.75
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 8
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	74.08
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	54048.00

54120.0	34.47	-32.91	-35.17	145672.1	47.80	21.75	428.84	53468.19422673.32
54288.0	34.39	-32.92	-35.20	150133.8	48.13	22.12	429.62	53590.93423434.25
54456.0	34.32	-32.92	-35.23	154522.7	48.44	22.47	430.39	53711.88424192.91
54624.0	34.25	-32.93	-35.26	158836.7	48.75	22.81	431.13	53831.09424949.29
54792.0	34.19	-32.94	-35.29	163077.3	49.05	23.13	431.86	53948.64425703.43
54960.0	34.13	-32.95	-35.32	167245.9	49.34	23.44	432.57	54064.60426455.39
55128.0	34.07	-32.96	-35.35	171343.5	49.62	23.75	433.26	54179.04427205.22
55296.0	34.02	-32.97	-35.38	175372.2	49.90	24.04	433.94	54292.03427952.98
55464.0	33.97	-32.98	-35.41	179333.0	50.16	24.32	434.60	54403.63428698.71
55632.0	33.92	-32.98	-35.44	183227.2	50.42	24.59	435.25	54513.88429442.46
55800.0	33.88	-32.99	-35.46	187055.9	50.68	24.85	435.88	54622.84430184.27
55968.0	33.84	-33.00	-35.49	190820.0	50.93	25.11	436.50	54730.56430924.18
56136.0	33.79	-33.01	-35.52	194521.6	51.17	25.35	437.10	54837.09431662.25
56304.0	33.76	-33.02	-35.54	198153.1	51.40	25.59	437.70	54942.54432399.50
56472.0	33.72	-33.03	-35.57	201732.4	51.63	25.82	438.28	55046.82433134.00
56640.0	33.68	-33.04	-35.59	205252.0	51.86	26.05	438.86	55150.02433866.77
56808.0	33.65	-33.05	-35.62	208712.8	52.08	26.26	439.42	55252.18434597.83
56976.0	33.62	-33.06	-35.64	212116.6	52.29	26.47	439.97	55353.34435327.24
57144.0	33.59	-33.06	-35.67	215464.0	52.50	26.68	440.51	55453.54436055.03
57312.0	33.56	-33.07	-35.69	218756.0	52.70	26.88	441.04	55552.81436781.23
57480.0	33.53	-33.08	-35.71	221993.7	52.90	27.07	441.57	55651.17437505.88
57648.0	33.51	-33.09	-35.74	225177.6	53.10	27.25	442.08	55748.64438228.99
57816.0	33.48	-33.10	-35.76	228309.5	53.29	27.44	442.59	55845.27438950.61
57984.0	33.46	-33.11	-35.78	231389.7	53.47	27.61	443.09	55941.08439670.77
58152.0	33.43	-33.12	-35.80	234419.4	53.66	27.79	443.58	56036.08440389.50
58320.0	33.41	-33.13	-35.82	237399.3	53.83	27.95	444.06	56130.31441106.82
58488.0	33.39	-33.14	-35.85	240329.9	54.01	28.11	444.54	56223.79441822.75
58656.0	33.37	-33.14	-35.87	243212.8	54.18	28.27	445.01	56316.53442537.34
58824.0	33.35	-33.15	-35.89	246048.5	54.35	28.43	445.47	56408.56443250.60
58992.0	33.33	-33.16	-35.91	248837.7	54.51	28.58	445.93	56499.90443962.56
59160.0	33.31	-33.17	-35.93	251581.3	54.67	28.72	446.38	56590.56444673.24
59328.0	33.29	-33.18	-35.95	254279.7	54.83	28.86	446.82	56680.57445382.66
59496.0	33.27	-33.19	-35.97	256934.2	54.98	29.00	447.26	56769.94446090.86
59664.0	33.25	-33.20	-35.99	259545.4	55.13	29.14	447.69	56858.69446797.85
59832.0	33.24	-33.21	-36.01	262105.7	55.28	29.27	448.12	56946.90447504.64
59832.0	33.24	-33.21	-36.01	262105.7	55.28	29.27	448.12	56946.90447504.64

TOTAL ENERGY INPUT BTU	=	0.172404E+11
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.63
SEASONAL ENERGY RATE BTU/HR	=	291585.02
TOTAL ENERGY INPUT GAL FUEL	=	123145.49
AVERAGE LB. WATER PER LB. FUEL	=	26.73
SEASONAL LB. WATER PER LB. FUEL	=	25.49
ENERGY FROM AIR TO ICE BTU	=	0.780995E+10

SEASONAL ENERGY LOSS, AIR TO ICE	BTU	=	0.819762E+09
TOTAL WATER WITHDRAWN	GAL	=	2555660.26
SEASONAL WATER WITHDRAWN	GAL	=	146010.52
TOTAL WATER LOSS	GAL	=	34563.42
SEASONAL WATER LOSS	GAL	=	0.00

YEAR 8
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	72.97
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	59832.01

60000.0	33.18	-33.27	-36.03	255489.4	54.94	28.89	448.50	57111.50449320.25
60168.0	33.23	-33.33	-36.05	247381.9	54.50	28.42	448.88	57290.44451320.33
60336.0	33.28	-33.40	-36.07	239394.4	54.06	27.95	449.27	57471.65453321.34
60504.0	33.34	-33.47	-36.09	231510.9	53.62	27.48	449.69	57655.33455325.24
60672.0	33.40	-33.54	-36.11	223748.6	53.17	27.01	450.11	57841.41457330.04
60840.0	33.46	-33.61	-36.13	216084.2	52.71	26.54	450.56	58030.19459338.72
61008.0	33.52	-33.68	-36.15	208542.6	52.24	26.07	451.02	58221.54461348.27
61176.0	33.59	-33.75	-36.18	201125.3	51.77	25.61	451.50	58415.53463358.69
61344.0	33.66	-33.82	-36.20	193824.5	51.29	25.14	452.00	58612.33465370.96
61512.0	33.74	-33.89	-36.22	186641.3	50.80	24.68	452.52	58812.03467385.06
61680.0	33.82	-33.97	-36.25	179560.5	50.30	24.21	453.07	59014.88469402.97
61848.0	33.90	-34.04	-36.27	172607.4	49.80	23.75	453.63	59220.77471421.68
62016.0	33.99	-34.11	-36.30	165775.5	49.28	23.29	454.22	59429.89473442.18
62184.0	34.09	-34.19	-36.33	159073.7	48.75	22.84	454.84	59642.28475463.45
62352.0	34.19	-34.26	-36.35	152494.9	48.22	22.38	455.48	59858.14477486.47
62520.0	34.30	-34.34	-36.38	146024.0	47.67	21.93	456.15	60077.76479513.20
62688.0	34.41	-34.42	-36.41	139678.9	47.11	21.47	456.85	60301.15481541.63
62808.0	34.50	-34.47	-36.43	135242.6	46.71	21.15	457.37	60462.91482989.26

TOTAL ENERGY INPUT	BTU	=	0.180510E+11
SEASONAL ENERGY INPUT	BTU	=	0.810595E+09
SEASONAL ENERGY INPUT	GAL FUEL	=	5789.96
SEASONAL ENERGY RATE	BTU/HR	=	272377.43
TOTAL ENERGY INPUT	GAL FUEL	=	128935.45
AVERAGE LB. WATER PER LB. FUEL	=	26.61	
SEASONAL LB. WATER PER LB. FUEL	=	24.16	
ENERGY FROM AIR TO ICE	BTU	=	0.822323E+10
SEASONAL ENERGY LOSS, AIR TO ICE	BTU	=	0.413280E+09
TOTAL WATER WITHDRAWN	GAL	=	2802263.47
SEASONAL WATER WITHDRAWN	GAL	=	246603.21
TOTAL WATER LOSS	GAL	=	34563.42
SEASONAL WATER LOSS	GAL	=	0.00

YEAR 9
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	74.23
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	62808.00

62856.0	34.61	-34.48	-36.44	134984.5	46.67	21.14	457.59	60513.00483383.89
---------	-------	--------	--------	----------	-------	-------	--------	-------------------

63024.0	34.55	-34.49	-36.46	139569.4	47.02	21.54	458.41	60636.07484118.31
63192.0	34.47	-34.49	-36.49	144083.6	47.36	21.92	459.21	60757.26484830.74
63360.0	34.39	-34.50	-36.52	148509.3	47.69	22.28	459.98	60876.65485582.02
63528.0	34.32	-34.50	-36.55	152864.6	48.02	22.62	460.74	60994.18486310.22
63696.0	34.25	-34.51	-36.57	157142.6	48.33	22.96	461.47	61110.00487036.38
63864.0	34.18	-34.52	-36.60	161345.6	48.63	23.28	462.19	61224.21487760.56
64032.0	34.12	-34.52	-36.62	165474.6	48.92	23.59	462.88	61336.86488482.82
64200.0	34.07	-34.53	-36.65	169531.3	49.21	23.89	463.56	61448.03489203.20
64368.0	34.01	-34.53	-36.67	173516.9	49.49	24.18	464.23	61557.79489921.74
64536.0	33.96	-34.54	-36.70	177432.7	49.76	24.46	464.88	61666.17490638.48
64704.0	33.92	-34.55	-36.72	181280.7	50.02	24.72	465.51	61773.26491353.48
64872.0	33.87	-34.55	-36.75	185061.9	50.28	24.98	466.13	61879.09492066.78
65040.0	33.83	-34.56	-36.77	188777.6	50.52	25.23	466.74	61983.72492778.42
65208.0	33.79	-34.57	-36.79	192429.1	50.77	25.48	467.34	62087.19493488.43
65376.0	33.75	-34.57	-36.82	196017.3	51.00	25.71	467.92	62189.54494196.84
65544.0	33.71	-34.58	-36.84	199544.1	51.23	25.94	468.49	62290.82494903.71
65712.0	33.68	-34.59	-36.86	203010.4	51.46	26.16	469.05	62391.06495609.06
65880.0	33.65	-34.59	-36.88	206417.2	51.68	26.37	469.60	62490.30496312.93
66048.0	33.61	-34.60	-36.90	209765.8	51.89	26.58	470.14	62588.57497015.35
66216.0	33.58	-34.61	-36.93	213056.8	52.10	26.78	470.68	62685.90497716.35
66384.0	33.55	-34.61	-36.95	216292.1	52.31	26.98	471.20	62782.33498415.96
66552.0	33.53	-34.62	-36.97	219472.2	52.51	27.16	471.71	62877.89499114.22
66720.0	33.50	-34.63	-36.99	222598.3	52.70	27.35	472.22	62972.60499811.15
66888.0	33.47	-34.63	-37.01	225663.3	52.89	27.53	472.71	63066.57500507.76
67056.0	33.45	-34.64	-37.03	228683.7	53.08	27.70	473.20	63159.66501202.11
67224.0	33.43	-34.65	-37.05	231653.6	53.26	27.87	473.68	63251.99501895.21
67392.0	33.40	-34.66	-37.07	234573.2	53.44	28.03	474.16	63343.57502587.09
67560.0	33.38	-34.66	-37.08	237443.4	53.61	28.19	474.62	63434.42503277.77
67728.0	33.36	-34.67	-37.10	240265.1	53.78	28.35	475.08	63524.57503967.27
67896.0	33.34	-34.68	-37.12	243038.8	53.95	28.50	475.53	63614.03504655.62
68064.0	33.32	-34.69	-37.14	245766.1	54.11	28.64	475.98	63702.82505342.84
68232.0	33.30	-34.69	-37.16	248447.3	54.27	28.79	476.42	63790.97506028.96
68400.0	33.28	-34.70	-37.18	251083.4	54.42	28.92	476.86	63878.49506713.99
68568.0	33.27	-34.71	-37.19	253675.1	54.58	29.06	477.28	63965.40507397.95
68592.0	33.26	-34.71	-37.20	254041.7	54.60	29.08	477.35	63977.77507495.58

TOTAL ENERGY INPUT BTU	=	0.197375E+11
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.63
SEASONAL ENERGY RATE BTU/HR	=	291585.01
TOTAL ENERGY INPUT GAL FUEL	=	140982.08
AVERAGE LB. WATER PER LB. FUEL	=	26.53
SEASONAL LB. WATER PER LB. FUEL	=	25.68
ENERGY FROM AIR TO ICE BTU	=	0.903625E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.813026E+09
TOTAL WATER WITHDRAWN GAL	=	2948273.99
SEASONAL WATER WITHDRAWN GAL	=	146010.52
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 9
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.00
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	68592.01

68736.0	33.20	-34.76	-37.21	248599.6	54.31	28.76	477.67	64116.94509009.57
68904.0	33.25	-34.82	-37.23	240504.9	53.88	28.27	478.05	64295.66510989.41
69072.0	33.31	-34.88	-37.25	232517.3	53.43	27.79	478.45	64476.83512971.87
69240.0	33.37	-34.94	-37.27	224653.9	52.98	27.31	478.86	64660.36514954.95
69408.0	33.43	-35.00	-37.29	216891.3	52.52	26.83	479.29	64846.56516941.63
69576.0	33.49	-35.06	-37.31	209254.5	52.06	26.35	479.73	65035.28518928.90
69744.0	33.56	-35.13	-37.33	201736.6	51.58	25.87	480.20	65226.68520917.75
69912.0	33.63	-35.19	-37.35	194346.6	51.10	25.39	480.68	65420.77522907.18
70080.0	33.71	-35.25	-37.37	187077.0	50.62	24.92	481.19	65617.73524898.14
70248.0	33.79	-35.32	-37.39	179912.6	50.12	24.44	481.71	65817.79526892.62
70416.0	33.87	-35.38	-37.41	172878.8	49.61	23.97	482.26	66020.85528887.62
70584.0	33.96	-35.45	-37.43	165968.8	49.10	23.49	482.84	66227.09530884.12
70752.0	34.06	-35.52	-37.46	159191.8	48.57	23.02	483.43	66436.55532881.09
70920.0	34.16	-35.58	-37.48	152540.4	48.04	22.55	484.06	66649.43534879.50
71088.0	34.27	-35.65	-37.50	145999.8	47.49	22.09	484.71	66866.03536881.33
71256.0	34.39	-35.72	-37.53	139587.5	46.93	21.62	485.39	67086.34538884.57
71424.0	34.51	-35.79	-37.55	133320.5	46.37	21.16	486.10	67310.35540887.17
71568.0	34.62	-35.85	-37.57	128056.6	45.87	20.77	486.74	67505.52542604.34

TOTAL ENERGY INPUT BTU	=	0.205481E+11
SEASONAL ENERGY INPUT BTU	=	0.810592E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.94
SEASONAL ENERGY RATE BTU/HR	=	272376.54
TOTAL ENERGY INPUT GAL FUEL	=	146772.02
AVERAGE LB. WATER PER LB. FUEL	=	26.45
SEASONAL LB. WATER PER LB. FUEL	=	24.34
ENERGY FROM AIR TO ICE BTU	=	0.944649E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.410244E+09
TOTAL WATER WITHDRAWN GAL	=	3194884.69
SEASONAL WATER WITHDRAWN GAL	=	246610.70
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 10
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	74.36
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	71568.00

71592.0	34.64	-35.86	-37.58	127184.5	45.78	20.70	486.85	67538.38542891.13
71760.0	34.68	-35.86	-37.60	131831.3	46.16	21.12	487.69	67660.59543598.05
71928.0	34.59	-35.86	-37.63	136437.8	46.52	21.52	488.51	67781.09544303.73
72096.0	34.50	-35.86	-37.65	140959.4	46.87	21.90	489.30	67899.62545007.45
72264.0	34.42	-35.87	-37.68	145397.4	47.21	22.26	490.07	68016.26545709.27
72432.0	34.34	-35.87	-37.70	149754.5	47.54	22.61	490.82	68131.13546409.26
72600.0	34.27	-35.87	-37.72	154032.2	47.85	22.95	491.55	68244.30547107.46
72768.0	34.21	-35.88	-37.75	158232.0	48.16	23.28	492.26	68355.87547803.91
72936.0	34.14	-35.88	-37.77	162355.6	48.46	23.59	492.95	68465.89548498.67
73104.0	34.09	-35.89	-37.79	166404.2	48.75	23.89	493.63	68574.44549191.77
73272.0	34.03	-35.89	-37.81	170380.3	49.04	24.18	494.28	68681.59549883.28
73440.0	33.98	-35.89	-37.83	174285.0	49.31	24.46	494.93	68787.40550573.21
73608.0	33.93	-35.90	-37.85	178119.8	49.58	24.73	495.55	68891.92551261.63
73776.0	33.88	-35.90	-37.88	181886.0	49.84	24.99	496.17	68995.20551948.55
73944.0	33.84	-35.91	-37.90	185584.7	50.09	25.24	496.77	69097.30552634.02
74112.0	33.80	-35.91	-37.92	189218.2	50.34	25.48	497.36	69198.26553318.08
74280.0	33.76	-35.92	-37.94	192787.2	50.58	25.72	497.94	69298.12554000.76

74448.0	33.72	-35.92	-37.96	196293.1	50.81	25.94	498.50	69396.92554682.09
74616.0	33.69	-35.93	-37.98	199737.1	51.04	26.16	499.06	69494.71555362.11
74784.0	33.65	-35.93	-38.00	203120.1	51.26	26.38	499.60	69591.51556040.84
74952.0	33.62	-35.94	-38.01	206444.1	51.48	26.58	500.13	69687.37556718.31
75120.0	33.59	-35.94	-38.03	209709.7	51.69	26.78	500.66	69782.32557394.56
75288.0	33.56	-35.95	-38.05	212918.2	51.89	26.98	501.17	69876.38558069.61
75456.0	33.53	-35.95	-38.07	216070.6	52.10	27.17	501.68	69969.59558743.48
75624.0	33.51	-35.96	-38.09	219167.6	52.29	27.35	502.18	70061.96559416.20
75792.0	33.48	-35.96	-38.11	222211.0	52.48	27.53	502.67	70153.54560087.81
75960.0	33.46	-35.97	-38.12	225201.4	52.67	27.70	503.15	70244.35560758.31
76128.0	33.43	-35.98	-38.14	228139.9	52.85	27.87	503.62	70334.40561427.74
76296.0	33.41	-35.98	-38.16	231027.3	53.03	28.03	504.09	70423.73562096.12
76464.0	33.39	-35.99	-38.18	233864.3	53.21	28.19	504.55	70512.34562763.45
76632.0	33.36	-35.99	-38.19	236652.5	53.38	28.34	505.00	70600.28563429.79
76800.0	33.34	-36.00	-38.21	239392.4	53.54	28.49	505.45	70687.55564095.14
76968.0	33.32	-36.01	-38.23	242084.9	53.71	28.64	505.89	70774.17564759.51
77136.0	33.31	-36.01	-38.24	244730.8	53.87	28.78	506.32	70860.16565422.94
77304.0	33.29	-36.02	-38.26	247330.6	54.02	28.92	506.75	70945.54566085.43
77352.0	33.28	-36.02	-38.26	248065.5	54.07	28.96	506.87	70969.83566274.55

TOTAL ENERGY INPUT BTU	=	0.222346E+11
SEASONAL ENERGY INPUT BTU	=	0.168653E+10
SEASONAL ENERGY INPUT GAL FUEL	=	12046.67
SEASONAL ENERGY RATE BTU/HR	=	291585.86
TOTAL ENERGY INPUT GAL FUEL	=	158818.69
AVERAGE LB. WATER PER LB. FUEL	=	26.40
SEASONAL LB. WATER PER LB. FUEL	=	25.80
ENERGY FROM AIR TO ICE BTU	=	0.102555E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.809045E+09
TOTAL WATER WITHDRAWN GAL	=	3340880.21
SEASONAL WATER WITHDRAWN GAL	=	145995.52
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

YEAR 10
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	73.02
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	77352.01

77472.0	33.21	-36.06	-38.27	243800.9	53.84	28.70	507.14	71083.09567490.62
77640.0	33.26	-36.11	-38.29	235686.3	53.40	28.20	507.52	71261.21569452.58
77808.0	33.32	-36.17	-38.31	227698.0	52.95	27.71	507.91	71441.64571414.86
77976.0	33.38	-36.22	-38.32	219813.1	52.49	27.22	508.32	71624.66573380.44
78144.0	33.45	-36.28	-38.34	212056.4	52.03	26.73	508.75	71810.15575346.33
78312.0	33.51	-36.33	-38.36	204421.1	51.56	26.24	509.19	71998.25577313.51
78480.0	33.59	-36.39	-38.38	196916.0	51.08	25.75	509.66	72188.98579280.96
78648.0	33.66	-36.45	-38.40	189533.5	50.60	25.26	510.14	72382.49581249.66
78816.0	33.74	-36.51	-38.42	182258.7	50.10	24.77	510.64	72579.05583221.58
78984.0	33.82	-36.57	-38.43	175117.1	49.60	24.29	511.17	72778.52585193.71
79152.0	33.91	-36.63	-38.45	168108.8	49.09	23.80	511.72	72981.00587166.04
79320.0	34.01	-36.69	-38.47	161227.8	48.57	23.32	512.29	73186.71589139.53
79488.0	34.11	-36.75	-38.49	154474.6	48.04	22.84	512.89	73395.74591114.17
79656.0	34.22	-36.81	-38.52	147834.2	47.49	22.36	513.52	73608.41593091.92
79824.0	34.33	-36.87	-38.54	141324.3	46.94	21.89	514.17	73824.69595070.76
79992.0	34.45	-36.93	-38.56	134961.8	46.38	21.41	514.86	74044.57597048.66

80160.0	34.58	-36.99	-38.58	128732.3	45.80	20.94	515.57	74268.37599027.60
80328.0	34.72	-37.06	-38.60	122636.7	45.21	20.47	516.33	74496.26601007.54
80328.0	34.72	-37.06	-38.60	122636.7	45.21	20.47	516.33	74496.26601007.54

TOTAL ENERGY INPUT BTU	=	0.230452E+11
SEASONAL ENERGY INPUT BTU	=	0.810597E+09
SEASONAL ENERGY INPUT GAL FUEL	=	5789.98
SEASONAL ENERGY RATE BTU/HR	=	272378.19
TOTAL ENERGY INPUT GAL FUEL	=	164608.67
AVERAGE LB. WATER PER LB. FUEL	=	26.33
SEASONAL LB. WATER PER LB. FUEL	=	24.45
ENERGY FROM AIR TO ICE BTU	=	0.106639E+11
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.408375E+09
TOTAL WATER WITHDRAWN GAL	=	3587475.91
SEASONAL WATER WITHDRAWN GAL	=	246595.71
TOTAL WATER LOSS GAL	=	34563.42
SEASONAL WATER LOSS GAL	=	0.00

TOTAL ENERGY INPUT BTU	=	0.230452E+11
TOTAL ENERGY INPUT GAL FUEL	=	164608.67
TOTAL ENERGY LOSS AIR TO ICE BTU	=	0.106639E+11

Case 12

ANTARCTIC PARABOLIC ICE RESEVOIR FORMATION

BOILER WATER TEMP DEG F = 124.00
 BOILER WATER FLOW RATE lbm/hr = 5033.00
 CONVECTIVE COEFFICIENT BTU/HR-FT2-F = 32.50
 INITIAL DRILL RADIUS FT = 1.50
 DEPTH TO TOP OF WATER AT START FT = 157.00
 INITIAL PARABOLIC WATER DIAMETER D FT = 4.24
 INITIAL PARABOLIC WATER HEIGHT HW FT = 10.00
 INITIAL WATER TEMP TW DEG F = 124.00
 INITIAL AIR TEMP TA DEG F = -60.00
 INITIAL ICE SURFACE TEMP TS DEG F = -60.00
 AMBIENT ICE TEMP DEG F = -60.00
 EFFECTIVE LATENT HEAT BTU/LB = 392.35
 TIME IN HRS, WATER VOL MW GALLONS, ICE AREA AI FT2, AIR VOL VA FT3

TIME	TW	TA	TS	MW	D	HW	HWB	AI	VA
0.0	124.00	-60.00	-60.00	527.5	4.24	10.00	167.00	1479.69	1109.77
24.0	88.17	-51.53	-56.96	2530.8	9.19	10.24	174.30	1703.72	1362.60
48.0	73.47	-48.01	-54.92	4404.0	11.67	11.03	178.42	1880.60	1649.00
72.0	66.21	-45.53	-53.27	6148.0	13.41	11.67	181.51	2038.04	1952.38
96.0	61.72	-43.63	-51.88	7793.6	14.76	12.20	184.06	2183.60	2266.90
120.0	58.60	-42.10	-50.70	9362.8	15.89	12.65	186.26	2320.67	2589.26
144.0	56.27	-40.84	-49.67	10871.5	16.86	13.06	188.22	2451.14	2917.26
168.0	54.45	-39.76	-48.77	12331.9	17.71	13.42	190.00	2576.21	3249.36
168.0	54.45	-39.76	-48.77	12331.9	17.71	13.42	190.00	2576.21	3249.36

TOTAL ENERGY INPUT BTU = 0.672036E+08
 SEASONAL ENERGY INPUT BTU = 0.672036E+08
 SEASONAL ENERGY INPUT GAL FUEL = 480.03
 SEASONAL ENERGY RATE BTU/HR = 400017.36
 TOTAL ENERGY INPUT GAL FUEL = 480.03
 AVERAGE LB. WATER PER LB. FUEL = 28.73
 SEASONAL LB. WATER PER LB. FUEL = 28.73
 ENERGY FROM AIR TO ICE BTU = 0.267174E+07
 SEASONAL ENERGY LOSS, AIR TO ICE BTU = 0.267174E+07
 TOTAL WATER WITHDRAWN GAL = 0.00
 SEASONAL WATER WITHDRAWN GAL = 0.00
 TOTAL WATER LOSS GAL = 6637.45
 SEASONAL WATER LOSS GAL = 6637.45

YEAR 1 STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr = 7549.50
 BOILER WATER TEMPERATURE DEG F = 133.92
 WATER WITHDRAWAL GAL/DAY = 0.00
 WITHDRAWAL FLOW RATE GAL/MIN = 15.00
 CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F = 32.50
 START WITHDRAWAL AT HOUR = 168.00

192.0	70.23	-36.34	-47.64	15748.3	19.30	14.42	192.76	2758.30	3720.25
360.0	52.33	-29.40	-41.50	42080.6	27.15	19.48	206.63	3911.17	7516.60
384.0	51.24	-28.78	-40.87	45704.4	27.93	19.99	208.06	4052.68	8065.73

TOTAL ENERGY INPUT BTU = 0.240004E+09
 SEASONAL ENERGY INPUT BTU = 0.172800E+09
 SEASONAL ENERGY INPUT GAL FUEL = 1234.29
 SEASONAL ENERGY RATE BTU/HR = 800000.93
 TOTAL ENERGY INPUT GAL FUEL = 1714.31
 AVERAGE LB. WATER PER LB. FUEL = 30.79

SEASONAL LB. WATER PER LB. FUEL	=	31.59
ENERGY FROM AIR TO ICE BTU	=	0.112432E+08
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.857146E+07
TOTAL WATER WITHDRAWN GAL	=	0.00
SEASONAL WATER WITHDRAWN GAL	=	0.00
TOTAL WATER LOSS GAL	=	20672.83
SEASONAL WATER LOSS GAL	=	14035.38

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	157.21
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	384.00

528.0	47.30	-26.25	-38.00	63856.2	31.46	22.02	215.22	4865.36	11623.03
696.0	44.56	-24.25	-35.75	85404.4	34.80	24.06	221.88	5690.21	15578.54
864.0	42.65	-22.71	-34.09	108221.9	37.70	25.98	227.38	6410.56	19265.14
1032.0	41.26	-21.45	-32.76	131815.0	40.27	27.74	232.08	7056.59	22756.04
1200.0	40.19	-20.36	-31.65	156323.9	42.60	29.40	236.18	7641.02	26041.55
1368.0	39.35	-19.39	-30.68	181666.5	44.74	30.97	239.83	8174.87	29138.63
1488.0	38.84	-18.76	-30.06	200208.0	46.17	32.04	242.20	8530.18	31247.95

TOTAL ENERGY INPUT BTU	=	0.109921E+10
SEASONAL ENERGY INPUT BTU	=	0.859205E+09
SEASONAL ENERGY INPUT GAL FUEL	=	6137.18
SEASONAL ENERGY RATE BTU/HR	=	778261.01
TOTAL ENERGY INPUT GAL FUEL	=	7851.49
AVERAGE LB. WATER PER LB. FUEL	=	33.73
SEASONAL LB. WATER PER LB. FUEL	=	34.55
ENERGY FROM AIR TO ICE BTU	=	0.937090E+08
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.824658E+08
TOTAL WATER WITHDRAWN GAL	=	26998.71
SEASONAL WATER WITHDRAWN GAL	=	26998.71
TOTAL WATER LOSS GAL	=	71691.79
SEASONAL WATER LOSS GAL	=	51018.96

YEAR 1
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	144.81
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT2-F	=	32.50
START WITHDRAWAL AT HOUR	=	1488.01

1536.0	33.38	-19.51	-29.88	202117.7	46.34	32.12	242.60	8605.14	31783.26
1704.0	33.09	-19.34	-29.41	199745.3	46.27	31.83	243.11	8758.76	33129.25
1872.0	33.10	-19.18	-29.03	197697.4	46.22	31.58	243.61	8905.98	34407.41
2040.0	33.11	-19.05	-28.72	196074.6	46.19	31.35	244.12	9048.91	35631.51
2208.0	33.12	-18.96	-28.45	194828.8	46.19	31.16	244.63	9187.84	36806.68
2376.0	33.13	-18.88	-28.23	193917.4	46.20	31.00	245.15	9323.07	37937.56
2544.0	33.13	-18.82	-28.04	193302.6	46.23	30.87	245.66	9454.87	39028.36
2712.0	33.14	-18.77	-27.88	192950.2	46.27	30.75	246.18	9583.49	40082.87
2880.0	33.14	-18.73	-27.73	192830.1	46.33	30.66	246.69	9709.17	41104.62
3048.0	33.14	-18.69	-27.60	192914.4	46.39	30.58	247.20	9832.14	42096.79

3216.0	33.13	-18.66	-27.49	193178.1	46.47	30.52	247.71	9952.61	43062.30
3384.0	33.13	-18.63	-27.38	193598.2	46.56	30.48	248.22	10070.76	44003.86
3552.0	33.13	-18.61	-27.29	194153.4	46.65	30.44	248.73	10186.79	44923.96
3720.0	33.12	-18.59	-27.20	194817.0	46.75	30.42	249.23	10300.96	45825.95
3888.0	33.12	-18.57	-27.12	195586.5	46.85	30.40	249.73	10413.28	46710.07
4056.0	33.11	-18.55	-27.05	196437.2	46.96	30.40	250.23	10523.99	47579.36
4224.0	33.10	-18.53	-26.98	197353.4	47.07	30.40	250.72	10633.24	48435.81
4392.0	33.10	-18.52	-26.92	198320.3	47.18	30.40	251.21	10741.20	49281.28
4560.0	33.09	-18.50	-26.86	199323.5	47.30	30.41	251.69	10848.01	50117.56
4728.0	33.08	-18.49	-26.80	200350.3	47.41	30.42	252.17	10953.82	50946.44
4896.0	33.08	-18.48	-26.75	201387.5	47.52	30.43	252.65	11058.77	51769.58
5064.0	33.07	-18.47	-26.70	202422.7	47.64	30.44	253.12	11163.01	52588.67
5232.0	33.06	-18.47	-26.65	203443.8	47.75	30.45	253.59	11266.68	53405.31
5400.0	33.06	-18.46	-26.61	204444.5	47.86	30.46	254.06	11369.86	54220.35
5568.0	33.05	-18.46	-26.57	205425.3	47.96	30.47	254.52	11472.56	55033.87
5736.0	33.04	-18.46	-26.53	206386.1	48.07	30.48	254.98	11574.79	55845.88
5904.0	33.04	-18.46	-26.49	207327.1	48.17	30.49	255.43	11676.56	56656.39
6072.0	33.03	-18.46	-26.46	208248.4	48.27	30.50	255.89	11777.87	57465.43
6240.0	33.02	-18.46	-26.43	209149.9	48.37	30.51	256.33	11878.75	58273.00
6408.0	33.02	-18.47	-26.40	210032.5	48.47	30.51	256.78	11979.18	59079.15
6576.0	33.01	-18.47	-26.37	210896.0	48.56	30.52	257.22	12079.19	59883.88
6744.0	33.01	-18.48	-26.34	211740.7	48.65	30.52	257.66	12178.78	60687.21
6912.0	33.00	-18.49	-26.32	212566.6	48.74	30.53	258.09	12277.96	61489.16
7080.0	32.99	-18.50	-26.29	213373.9	48.83	30.53	258.53	12376.73	62289.73
7248.0	32.99	-18.51	-26.27	214155.1	48.92	30.53	258.95	12475.19	63089.95
7272.0	32.99	-18.51	-26.27	214266.3	48.93	30.53	259.02	12489.21	63204.01

TOTAL ENERGY INPUT BTU	=	0.222387E+10
SEASONAL ENERGY INPUT BTU	=	0.112466E+10
SEASONAL ENERGY INPUT GAL FUEL	=	8033.30
SEASONAL ENERGY RATE BTU/HR	=	194443.94
TOTAL ENERGY INPUT GAL FUEL	=	15884.79
AVERAGE LB. WATER PER LB. FUEL	=	28.34
SEASONAL LB. WATER PER LB. FUEL	=	23.08
ENERGY FROM AIR TO ICE BTU	=	0.618889E+09
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.525180E+09
TOTAL WATER WITHDRAWN GAL	=	171606.79
SEASONAL WATER WITHDRAWN GAL	=	144608.08
TOTAL WATER LOSS GAL	=	97650.82
SEASONAL WATER LOSS GAL	=	25959.03

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	59.48
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	7272.00

7416.0	32.96	-18.69	-26.26	207519.0	48.58	30.01	259.35	12646.03	64804.63
7584.0	33.01	-18.93	-26.26	197918.0	48.04	29.26	259.74	12848.32	66888.22
7752.0	33.07	-19.19	-26.28	188388.8	47.49	28.51	260.15	13054.01	68975.78
7920.0	33.13	-19.47	-26.32	178948.6	46.91	27.74	260.58	13263.12	71065.37
8088.0	33.20	-19.75	-26.38	169600.2	46.32	26.97	261.04	13475.88	73157.05
8256.0	33.27	-20.05	-26.44	160337.7	45.71	26.19	261.51	13692.59	75251.87
8424.0	33.35	-20.37	-26.53	151155.8	45.07	25.39	262.02	13913.59	77350.88
8592.0	33.44	-20.69	-26.62	142065.9	44.40	24.59	262.55	14139.12	79453.17
8760.0	33.55	-21.03	-26.73	133071.0	43.71	23.77	263.12	14369.51	81558.84

8928.0	33.66	-21.38	-26.85	124183.6	42.98	22.94	263.72	14605.07	83667.02
9096.0	33.79	-21.74	-26.98	115399.8	42.22	22.10	264.36	14846.32	85778.81
9264.0	33.94	-22.12	-27.12	106716.4	41.41	21.24	265.05	15093.89	87895.31
9432.0	34.11	-22.51	-27.28	98138.9	40.56	20.36	265.78	15348.39	90016.69
9600.0	34.31	-22.92	-27.44	89689.0	39.65	19.47	266.57	15610.35	92141.12
9768.0	34.54	-23.33	-27.62	81373.8	38.68	18.56	267.43	15880.64	94268.79
9936.0	34.81	-23.77	-27.80	73184.7	37.64	17.62	268.37	16160.48	96401.86
10104.0	35.14	-24.22	-28.00	65146.0	36.52	16.67	269.40	16450.99	98538.56
10248.0	35.49	-24.62	-28.17	58355.9	35.47	15.82	270.36	16710.04	100376.40

TOTAL ENERGY INPUT BTU	=	0.276427E+10
SEASONAL ENERGY INPUT BTU	=	0.540397E+09
SEASONAL ENERGY INPUT GAL FUEL	=	3859.98
SEASONAL ENERGY RATE BTU/HR	=	181584.58
TOTAL ENERGY INPUT GAL FUEL	=	19744.77
AVERAGE LB. WATER PER LB. FUEL	=	28.17
SEASONAL LB. WATER PER LB. FUEL	=	27.45
ENERGY FROM AIR TO ICE BTU	=	0.857715E+09
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.238826E+09
TOTAL WATER WITHDRAWN GAL	=	418210.00
SEASONAL WATER WITHDRAWN GAL	=	246603.21
TOTAL WATER LOSS GAL	=	97650.82
SEASONAL WATER LOSS GAL	=	0.00

YEAR 2
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	61.98
WATER WITHDRAWAL GAL/DAY	=	600.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	10248.01

10272.0	35.55	-24.68	-28.20	57243.4	35.29	15.68	270.54	16754.08	100682.08
10440.0	35.53	-24.85	-28.41	59881.0	35.62	16.11	271.83	16923.45	101541.27
10608.0	35.38	-25.02	-28.60	62482.9	35.94	16.51	273.09	17089.94	102397.57
10776.0	35.25	-25.18	-28.79	65022.2	36.25	16.89	274.31	17253.53	103251.20
10944.0	35.13	-25.33	-28.97	67515.3	36.55	17.25	275.48	17414.19	104100.29
11112.0	35.02	-25.47	-29.14	69954.7	36.84	17.59	276.63	17572.17	104945.90
11280.0	34.92	-25.61	-29.31	72340.9	37.13	17.91	277.73	17727.61	105788.11
11448.0	34.83	-25.75	-29.47	74675.3	37.41	18.21	278.81	17880.64	106627.04
11616.0	34.74	-25.88	-29.63	76958.3	37.68	18.50	279.85	18031.39	107462.77
11784.0	34.66	-26.00	-29.77	79190.8	37.94	18.77	280.87	18179.97	108295.37
11952.0	34.59	-26.12	-29.92	81373.8	38.19	19.03	281.86	18326.48	109124.93
12120.0	34.52	-26.24	-30.06	83508.0	38.44	19.28	282.83	18471.02	109951.53
12288.0	34.46	-26.35	-30.19	85594.1	38.68	19.52	283.77	18613.67	110775.24
12456.0	34.40	-26.46	-30.32	87633.6	38.92	19.75	284.69	18754.54	111596.15
12624.0	34.34	-26.56	-30.44	89627.1	39.14	19.96	285.60	18893.69	112414.33
12792.0	34.29	-26.66	-30.56	91575.6	39.36	20.17	286.48	19031.20	113229.85
12960.0	34.24	-26.76	-30.67	93479.8	39.58	20.36	287.34	19167.13	114042.78
13128.0	34.19	-26.85	-30.78	95340.5	39.79	20.55	288.19	19301.56	114853.17
13296.0	34.14	-26.94	-30.89	97159.0	39.99	20.73	289.01	19434.55	115661.11
13464.0	34.10	-27.03	-31.00	98935.9	40.18	20.91	289.83	19566.14	116466.65
13632.0	34.06	-27.12	-31.10	100672.0	40.37	21.07	290.62	19696.41	117269.86
13800.0	34.02	-27.20	-31.19	102368.3	40.56	21.23	291.41	19825.39	118070.78
13968.0	33.99	-27.28	-31.29	104025.1	40.74	21.39	292.18	19953.14	118869.47
14136.0	33.95	-27.36	-31.38	105644.0	40.92	21.53	292.93	20079.70	119666.00
14304.0	33.92	-27.44	-31.47	107217.3	41.09	21.67	293.68	20205.22	120461.40
14472.0	33.89	-27.51	-31.55	108762.1	41.25	21.81	294.41	20329.54	121253.76

14640.0	33.86	-27.59	-31.63	110270.8	41.42	21.94	295.13	20452.79	122044.10
14808.0	33.83	-27.66	-31.72	111743.9	41.57	22.06	295.84	20575.02	122832.45
14976.0	33.80	-27.73	-31.79	113182.8	41.73	22.18	296.53	20696.26	123618.90
15144.0	33.78	-27.80	-31.87	114587.9	41.88	22.30	297.22	20816.54	124403.47
15312.0	33.75	-27.86	-31.94	115959.8	42.02	22.41	297.90	20935.90	125186.21
15480.0	33.73	-27.93	-32.02	117299.2	42.16	22.51	298.57	21054.36	125967.16
15648.0	33.70	-27.99	-32.08	118606.5	42.30	22.62	299.23	21171.96	126746.35
15816.0	33.68	-28.05	-32.15	119883.0	42.44	22.72	299.88	21288.72	127523.83
15984.0	33.66	-28.11	-32.22	121128.9	42.57	22.81	300.52	21404.67	128299.65
16032.0	33.65	-28.13	-32.24	121479.3	42.60	22.84	300.70	21437.65	128521.01

TOTAL ENERGY INPUT BTU	=	0.388862E+10
SEASONAL ENERGY INPUT BTU	=	0.112435E+10
SEASONAL ENERGY INPUT GAL FUEL	=	8031.08
SEASONAL ENERGY RATE BTU/HR	=	194390.05
TOTAL ENERGY INPUT GAL FUEL	=	27775.85
AVERAGE LB. WATER PER LB. FUEL	=	28.82
SEASONAL LB. WATER PER LB. FUEL	=	30.42
ENERGY FROM AIR TO ICE BTU	=	0.129105E+10
SEASONAL ENERGY LOSS, AIR TO ICE BTU	=	0.433340E+09
TOTAL WATER WITHDRAWN GAL	=	564213.01
SEASONAL WATER WITHDRAWN GAL	=	146003.02
TOTAL WATER LOSS GAL	=	97650.82
SEASONAL WATER LOSS GAL	=	0.00

YEAR 3
STANDBY OR WATER WITHDRAWAL

BOILER WATER FLOW RATE lbm/hr	=	7549.50
BOILER WATER TEMPERATURE DEG F	=	60.15
WATER WITHDRAWAL GAL/DAY	=	2000.00
WITHDRAWAL FLOW RATE GAL/MIN	=	15.00
CONVECTIVE COEFF AFTER R=30 FT BTU/HR-FT ² -F	=	32.50
START WITHDRAWAL AT HOUR	=	16032.00

16152.0	33.64	-28.28	-32.28	116419.2	42.17	22.34	301.12	21587.30	129810.55
16320.0	33.79	-28.53	-32.36	107302.6	41.33	21.44	301.73	21825.24	131878.02
16488.0	33.97	-28.78	-32.44	98339.4	40.44	20.51	302.39	22070.23	133949.38
16656.0	34.17	-29.05	-32.52	89536.3	39.51	19.57	303.11	22323.02	136024.80
16824.0	34.42	-29.32	-32.61	80891.7	38.51	18.61	303.89	22584.60	138105.42
16992.0	34.70	-29.61	-32.71	72405.2	37.43	17.63	304.76	22856.15	140192.42
17160.0	35.05	-29.91	-32.81	64093.3	36.27	16.62	305.72	23138.94	142285.02
17328.0	35.49	-30.22	-32.92	55965.6	35.00	15.59	306.79	23434.69	144383.42
17496.0	36.03	-30.55	-33.03	48041.9	33.61	14.52	308.00	23745.53	146486.94
17664.0	36.74	-30.89	-33.16	40326.9	32.04	13.40	309.39	24074.62	148596.83
17832.0	37.71	-31.26	-33.29	32827.9	30.26	12.24	311.02	24426.38	150714.38
18000.0	39.11	-31.65	-33.42	25562.8	28.17	11.00	312.98	24807.29	152839.94
18168.0	41.30	-32.07	-33.57	18568.0	25.62	9.65	315.42	25227.73	154971.83
18336.0	45.33	-32.54	-33.72	11867.2	22.32	8.13	318.70	25708.10	157110.23
18504.0	55.88	-33.09	-33.89	5460.7	17.33	6.21	323.90	26301.94	159256.49

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestion for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE March 1995		3. REPORT TYPE AND DATES COVERED	
4. TITLE AND SUBTITLE Thermal Design of an Antarctic Water Well				5. FUNDING NUMBERS	
6. AUTHORS Virgil J. Lunardini and John Rand					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Cold Regions Research and Engineering Laboratory 72 Lyme Road Hanover, N.H. 03755-1290				8. PERFORMING ORGANIZATION REPORT NUMBER Special Report 95-10	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of the Chief of Engineers Washington, D.C. 20314-1000				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. Available from NTIS, Springfield, Virginia 22161				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The thermal and mechanical aspects of a potable water reservoir, formed at depth in a permanent snowfield in Antarctica, are detailed. The thermal model can be used for preliminary design, to predict reservoir size and depth, water temperature and mass, and energy requirements as a function of time. Predictions are made for the South Pole environment, but the model is valid for other permanent snowfields. The reservoir characteristics are influenced by the rate and timing of potable water removal during the lifetime of the reservoir.					
14. SUBJECT TERMS Energy requirements Firn/ice heat loss Ice cap facilities Ice melt Polar utilities Water reservoir				15. NUMBER OF PAGES 104	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED		18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED		19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	
				20. LIMITATION OF ABSTRACT UL	